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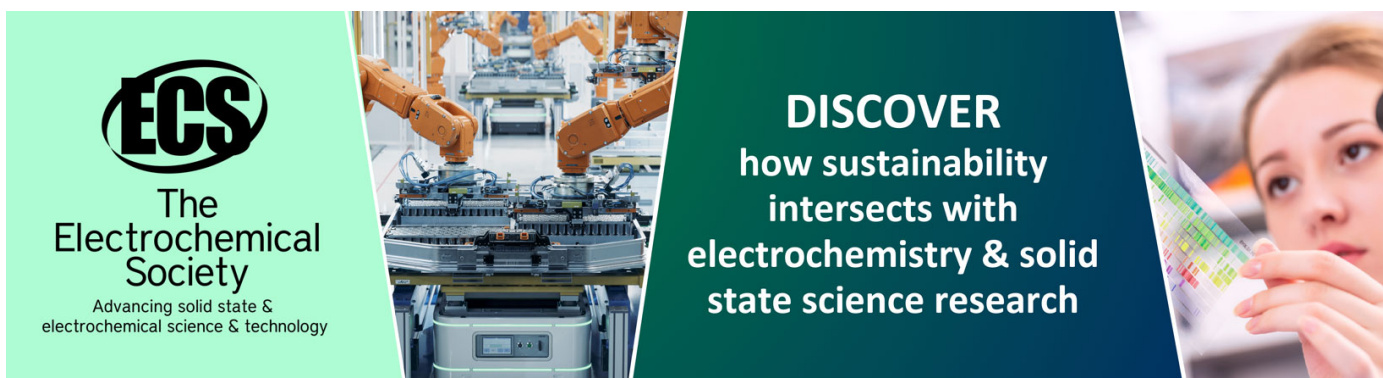
Invaders of Langat River: Introduction of varied vermiculated sailfin catfish, *Pterygoplichthys* *disjunctivus*

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Invaders of Langat River: Introduction of varied vermiculated sailfin catfish, *Pterygoplichthys disjunctivus*

S P Anand Prakash¹, N A Mohamed¹, M N A Azmai², A Abu Bakar³, R Othman¹ and I F Abdul Ghani¹

¹ Department of Science and Biotechnology, Faculty of Engineering and Life Sciences University Selangor, Bestari Jaya Campus, 45600, Bestari Jaya, Selangor, Malaysia

² Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400, UPM Serdang, Selangor, Malaysia

³ Department of biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris (UPSI), 35900, Tanjung Malim, Perak, Malaysia

E-mail: intanfaraha@unisel.edu.my

Abstract Globally and locally, invasive aquatic species pose a major threat towards aquatic ecosystems. Among the most successful of these aquatic invaders in Malaysian freshwater river systems is the vermiculated sailfin catfish or *Pterygoplichthys disjunctivus*. The study is conducted in Langat River, a subsidiary of the Selangor River basin which flows through the capital and high population density areas of the country. The impact of the species can be seen through its overpopulation and high density in the river due to the absence of natural predators and extremely high fecundity. This study provides the first report on the occurrence of introduced vermiculated sailfin catfish, *P. disjunctivus*, from Langat River, where the *P. pardalis* had been previously reported. In this study, random sampling exercises were conducted by using gill nets in a stretch of the Langat River. Out of 24 samples of *Pterygoplichthys* obtained, 11 were of *P. pardalis*. This was further confirmed by the morphometric and meristic characters as well as the patterns on the fish. Furthermore, during the sampling, we also described a new body pattern *Pterygoplichthys*, which does not fit both *P. pardalis* and *P. disjunctivus* entirely. The new body pattern of *Pterygoplichthys*, could be the result of hybridization between both species or variation patterns within the same species. However, a deeper study is necessary to be conducted to confirm this claim.

1. Introduction

The aquatic ecosystem of Malaysia hosts a large number of native fish that cannot be found in other parts of the world. This ecosystem, however, is currently being threatened by the presence of other fish species that came from outside of the country. The invasion of the aquatic ecosystem of Malaysia is widely recognized as the effect of human intervention in introducing species that are showing a threat to biodiversity. Among the many invasive species that are currently roaming the water of Malaysia, the vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*) is one of the most commonly found. This species is considered highly popular in the aquarium fish trade as it is used to control the algae build-up in an aquarium, in addition to its unique body pattern [1,2].

Pterygoplichthys belong to the *Loricariidae* family, comprising over 600 species. They are characterized by possessing a ventral mouth and large bony plates. In addition, the *Pterygoplichthys*



species can be identified by having 10 or more dorsal fins and distinguishing body patterns on its ventral side. *Pterygoplichthys* is often mistaken for *Hypostomus*, another genus in the *Loricariidae* family but can be differentiated by *Hypostomus spp*, which only has 7 dorsal fins. There are currently two *Pterygoplichthys* species that can be found in Malaysia, which are *P. pardalis* and *P. disjunctivus* (Hasyimah et al., 2013).

Originating from the Amazon River, *P. disjunctivus* made its way into the country as a result of the ornamental fish trade and aquarium enthusiast that released the fish when it became too big for the aquarium. The species is reported as a hardy fish as it can easily adapt to our local environment besides being able to tolerate a wide range of habitat conditions making it a naturally successful invader to our aquatic ecosystem. The species have also been reported to cause several ecological impacts in its introduction to its non-native habitats. The impact includes the disturbance to the local food chain by competition with local fish as well as destroying and causing erosion to the riverbank structure by its burrowing habits. The burrowing in the riverbanks also causes the increase of water turbidity of the effected river [3].

In Malaysia, the presence of *Pterygoplichthys* have been detected and sighted with report as early as the 1990 in Johor [4]. Since then, the species have been reported causing a few problems and effecting the biodiversity of our local aquatic environment. The spread of the invasive species needs to be obtained in order to contain the effect of the alien species. The following study identifies the presence of *P. disjunctivus* in the Langat River with special notes on the new body patterns of the species that suggest hybridization or perhaps a variation within the species.

2. Materials and methods

The study was initiated and carried out at the Langat River, a tributary of the Selangor River Basin which is located at Bangi near the Universiti Kebangsaan Malaysia campus with the coordinates of 2.9244146, 101.7644024.

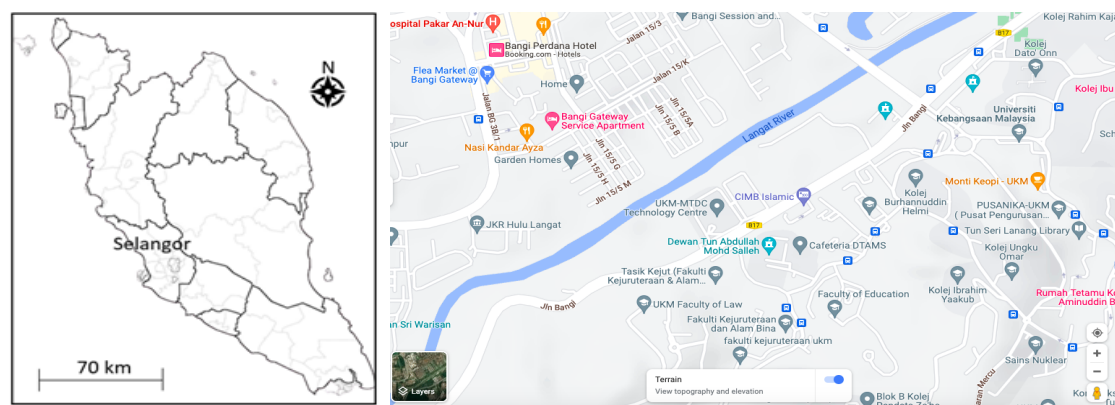


Figure 1. Sampling site and location of the occurrence of vermiculated sailfin catfish, *Pterygoplichthys disjunctivus* in Langat River.

The study area has a water depth which is shallow between 0.5 to 1.5 meters and flows over a sandy bottom area with murky water. The flow of water is moderate with low cover and the river banks have tall grasses growing at the side. This stretch of the Langat River is located between Serdang and Bangi which is an urban area with a population that exceeds 50,000 people according to a population census study conducted.

2.1. Sampling method

The sampling exercise took place on the 1st of March 2022 by using twine cast nets of length 150cm, width of 305cm and a mesh size of 2cm. Sampling was conducted for two hours. The fishes obtained were measured with for their morphometric measurements, their patterns observed and recorded before

being fixated in a solution of 30% formalin and 70% ethanol for long storage and kept in the Ichthyophysiology lab University Selangor for further long-term preservation. Each of the fishes were labelled and tagged with a plastic tag to keep record.

2.2. Measurement and data collection

Measurements were taken in millimeters (mm) using specific calipers and rulers. Morphometric measurement of the collected fishes such as head length, dorsal spine length, pectoral spine length, predorsal length, percentage of head length, head depth, snout length, orbital diameter and interorbital distance were taken. Specimens were identified based on keys provided by Armbruster and Page (2006), Page and Robins (2006), as well as Golani and Snovsky (2013) [5–7]. Selected counts and measurements were made on the left side of specimens. Measurements were taken in millimeters (mm) using dial calipers and were converted to percentage of standard length (SL) or head length (HL). The morphometric measurement was later compared using one-way ANOVA followed by Tukey's post hoc test. The photos of freshly caught and preserved specimens were also taken for further identification.

3. Results and discussion

From the observation, the main characters that distinguish the three types of *Pterygoplichthys* spp found in Langat River is the body pattern on the ventral side of their body. Of all the samples, there were three types of body patterns with the majority of them is the Amazon sailfin catfish, *P. pardalis* that accounted for 11 samples. Based on the coloration and body pattern, the three types of sample were the Amazon sailfin catfish *P. pardalis*, vermiculated sailfin catfish *P. disjunctivus* 'type A' and vermiculated sailfin catfish *P. disjunctivus* 'type B'. The selected morphometric and meristic measurements for all samples were summarized in Table 1 and Table 2 respectively.

In Table 1 and Table 2, results from the selected morphometric and meristic measurements revealed all measurements fell within the same range with no significant differences. Due to that, coloration and body pattern on the ventral side of their body were useful and used as a preliminary analysis in differentiating all samples from the area.

This study presents the first report of *P. disjunctivus* in Langat river area. In several research papers, two species of *Pterygoplichthys* were reported found in Malaysia. The populations of *P. pardalis* were found in Langat river, Selangor, Perak river, Perak [8], Muar river, Negeri Sembilan [4], Gombak river, Selangor [9] and population were established in Pusu river, Selangor where at least two species of *Pterygoplichthys* thrive well: *Pterygoplichthys pardalis* and *P. disjunctivus* [10].

Pterygoplichthys disjunctivus was identified by having dark vermiculated pattern on a light background with the vermiculations patterns continuously with one another. Contrastingly, *P. pardalis* can be identified based on the dark spot with a light background on the ventral side of its body. In addition, we found a new pattern of *P. disjunctivus* which we labelled as *P. disjunctivus* 'type B'. The samples have a non-continuous vermiculated pattern combined with the dark spot pattern on the ventral side of its body.

An invasive species refers to any animals that has been introduced into an environment where it was not native to that ecosystem and threatens the biological diversity. The importation of *Pterygoplichthys* to Malaysia freshwater ecosystem has been due to ornamental fish industry [1]. Like other invasive fish species, the occurrence of *Pterygoplichthys* in Malaysia ecosystem has been reported to cause damaged and negative impacts. Such damage may be in the form of environmental damage, human health damage or even economic damage to the country. The impacts of the introduction of *Pterygoplichthys* include potential dominance, competition for food and shelter, water quality deterioration due increase in water turbidity, the effect of the burrowing activities of the males, as well as predation on the eggs of other species. Eventually, all of these impacts will lead to a reduced number of native fish species.

Pterygoplichthys successfully invades new habitats due to its strong spine and hard scale that protects them from any predator, tolerance to low concentrations of oxygen in their habitat, and nest construction parental care. Previously, according to Samat et al. (2016), *P. pardalis* in Langat River has made its way to dominating as the environmental condition of Langat River facilitates the reproductive strategies of

this species [11]. In this study, the presence of *P. disjunctivus* ‘type B’. The same finding has been reported by Saba et al (2020), with the presence of the new body pattern of *Pterygoplichthys pardalis* ‘type B’ in Pusu River, Gombak basin Malaysia [10]. The presence of the new body pattern type could be resulted from the hybridization of *P. pardalis* and *P. disjunctivus*, or could it be another variation of these two species. The presence of *P. disjunctivus* in Langat River is now intimidating. The occurrence of *P. disjunctivus* in that area, along with the new type which may have resulted from hybridization, might worsen the scenario. To confirm the claim that the new type resulted from hybridization, deeper investigation based on molecular analysis is crucial to confirm this claim. The morphometric and meristic data for the three types of *Pterygoplichthys* found in this area fell within the same range and did not show any significant difference. However, based on the body pattern, it is glaring that *P. disjunctivus* ‘type B’ had a combination pattern of the species which *P. pardalis* and *P. disjunctivus*.

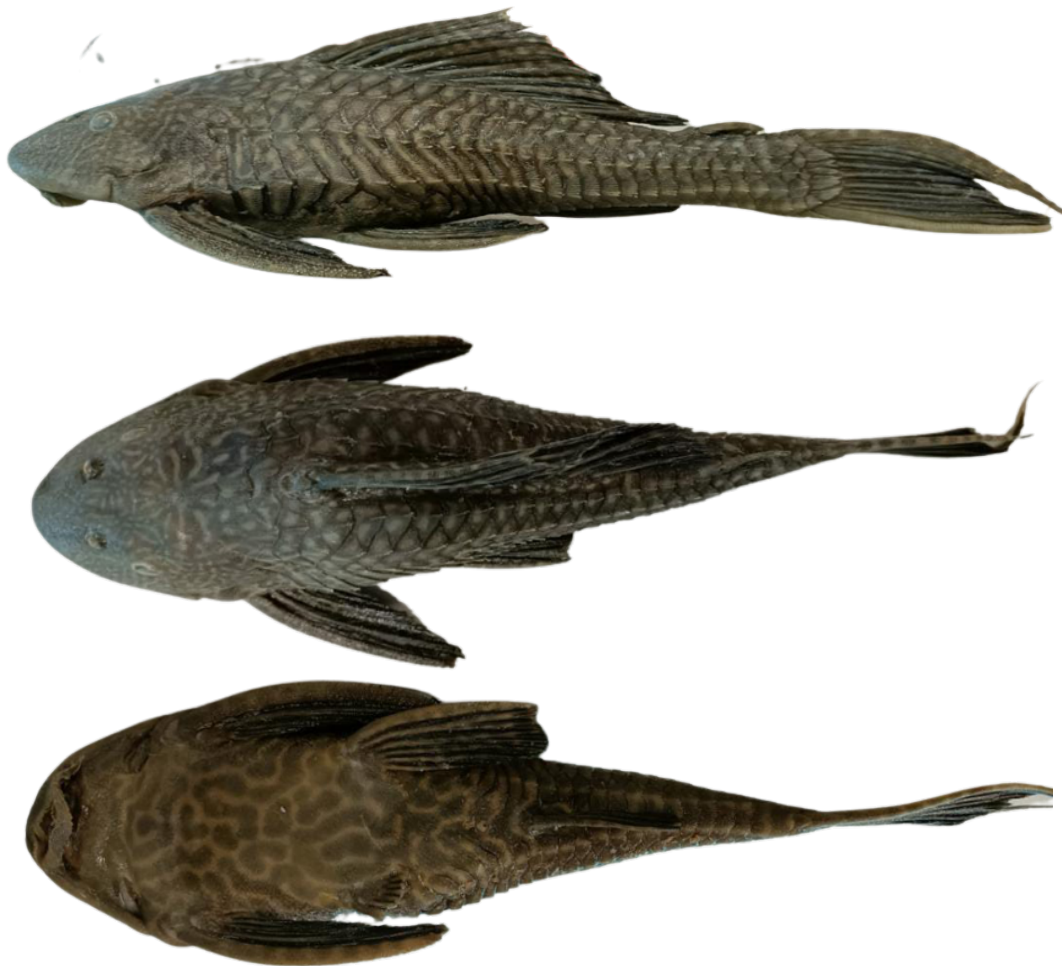


Figure 2. Dorsal, lateral, and ventral views of the Amazon sailfin catfish, *Pterygoplichthys disjunctivus*.

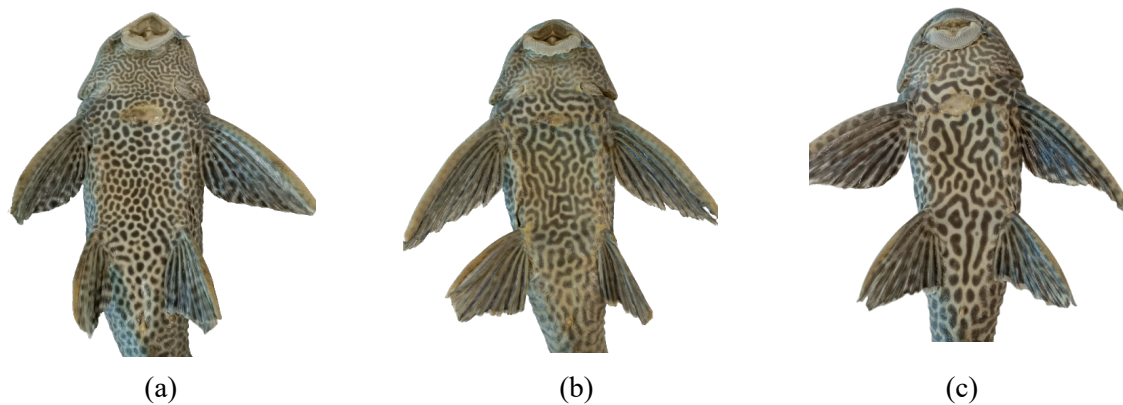


Figure 3. Comparison of the body pattern on the ventral part of *Pterygoplichthys* spp. from Langat River basin. (a) *Pterygoplichthys pardalis*, (b) *Pterygoplichthys disjunctivus* 'type A' and (c) *Pterygoplichthys disjunctivus* 'type B'.

Table 1. Selected morphometrics characters of Amazon sailfin catfish, *Pterygoplichthys pardalis*, and vermiculated sailfin catfish *Pterygoplichthys disjunctivus* 'type A' and *Pterygoplichthys disjunctivus* 'type B'.

Species	<i>Pterygoplichthys pardalis</i>		<i>P. disjunctivus</i> 'type A'		<i>P. disjunctivus</i> 'type B'	
	(n=11)		(n=8)		(n=5)	
	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD
Morphometric Characters						
Total length (mm)	313-430		331-426		328-431	
Standard length (mm)	220-330		215-321		225-335	
Percentage of standard length						
Head length	18.9-22.1	20.2 $\pm$ 1.3	15.4 - 20.9	17.8 $\pm$ 1.1	19.6 - 23.1	21.3 $\pm$ 0.9
Dorsal spine length	14.1-20.3	16.4 $\pm$ 1.5	10.5 - 16.8	13.8 $\pm$ 2.1	15.4 - 20.2	17.6 $\pm$ 1.8
Pectoral spine length	21.2-25.6	22.3 $\pm$ 0.9	16.3 - 21.4	18.4 $\pm$ 2.3	20.4 - 21.2	20.5 $\pm$ 0.9
Predorsal length	34.5-40.3	37.6 $\pm$ 1.6	26.7 - 31.1	28.4 $\pm$ 1.5	29.7 - 34.1	31.2 $\pm$ 1.8
Percentage of head length						
Head depth	58.3 - 61.1	59.2 $\pm$ 1.4	55.7 - 60.8	58.3 $\pm$ 1.6	61.2 - 64.2	62.4 $\pm$ 1.4
Snout length	36.7 - 21.5	37.9 $\pm$ 1.7	33.5 - 38.9	36.1 $\pm$ 1.7	37.4 - 40.7	39.1 $\pm$ 1.9
Orbital diameter	9.8 - 12.4	10.1 $\pm$ 1.2	9.9 - 11.4	10.8 $\pm$ 0.9	10.3 - 13.4	12.6 $\pm$ 1.6
Interorbital distance	43.2 - 50.1	47.6 $\pm$ 2.1	41.7 - 59.8	52.6 $\pm$ 1.3	54.6 - 59.4	56.7 $\pm$ 1.9

Table 2. Selected meristic characters of Amazon sailfin catfish, *Pterygoplichthys pardalis* and vermiculated sailfin catfish *Pterygoplichthys disjunctivus* ‘type A’ and *Pterygoplichthys disjunctivus* ‘type B’.

Species	<i>P.pardalis</i>	<i>P.disjunctivus</i> ‘type A’	<i>P. disjunctivus</i> ‘type B’
	(n=11)	(n=8)	(n=5)
	Range	Range	Range
Dorsal-fin rays	I, 11 (5), I, 12 (4), I,13 (2)	I, 11 (3), I, 13 (5)	I, 12(3), I, 13 (2)
Anal-fin rays	I, 4 (11)	I, 4 (8)	I, 4 (5)
Pectoral fin rays	I,6 (11)	I,6 (8)	I,6 (5)
Pelvic fin rays	I,5 (11)	I,5 (8)	I,5 (5)
Lateral line plates	28 (9), 30 (2)	29 (5), 30 (3)	28 (2), 29 (3)
Predorsal plates	3 (11)	3 (8)	3(5)

4. Conclusion

This study provides the first report on the occurrence of introduced vermiculated sailfin catfish, *Pterygoplichthys disjunctivus*, from the Gombak basin, Selangor. Moreover, we also described two body patterns of the *P.disjunctivus* collected from the river. The variant which does not fit entirely with the known characteristics of *P. pardalis* or *P. disjunctivus* it, is hypothesized to be a result of interbreeding and hybridization of the two species, but deeper study should be conducted to confirm this claim.

Author’s contribution

The authors confirm contribution to the paper as follows: study conception and design: Intan Faraha A Ghani; Data collection: Shatha Prakash A/L Anand Prakash, Nabil Arif Mohamad; Analysis and interpretation of results: Shatha Prakash A/L Anand Prakash, Nabil Arif Mohamad, Intan Faraha A Ghani, Mohammad Noor Amal Azmai; Draft manuscript preparation: Shatha Prakash A/L Anand Prakash, Intan Faraha A Ghani; All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest Statement

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; participation in speakers’ bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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