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Feeding habits of hatchery-reared young Mekong giant catfish in a fish pond and in Mae peum reservoir

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ABSTRACT
We studied the feeding habits of the hatchery-reared young Mekong giant catfish released in a fish pond and Mae peum reservoir, northern Thailand. We examined the gut (stomach and intestine) contents of 5 catfish, Relative Length of Gut (RLG) of 4 catfish and plankton composition in the reservoir. The gut contents of the catfish in the fish pond consisted of a fluid like the pellets, zooplankton, phytoplankton and aquatic plants. The gut contents in the reservoir consisted of unspecified contents, zooplankton and phytoplankton. The majority of prey items were the Branchiopoda (75 % in zooplankton) and Chlorophyceae (98 % in phytoplankton) in the gut contents of the catfish in the reservoir, while the major plankton in the reservoir were copepoda including nauplius and copepodid (mean: 50 %) and eurotatorea (mean: 41 %) in zooplankton, and chrysophyceae (mean: 52 %) and chlorophyceae (mean: 38 %) in phytoplankton. It is reasonable to suppose that the catfish positively selected their major prey items if a particular prey item was found in the gut contents, contrary to the organism composition in the reservoir. However, the cuticle and the cell walls of these plankton are resistant to intestine enzymes of some fish. Furthermore, RLG of 4 catfish were greater than 1. In general, a fish is carnivorous when RLG is less than 1, while the fish is herbivorous or omnivorous when RLG is greater than 1. These results indicate that the hatchery-reared young catfish fed on the potential prey items in front of the catfish, and the catfish might not be piscivorous but planktivorous.

KEYWORDS: Mekong giant catfish, *Pangasianodon gigas*, Automatic Fish Recapture System (AFR System), feeding habits, gut contents

INTRODUCTION

The Mekong giant catfish (Pla Buk in Thailand), *Pangasianodon gigas* (Chevey, 1930), is endemic to the Mekong River basin and is one of the largest freshwater fish in the world. A 2.7 m adult male catfish weighing in at 293 kg was recaptured in the Mekong River near Chiang Mai province in northern Thailand in June 2005. The catfish is delicious and is also a valuable animal protein resource for the residents in the north of Thailand. However, due to the watershed development of the Mekong River in recent times and due to the incidental catch and so on, the number of the wild catfish in the Mekong River has decreased year by year (Mattson et al., 2000 and Hogan, 2004). Therefore, the catfish is listed on IUCN Red List as Critically Endangered and is included in CITES Appendix I of most endangered species. The import and export of this species is therefore strictly regulated.

The fishing of catfish is strictly regulated in Thailand against these backgrounds. In Thailand, only the fishery cooperative of the Chiang Khong District, in the north of Thailand is allowed to catch the wild catfish from April to June. In order to conserve and enhance the catfish resource, the Thai government has attempted to develop an artificial hatching technique since the 1980s. In 2001, they succeeded in producing second filial generation (F2) from first filial generation (F1) of the catfish. Currently, the seedlings of the hatchery-reared fry, larval and young catfish, are released into the lakes, reservoirs and the Mekong River in Thailand in order to enhance the stock of the catfish.

It is very important to know the feeding habits of the catfish in the natural environment in order to conduct stock enhancement by releasing the seedlings, because prevention of starvation, improvements of their growth and effective management can be conducted from this knowledge. The following points of wild and hatchery-reared catfish were revealed according to the recent study on the catfish. The hatchery-reared fry catfish fed on plankton and were cannibalistic in a fish tank (Akagi et al., 1996 and Mattson et al., 2000). The wild adult catfish fed on the filament attached algae, *Cladophora sp.*, in the Mekong River and were herbivorous (Akagi et al., 1996 and Mattson et al., 2000). There has never been a study of the feeding habits of the hatchery-reared young catfish in the natural environment. Young catfish in particular are at a very important stage of development, because this stage corresponds to the intermediate phase of their growth process. Therefore, the objective of this study is to understand the feeding habits of the hatchery-reared young catfish.

MATERIALS AND METHODS

This study was conducted at 2 study sites from 2004 to 2005. One was a fish pond in Phayao Inland Fisheries Station in Phayao, Thailand. The other was Mae Peum reservoir in Phayao, Thailand (Fig. 1). This irrigation reservoir had been constructed by damming a river in 1982. The area of the reservoir is approximately 8.3 km^2, and the maximum depth is approximately 15 m.

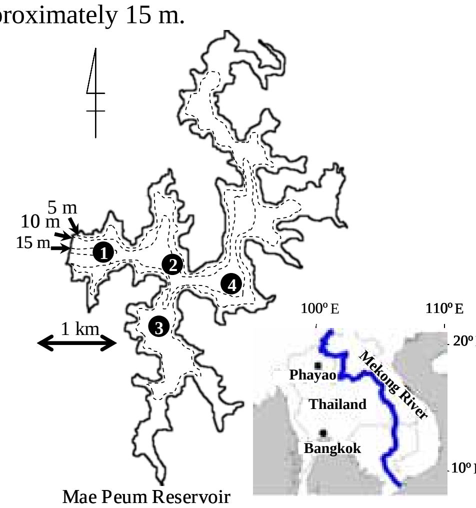

Fig. 1 Map of Mae peum reservoir and Phayao in Thailand. The filled circles represent the sampling points of plankton.

In the Fish Pond

We examined whether or not the hatchery-reared young Mekong giant catfish fed on pellet only in the fish pond. In September 2005, we kept two catfish (FL: 85 cm, 95 cm) for 15 days in the fish pond (20 m × 30 m, 0.6 m depth) of the Phayao Inland Fisheries station located in northern Thailand (Fig. 1). The fish were fed pellets at 9 a.m. and 2 p.m. on weekdays. Afterwards, we obtained their gut (stomach and intestine) contents and examined whether or not the fish fed on prey items. The obtained gut contents were fixed with 10 % formalin solution and examined under the microscope. The zooplankton were identified to the possible lowest taxa, and then the number of the individuals of zooplankton were counted (Akagi et al., 1996, Kawai, 1985, Hynes, 1950, Hyslop, 1980 and Engel, 1976). Also, the phytoplankton were identified and the number of the cells of phytoplankton were counted (Yuwadee, 2005, Yamagishi, 1999, Hynes, 1950, Hyslop, 1980 and Gale and Lowe, 1971). Moreover, the gut length of the fish was measured, and the gut length (GL) to fork length (FL) ratio (RLG: Relative length of gut) was determined as a possible indicator of major diet (Bagarinao and Thayaparan, 1986 and Takeuchi, 1991).

$$RLG = GL / FL$$

In Mae peum Reservoir

We examined what the hatchery-reared young catfish fed on in the Mae peum reservoir. This experiment was conducted in August, October and December 2004 in the Mae peum reservoir located in northern Thailand (Fig. 1).

Three hatchery-reared young catfish (FL: 72.3 ± 3.5 cm) used in the experiment were reared in an earthen pond after production by artificial insemination at the Phayao Fisheries Station (Table 1). The catfish were 4 to 10 years old. None of the catfish were fed for 1 week before releasing, in order to obtain the gut contents from the reservoir. We recaptured each catfish after 4, 4 and 8 days from the release using the AFR system in the reservoir (Yamagishi et al., 2005), and then we obtained the gut contents of the catfish. Using the same methods as the experiment in the fish pond, we fixed with 10 % formalin solution and counted the number of individuals and the number of cells. The GL of two catfish in October and December was measured and RLG was determined.

A survey of the plankton composition in the reservoir was carried out on December 21. The plankton were vertically sampled from 6 m depth to the surface at four stations using a plankton net with mesh size of 63 μm (Kitahara Quantitative Plankton Net, NXX25) because the catfish moved vertically diurnally between the surface layer and a depth of about 6 m in a preliminary study around the same time (Fig. 1). The obtained plankton were fixed with 10 % formalin solution and examined by using an optical microscope. They were identified down to family, order or genus (Akagi et al., 1996, Kawai, 1985, Yuwadee, 2005 and Yamagishi, 1999). The number of the individuals of zooplankton and the cells of phytoplankton were counted.

Table 1 Gut contents weight (GCW), Fork length (FL), Gut length (GL) and Relative length of gut (RLG) of the sample fish.

Sample fish	GCW (g)	FL (cm)	GL (cm)	RLG
In the fish pond				
2005/09 (1)	6.6	85.0	215.5	2.54
2005/09 (2)	221.0	95.0	422.0	4.49
In Mae peum reservoir				
2004/08 (3)	26.8	76.0	-	-
2004/10 (4)	26.9	72.0	191.0	2.65
2004/12 (5)	22.1	69.0	151.0	2.19

RESULTS

The results of the gut contents weights (GCW) are shown in Table 1. The gut contents of the catfish in the fish pond consisted of fluid like the pellet, zooplankton, phytoplankton and aquatic plants (wet weight: 352.5 mg) (Table 2). The gut contents in the Mae Peum reservoir consisted of unspecified contents, zooplankton and phytoplankton (Table 3 and Fig. 2). We found the plankton in the stomach and intestine of the catfish recaptured at noon (approximately 11:00) and at evening (approximately 17:00) in the reservoir.

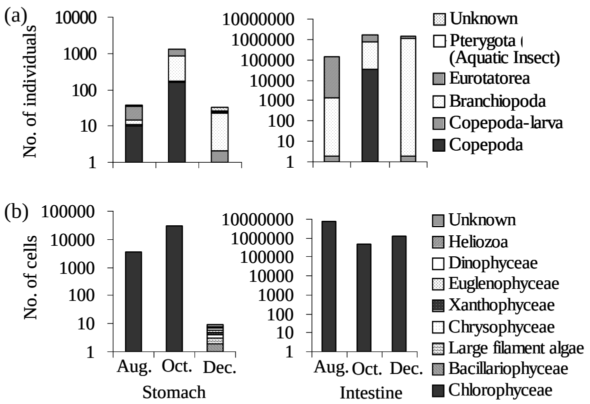

Fig. 2 Total number of individuals and cells of plankton of the stomach and the gut contents. (a): Zooplankton. (b): Phytoplankton.

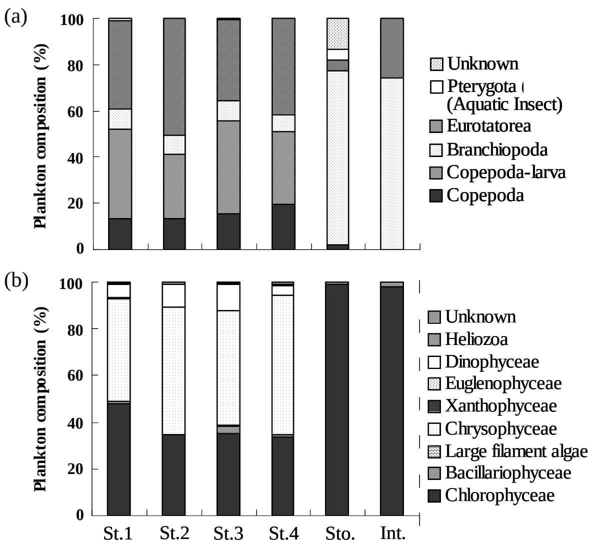

Fig. 3 Plankton composition of the catfish and in the reservoir in December. Sto. and Int. means Stomach and Intestine, respectively. (a): Zooplankton. (b): Phytoplankton.

In December, the majority of prey items were branchiopoda (75 % in zooplankton) and chlorophyceae (98 % in phytoplankton) in both stomach and intestine contents, while these plankton were not the major items in the reservoir (Fig. 3). The major plankton in the reservoir were copepoda including nauplius and copepodid (mean: 50 %) and eurotatorea (mean: 41 %) in zooplankton, and chrysophyceae (mean: 52 %) and chlorophyceae (mean: 38 %) in phytoplankton (Fig. 3).

The results of GL, FL and RLG are shown in Table 1. RLG of four out of five fish were greater than 1. One gut length was not measured.

DISUCUSSION

It seems that the fluids in the gut contents of the catfish in the fish pond were the pellets which had been digested. Moreover, aquatic plants, *Ipomoea Aquatica* (Pak bung in Thai, water convolvulus in English) abounded around the fish pond. It seems that the aquatic plants in the gut contents were *Ipomoea Aquatica*. We fed the fish with food pellets but the fish fed on the pellets, the aquatic plants, zooplankton and phytoplankton. These results indicate that the hatchery-reared young fish fed on the potential prey items available to the fish.

The gut contents of the catfish in the Mae Peum reservoir were zooplankton and phytoplankton. In December, the majority of prey items were branchiopoda (75 % in zooplankton) and chlorophyceae (98 % in phytoplankton) in both stomach and intestine contents, while these plankton were not the major items in the reservoir (Fig. 3). The major plankton in the reservoir were copepoda including nauplius to copepodid (Mean: 50 %) and eurotatorea (Mean: 41 %) in zooplankton, and chrysophyceae (Mean: 52 %) and chlorophyceae (Mean: 38 %) in phytoplankton (Fig. 3). It is reasonable to suppose that the fish positively selected their major prey items if a particular prey item was found in the gut contents, contrary to the organism composition in the reservoir. However, the cuticle and the cell wall of these plankton are resistant to intestine enzymes of some fish, so that it is not necessarily appropriate to suggest that the major prey items were primary (Gannon, 1976, Nakamoto and Okino, 1972 and Yoshida and Sera, 1970). Attention should be paid to over-estimation of prey items which are digested slowly and to under-estimation or oversight of prey items which are digested rapidly (Ikewaki and Sawada, 1991). Actually, when we count the number of individuals or cells, we count their outer shape. From these results, we think that the hatchery-reared young catfish did not feed on branchiopoda and chlorophyceae with positive selective feeding but a number of these plankton were found due to the difference of digestion rate. From these results, it is not necessarily the case that the hatchery-reared young catfish fed on branchiopoda and chlorophyceae with positive selective feeding due to the difference of digestion rate.

In general, a fish is carnivorous when RLG is less than 1, while the fish is herbivorous or omnivorous when RLG is greater than 1 (e.g. grass carp: herbivorous: 2.16, silver carp: micro-planktivorous: 5.28, and carp and gold fish: omnivorous: 2.04 and 5.15) (Bagarinao and Thayaparan, 1986 and Takeuchi, 1991). In this study, RLG of Mekong giant catfish ranged from 2.19 to 4.49 and was greater than 1. RLG examination suggested that the young catfish might not be piscivorous.

Furthermore, the juvenile and larval Mekong giant catfish had teeth and fed on prey items including cannibalism (Mattson et al., 2002 and Tyson and Vidthayanon, 1991). The wild adult fish did not have teeth and fed on the algae (Akagi et al., 1996, Mattson et al., 2002 and Tyson and Vidthayanon). The young catfish in this study did not have teeth. From the examination of the gut contents, the young catfish did not feed on fish, and did feed on zooplankton and phytoplankton like copepoda, chlorophyceae and so on. These results indicate that the hatchery-reared young Mekong giant catfish might not be piscivorous but planktivorous.

The knowledge of kind and amount of the prey items of the fish is very important and essential for the stock enhancement through the seedlings release. The knowledge of the prey items will become a guideline for determining the environmental capacity which is useful for the prevention of their starvation and improvement of their growth after the release. Furthermore, for the stock enhancement, the feeding habits of released stock must be revealed and attention must be given to the effects of released stock on other species, especially when releasing carnivorous species (Masuda and Tsukamoto 1998). From this study, it is revealed that attention should be paid to the amount of plankton which are the prey items of the young catfish in the reservoir in order to enhance the stock effectively. In this study, the catfish fed on the plankton in the reservoir and might not be piscivorous but planktivorous so that the above risk could be reduced. However, there is a possibility that the Mekong giant catfish competes with other animals, for example planktivorous, omnivorous and herbivorous excluding piscivorous. Therefore, as a next step, it is necessary to reveal the competitive relationship between Mekong giant catfish and other planktivorous, omnivorous or herbivorous in order to evaluate the effect on ecology. The number of samples is small in this study. In general, several tens or hundred of samples are used in the gut contents analysis. Hence, it is necessary to study their feeding habits continuously. The environmental capacity of this species can be quantitatively estimated and the most important prey item for the catfish can be reveled by further continuous study. These environmental capacities and prey items are essential knowledge in order for the catfish to survive and grow effectively.

Table 2 List of gut contents of two catfish (No. 1 and 2) in the fish pond found by examination under the microscope.

Class (Subclass)	Order	Family	Genus	Fish No.
Zooplankton				
Crustacea (Copepoda)	-	-	-	2
Crustacea (Branchiopoda)	Cladocera	-	-	1, 2
Eurotatorea (Monogononta)	Ploimidae	Brachionidae	-	2
Eurotatorea (Monogononta)	Ploimidae	-	-	1
Insecta (Pterygota) (Aquatic Insect)	Diptera	-	-	1
Unknown	-	-	-	1
Phytoplankton				
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Staurastrum	2
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Cosmarium	1
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Closterium	1, 2
Chlorophyta (Chlorophyceae)	Zygnematales	Zygnemataceae	Spirogyra	1
Chlorophyta (Chlorophyceae)	Chlorococcales	Scenedesmaceae	Scenedesmus	1, 2
Chlorophyta (Chlorophyceae)	Chlorococcales	Oocystaceae	Selenastrum	2
Chlorophyta (Chlorophyceae)	Chlorococcales	Hydrodictyceae	Pediastrum	1, 2
Bacillariophyta (Bacillariophyceae)	Naviculales	-	-	1, 2
Euglenophyta (Euglenophyceae)	Euglenales	Euglenaceae	Euglena	1, 2
Euglenophyta (Euglenophyceae)	Euglenales	Euglenaceae	Phacus	2
Xanthophyta (Xanthophyceae)	Mischococales	Centritractaceae	Centritractus	1, 2
Filament algae 1 (Unknown)	-	-	-	1, 2
Filament algae 2 (Unknown)	-	-	-	1, 2
Unknown 1	-	-	-	2
Unknown 2	-	-	-	2
Unknown 3	-	-	-	2
Aquatic plant				
Magnoliophyta (Magnoliopsida) (*Ipomoea Aquatica*)	Solanales	Convolvulaceae	Ipomoea	1
Fluid like pellets				1, 2

Table 3 List of gut contents of three catfish (No. 3, 4 and 5) in the Mae peum reservoir found by examination under the microscope.

Class	Order	Family	Genus	Fish No.
Zooplankton				
Crustacea (Copepoda)	Calanoida	-	-	4,
Crustacea (Copepoda)	Cyclopoida	-	-	4
Crustacea (Copepoda)	-	-	-	3, 4, 5
Crustacea (Copepoda)	Nauplius- copepodid	-	-	3, 4
Crustacea (Branchiopoda)	Cladocera	Bosminidae	-	4, 5
Crustacea (Branchiopoda)	Cladocera	-	-	3, 4, 5
Eurotatorea (Monogononta)	Ploimidae	Brachionidae	Brachionus	3
Eurotatorea (Monogononta)	Ploimidae	Brachionidae	Keratella	3, 4
Eurotatorea (Monogononta)	Ploimidae	Trichocercidae	Trichocerca	3, 4
Eurotatorea (Monogononta)	Ploimidae	Synchaetidae	Synchaeta	3, 4
Eurotatorea (Monogononta)	Ploimidae	Synchaetidae	Polyarthra	4
Eurotatorea (Monogononta)	Ploimidae	Conochilidae	-	3, 4
Eurotatorea (Monogononta)	Ploimidae	-	-	3, 4, 5
Insecta (Pterygota) (Aquatic Insect)	Diptera	Chironomidae	-	5
Unknown	-	-	-	4, 5
Phytoplankton				
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Staurastrum	3, 4, 5
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Cosmarium	4, 5
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Closterium	3, 4
Chlorophyta (Chlorophyceae)	Zygnematales	Desmidiaceae	Hyalotheca	5
Chlorophyta (Chlorophyceae)	Chlorococcales	Scenedesmaceae	Scenedesmus	3, 4
Chlorophyta (Chlorophyceae)	Chlorococcales	Hydrodictyceae	Pediastrum	3, 4
Chlorophyta (Chlorophyceae)	Volvocaceae	-	-	5
Bacillariophyta (Bacillariophyceae)	Coscinodiscineae	Melosiraceae	Aulacoseira	3
Bacillariophyta (Bacillariophyceae)	Naviculales	Naviculaceae	-	3, 4, 5
Chrysophyta (Chrysophyceae)	Ochromonadales	Synuraceae	Mallomonas	3
Euglenophyta (Euglenophyceae)	Euglenales	Euglenaceae	Euglena	3
Euglenophyta (Euglenophyceae)	Euglenales	Euglenaceae	Phacus	3, 4, 5
Xanthophyta (Xanthophyceae)	Mischococales	Centritractaceae	Centritractus	
Small filament algae (Unknown)	-	-	-	3, 4
Large filament algae (Unknown)	-	-	-	3, 4, 5
Unknown	-	-	-	3, 4, 5

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REFERENCES

Akagi O., Akimichi T., Akishinonomiya F. and Takai Y. (1996). An Ethnoichthyological Study of *Pla Buk* (*Pangasianodon gigas*) at Chiangkhong, Northern Thailand, *Bulletin of the National Museum of Ethnology*, **21**, 2, 293-333.

Bagarinao T. and Thayaparan K. (1986), The length-weight relationship, food habits and condition factor of wild juvenile milkfish in Sri Lanka, *Aquaculture*, **55**, 241-246.

Engel S. (1976). Food habits and prey selection of coho salmon (*Oncorhynchus kisutch*) and cisco (*Coregonus artedii*) in relation to zooplankton dynamics in Pallette lake, Wisconsin, *Transaction of American Fisheries Society*, **5**, 607-614.

Gale W. F. and Lowe R. L. (1971). Phytoplankton ingestion by the fingernail clam, Sphaerium Transversum (say), in pool 19, Mississippi river, *Ecology*, **52**, 3, 507-513.

Gannon. J. E. (1976). The effects of differential digestion rates of zooplankton by Alewife, *Alosa pseudoharengus*, on determinations of selective feeding, *Transactions of the American Fisheries Society*, **1**, 90-95.

Hogan Z. (2004). Threatened fishes of the world: Pangasianodon gigas Chevey, 1931 (Pangasiidae), *Environmental Biology of Fishes*, **70**, 3, 210-210.

Hynes H. B. N. (1950). The food of fresh-water Sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of food of fishes, *The Journal of Animal Ecology*, **19**, 1, 36-58.

Hyslop E. J. (1980). Stomach contents analysis-review of methods and their application, *Journal of Fish Biology*, **17**, 411-429.

Ikewaki Y. and Sawada Y. (1991). Food habits of marine fish larvae, *Early Development in Fishes*, Edited by Tanaka M., Published by Kouseisha-Kouseikaku, 86-104.

Kawai T. (1985). An Illustrated Book of Aquatic Insects of Japan, Published by Tokai University Press.

Masuda R. and Tsukamoto K. (1998). Stock enhancement in Japan: Review and perspective, *Bulletin of Marine Science*, **62**, 2, 337-358.

Mattson, Niklas S., Buakhamvongsa K., Sukumasavin N., Tuan N. and Vibol O. (2002). Mekong giant fish species: on their management and biology, *MRC Technical Paper*, 3, Mekong River Commission, 13-18.

Mizuno T. and Takahashi E. (1991). An Illustrated Guide to Freshwater Zooplankton in Japan, Published by Tokai University Press.

Nakamoto N. and Okino T. (1972). Activity of phytoplankton excreted by fish, *Bulletin of Plankton Society of Japan*, **19**, 1, 1-4.

Takeuchi T. (1991). Digestion and Nutrition, Fish Physiology, Edited by Itazawa Y. and Hanyu I. Published by Kouseisha-kouseikaku, 67-101.

Tyson R. R. and Vidthayanon C. (1991). Systematic Revision of the Asian catfish family Pangasiidae, with biological observations and descriptions of three new species, *Proceedings of the Academy of Natural Sciences of Philadelphia*, **143**, 97-144.

Yamagishi T. (1999). Introduction to the Freshwater Algae, Published by Uchida Rokakuho, Tokyo, Japan.

Yamagishi Y., Arai N., Mitsunaga Y., Mitamura H. and Viputhanumas T. (2005). Development of an Automatic Fish Recapture System and Recapturing Experiments on Mekong giant Catfish, *Journal of Advanced Marine Science and Technology Society*, **10**, 2, 51-57.

Yoshida Y. and Sera H. (1970). On chitinolytic activities in the digestive tracts of several species of fishes and the mastication and digestion of foods by them, *Bulletin of the Japanese Society of Scientific Fisheries*, **36**, 8, 751-754.

Yuwadee P. (2005). Freshwater algae in northern Thailand, Published by The Biodiversity Research and Training Program (BRT).