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Habitat characteristic of suckermouth armored catfish *Pterygoplichthys pardalis* in ciliwung river, indonesia

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Abstract
The characteristics of habitat will affect the survival of organisms in an ecosystem including for suckermouth armored catfish *Pterygoplichthys pardalis* in Ciliwung River Indonesia. There is still no information that explains the suitable habitats for feeding, spawning and breeding sites of *P. pardalis* in the Ciliwung. The purpose of this study is to identify the habitat characteristics for feeding, spawning, and growing of *P. pardalis* in the Ciliwung. The results shows that the characteristics of the feeding habitats for *P. pardalis* in Ciliwung includes; temperatures of 28ºC-29ºC, light intensity of 1,12-7,74 Klux, depth of 50–148 cm, turbidity of 18,13–42,39 FTU, current velocity 0,4-2,1 m/s, BOD5 3,8-5,7 mg/l, pH 6,5-6,9 with a phosphate value of 0,05-0,1 ppm and ammonia 0,6 to 4,6 ppm. The characteristics of spawning habitats around *P. pardalis'* nesting burrows are at temperatures 27,9–28,3ºC, DO 6,3–6,7 mg/L, pH 6,5–7,5 with a TDS value of 0,098-0,222 mg/L, the turbidity of 6,80-18,88 FTU and substrate measuring of 0.062-0.004 mm in the form of mud particles. The type of vegetation that is often found in the *Eupatorium triplinerve* (IVI = 0,469), *Cynodon dactylon* (IVI = 0,550) and *Pennisetum purpureum* (IVI = 0,236).

Keywords: *Pterygoplichthys pardalis,* ciliwung river, indonesia, feeding habitat. spawning habitat

1. Introduction
Freshwater is an important habitat for many species of fish, including *Pterygoplichthys pardalis.* One of the habitats that support *P. pardalis* life in Jakarta is the Ciliwung River. Ciliwung River is one of the rivers in Indonesia originating from the base of Pangrango Mountain, West Java. The river flows towards Jakarta through Bogor Regency, Bogor City, Depok City and ends in the Jakarta Bay's estuary. The length of the Ciliwung river from the upstream to the estuary on the coast of the Jakarta bay in North Jakarta ± 117 km, with an area of the Ciliwung River flow of 347 km2, which is bounded by the Cisadane watershed in the west and the Citarum watershed in the east. The upper part of the Ciliwung River flows covering an area of 146 km2 is a mountainous area with an elevation of 300-3000 above sea level (asl). The upstream part starts in Tugu Village and flows to East Bogor District [1]. The central part of the Ciliwung River covering an area of 94 km2 is a bumpy and hilly area with an elevation of 100-300 asl. Furthermore, the downstream part of the Ciliwung River flow covering an area of 82 km2 is a lowland with sloping topography and elevations between 0-100 asl [2].
There are only one species of suckermouth armored catfish in the Ciliwung River, the species is *P. pardalis* [3, 4]. A literature search conducted in 1910 provided information that 187 species of fish lived in the Ciliwung River flow area. However, in 2009 there was a decline in the diversity of fish species until only 20 species include the other 5 alien species than began to be discovered since 1970. The decline in fish species diversity in the Ciliwung River was recorded at 92.5% in 2010, one of the causes was the presence of *P. pardalis* in the river [5, 6].
P. pardalis is a freshwater fish originating from the Amazon River and entered various countries through the ornamental fish trade [7]. Suckermouth armored catfishes originating from South America is one of the popular pets. This is due to the fish having an attractive appearance and is used to clean algae [8]. In Indonesia, this fish is called 'broom fish', because it feeds on the remains of feed, algae, moss, and the remains of dead biota in waters. *P. pardalis* can grow up to 60 cm [9].
P. pardalis can be found in narrow streams in mountains, river mouths, even in waters with high levels of pollution [10]. The existence of *P. pardalis* can be known from the nesting

burrows that appear in the form of a set along the slopes of the Ciliwung River. The nesting burrow serves as a place for laying fish eggs [11]. The high number of plecos population in polluted waters shows that plecos fish can adapt to the polluted water environment and is having an important role in controlling the abundance of algae. The density of plecos fish in the Ciliwung River is high, allowing a high abundance of algae which is also characterized by high turbidity values [12] [13].

For some people who live around the Ciliwung River, *P. pardalis* is used as a food source that can be processed into several food products. Examples of products using this flesh are dumplings, meatballs, fish cakes and chips that have economic value [14, 15]. For the communities that live in Ciliwung River water bank, the utilization of food products made from *P. pardalis* flesh in the Ciliwung River can be an alternative livelihood and provide additional income.

The great economic potential resulting from the existence of *P. pardalis* in the Ciliwung River requires an effort to support increasing economic value while maintaining and protecting the preservation of fish species in the Ciliwung River. The aims of this study to identify the characteristics of suitable habitat for feeding, spawning, growing, and developing for *P. pardalis* in the Ciliwung River, as well as the type of vegetation contained in the spawning habitat. The results of this study are expected to support efforts to preserve the diversity of fish species and *P. pardalis* management strategies in the Ciliwung River.

2. Material and methods

2.1. P. pardalis Sampling at the Ciliwung River Stream Area

Sampling has been done along the Ciliwung River based on the planned stations. The samples were taken using three repetitions in different weeks. There were three observations and sampling stations from each coordinate, St1 station with S 06.244053°-E 106.862654º, St2 stations with S 06.25830°-E 106.86040° and St3 station with S 06.28599°-E 106.84717° (Figure 1). The coordinates were determined using *a purposive sampling* method in consideration that samples collection Ciliwung River is regarded as a highly polluted area.

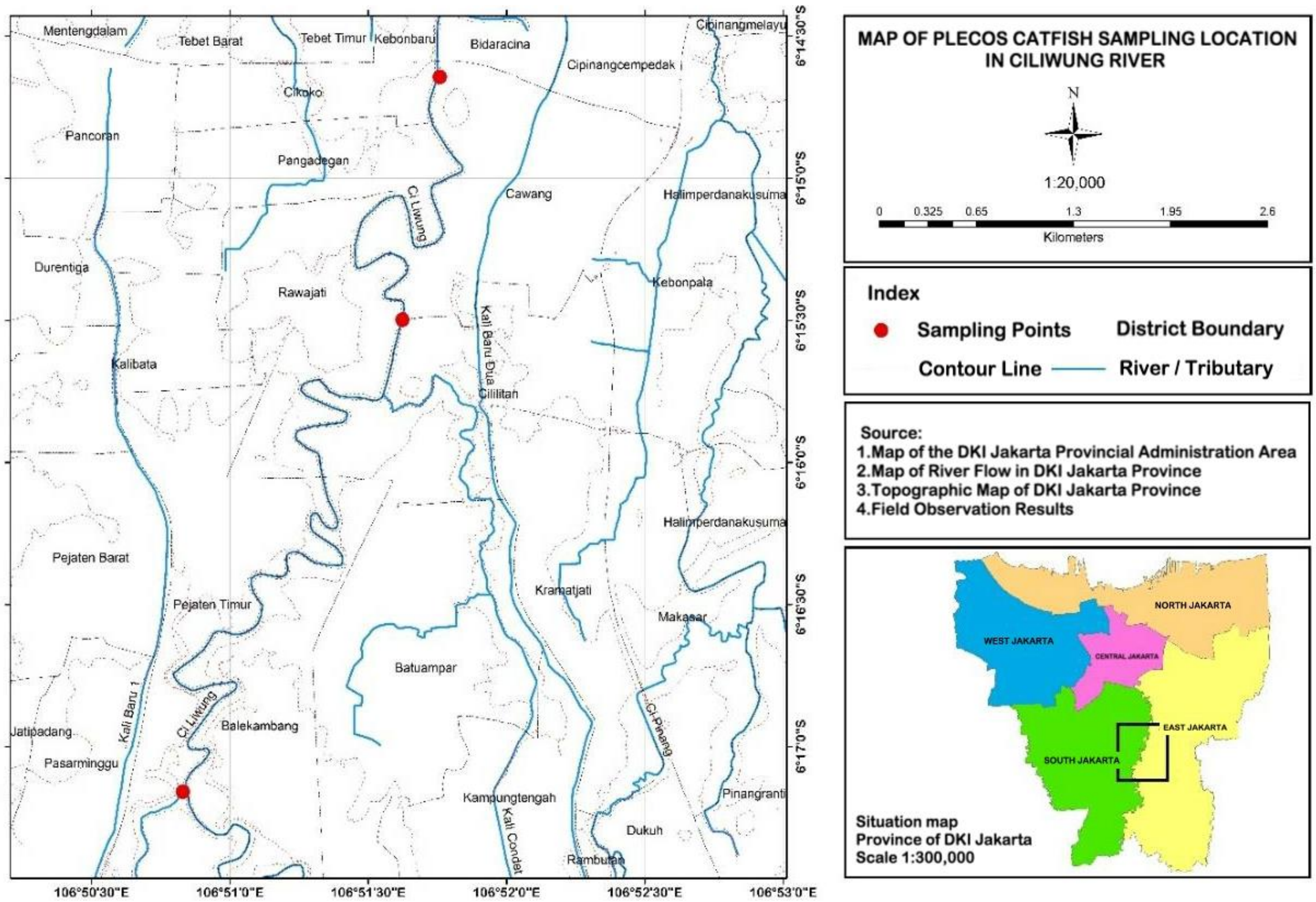

Fig 1: Three observations and sampling stations along Ciliwung River, Indonesia

The sample collection used a purposive sampling method, a technique to decide samples

2.2. Measurement of river water quality

Determination of sampling points for observing environmental parameters was done through data collection of water quality three times with each distance between the replication points ± 5 meters. The measured water quality data are rainfall, temperature, current velocity, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), river depth, brightness, turbidity, measurement methods and tools (Table 1). Phosphate (PO_4) and Ammonia (NH_3) measurements were carried out at the Center for Integrated Laboratory of the Faculty of Science and Technology of UIN Syarif Hidayatullah Jakarta.

Table 1: Water quality data collection methods in the Ciliwung River Watershed

Parameter	Physics Unit	Tools and Methods of sampling
Rainfall	mm	Secondary data from meteorological stations
Temperature	ºC	Thermometer
Current velocity	m/second	*Current Meter*
River depth	cm	Scale sticks
Clearness	%	*Secchi disk*
Turbidity	NTU	Turbidimeter
pH	-	pH meter
Dissolved oxygen (DO)	mg/L	BOD meter
Biochemical oxygen demand (BOD)	mg/L	COD meter
Phosphate	mg/L	*spectrophotometer Uv-Vis*
Ammonia	mg/L	*spectrophotometer Uv-Vis*

2.3. Measurement of *P. pardalis* feeding habitat in the Ciliwung River

Measurement of feeding habitat data was carried out at three stations (St1, St2, and St3). The data from those stations was collected five times repeated around the banks of the Ciliwung River. Quantitative assessment of feeding habitat includes conditions in the environment around the waters (condition of physical and chemical parameters of the waters) in the Ciliwung River [16]

2.4. Measurement of *P. pardalis* spawning habitat in the Ciliwung River

Spawning habitat data measurements were carried out at two stations (A and B), each of which was repeated five times around the banks of the Ciliwung River. Quantitative assessment for spawning habitats including conditions in the environment around the waters (condition of physical and chemical parameters of the waters) and measuring NBSW (Nesting Burrow Surface Width), NBSL (Nesting Burrow Surface Length), depth, height, and substrate was carried out for data collection on *P. pardalis* spawning habitat in the Ciliwung River [16].

2.5. Determination of the point and sampling of riparian vegetation

The determination of vegetation points was using a purposive sampling method. In each plot, a rectangular shape was made and samples were taken. Riparian vegetation was observed by direct observation along 3 meters in width depending on riparian width in each spawning habitat plot [1]. Data taken included plant names (identification), the number of individuals found and data analysis in the form of IVI (Important Value Index).

2.6. Important value index of riparian vegetation in ciliwung river watershed

The important value index is a quantitative parameter that can be used to express the level of dominance (level of control) of species in a plant community. Important value index can be written with the formula Important Value Index (IVI) = FR + DR (for seedling, sapling, and non-tree plants) [17]:

IVI = FR + DR

Note:

IVI = important value index

FR = relative frequency

KR = relative density

3. Results

Ciliwung river water quality

The measurement results of the physical and chemical parameters of water quality at the three locations show habitat characteristics for *P. pardalis* growth and feeding in the Ciliwung River. The feeding habitat characteristics of *P. pardalis* in the Ciliwung River flow area are the temperature with a range of normal values, the light intensity of 1,12-7,74 Klux, depth of 50–148 cm, turbidity of 18,13–42,39 FTU, current velocity of 0,4-2,1 m/s, BOD5 3,8–5,7 mg/l, pH 6,5–6,9 with a phosphate value of 0,05–0,1 ppm and ammonia from 0,6 to 4,6 ppm. The current velocity in the Ciliwung River at the time of measurement shows the value varies at each station. Stations 1 and 3 have strong current velocity (station 1 at 5 m/s and station 3 at 2,1 m/s). Station 2 has a weak current velocity of 0,4 m/s (Table 2).

Table 2: Physical and chemical quality conditions of *P. pardalis* feeding habitat in the Ciliwung River

Physical factors of the waters	Stations		
	1	2	3
Temperature (°C)	28,1 ± 1,19	28,5 ± 0,4	28,4 ± 1,16
Light Intensity (Klux)	3,69 ± 0,35	1,12 ± 0,51	7,74 ± 0,65
Depth (cm)	148 ± 0	50 ± 4,25	130 ± 43,5
Turbidity (FTU)	29,35 ± 4,01	42,39 ± 2,07	18,13 ± 8,49
Flow velocity (m/s)	1,5 ± 0,86	0,4 ± 0,28	2,1 ± 1,60
pH	6,5 ± 0,66	6,7 ± 0,37	6,9 ± 0,1
Biochemical Oxygen Demand (mg/L)	5,7 ± 0,93	3,8 ± 2,29	4,9 ± 1,37
Phosphate (ppm)	0,05 ± 0,01	0,04 ± 0,001	0,1 ± 0,012
Ammonia (ppm)	0,6 ± 0,15	2,7 ± 0,05	4,6 ± 0,95
Dissolved Oxygen (mg/L)	5,93 ± 0,92	4,66 ± 1,81	5,23 ± 1,50

The turbidity value is inversely proportional to the value of dissolved oxygen levels. The value of water turbidity is an illustration of the number of materials suspended in the waters including, clay, dust, plankton, and organisms. The value of clearness is directly proportional to turbidity due to a large number of suspended solids due to domestic waste and activities in the Ciliwung River. The high turbidity value between 18,13–42,39 FTU in all three locations was caused by the accumulation of organic material from residential and industrial activities around the riverbank (Table 2).

The degree of acidity (pH) is a value to determine the acidity or basicity of waters. The results of the pH measurement of the Ciliwung River waters indicate that a pH value of 6,5-6,9 in the water still supports the life of plecos fish for growth and food.

The lowest BOD_5 concentration was found at the second station which was 3,8 m/L (Table 2). The first station had a higher BOD_5 value of 5,7 mg/l compared to the BOD_5 value of the third station which is 4,9 mg/l (Table 2). This condition resulted in a higher density of plecos at the first station with a value of 58 individuals/m^2 compared to the total density of plecos at the third station with a value of 36 individuals/m^2

Measurement of phosphate concentration values obtained in this study indicates that the waters of the Ciliwung River do not exceed the recommended phosphate concentration values for rivers and waters (ranging from 0,04-0,1 ppm). The results of the calculation of the concentration of ammonia in the waters of the Ciliwung River showed quite high values, which ranged from 0,6 to 4,6 mg/L (Table 2).

3.1. *P. pardalis* habitat characteristic in the Ciliwung River

The characteristics of *P. pardalis* nesting burrows found on the slopes of the Ciliwung River area, the nesting burrow surface width is 18-38 cm, the depth is 42-122 cm, the nesting burrows surface length is 10-22 cm, the height is 50-130 cm and the intensity of light on the surface of the nesting burrows is 0,95-4,51 (Table 3).

Table 3: Spawning habitat characteristics of *P. pardalis* in Ciliwung River

Repetition	NBSW (cm)	Depth (cm)	NBSL (cm)	Height (cm)	Light Intensity (Klux)
1	30	102	15	120	1,15
2	23	42	14	100	1,80
3	20	122	22	130	4,29
4	18	107	10	80	4,51
5	21	52	14	50	3,66
6	22	55	11	100	2,31
7	38	57	10	95	1,44
8	28	89	17	100	2,91
9	18	108	15	95	1,80
10	22	38	13	85	0,95
Average	24	77.2	14.1	95.5	2,48

Note:
NBSW: The width size of the nesting burrow surface
Depth: The size from the nesting burrow surface to the end of the Nesting Burrow
NBSL: The length size of the nesting burrow surface
Height: The depth of the nesting burrows from the river water height

P. pardalis in Ciliwung River has a specific spawning habitat such as the physical and chemical conditions around the *P. pardalis* nesting burrows, namely temperatures ranging from 27,9–28,3ºC, DO 6,3–6,7 mg/L, pH 6,5–7,5 with TDS value of 0,098-0,222 mg/L, the turbidity of 6,80-18,88 FTU and substrates measuring 0,062-0,004 mm in the form of mud particles.

The riparian vegetation structure measured by the *P. pardalis* capture location shows the types of vegetation that are often found are *Eupatorium triplinerve* (IVI value = 0,469), *Cynodon dactylon* (IVI value = 0,550) and *Pennisetum purpureum* (IVI value = 0,236) (Table 4).

Table 4: The structure of riparian vegetation in the three *P. pardalis* spawning sites around the Ciliwung River

Station	Latin name	Localized/Common Name	Number of Individual	IVI
1	*Eupatorium triplinerve*	Daun panahan (Ayapana)	288	0.469
	Acalypha indica	Anting-anting (Indian Acalypha)	3	0.067
	Amaranthus spinosus	Bayam duri (spiny amaranth)	5	0.070
	sp 1	NA	3	0.067
	Ludwigia hyssopifolia	Cacabean (Seedbox)	5	0.070
	Cynodon dactylon	Rumput kawat (Bermuda grass)	210	0.550
	Penisetum purpureum	Rumput gajah (elephant grass)	6	0.236
2	*Artocarpus communis*	Kluwih (Breadfruit)	1	0.064
	Penisetum purpureum	Rumput gajah (elephant grass)	73	0.236
	Peperomia pellucida	Tumpangan air (pepper elder)	1	0.064
	Coleus amboinicuslour	Torbangun (Cuban oregano)	3	0.067
	Althernanthera sessilis	Daun tolod (dwarf copperleaf)	4	0.068
3	*Cynodon dactylon*	Rumput kawat (Bermuda grass)	91	0.550
	Chromolaena Odorata	Krinyuh (Siam weed)	6	0.071
	Colocasia esculenta	Talas (Taro)	9	0.075
	Pterygota alata	Pterigota (Pterygota)	1	0.064

4. Discussion

P. pardalis is an invasive species distributed in freshwater in Indonesia including, Ciliwung River that flows from Bogor to the Jakarta gulf. They bear a wide range of adaptation, hence causing population growth and creating larger threats to Ciliwung River. P. pardalis requires certain environmental conditions for growth and survival. Aquatic conditions that are habitat for P. pardalis are characterized by shallow waters, the substrate in the form of mud, slow current velocity, warm temperature (21-29ºC), DO 3 ppt (polluted), pH (7±1) and waters with eutrophic conditions or hypoxic [18]. Although *P. pardalis* can adapt to environments that are not quite proper of course there are certain limitations.

Previous research suggests that *P. pardalis* prefers warmer waters due to higher chances of food and invasion whereas in extreme (dry/cold) weather *P. pardalis* will occupy nesting burrows in river slopes [19]. The water temperature quality for *P. pardalis* has a warmer range between 21-29ºC [11]. In these conditions, *P. pardalis* will reproduce to coincide with the amount of phytoplankton available in the waters. Phytoplankton at a temperature of 20-30ºC is an optimal condition to be able to grow in water [20].

The current velocity from a body of water can also determine the spread of organisms that live in freshwater [21]. The stronger the current velocity, the more plecos will spread and affect population density in all three locations.

Concentration based on the results of BOD_5 measurements at the three Ciliwung River locations shows that pollution levels are still low and can be categorized as good waters. BOD_5 values of good waters for biota range from 0-10 mg/L [22]. The greater concentration of BOD_5 indicates that the water has been polluted.

Oxygen is a very important compound for the life of an organism, especially for respiratory and metabolic processes. DO levels that are good for fish growth are above 5 mg/L [23]. The low DO value at the second station with a value of 4,66 mg/l can be caused by the high turbidity value of 42,39 FTU entering the waters so that most of the oxygen is consumed by microorganisms in the process of metabolizing organic matter (Table 2). Dissolved oxygen will decrease if a lot of waste, especially organic waste, enters the waters [24]. This is because the oxygen is used by anaerobic bacteria in the process of breaking down organic materials from waste that pollute the waters.

According to Yossa & Araujo-lima's research, plecos can live in waters with low oxygen content and high organic matter content because they can take oxygen from the air and have the main food type in the form of detritus [25]. Besides, the ideal pH for freshwater biota life is between 6,8-8,5 [26]. Very low and very high pH values cause the solubility of metals in the water so that it is toxic to aquatic organisms.

Measurement of phosphate concentration values obtained in this study indicates that the waters of the Ciliwung River do not exceed the recommended phosphate concentration values for rivers and waters (ranging from 0,04-0,1 ppm). The results of the calculation of the concentration of ammonia in the waters of the Ciliwung River showed quite high values, which ranged from 0,6 to 4,6 mg/L (Table 2). This is consistent with research conducted by Anhwange that states that the maximum recommended phosphate level for rivers and waters that have been reported is 0,1 mg/L [27]. Phosphate compounds in water come from natural sources such as soil erosion, animal waste and weathering and destruction of organic matter and phosphate minerals [28]. Besides naturally and seeing the conditions around the research location in an industrial area, the source of phosphate in the waters of the Ciliwung River is contentedly sourced from the results of human activities, such as domestic waste disposal and other activities as well as water runoff from agricultural activities or community plantations based on phosphorus.

Pescod recommends that the ammonia content in water should not be more than 1 mg/L so that the fish life becomes normal and the waters are not polluted [29]. The high concentration of ammonia in the three locations was due to the people living on the banks of the Ciliwung River, carrying out the Public Bathing, Washing, and Toilet activities directly to the river. Besides, there is a household waste disposal near the research location.

Based on the previous research, the excavation and maintenance of burrows by certain loricariid catfish species is rather unique among primary freshwater fishes. The complex behavior of creating and maintaining burrows by *Pterygoplichthys* and certain other loricariids is most similar to that of several marine fishes. As with *Pterygoplichthys*, their burrows are also generally used for spawning and nesting habitat [30]

The existence of *P. pardalis* in the Ciliwung River can be known from the nesting burrows that are seen in the form of a set along the riverbank slopes. The burrows are reportedly excavated and maintained by adult males. Burrows typically occurring aggregates with individual colonies consisting of few to perhaps dozens of burrows [30]. The nesting burrow serves as a place for laying fish eggs [11]. One important aspect that supports the success of fish spawning is the spawning habitat. This is because the sustainability of a fish species in its natural habitat is closely related to the success of the fish in spawning activities [31]. The spawning strategy possessed by *P. pardalis* is strongly influenced by the size of the nesting burrow surface width, nesting burrow surface length, depth, height and, light intensity.

The nesting burrows found along the slope of the Ciliwung River has the shape of a cave in the water and has one nesting burrow surface. According to the Lienart el al, burrows dug by *Pterygoplichthys* spp were typically found along sections of exposed, steep banks contiguous to forest, agricultural fields or cattle pastures [32].

The results of the nesting burrow's surface width and nesting burrows's surface length measurement are influenced by the size of *P. pardalis*. The fish will make a nesting burrow around the slope of the river following body size which is generally capable of reaching sizes > 40 cm in two years [11] [30]. The depth and height of the *P. pardalis* nesting burrows are influenced by light entering those nesting burrows. The higher the light intensity, the higher the nesting burrows depth. High depth will reduce the light entering the nesting burrow so that *P. pardalis* will do the spawning if there is a low value of the light. Nico *et al.* recorded all of most burrows of *Pterygoplichthys* spp. Concentrated within one meter depth of the river bank, suggesting low depth preference by these fishes [30, 33]

The type of spawning carried out by *P. pardalis* on the slope of the Ciliwung River nesting burrows is spawning on the type of mud or clay substrate with water temperatures ranging from 27,9-28,3ºC. The making of spawning nesting burrow by adult *P. pardalis* was carried out by excavation until the eggs are protected by biotic and abiotic conditions in the waters. Hoover's results explained that the *Pterygoplichthys sp* spawning nesting burrows were found on soil substrate types containing almost no gravel > 2 mm, rough sand (0,42-2,0 mm), fine sand (0,15-0,25 mm), as well as dust and clay (<0,074 mm) [34].

One important role of the riparian vegetation for the existence of fish populations is as a place for shelter, foraging, and mating. *Cynodon dactylon* and *Pennisetum purpureum* and other species play important roles in fulfilling the food of *P. pardalis* which is known to consume amorphously, periphyton, plant, and macroinvertebrate detritus [35, 20]. According to Flecker's research, how *Pterygoplichthys sp* eat is by grazing algae that are attached to the surface of rocks, wood, aquatic vegetation, sediments, and occasional animals

[36]. *P. pardalis* also eats detritus, sediments, and wood [37].

Riparian vegetation is one of the factors that living things can survive and obtain food. Riparian vegetation is an important source of organic material for aquatic organisms. Vegetation parts such as fruits, seeds, flowers and leaves that fall into the river become an allochthonous organic source that is very necessary for the productivity of river fisheries [38].

Riparian vegetation is also very much needed by animals as a place to seek protection, mating and spawning [39]. Riparian vegetation can absorb dissolved solids carried by surface water. The roots of riparian vegetation can bind the dissolved solids so that the river water looks clear. Soil particles captured by riparian vegetation prevent sedimentation in rivers. This is very beneficial for animals such as fish that like the not-muddy riverbed [40].

The presence of riparian vegetation can reduce light entering the river. Light becomes a limiting factor for the growth of these photosynthetic organisms. If the light is lacking due to the presence of riparian vegetation then the growth of photosynthetic organisms can be controlled. However, if there is too much light then the growth of the organism will be very fast [40].

5. Conclusion

The characteristics of *P. pardalis* feeding habitats in the Ciliwung River flow area include temperatures with a range of normal values (28-29 degrees celsius), the light intensity of 1,12-7,74 Klux, depth of 50–148 cm, turbidity of 18,13–42,39 FTU, current velocity of 0,4-2,1 m/s, BOD5 3,8–5,7 mg/l, pH 6,5–6,9 with phosphate values of 0,05 –0,1 ppm and ammonia from 0,6 to 4,6 ppm. The characteristics of spawning habitats around *P. pardalis* spawning nesting burrows in the Ciliwung River include temperatures ranging from 27,9–28,3ºC, DO 6,3–6,7 mg/L, pH 6,5–7,5 with a TDS value of 0,098-0,222 mg/L, the turbidity of 6,80-18,88 FTU and substrate measuring 0.062-0.004 mm in the form of mud particles, with the type of vegetation that is often found in the *Eupatorium triplinerve* type (INP = 0,469), *Cynodon dactylon* (INP value = 0,550) and *Pennisetum purpureum* (INP value = 0,236).

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