



**UNIVERSITI PUTRA MALAYSIA**

**ECOLOGICAL ASSESSMENT OF THE AMAZON SAILFIN CATFISH  
(*Pterygoplichthys pardalis*) IN THE LANGAT RIVER,  
MALAYSIA**

**ABDULLAH SAMAT**

**FS 2008 36**



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MALAYSIA**

**By**

**ABDULLAH SAMAT**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the  
Degree of Doctor of Philosophy**

**January 2008**



## DEDICATION

This thesis is dedicated to my parents, brothers and sisters who supported me all the way since the beginning of my studies.

Also this dedicated to my wife (Zaini) and my children (Nur Amierah, Amierul, Arief and Azrie) who offered me unconditional love and support throughout the course of this thesis.



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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**ABDULLAH SAMAT**

**January 2008**

**Chairman: Professor Fatimah Md. Yusoff, PhD**

**Faculty: Faculty of Science**

This study identified the ecological characteristics of an exotic fish species, *Pterygoplichthys pardalis* that have successfully occupied Malaysian rivers. The objectives of the study were to investigate the existing environment of Langat River where this species were found which included the water quality, food availability and habitat types, and to understand the basic ecology of the fish species including feeding, growth, reproduction that have contributed to the successful colonisation.

The prediction was if the existing environment is suitable for the species, then the survival of the species will be enhanced due to favorable growth and reproduction.

The study was conducted in Langat River between January 2003 and December 2004, and seven sampling sites (S-1 to S-7) were established. Statistical inference was used to estimate certain parameters (physical and biological) that are important in hypothesis testing. The physicochemical parameters of the water except dissolved oxygen (< 5 mg/l), total suspended solid (> 400 mg/l), chemical oxygen demand (> 50 mg/l) and ammonia-nitrogen (> 0.2 mg/l) were within the tolerance

levels to most indigenous fish species. In the existing environment, the *P. pardalis* showed a negative allometric growth dimension ( $b = 2.538 \pm 0.039$ ). The influence of seasonal rainfall (water level) on the condition of *P. pardalis* was not evident. Good structure and function of its digestive tract has enabled the consumption of many and various kinds of food materials. Small size food particles ( $< 500 \mu\text{m}$ ) were preferred and detritus from sediment was its major diet composition. The percentage of the food items identified both in the stomach and on the river bottom was almost similar, indicating that this fish fed on the food available in the habitat. The reproductive performance of this species was based on the male-female ratio of 1:1.7 and continuously reproduced that peaked during the rainy season between September and January. The number of eggs (fecundity) varied from 1,297 to 18,791 per brood and they were asynchronous batch spawner. Eggs were deposited deep (about 1 m) in the burrow to hide them from predators. *Pterygoplichthys pardalis* is a hardy species and exhibited typical characteristics of an invasive species where it has successfully survived in the Langat River.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENAKSIRAN EKOLOGI IKAN KELI LAYARAN AMAZON  
(*Pterygoplichthys pardalis*) DI SUNGAI LANGAT,  
MALAYSIA**

Oleh

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Kajian ini mengenal pasti sifat-sifat ekologi spesies ikan eksotik *Pterygoplichthys pardalis* sehingga membolehkannya berjaya hidup di dalam sungai-sungai di Malaysia. Objektif kajian ini adalah untuk mengkaji persekitaran sedia ada di mana ikan ini hidup yang merangkumi kualiti air, kesediaan makanan dan jenis habitat dan untuk memahami asas biologi ikan termasuk makanan, tumbesaran dan pembiakan yang telah menyumbang kepada kejayaan penjajahannya. Jangkaan yang dibuat ialah sekiranya persekitaran sedia ada sesuai untuk spesies ini, maka kemandirian akan teransang oleh tumbesaran dan pembiakan yang menggalakkan. Kajian ini telah dijalankan di Sungai Langat di antara bulan Januari 2003 hingga Disember 2004 dan tujuh lokasi pensampelan (S-1 hingga S-7) telah ditetapkan. Inferen statistik telah digunakan untuk menganggar parameter tertentu (biologikal dan fizikal) yang penting dalam ujian hipotesis. Parameter fizikokimia air kecuali oksigen terlarut ( $< 5$  mg/l), jumlah pepejal terampai ( $> 400$  mg/l), permintaan oksigen kimia ( $> 50$  mg/l) and ammonia-nitrogen ( $> 0.2$  mg/l) berada pada tahap

luwes bagi kebanyakan spesies ikan tempatan. Dalam persekitaran ini, *Pterygoplichthys pardalis* menunjukkan dimensi tumbesaran alometrik negatif ( $b = 2.538 \pm 0.039$ ). Pengaruh musim hujan (paras air) terhadap kondisi *P. pardalis* tidak terbukti. Struktur dan fungsi saluran penghadaman yang baik telah membolehkannya mengambil banyak dan berbagai jenis makanan. Zarah makanan bersaiz kecil ( $< 500 \mu\text{m}$ ) menjadi pilihan dan detritus dari sedimen merupakan komposisi utama kandungan makanannya. Peratusan jenis-jenis makanan yang dikenalpasti dari kedua-dua perut dan dasar sungai menunjukkan bahawa ikan ini mengambil makanan berdasarkan kepada apa yang terdapat dalam habitat. Kemampuan membiak bagi spesies ini berasaskan kepada nisbah jantina 1:1.7 dan berlaku berterusan dengan musim puncak di antara bulan September dan Januari. Jumlah telur (kesuburan) berbeza daripada 1,297 hingga 18,791 per induk dan *P. pardalis* ini tidak melepaskan telur dengan peringkat-peringkat yang khusus. Telor diletakkan jauh (1 m) ke dalam lubang yang boleh menyembunyikannya daripada pemangsa. *Pterygoplichthys pardalis* adalah spesies yang tahan lasak dan menampilkan ciri-ciri tipikal spesies invasif yang telah berjaya meneruskan kehidupan di Sungai Langat.

## ACKNOWLEDGEMENTS

In the name of god 'Allah'; the most gracious, the most merciful.

My sincere and greatest gratitude to my advisor (Dr. Fatimah Md. Yusoff) for her guidance, encouragement and tremendous patience during the course of the study. I also extend my gratitude to my advisory committee (Dr. Shukor Md. Nor, Dr. Mazlan Abd. Ghaffar and Dr. Aziz Arshad) for their work in shaping my thesis. I must thank Dr. Shukor who consistently gave his full support with ideas and critical comments to my works and Mr. Zdcc for his helps in choosing better tool to be used in data analysis. I also acknowledge the other Faculty of Science and staff of the Bioscience Institute at Universiti Putra Malaysia (Mr. Prumal, Ms. Aina, Ms. Zarina, Ms. Shuhaila) for the numerous technical and administrative occasions that I sought their help and advice.

I greatly appreciate the many friendships which evolved from working with the wonderful graduate students of the Bioscience Institute whom I consider special and sometimes unique. Outside of the country, I acknowledge Dr. Mary E. Power of University of California Berkeley for sending me her research papers and related literatures on armored catfishes and Dr. Jonathan W. Armbruster of Auburn University for his kind to confirm the identity of the species studied.

Thanks also due to Mr. Azrindra and Mr. Husdy who were continuously help me in my field work to collect samples, and Mr. Azman who spent much of his time helping me analyzing water and soil samples in the laboratory at the Universiti



Kebangsaan Malaysia. Help by local residents (Mr. Mohd. Marjunid, Mr. Mohd. Ramli, Mr. Wahab and Mr. Mohijan) in the field is also acknowledged.

This study was also only possible with direct support of labor from many different parties. Herein I attempt to acknowledge individuals and groups that have contributed during the study were taken place and I apologize if I have left anyone out. I thank Puncak Niaga (M) Sdn. Bhd. (Mrs. Rowina Merican) and Genting Sanyen Sd. Bhd. (Mr. Ir. Nathan Francis) for providing water level data for the duration of 2003-2004 that was recorded at Batu-10 in Hulu Langat and at Labuhan Dagang in Kuala Langat, respectively. I thank the Department of Geography at the Faculty of Social Sciences and Humanities, Universiti Kebangsaan Malaysia for the secondary rainfall data collected near Bangi.

Finally, it is to acknowledge that the field and laboratory works were primarily benefited from the IRPA Grant no. 09-02-02-0065-EA180 awarded to Dr. Mazlan and a Research Fellowship from UKM no. ST/16/2004 awarded to the author to conduct this study.

Thank you.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory committee were as follows:

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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been dully acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

**ABDULLAH BIN SAMAT**

Date: 17 August 2007



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## CHAPTER 1

### INTRODUCTION

Traditionally, biological and ecological studies on freshwater fishes mainly focused on indigenous species. However, the establishment of exotic species in the natural ecosystem also has received attention from scientists as well as environmental managers (Vitousek et al. 1997; Adams et al. 2001; Cleland et al. 2004). By definition, 'exotic species' is a species that has been introduced from another geographic region to an area outside its native range. The species is called 'invasive species' when it manages to colonise the natural or semi-natural ecosystems where it was introduced, and is an agent of change and threatens native biodiversity (Clout and Lowe 1996).

The abundance and distribution of exotic species may point to their superior ability to find a suitable habitat shortly after introduction. Habitat that is suitable for exotic species (e.g. *Pterygoplichthys pardalis*) should include all physical and biological environments that determine the survival of the species and dynamics of a population. The two most important characteristics controlling the population growth are reproduction and death. For feral species to establish a population, the reproduction rate must exceed the death rate (Williamson and Fitter 1996).

The mechanisms of colonisation, competition and extinction experienced by a species are fascinating but also very complex in nature. Due to this nature, there are four questions commonly addressed as stated by Holgate (1986). 1) What are the

characteristics of the species that make it capable of dispersion to invade new habitats? 2) What are the features that determine the successful establishment if it does arrive in a new setting? 3) What are the characteristics of the receiving habitat that make it prone to invasion? 4) What management strategies are appropriate to control invading species? In Malaysia, none of these factors have been investigated on any one of the exotic invasive species found. For example, the highest number of vertebrate species introduced into this country is fishes. However, there is no known study on a single exotic fish species that has been conducted although it has long been noted that some of them such as *Puntius gonionotus*, *Oreochromis mossambicus* and *Poecilia reticulata* are able to grow well in the local environment (Ang et al. 1989). These exotic species could survive in the local waters because they have managed to propagate due to the tolerance of a wide range of environments that include climate, water quality and food availability. Several fish species managed to establish their population within a short period of time in many habitats which may not be suitable for native species. As in many other countries, the occurrence of exotic fish species in this country is more readily available in disturbed habitats than elsewhere suggesting the linkage with human activities (Williamson 1996; Mack and D'Antonio 1998).

The invasion of exotic species is recognized as a serious threat to local biodiversity.

The invasion of exotic species is one of the major causes of species endangerment (Chech and Krausman 1997). Other threats to habitats and the native fish species include non-point source pollutants, aquatic food web disruption, loss of spawning substrate and nursery areas, disruption of sediment transport and altered water levels. Studies have found that invasive species can alter basic ecosystem functions

such as nutrient cycling, water quality and soil retention. Most invasive fish species provide little to no habitat value and frequently have characteristics that make them inhospitable to native species. There is no effort undertaken to eradicate the invasive fish species in the local aquatic ecosystems. Scarcely found documented knowledge on the biology and ecology of the invasive species in the local aquatic ecosystem seem to hide the effects of their presence.

There are at least six (24%) exotic fish species in the Langat River and at least three of them were observed to be invasive with significant impacts on habitat and native species (Samat et al. 2002). These exotic invasive fish species are *Oreochromis mossambicus*, *O. niloticus* and *Pterygoplichthys pardalis*. The greatest abundance among these three exotic invasive fish species in the Langat River was represented by *P. pardalis* (Samat 1999); the species focus of in study. The study needed to find how this exotic fish species managed to establish its population successfully in the local freshwater ecosystem of Langat River by examining the introduction pathway, the biology of the individual species, the ecology of the habitats and the community.

Published reports from many parts of the world have also revealed that many of the exotic species in their actively managed condition showed obvious beneficial value or were simply benign (e.g. Casselman et al. 1999; Perrings et al. 2002). However, a few of these exotic species have caused serious and sometimes irreversible harm when they persist and spread beyond manageable boundaries (e.g. Adams et al. 2001; Perrings 2005). In other words, they became a serious pest to the local aquatic biodiversity where they were introduced (Williamson 1996). A particularly striking example of freshwater invader of fish that has changed the nature of the whole

community is the Nile perch (*Lates niloticus*) in Lake Victoria, East Africa (Green 1986; Kaufman 1992) and in Lake Nabugabo, Uganda (Schofield and Chapman 1999). Similar scenario may have probably occurred in the Malaysian aquatic ecosystems. Therefore, it is very important to know and understand the invading process holistically.

It is a very common scenario that by the time the exotic species is reported to invade a new habitat, the population usually has already been well established and begun to have negative effects on the native species and their habitats. In such a disrupted ecosystem, ecological restoration and management are a real problem and to fix the problem is challenging. Comprehensive understanding of the effects of invasive species requires detailed study on their basic biology (autecology), and how this interacts with its environment and the native biotic community (synecology). This kind of study will bring a better understanding of the spread of the exotic species, and may suggest methods of controlling and monitoring the expanding population for a viable management plan.

Studies were conducted in both field and laboratory at a scale appropriate for the specific research question highlighted in the earlier sections. An invasive fish species common in Malaysian freshwater ecosystems (*Pterygoplichthys pardalis*) was studied. The introduction of this species to this country was solely for the aquaria. Its presence in natural waters was unintentional. Nowadays, this harmless fish species has already become one of the most successful exotic invasive fish species besides tilapias (*Oreochromis* spp.). What character(s) or factors that made

this fish species so successful in its new habitat is just a simple question to ask, yet no appropriate scientific answer is available.

Generally, exotic invasive fish species represent a potential significant threat to the natural resources of the local aquatic ecosystem. If left unstudied, these exotic species (e.g. *P. pardalis*) will radically reduce the aquatic biological diversity in the near future. Considering the wide scope of the biology and ecology of the exotic invasive species, a well-considered approach is required to ensure that progress is actually made. Information gathered in this study will be used to guide students, researchers and managers of the related field including the Fisheries Department and the Wildlife Department and the National Park Authority for a better management of the local aquatic ecosystem with the main objective of maintaining high local biological diversity.

The objectives of this study were to:

- 1) Investigate the physical and chemical characteristics of the *P. pardalis* habitat.
- 2) Study the growth performance of *P. pardalis*.
- 3) Describe the digestive tract morphology and the food items taken by the *P. pardalis*.
- 4) Investigate the reproductive biology of *P. pardalis*.

The above objectives were generated based on several issues and questions generally highlighted above. Some of the questions are as follows.

- 1) What are the physical and chemical conditions of the habitat where the *P. pardalis* has become established?