THE UNIVERSITY OF MANITOBA

BIOLOGY AND SOME MANAGEMENT PROBLEMS OF THIRTEEN ECONOMICALLY IMPORTANT FISH SPECIES IN UBOL RATANA RESERVOIR, THAILAND

by

SANAY PHOLPRASITH

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT

FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF ZOOLOGY

WINNIPEG, MANITOBA

MAY, 1974

BIOLOGY AND SOME MANAGEMENT PROBLEMS OF THIRTEEN ECONOMICALLY IMPORTANT FISH SPECIES IN UBOL RATANA RESERVOIR, THAILAND

by

SANAY PHOLPRASITH

A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

ACKNOWLEDGMENTS

The author wishes to thank Dr. W.E. Johnson, the former Director of the Freshwater Institute and the NIFI Project Director, not only for his invaluable suggestions on this thesis, but also for his hospitality while I was studying in this country.

Greatest thanks to Dr. G.H. Lawler, the Director of the Freshwater Institute and Co-director of the NIFI Program, for his endless kindness and assistance throughout the study, and especially during the preparation of this manuscript.

A special thanks to Dr. M.C. Healey, the Program Leader of Fish Population and Production, Freshwater Institute, for his invaluable suggestions and assistance in interpreting the result of this thesis.

The author is grateful to his thesis advisers, Dr. F.J. Ward, Dr. C.C. Lindsey, and Dr. J.W.T. Dandy in the Zoology Department, Dr. K. Patalas, Dr, Ian Dickson and Mr. J.W. Whitaker in the Freshwater Institute.

Sincere thanks to the Department of Zoology and the Head, Dr. H.E. Welch, for his great kindness and suggestions in planning the study program.

The author is grateful to the Canadian International Development Agency for their arrangement and financial support throughout this study in this country.

The assistance of his colleagues in Thailand in supplying information for this thesis is gratefully acknowledged.

At last, but not least, the author wishes to thank Mr. Chirdchai

Amatyakul, Chief of Inland Fishery Division, Department of Fisheries, Thailand. His endless kindness and encouragement are also very much appreciated.

ABSTRACT

Food habits, sexual maturity and spawning season, seasonal change in mean size, survival rate and biomass for 13 species of fishes in Ubol Ratana Reservoir were determined in order to study their biology and to use as a basic information in designing further research on fishery management in Thailand's reservoirs and lakes.

The fish studied are divided into three trophic levels of equal importance in fisheries. *Cirrhinus jullieni*, *Puntius gonionotus*, *Osteochilus hasselti*, and *Morulius chrysophekadion* are herbivorous. *Cyclocheilichthys apogon*, *Notopterus notopterus*, *Ompok bimaculatus*, *Ophicephalus striatus*, and *Pristolepis fasciatus* are carnivorous. *Hampala dispar*, *Ophicephalus lucius* and *Ophicephalus micropeltes* are predators. Fecundity and size at maturity of these species are widely variable but their spawning season occur in the rainy season during May-October. However, *N. notopterus*, *H. dispar*, *C. apogon*, *O. striatus* and *O. marmoratus* appear to have longer spawning seasons.

The 13 species had various patterns of seasonal change in mean size, size frequency distribution, and comparative maximum size between shallow water survey samples and the commercial catch. Combination of these observations was used to predict seasonal patterns of migration and distribution of these species in the reservoir. Comparison of survey and commercial catches suggests that survey samples may possibly be used as an index to predict the commercial catch of some species.

INTRODUCTION

Attempts at the biological management of large water bodies began only recently in Thailand in contrast with the situation in the temperate zone. Although a considerable accumulation of biological information exists for a number of reservoirs, to date no attempt has been made systematically to examine these data with a view to improving management techniques.

The objectives of this thesis are twofold. Firstly, to describe the biology of 13 commercially important species in Ubol Ratana Reservoir in northeastern Thailand. Secondly, to consider whether the information presently available can be used to improve the management of the reservoir.

Fisheries in Thailand and the importance of Ubol Ratana Reservoir

Fish and its products is a staple food of the Thai people. It is a cheap source of protein that they can obtain throughout the country, therefore, most of their meals are composed of fish or fishery products.

Fisheries rank next to agriculture among the basic industries of the country. Total annual catches have increased from 393,855 metric tons in 1963 to 1,448,404 metric tons in 1970. Freshwater fish comprised about 15 to 20% of these catches; 70,481 tons in 1963 and 112,714 tons in 1970 (Anon., 1972).

Ubol Ratana Reservoir plays an important role in freshwater fisheries of the country. It produced 1,395.1, 1,402.9 and 2,120 tons

of freshwater fish in 1969, 1970 and 1971 respectively (Pholprasith *et al.*, 1969, 1970 and 1971). There are 1,196 families around this reservoir who take up fishing in order to earn additional income and for daily consumptions (Anon., 1973). Fish caught from this reservoir are consumed by the population in Khonkaen and other nearby provinces such as Udornthani and Nongkai in the northeast. Therefore, the development of fisheries in this reservoir provides protein nutrition and economic stability to the people in some parts of the northeast.

Sources of information

Information used in this thesis came from two main sources. Comparative information concerning distribution, morphological characteristics, food habits, size at first maturity and spawning season in other reservoirs came from reports by various authors which were published in Thai and from Smith (1945). Data on relative abundance, size frequency distribution, food habits and spawning season in Ubol Ratana Reservoir were collected by me between 1969 and 1971 with some additional observations in summer 1973.

By drawing together many scattered and diverse pieces of information it has been possible to make up-to-date descriptions of the major features of the biology of the species considered. The various sources of information for each species will be acknowledged in the section describing the biology of individual species.

DESCRIPTION OF THE STUDY AREA

Ubol Ratana Reservoir, the largest man-made lake in Thailand, is situated in Khonkaen Province, in northeast Thailand (Fig. 1). The average annual rainfall in this area is about 1,200 mm, most of which falls between April and October (Fig. 2). The average monthly temperature in this area ranges between 21.4°C in December and 30.5°C in May (Anon., 1969).

The dam was completed in January 1965 and the lake was filled in nine months. The lake has a complex dendritic shape (Fig. 3). The main basin follows the course of the Pong River and a major arm runs southward along the course of the Cheon River. Its watershed area is about 12,000 km^2 (Anon., 1973).

At maximum storage elevation of 182 m above sea level it has a total surface area of 410 km^2, with a maximum depth of 19.5 m and the mean depth of 15.7 m. At its minimum elevation of 176 m above sea level its surface area is reduced to 160 km^2 with mean depth to about 10 m (Anon., 1973).

Physical and chemical characteristics

Sidthimunka *et al*. (1968) reported that in November 1966, the reservoir was not stratified but that in April 1967 there was weak thermal stratification that eventually broke down under the influence of monsoon winds. Shiraishi and Kimura (1971) reported both thermal and chemical stratification in this reservoir in July 1969. The thermocline lay between 11 and 13 m.

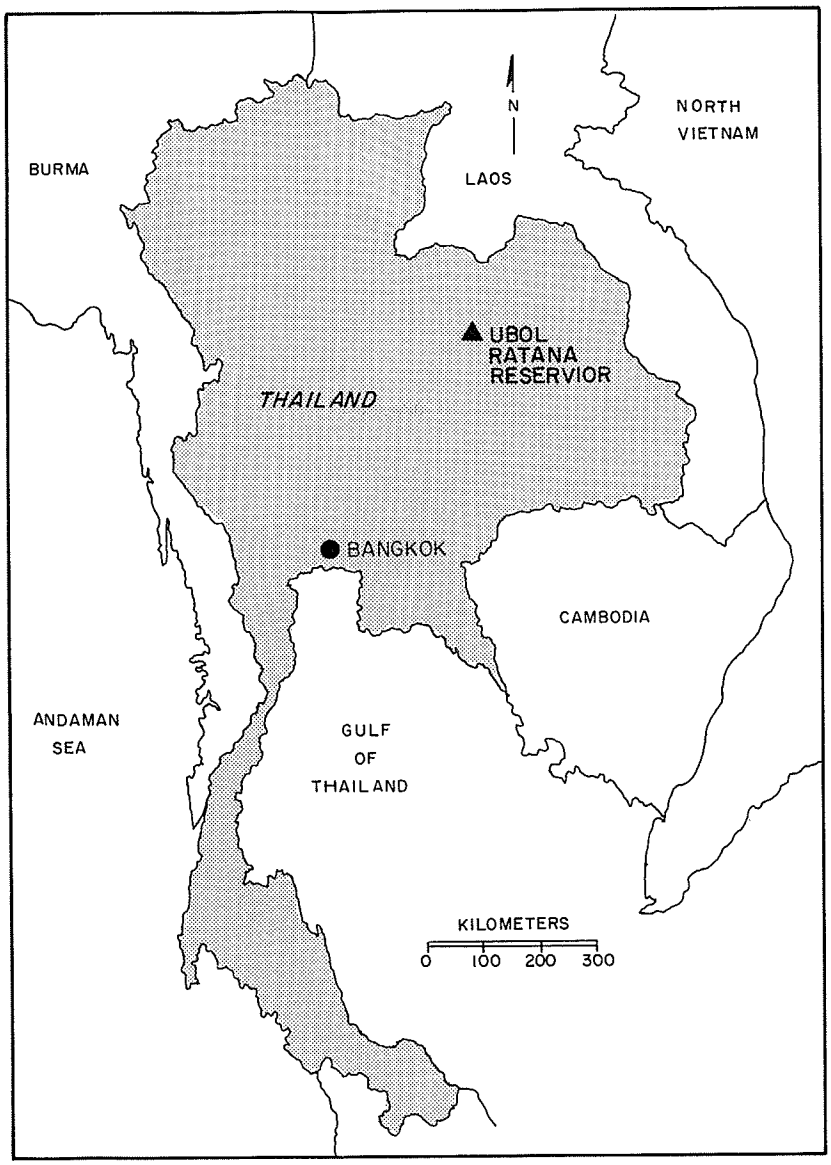

Fig. 1. Map of Thailand showing site (▲) of Ubol Ratana Reservoir.

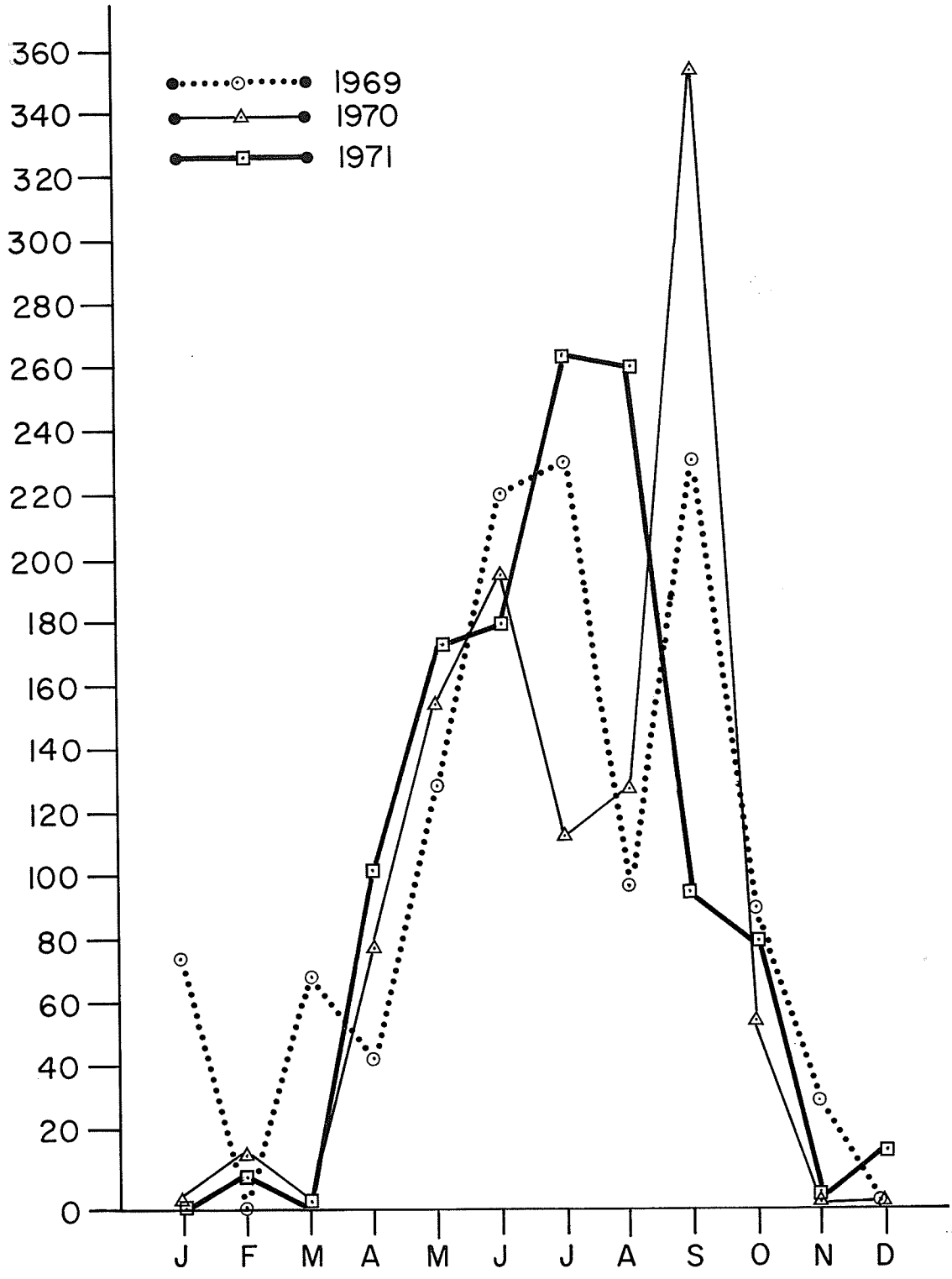

Fig. 2. Monthly rainfall (mm) in Ubol Ratana Reservoir during 1969-1971.

In November 1966 dissolved oxygen was as high as 6.48 mg/l at the surface and gradually declined to 4.00 mg/l at 12 m. Carbon dioxide ranged from 5.55 mg/l at the surface to 7.90 mg/l at 12 m. Other chemical properties such as H_2S, PO_4 and alkalinity did not indicate any great difference with depths (Sidthimunka *et al*. (1968)

Plankton and benthos

Plankton and benthos in the reservoir were studied by Sidthimunka *et al*. (1968). Plankton standing crop in the reservoir was high. Though the species of plankters occurring in different seasons appeared to be the same, there were some differences in the relative abundance of different groups. While protozoans, rotifers and nauplii of copepods were dominant in April, cladocerans, copepods and *Polycystis* sp. were dominant in November. *Volvox* sp. and rotifers were present in small quantities during both periods. Plankton were generally more abundant in November than in April (Sidthimunka *et al*., 1968).

Annelids, *Chaoborus* spp, chironomids and gastropods were the dominant benthos in April and November. Stray specimens of Ceratopogonidae, ostracods, *Promoresia* spp, *Caenis* spp, were also found. Generally, benthos was most abundant between the depths of two to six meters (Sidthimunka *et al*., 1968).

Fish fauna

Species composition and relative abundance of fish in the area has changed as a result of constructing the reservoir (Sidthimunka *et al*., 1968). Prior to impoundment 77 species of fishes were captured in samples from the Cheon and Pong Rivers. Most abundant were carp (31

species) which constituted 59.9% of the samples by weight, and catfish (14 species) which constituted 20.6% by weight.

Fewer species of fish were captured after impoundment. Of the 77 species that were recorded in the rivers before dame construction, only 43 were observed one year after the reservoir was formed (Sidthimunka *et al.*, 1968). An additional nine species which were not observed before impoundment were present in the post-impoundment samples. Cyprinids decreased from 31 to 25 species; cobitids decreased from 9 to 6 species; catfish (Siluridae and Bagridae) decreased from 10 to 5 species; and anabantids from 6 to 3 species. Of the nine new species found, 1 was the swamp eel (*Fluta alba*), 1 was the cobitid (*Nemacheilus poculi*), the remaining 7 were cyprinids.

The relative abundance of carnivorous species was much greater after impoundment. While cyprinids continued to be the most numerous in respect to number of species, they constituted only 24.1% by weight of the samples as against 55.9% prior to impoundment. On the other hand, *Ophicephalus* species comprised 34.8% of the total weight of samples after impoundment as against 16.5% prior to impoundment (Sidthimunka *et al.*, 1968).

MATERIALS AND METHODS

Data used in this study were taken from two major sources. Those used in calculations for mean length comparisons, survival rates, and biomass were taken from rotenone sampling along the margin of the reservoir. Data on annual commercial catch and domestic catch size were taken from commercial fishing records collected at the major landing site in the reservoir.

Information was collected on all species in the reservoir, however only the 13 most commercially valuable species will be discussed in this thesis. These were: *Notopterous notopterous*, *Hampala dispar*, *Cyclocheilichthys apogon*, *Cirrhinus jullieni*, *Puntius gonionotus*, *Osteochilus hasselti*, *Morulius chrysophekadion*, *Ompok biomaculatus*, *Ophicephalus striatus*, *O. lucius*, *O. micropeltes*, *Pristolepis fasciatus* and *Oxyeleotris marmoratus*. Although *P. gonionotus*, *O. bimaculatus*, *O. striatus*, *O. lucius*, *O. micropeltes* and *P. fasciatus* were not as abundant as some other species, their high commercial value both at Ubol Ratana Reservoir and throughout the country make them worth studying.

1. Survey of fish fauna

A survey for species composition and abundance of the fish in Ubol Ratana Reservoir was conducted by dividing the reservoir into five different sectors (Zones I, II, III, IV, V, Fig. 3). The sampling station for each sector was located in the littoral zone. The maximum depth of the sampling station varied from 1.50 to 2.0 m whereas mean depth of the

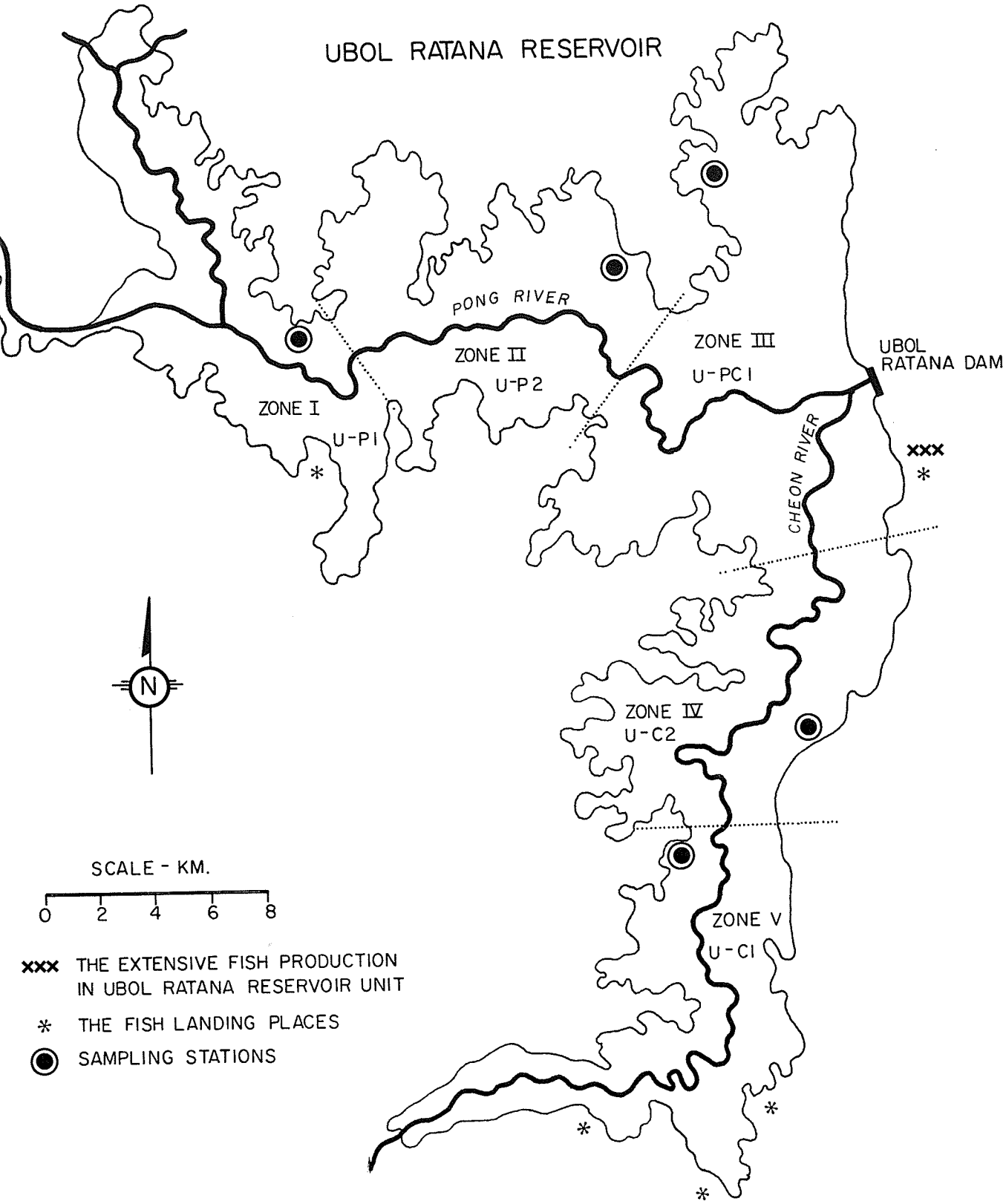

Fig. 3. Map of Ubol Ratana Reservoir showing sampling stations.

reservoir varied from 10 to 15.75 m. All sectors were sampled in the third week of every month from March 1969 to August 1971.

A sampling area of about 800 m^2 was enclosed by a 100 meter long seine having 13 mm mesh. General characteristics of the sampling station such as water temperature, pH,transparency, mean depth, type of bottom and vegetation were observed. The area enclosed by the net then was poisoned with rotenone. The dosage of rotenone used was 1 kg/100 m^3 of water. Dead and moribund fish floating on the surface were collected with dipnets. Later, the net was hauled like a seine to capture any fish that had sunk to the bottom.

Most fish were identified to species at the sampling site with the aid of Smith (1945). A few of the smaller species could not be identified in the field. Representatives of these species were preserved in formalin and taken to the laboratory for more detailed examination. All fish were individually measured and weighed in the field except those smaller than 20 mm which were weighed in a group.

All data were transferred to IBM punch cards and a number of summaries of the information were performed by computer. These summaries included the calculation of mean length and weight and standard error for each month and length frequency histograms.

The rotenone sampling method that was used in this study is a well-known method and widely used in the study of fish populations. Swingle (1953), Swingle and Swingle (1967), and Hayne _et al_. (1967), indicated that this method was essentially a marginal, shallow water sampling technique and that many of its shortcomings were well known.

Probably the greatest shortcomings in this method are that small fish may not be recovered after poisoning and that, because only a limited depth range can be sampled, the sample may not be truly representative of population structure. Further, it should be remembered that samples collected by this method are at best an index of population size.

Data on the commercial fishery were collected from the daily accounts of the fishmongers at the fish landing place. The only readily available information was total landings in kilograms for each species. In addition some data is available on maximum sizes of fish captured in the fishery. Most commercial fishing is done with gill nets so that commercial catch data are based by the selectivity of gill nets. The commercial fishery, however, operates in the deeper water of the reservoir and so provides a valuable comparison with the rotenone sampling.

To properly interpret the survey data it is important to know whether the samples were representative of the population structure in the 13 species being considered. Although this question cannot be answered with certainty, three pieces of information will help in making a decision. Firstly, if the maximum size of fish captured in the survey sampling was substantially smaller than that of fish captured in the commercial fishery, one could conclude that the largest size classes of fish were not available to the survey sampling. Secondly, it is known that all 13 species spawn in the littoral and that their young use the littoral as a nursery area. If the larger fish are generally absent from the littoral except at spawning, then the mean size of fish in the rotenone samples should increase dramatically during the spawning season. Finally,

if the sample of fish from the littoral is representative of the abundance of fish in the reservoir, then fluctuations in survey catch should show the same pattern as fluctuations in commercial catch, allowing of course for fluctuations in market value, etc., which would influence fishermen.

2. Survival rates estimates

The general method of estimating survival is by comparing the number of animals alive at successive ages. When age is not available, as in our case, length frequencies can be used in a similar manner (Ricker, 1958). A modification of Jackson's (1939) method was used to calculate the survival rate according to size. This calculation is based on number of fish in each 30 mm size class instead of number of fish in each age class. The size class of the greatest abundance was considered as the first group in the calculation of survival by the following formula (Ricker, 1958).

$$\hat{S} = \frac{N_2 + N_3 + N_4 + \ldots\ldots N_r}{N_1 + N_2 + N_3 + \ldots\ldots N_{r-1}}$$

$\hat{S}$ = Survival

N_1 = Abundance of the size class with greatest number.

$N_2 \ldots N_4$ = Abundance of successive larger size classes.

An important assumption in applying this method is that the rotenone sample is a representative selection of all sizes in the

population. Survival will only be calculated for those species for which samples are shown to be representative.

3. Calculation of biomass

The biomass of each size class for each species can be calculated by the formula (Ricker, 1971):

$$B = N\bar{w}$$

where

B = Biomass of each size class

N = Number of fish in each size class

$\bar{w}$ = Average weight of individuals in each size class for each species (from tables of Sidthimunka 1973). Sidthimunka's tables were derived from measurement of fishes taken from all types of natural waters throughout Thailand over an extended period of time, so that they can be considered typical average weights of that species.

Calculation of biomass was carried out only for those species in which the samples appear to be the representative of the population.

The number of surveys in each year was different, so the total biomass of each size class was divided by number of surveys and the area surveyed in hectare to obtain the average biomass in grams per hectare for each species in the shallow littoral zone.

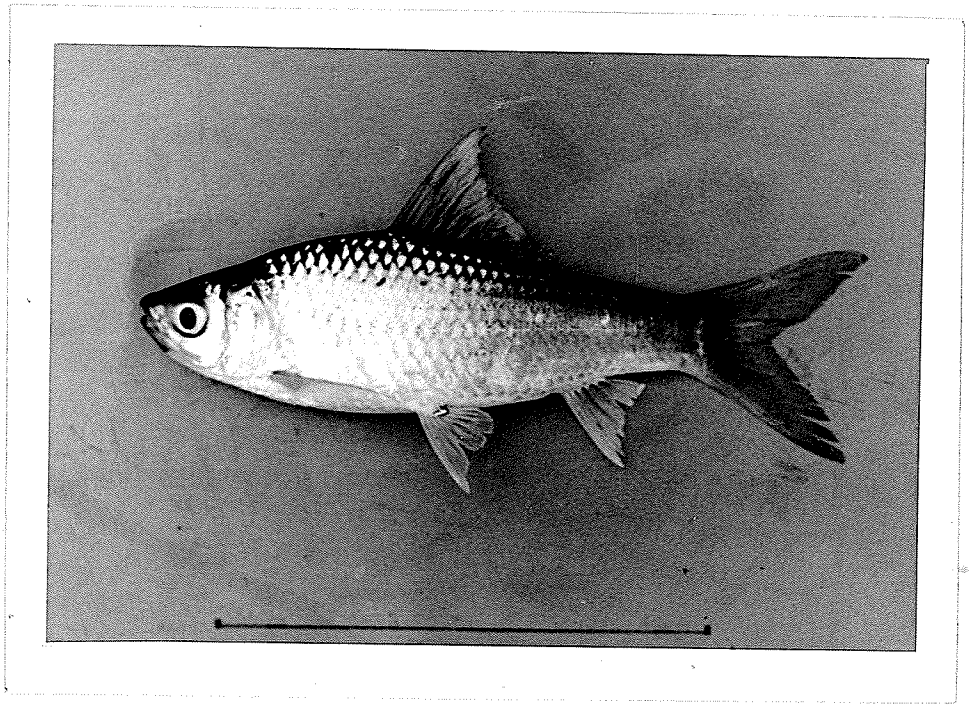

Plate 1. Cirrhinus jullieni Sauvage

Thai name: -

RESULTS

Results will be presented in the following manner. First, descriptions of the general biology for each species according to their trophic level. Second, the representativeness of the rotenone samples for each species will be discussed. Finally, calculations of survival rate and biomass will be made where it is appropriate.

Cirrhinus jullieni Sauvage Thai name: -

Subclass Teleostomi

Order Eventognathi

Family Cyprinidae

Distribution and habitats

The range of this species embraces Laos, Cambodia and Thailand. It has been found in various parts of central, northern, and eastern Thailand, being especially common in tributaries of the upper Chao Phya River. The usual size of this fish is 150-170 mm and it may reach a length of 200 mm (Smith 1945).

In the early period after the reservoir filled, the population of *C. jullieni* was scarce, but it has become steadily more abundant. The annual catch in 1969 was only 23.0 tons, rose to 72.8 tons in 1970 and to 444.3 tons in 1971 (Pholprasith *et al.*, 1969, 1970, 1971).

Food habits

C. jullieni is herbivorous. Sidthimunka (1972) reported that *C.*

jullieni in the Meklong River fed mainly on plant detritus, with phytoplankton and zooplankton as its secondary food. Fifty specimens from Ubol Ratana Reservoir were examined in June, 1973. Forty-two per cent of the stomach contents was plant detritus and 50% was phytoplankton and algae. There was no significant difference in the diets of fish ranging in length from 75 mm to 125 mm.

Size at first maturity and spawning season

This fish reaches first maturity at 127 mm in Ubol Ratana. Unfortunately, information that is relevant to the spawning of this species is rare. Smith (1945) reported that a specimen he obtained in September 8, 1934 in Bangkok was a female with ripe eggs. Fifty specimens from Ubol Ratana Reservoir ranging in size from 120 to 217 mm were examined in August 1973. Eight were immature, 22 had developing gonads, 13 were mature, and 7 were spent. Of 50 specimens examined in June, all had developing gonads only. Consequently, it is presumed that the spawning season of this fish falls in the period July-September.

Trends of mean length

Mean lengths of the fish captured in 1969, 1970 and 1971 have a similar seasonal trend. Mean length of the fish was greatest in May-July, then declined reaching a low point in August-September. The range of mean length was 39.9-190.4 mm (Table 1).

Mean length of the fish captured in 1971 was the largest of the three years, being 32.8 mm greater than the fish captured in 1970 and 63.8 mm greater than the fish captured in 1969 (Table 1).

Size frequency distribution was bimodal in 1970 and 1971, there being a scarcity of fish in the 104-134 mm size class (Table 2).

Table 1. Monthly mean length data of *Cirrhinus jullieni*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	110.0 ± 7.66	95.0 ± 0.00	105.0 ± 0.00	-	-	42.2 ± 6.28	51.5 ± 8.57	57.4 ±20.83	57.8 ± 9.36	98.3 ±32.85	56.3 ± 19.87
1970	97.0 ± 3.55	101.3 ±13.05	110.0 ± 0.00	169.7 ±24.84	- -	- -	190.4 ± 9.77	51.1 ± 9.87	57.1 ±25.63	64.5 ±26.03	71.2 ±18.61	- -	87.3 ± 54.16
1971	-	65.0 ± 0.00	94.5 ±13.02	-	183.0 ±11.26	-	-	179.0 ±13.19	39.9 ± 5.75	-	-	-	120.1 ± 62.15

Table 2. Size frequency of *Cirrhinus jullieni*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size (g)
0 - 14.5	2	2	1	5	0.001
14.6 - 44.5	167	41	41	249	0.11
44.6 - 74.5	25	22	7	54	1.5
74.6 - 104.5	22	19	26	67	6.1
104.6 - 134.5	3	1	2	6	16.6
134.6 - 154.5	-	3	32	35	35.8
164.6 - 194.5	-	15	38	53	67.2
194.6 - 224.5	-	1	-	1	96.2
224.6 - 254.5	-	-	-	-	-
254.6 - 284.5	-	-	-	-	
284.6 - 314.5	-	-	-	-	
314.6 - 344.5	-	-	-	-	
344.6 - 374.5	-	-	-	-	
374.6 - 404.5	-	-	-	-	
404.6 - 434.5	-	-	-	-	
434.6 - 464.5	-	-	-	-	
All size	219	104	147	470	

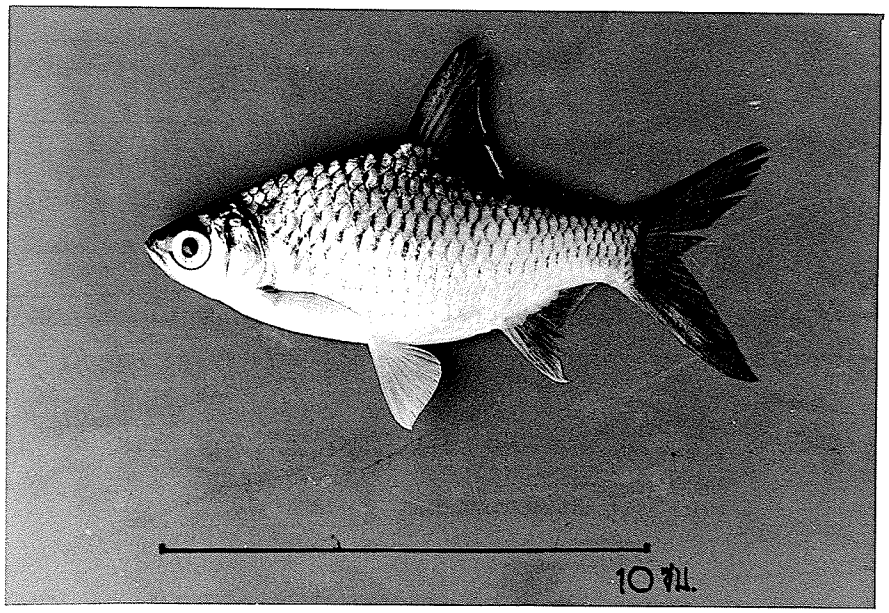

Plate 2. Puntius gonionotus (Bleeker)

Thai name: Pla tapien khao

Puntius gonionotus (Bleeker) Thai name: Pla tapien khao

Subclass Teleostomi

Order Eventognathi

Family Cyprinidae

Distribution and habitats

This species occurs in Java, Sumatra, Vietnam, Ceylon and Thailand. In Thailand it is most common in the rivers of the central region, especially in the Menam Chao Phya. It is not an outstanding species in southwestern and southeastern Thailand, and appears to be absent from the southern district bordering on Malaysia (Smith, 1945, Tarnchalanukit, 1970). Recently, it has been found in northeastern Thailand and in the Mekong River (Sidthimunka, 1970). This species is a common fish in Ubol Ratana Reservoir. The usual size of this fish is about 85-100 mm. Maximum length is greater than 500 mm (Tarnchalanukit, 1970). Its annual catch was 29.7 tons in 1969, 16.9 tons in 1970 and 48.1 tons in 1971 (Pholprasith, *et al.*, 1969, 1970, and 1971).

Food habits

This species is herbivorous. Fry and juveniles feed mainly on unicellular algae and zooplankton. Young and adult fish feed on higher aquatic plants such as Chlorophyceae, Characeae, Ceratophyllaceae, Bolygonaceae and Najadaceae (Tarnchalanukit, 1970). Popituk (1970) reported the fish in Bung Borapet fed 90% on aquatic plants and 10% on phytoplankton. However, Benjakarn (1973) found that 70% of the diet of *P. gonionotus* in Ubol Ratana Reservoir was aquatic plants, mostly

Hydrilla verticellata, which 30% of the diet was beetles.

Size at first maturity and spawning season

Paohom (1969) reported that size at first maturity of this fish is 85 mm, and 9 gm in weight. The number of eggs it lays is very high ranging from 124,464 at length 225 mm to 373,639 at length 295 mm. Spawning season is from late May to the middle of July. Tarnchalanukit (1970) reported that spawning can also occur in running water at the beginning of the rainy season (May-June). Its eggs are semibuoyant, round and transparent, having diameter 0.8-1 mm. After fertilized they will hatch within 8 to 12 hours at a water temperature of 29 to 32°C (Tarnchalanukit, 1970).

Trends of mean length

Seasonal trends of mean length of *P. gonionotus* captured in 1969, 1970 and 1971 were rather regular and very similar to those of *C. jullieni*. Highest in mean lengths occurred from April to August and minimum mean lengths from August to November (Table 3). The seasonal range of mean lengths was quite wide, 40 mm to 190 mm (Table 3).

Mean length of the fish captured in 1971 was the greatest of the three years, being 21.4 mm greater than the fish captured in 1970 and 50.6 mm greater than the fish captured in 1969 (Table 3).

Length frequency distribution was also very similar to *C. jullieni*, again bimodal with a scarcity of fish in the 104-134 mm size groups (Table 4).

Table 3. Monthly mean length data of *Puntius gonionotus*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	110.0 ± 7.66	95.0 ± 0.00	105.0 ± 0.00	-	-	42.2 ± 6.28	55.5 ±18.65	57.4 ±20.83	57.8 ± 9.36	98.3 ±32.85	58.1 ± 22.42
1970	97.0 ± 3.55	101.3 ±13.05	110.0 ± 0.00	169.7 ±24.84	-	-	190.4 ± 9.77	51.1 ± 9.87	57.1 ±25.63	64.5 ±26.03	71.2 ±18.61	-	87.3 ± 54.16
1971	-	65.0 ± 0.00	94.5 ±13.02	-	183.0 ±11.26	-	-	179.0 ±13.19	46.0 ±12.00	-	-	-	108.7 ± 62.01

Table 4. Size frequency of *Puntius gonionotus*.

Size category mm	Year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	2	2	1	5	0.005
14.6 - 44.5	107	41	59	267	0.33
44.6 - 74.5	25	22	20	67	2.8
74.6 - 104.5	26	19	26	71	9.5
104.6 - 134.5	5	1	2	8	22.6
134.6 - 164.5		3	32	35	44.2
164.6 - 194.5		15	38	53	76.4
194.6 - 224.5		1		1	132.2
224.6 - 254.5					
254.6 - 284.5					
284.6 - 314.5					
314.6 - 344.5					
344.6 - 374.5					
374.6 - 404.5					
404.6 - 434.5					
434.6 - 464.5					
All sizes	225	104	178	507	

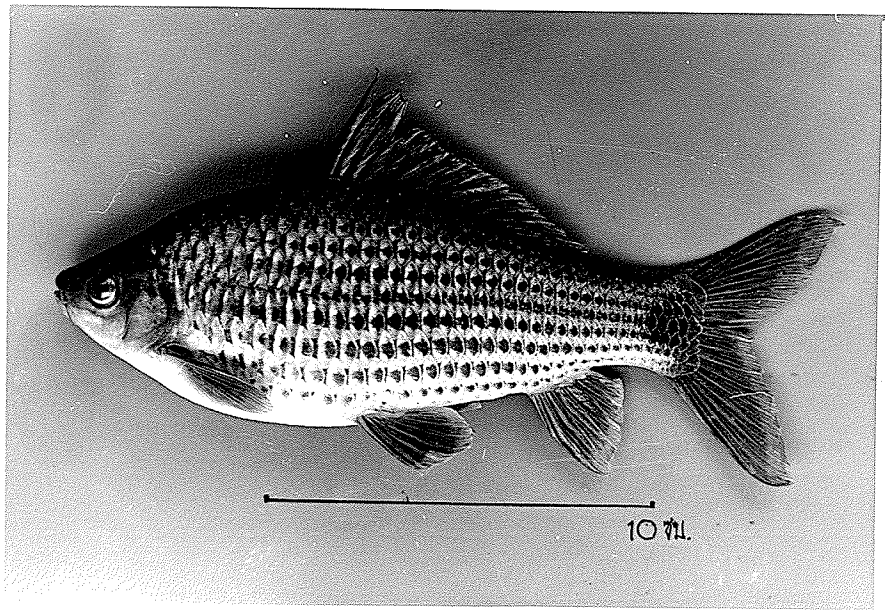

Plate 3. Osteochilus hasselti (Cuv. & Val.)

Thai name: Pla nok khao

Osteochilus hasselti (Cuv. & Val.) Thai name: Pla nok khao

Subclass Teleostomi

Order Eventognathi

Family Cyprinidae

Distribution and habitats

This is one of the most common and most widely distributed osteochilids in the rivers and lakes of the East Indies, Jahore, Malacca, Pahang, and other Malaya states, Cambodia, Vietnam, Indonesia and Thailand. In Thailand it is found throughout the length and breadth of the country (Smith, 1945, Chookajon, 1969).

Smith, 1945 stated that the length of the fish might exceed 300 mm, but in Ubol Ratana Reservoir examples as large as 250 mm are rare. There is no difference between average size of males and females (Chookajon, 1970).

O. hasselti is abundant in Ubol Ratana Reservoir. The annual catch in 1969 was 266.0 tons, it decreased to 92.0 tons in 1970 then rose to 236.6 tons in 1971 (Pholprasith *et al.*, 1969, 1970 and 1971).

Food habits

O. hasselti is herbivorous. Popituk (1970) reported that this species in Bung Borapet, at Nakornsawan in the central plain, fed 80% on aquatic plants, 10% on green algae and diatoms, and 10% on clams. Jaiyen (1971) reported that *O. hasselti* in Bung Kang Lava, Khonkaen fed mostly on aquatic plants; filamentous algae, diatoms and higher aquatic plants such as *Hydrilla verticellata* were its basic food. In

Ubol Ratana Reservoir, Chookajon (1970) found that young O. hasselti (50-99 mm) fed mainly on blue-green algae, green algae, desmids, and diatoms. Small amounts of debris were also found. Adult fish fed on annelids as well as plants. The amount of annelids in the guts of the fish increased in larger fish.

Size at first maturity and spawning season

Tarnchalanukit (1970) stated that the size at first maturity of O. hasselti was about 150-200 mm. Jaiyen (1971) reported that size at first maturity of this species in Bung Kang Lava, Khonkaen was 150 mm, and the number of eggs varied with size from 30,000-300,000. However, Jensirisak (1973) reported that size at first maturity in Ubol Ratana Reservoir was only 140 mm. In natural waters the peak of spawning usually falls at the end of the rainy season, but in ponds it can be made to spawn all year round by simulating correct environmental conditions (Tarnchalanukit, 1970). In Bung Kang Lava, southern Khonkaen, its spawning season was from July to September (Jaiyen, 1971). In Ubol Ratana Reservoir, Chookajon (1969) and Pholprasith (1969) reported that its spawning season fell during the period of August-September. However, Jensirisak (1972) reported that in 1972, the spawning season of O. hasselti began in July in Ubol Ratana. Jaiyen (1970) had also found that the spawning period of this species in Bung Kang Lava, was inconsistent from year to year.

Trends of mean length

O. hasselti showed a regular seasonal trend of mean length. Maximum mean length of the fish captured in 1969, 1970, and 1971

Table 5. Monthly mean length data of *Osteochilus hasselti*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969			124.0 ±35.58	186.8 ±41.63	59.2 ±29.07	-	187.3 ±36.63	108.7 ±86.50	66.4 ±40.19	49.1 ±21.62	42.9 ±17.31	80.5 ±20.46	76.7 ± 52.38
1970	85.5 ±26.31	92.2 ±37.06	98.7 ±26.35	121.7 ±41.35	146.0 39.16	205.0 ± 0.00	191.5 ±21.75	48.5 ±27.82	67.4 ±38.61	51.4 ±24.21	89.5 ±23.30	79.3 ±36.54	88.9 ± 47.28
1971	92.6 ±24.36	109.5 ±35.27	97.9 ±24.69	112.2 ±33.31	159.8 ±47.40	130.9 ±21.83	166.2 ±31.39	179.5 ±20.55	77.6 ±60.32	-	-	-	114.3 ± 48.66

Table 6. Size frequency of *Osteochilus hasselti*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	43	20	1	64	0.003
14.6 - 44.5	527	132	65	724	0.26
44.6 - 74.5	126	134	145	405	2.4
74.6 - 104.5	93	89	131	313	8.8
104.6 - 134.5	72	33	95	200	21.9
134.6 - 164.5	66	36	79	181	44.7
164.6 - 194.5	37	24	62	123	78.7
194.6 - 224.5	23	7	11	41	127.1
224.6 - 254.5	4	1	1	6	192.3
254.6 - 284.5					
284.6 - 314.5					
314.6 - 344.5					
344.6 - 374.5					
374.6 - 404.5					
404.6 - 434.5					
434.6 - 464.5					
All size	991	476	590	2057	

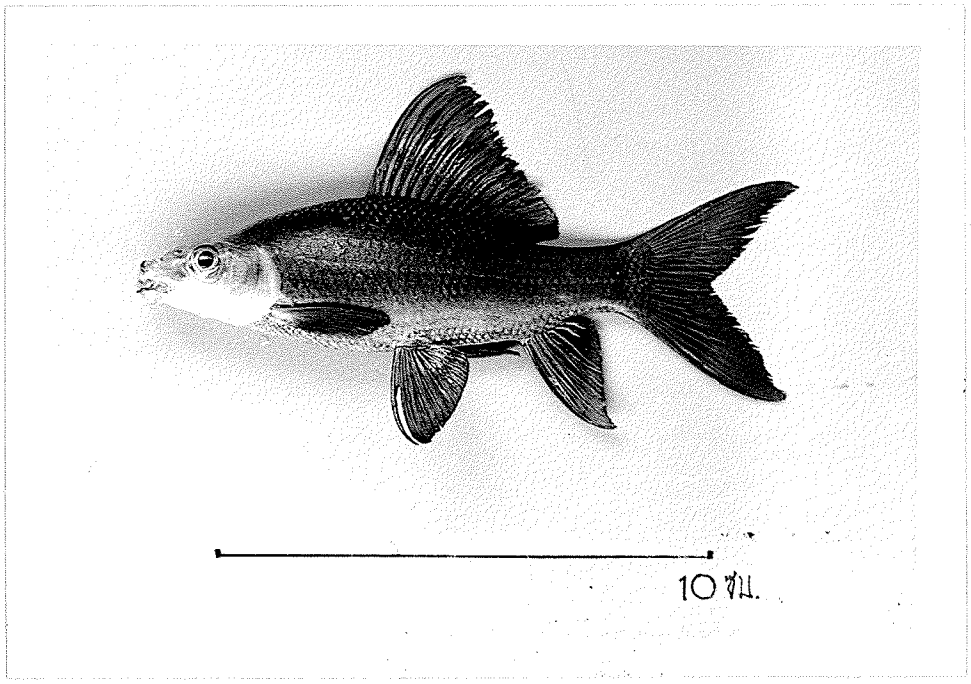

Plate 4. Morulius chrysophekadion (Bleeker)

Thai name: Pla ka

occurred in June-August and decreased sharply to minimum mean length in August-November. The range of mean lengths was 42.9-205.0 mm (Table 5).

Mean length of the fish captured in 1971 were greatest of the three years, being 25.4 mm greater than the fish captured in 1970 and 37.3 mm greater than the fish captured in 1969 (Table 5).

Length frequency distribution was unimodal, most fish falling into the 14-44 mm size class in 1969 and in the 44-74 mm size class in 1970 and 1971 (Table 6).

Morulius chrysophekadion (Bleeker) Thai name: Pla ka

Subclass Teleostomi

Order Eventognathi

Family Cyprinidae

Distribution and habitats

This striking species is distributed through Java, Borneo, Sumatra, Cambodia, and Laos, as well as Thailand. In Thailand, it inhabits rivers, canals, and lakes throughout the central region and the basin of the Chao Phya River. Bung Borapet, which connects with the Chao Phya River and the Nan River near Pakmampo, is an important breeding ground of this species (Smith, 1945). Recently, it has been found in Ubol Ratana Reservoir in Khon Kaen and as far northeast as the Mekong River (Pholprasith, 1969, 1970, and 1971; Sidthimunka *et al.*, 1970). This species is abundant in Ubol Ratana Reservoir. Its catch was 98.0 tons in 1969, decreased to 61.8 tons in 1970, then increased

to 112.4 tons in 1971 (Pholprasith, et al., 1969, 1970, and 1971).

Food habits

M. chrysophekadion is a herbivorous fish. Popituk (1970) reported this species in Bung Borapet, fed mostly on aquatic plants and algae. Its basic food is composed 70% of aquatic plants, and 30% green algae and diatoms. In addition to plants protozoans and crustaceans formed part of the food of this species in Ubol Ratana Reservoir (Veerakawoot and Jaiyen, 1970). They found 85% algae, 10% debris, and 5% protozoans and crustaceans in the stomach contents of M. chrysophekadion.

Size at first maturity and spawning season

Pinyoying (1971) noted that this species had high fecundity. A female 660 mm long had 751,300 eggs. The eggs were semibuoyant, spherical, and a grey colour when ripe. Pinyoying (1971) also stated that, in Bhumipol Reservoir, Northern Thailand, ripe fish were usually found in July. Kamolratana et al. (1972) reported that the size at first maturity of this fish in Ubol Ratana Reservoir was 400 mm. Number of eggs varies with size, from 79,000 to 1,090,000. The spawning season was July-October.

Trends of mean lengths

M. chrysophekadion showed a regular seasonal trend of mean length. Maximum mean length of the fish captured in 1969, 1970 and 1971 occurred in June-August then decreased sharply to minimum mean length in August-November. The range of mean lengths was 43.21-216.6 mm (Table 7).

Mean length of the fish captured in 1971 were greatest of the

Table 7. Monthly mean length data of *Morulius chrysophekadion*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	124.0 ±35.58	180.2 ±39.88	165.6 ±34.40	-	216.6 ±68.96	103.1 ±85.37	69.0 ±49.62	48.9 ±21.68	43.21 ±17.42	80.5 ±20.46	79.3 ± 57.91
1970	85.5 ±26.31	93.7 ±35.26	98.5 ±24.89	121.7 ±38.98	146.0 ±39.16	205.0 ± 0.00	191.5 ±21.75	48.5 ±27.82	67.4 ±38.61	51.0 ±24.23	89.5 ±23.30	79.3 ±36.54	89.6 ± 46.52
1971	92.6 ±24.36	109.8 ±34.90	97.9 ±24.69	121.8 ±40.29	164.3 ±37.41	135.5 ±29.15	166.2 ±29.15	179.5 ±20.55	77.6 ±60.32	-	-	-	115.4 ± 49.19

Table 8. Size frequency of *Morulius chrysophekadion*.

Size category mm	No. individual year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	46	21	1	68	0.005
14.6 - 44.5	532	132	65	809	0.7
44.6 - 74.5	129	135	145	409	2.3
74.6 - 104.5	93	106	132	331	7.8
104.6 - 134.5	73	37	96	206	18.2
134.6 - 164.5	70	36	82	188	35.1
164.6 - 194.5	37	24	65	126	64.3
194.6 - 224.5	23	7	13	43	101.1
224.6 - 254.5	5	1	1	7	149.8
254.6 - 284.5	2	-	-	2	211.8
284.6 - 314.5	1	-	-	1	288.7
314.6 - 344.5	4	-	-	4	382.0
344.6 - 374.5	1	-	-	1	493.4
374.6 - 404.5	1	-	-	1	624.3
404.6 - 434.5	-	-	-	-	
434.6 - 464.5	-	-	-	-	
All size	1017	499	600	2196	

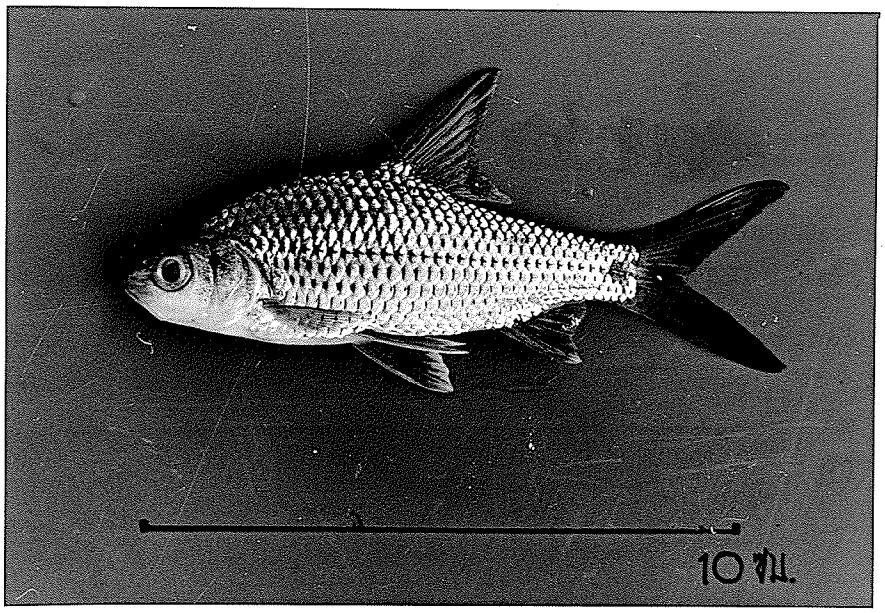

Plate 5. Cyclocheilichthys apogon (Cuv. & Val.)

Thai name: Pla sai ton

three years, being 25-8 mm greater than the fish captured in 1970 and 36.1 mm greater than the fish captured in 1969 (Table 7).

Length frequency distribution was unimodal, most fish falling into the 14-44 mm size class in 1969 and in the 44-74 mm size class in 1970 and 1971 (Table 8).

Cyclocheilichthys apogon (Cuv. & Val.) Thai name: Pla sai ton

Subclass Teleostomi

Order Eventognathi

Family Cyprinidae

Distribution and habitats

The range of this species includes Java, Borneo, Sumatra, and other islands in the East Indies, Malaya, Burma and Thailand. In local waters it is the commonest and most widely distributed species of Cyclocheilichthys. It has been found in the basin of the Chao Phya River as far north as Mae Poon; and in a mountain stream at Chantabun, Krat in southeast. It has also been found in many rivers in the southern part of Thailand (Smith, 1945). The usual size of this fish is 110-117 mm (Chookajon, 1969).

This species is the most abundant cyprinoid in Ubol Ratana Reservoir. Owing to its abundance, annual catches are high, being 469.6, 631.3 and 513.0 tons in 1969, 1970, and 1971 respectively (Pholprasith et al., 1969, 1970 and 1971).

Food habits

Sukomol (1970) reported that this fish in Ubol Ratana Reservoir feeds mainly on zooplankton, particularly cladocerans. Copepods are the secondary food. Small amounts of algae and detritus occurred in the gut, but diatoms and green algae were apparently not digestable by *C. apogon* (Sukomol, 1970). The young fish at 20-49 mm long feed mainly on cladocerans (Sukomol, 1970).

Size at first maturity

Chookajon (1969) and Sukomol (1970) reported that females of this species were bigger than males. In Ubol Ratana Reservoir, female fish matured at 98 mm long. Females of 150 mm contained about 4,000 eggs (Sukomol, 1970). Chookajon (1969) concluded that the peak of spawning of *C. apogon* in Ubol Ratana Reservoir was during July and August. Sukomol (1970) reported that *C. apogon* has a long spawning season and might spawn more than once a year. He observed two peaks of spawning, the first during July-August, and the second during December-January.

Trends of mean lengths

Mean lengths of the fish captured in 1969, 1970 and 1971 fluctuated in different patterns. Periods of reaching maximum and minimum mean length in each year were different. The range of mean lengths was narrow, 57.2-106.7 mm (Table 9).

Mean length of the fish captured in 1971 was largest of the three years being 7.0 mm greater than the fish captured in 1970 and 17.5 mm larger than the fish captured in 1969 (Table 9).

Table 9. Monthly mean length data of *Cyclocheilichthys apogon*

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	71.9 ±32.35	83.2 ±30.59	92.1 ±34.32	-	86.7 ±22.53	61.0 ±45.60	79.4 ±25.96	54.3 ±16.76	57.2 ±22.78	74.4 ±30.86	71.2 ± 33.03
1970	67.4 ±29.48	68.5 ±29.35	74.7 ±27.37	79.3 ±29.24	81.2 ±27.35	91.9 ±31.72	82.3 ±33.59	72.2 ±31.50	65.2 ±30.30	95.1 ±23.93	104.8 ±17.40	72.7 ±28.42	81.7 ± 30.49
1971	92.0 ±37.94	96.1 ±25.88	71.6 ±30.41	84.1 ±24.09	98.1 ±33.53	83.1 ±29.59	106.7 ±29.24	89.7 ±33.28	86.4 ±27.47	-	-	-	88.7 ± 30.75

Table 10. Size frequency of *Cyclocheilichthys apogon*.

Size category mm	No. individual year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	324	30	19	373	0.003
14.6 - 44.5	782	952	751	2,484	0.25
44.6 - 74.5	189	827	1,070	2,086	2.1
74.6 - 104.5	184	207	375	766	7.4
104.6 - 134.5	269	230	412	911	17.9
134.6 - 164.5	40	33	86	159	38.1
164.6 - 194.5	10	10	14	34	78.0
194.6 - 224.5	4	0	1	5	143.0
224.6 - 254.5	3	2	3	8	241.7
254.6 - 284.5	-	1	3	4	381.7
284.6 - 314.5	-	-	1	1	577.7
314.6 - 344.5	-	-	-		
344.6 - 374.5					
374.6 - 404.5					
404.6 - 434.5					
434.6 - 464.5					
All size	1,805	2,292	2,735	6,831	

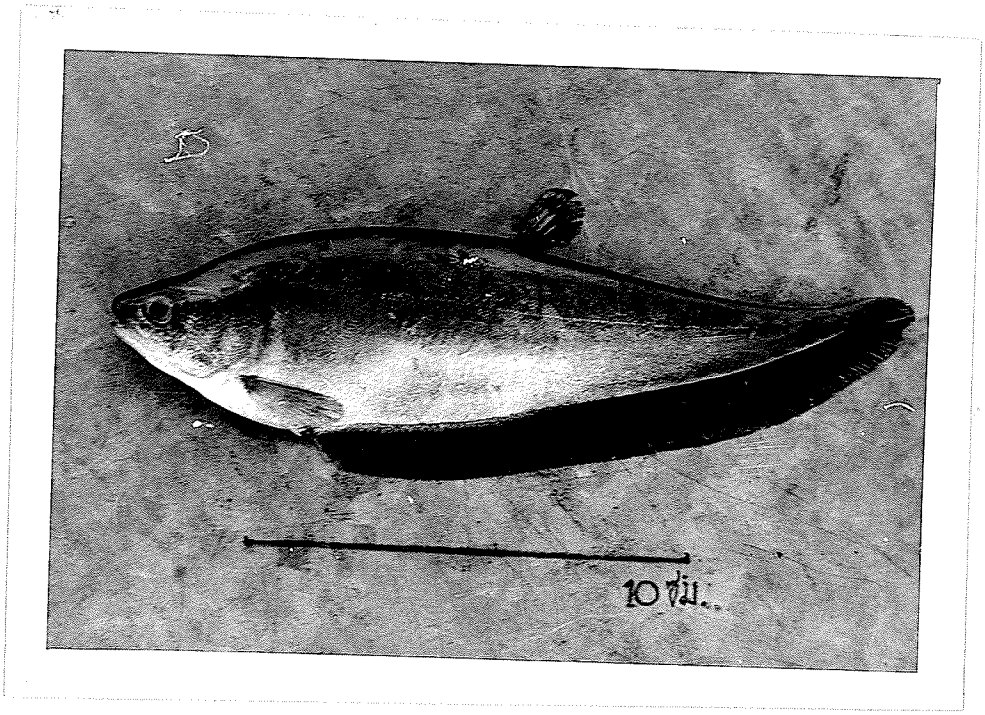

Plate 6. Notopterus notopterus (Pallas)

Thai name: Pla salat

Length frequency distribution was bimodal with a scarcity of fish in the 74-104 mm size class (Table 10).

Notopterus notopterus (Pallas) Thai name: Pla salat

Subclass Teleostomi

Order Isospondyli

Family Notopteridae

Distribution and habitats

The range of this species embraces Java, Sumatra, India, Burma, Malaya, and Thailand. It is generally distributed in Thailand, inhabiting rivers, swamps, and canals. In northern Thailand the fish appears to be uncommon. In Thailand, this fish may reach a length of 380 mm, while in India it may reach 600 mm (Smith, 1945). In Ubol Ratana Reservoir its annual catches in 1969, 1970 and 1971 were 104, 164 and 194 tons respectively (Pholprasith et al., 1969, 1970 and 1971).

Food habits

This species is a carnivorous fish. Popituk (1970) reported that the fish in Bung Borapet, Nakornsawan, fed mainly on aquatic insects (as high as 60% of the diet). Fish and freshwater shrimps were second in importance comprising 35% of the diet. The rest was plant debris. Kamolratana (1971) reported that in Bung Kang Lava, southern Khonkaen, insects and insect larvae also made up 60% of the diet; forage fish and freshwater shrimps were 38%, the rest were crustaceans, clams and debris. Insect larvae (Macronica sp.) were the basic food of the fish in Ubol

Ratana Reservoir. Freshwater shrimps (Order Mysidacea) were the secondary food, while a small amount of plant detritous was also found (Jensirisak, 1971).

Size at first maturity and spawning season

Jensirisak (1973) reported its size at first maturity to be 200 mm long. Fecundity varied from 1,034 - 2,000. The eggs are demersal with an adhesive membrane. At spawning the eggs are attached to submerged roots of aquatic plant or stumps about 1-2 meters below water surface.

This species in Ubol Ratana Reservoir appears to have a long spawning season and might spawn more than once a year because its fry were found during two periods; April-May and August-September in 1969 (Pholprasith, 1969). Jensirisak (1972, 1973), studying coefficient of maturity, concluded that the fish spawned during the periods of May-June and August-September.

Trends of mean lengths

Seasonal fluctuations of mean lengths of the fish in 1969, 1970 and 1971 samples have more or less the same trend. Mean length of the fish was greatest in the period of February-July then declined reaching a low point in July-September. The range of mean length was 68.0-209.0 mm (Table 11).

Mean length of the fish captured in 1969 were largest of the three years, being 21.1 mm greater than the fish captured in 1970 and 4.4 mm larger than the fish captured in 1971 (Table 11).

Length frequency distribution was unimodal, most fish falling into 104-134 mm size class in 1969 and in the 44-74 mm and 74-104 mm

Table 11. Monthly mean length data of *Notopterus notopterus*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	135.8 ± 33.45	188.4 ± 43.28	126.8 ± 70.39	-	209.0 ± 74.22	110.3 ±105.26	72.4 ±26.99	98.0 ±32.80	143.5 ± 39.91	135.5 ± 45.45	129.4 ± 64.29
1970	125.5 ± 55.68	176.8 ±72.73	113.4 ± 88.82	89.4 ±66.51	92.1 ±50.70	142.0 ± 93.99	68.0 ±18.07	98.1 ±59.49	89.3 ±21.05	99.0 ±35.39	106.8 ± 33.05	152.3 ± 51.96	108.3 ± 59.83
1971	115.8 ± 58.77	135.3 ±40.74	147.1 ± 35.01	144.8 ±58.09	177.6 ±64.73	121.7 ± 86.36	111.6 ±26.46	133.8 ±91.39	103.2 ±71.87	-	-	-	125.0 ± 70.47

Table 12. Size frequency of *Notopterus notopterus*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	14	17	4	35	0.01
14.6 - 44.5	50	70	49	169	0.52
44.6 - 74.5	50	129	53	232	2.1
74.6 -104.5	81	102	65	248	5.9
104.6 -134.5	97	66	32	195	12.5
134.6 -164.5	72	47	18	137	22.3
164.6 -194.5	29	29	27	85	35.8
194.6 -224.5	19	6	13	38	63.1
224.6 -254.5	13	4	13	30	99.4
254.6 -284.5	11	9	11	31	148.4
284.6 -314.5	5	5	4	14	212.4
314.6 -344.5	1	2	-	3	293.8
344.6 -374.5	-	-	-	-	
374.6 -404.5					
404.6 -434.5					
434.6 -464.5					
All size	442	486	289	1217	

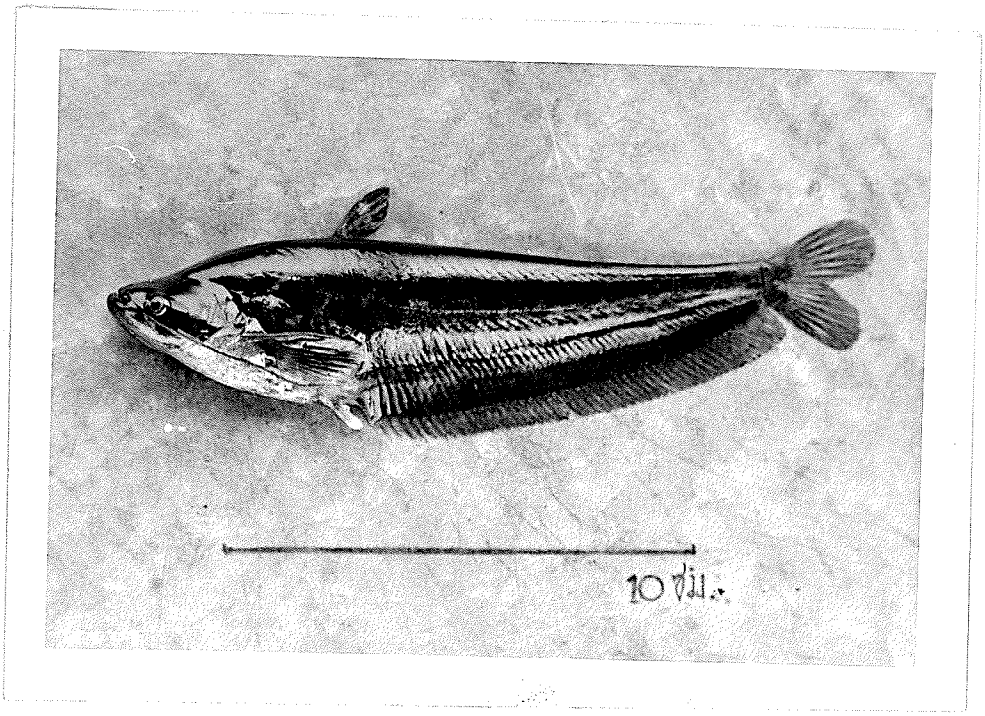

Plate 7. Ompok bimaculatus (Bloch)

Thai name: Pla cha oan

size classes in 1970 and 1971 respectively (Table 12).

Ompok bimaculatus (Bloch) Thai name: Pla cha oan

Subclass Telostomi

Order Nematognathi

Family Siluridae

Distribution and habitats

The distribution of this species extends from Java, Borneo, and Sumatra to Malaya, Thailand, and Indo-China, and thence to Burma, India and Ceylon. In Thailand the fish is widely distributed and abundant in rivers and lakes in the central plain, the peninsula, and in Southeastern and Eastern Thailand (Smith, 1945). This species attains a length of 400-450 mm but the usual size of the fish caught in Thailand does not greatly exceed 250 mm (Smith, 1945).

This species is not a predominant one in Ubol Ratana Reservoir, but its good taste and high price make it an economic species. Its annual catch has been increasing from 15.1 tons in 1969, to 31.1 tons in 1970, and 72.9 tons in 1971 (Pholprasith et al. 1969, 1970 and 1971).

Food habits

This fish is carnivorous. Benjakarn (1973) reported that in Ubol Ratana Reservoir insects, freshwater shrimps, and small fish constituted 60, 28, and 12% of the stomach contents respectively.

Size at first maturity and spawning season

Smith (1945) reported that two females of O. bimaculatus of

Table 13. Monthly mean length data of *Ompok bimaculatus*.

Month Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	111.3 ± 18.74	129.5 ±43.40	144.4 ±28.13	-	161.9 ±43.10	52.8 ±57.78	142.0 ± 0.0	40.5 ±30.89	125.9 ±36.58	101.5 ±19.63	106.3 ± 53.43
1970	110.9 ±35.93	79.4 ±21.97	124.7 ±30.92	146.1 ±51.70	178.9 ±47.64	83.0 ±0.0	124.4 ±53.20	109.0 ±66.13	110.0 ±38.83	122.8 ±28.41	98.0 ±42.88	68.2 ±23.41	107.2 ± 47.62
1971	71.7 ±25.95	94.2 ±34.84	97.8 ±25.91	146.6 ±43.44	104.8 ±51.52	150.2 ±25.70	161.8 ±14.12	133.0 ±45.0	144.2 ±59.76	-	-	-	109.1 ± 44.15

Table 14. Size frequency of *Ompok bimaculatus*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size (gm)
0 - 14.5	17	-	2	19	0.002
14.6 - 44.5	9	22	42	73	0.14
44.6 - 74.5	13	69	157	239	1.3
74.6 - 104.5	31	34	83	148	4.6
104.6 - 134.5	30	40	63	133	11.3
134.6 - 164.5	17	18	78	113	22.7
164.6 - 194.5	5	8	25	38	36.9
194.6 - 224.5	3	3	4	10	51.1
224.6 - 254.5	-	3	1	4	67.8
254.6 - 284.5	-	1	-	1	97.2
284.6 - 314.5					
314.6 - 344.5					
344.6 - 374.5					
374.6 - 404.5					
404.6 - 434.5					
434.6 - 464.5					
All size	125	198	455	778	

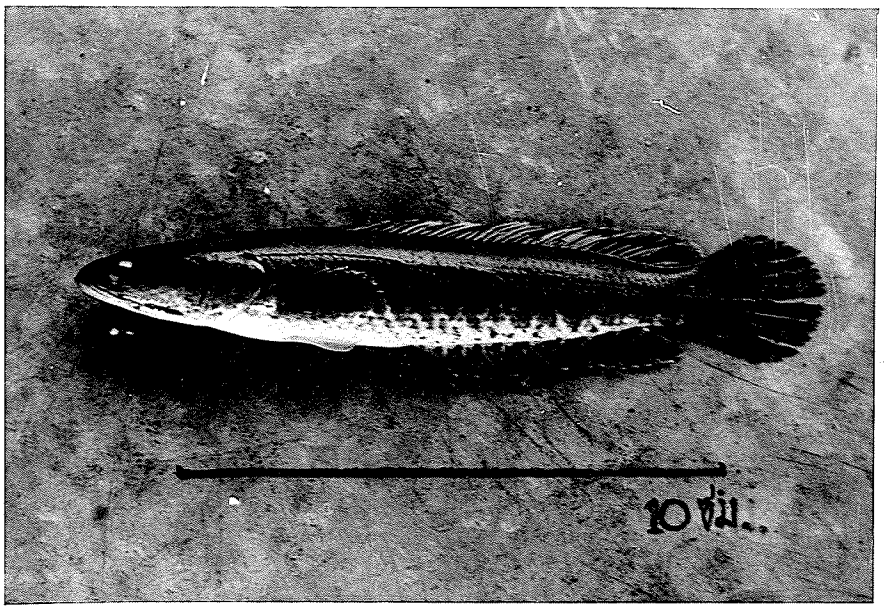

Plate 8. Ophicephalus striatus Bloch

Thai name: Pla chon

255 mm length taken in October 8, 1923 in the southern part of Thailand had large ovaries with nearly ripe eggs. However, Kamolratana et al. (1972) reported that this species in Ubol Ratana Reservoir attained first maturity at a length of 120 mm. Fecundity ranges from 1,700-68,000 (Kamolratana et al., 1972). Spawning season of this species fell in the period of September-October, in agreement with Smith (1945).

Trends of mean length

This species showed an irregular seasonal trend of mean length which was inconsistant from year to year. The seasonal range of mean length was 40.5-178.9 mm (Table 13).

Mean length of the fish captured was almost the same each year.

Length frequency distribution was unimodal, most fish falling into the 74-104 mm size class in 1969 and 44-74 mm size class in 1970 and 1971 (Table 14).

Ophicephalus striatus Bloch Thai name: Pla chon

Subclass Teleostomi

Order Labyrinthici

Family Ophicephalidae

Distribution and habitats

This species is the most widely distributed and economically the most important member of the genus. It ranges from China to India and Ceylon, and throughout the East Indies, Phillipines, Indonesia and Thailand (Smith, 1945). In Thailand, the fish is found throughout the

length and breadth of the coastal plains, central plains, eastern and northeastern plateau, in rivers, lakes, swamps and ricefields. It sometimes can tolerate a slightly brackish water (Tarnchalanukit, 1970). The usual size of this fish is 300-400 mm, however, Smith (1945) reported that a length of one meter might be attained.

This species is abundant in Ubol Ratana Reservoir. Annual catches are quite high and market value is good. In 1969, the annual catch was 48.2 tons, increased to 57.6 tons in 1970, and to 62.7 tons in 1971 (Pholprasith *et al*. 1969, 1970, and 1971).

Food habits

Tarnchalanukit (1970) reported that *O. striatus* altered its food and feeding habits with the growing stage. Fry fed mainly on phytoplankton, protozoa and crustaceans. Juvenile and young lived mostly on crustaceans, while algae were its secondary food. The adult is truly carnivorous. Apparently small fish and freshwater shrimps are its staple food (Sungkakul, 1972). Kamolratana, 1971 reported that the food compositions of *O. striatus* in Huey Taey, southeastern Khonkaen, was 55.95% small fish, 24.24% annelids, 5.74% insects and insect larvae, and 3.15% freshwater shrimps, while the rest were miscellaneous substances. Benjakarn (1973) reported that in Ubol Ratana Reservoir, insects were the most important food of *O. striatus*, as high as 52%, with 28% of freshwater shrimps, 18% of small fish and 2% of aquatic plants.

Size at first maturity and spawning season

Smith (1945), reported that the fish reached first maturity when 210 mm long. Jensirisak (1973) also reported that the fish in Ubol

Ratana matured at 210 mm. Evidently, this species can spawn throughout the year (Tarnchalanukit (1970) and Potongkum (1971)). Nevertheless, Jensirisak (1973) found that the peak of spawning of O. striatus in Ubol Ratana Reservoir fell in June.

Smith (1945), Tarnchalanukit (1970), and Potongkum (1971) have described the interesting spawning habits of this species. A floating nest having a diameter about 50 cm is prepared in shallow water by the parent fish by biting off aquatic vegetation. Eggs are laid as a thin film at the surface in early morning and taken care of by male fish. The eggs are creamy yellow with 1.4-1.5 mm in diameter and have a big oil globule. The eggs will hatch within 22-24 hours at a water temperature of 27.6°C. Morphological development of the fry will be completed in 22 days at the same temperature.

Trends of mean length

O. striatus showed irregular seasonal trends of mean length. Times of reaching maximum and minimum mean length in the three years were inconsistent. The seasonal range of mean length was 105.1-242.4 mm (Table 15).

Mean length of the fish captured in 1970 was greatest being 7.0 mm greater than the mean length in 1969 and 21.7 mm greater than the fish captured in 1971 (Table 15).

Length frequency distribution suggested a very weak bimodality. Similar numbers of fish were caught over a wide range of size classes (44-194 mm) (Table 16).

Table 15. Monthly mean length data of *Ophicephalus striatus*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	165.5 ±74.84	193.9 ±112.86	242.4 ±97.09	-	147.2 ±112.44	132.3 ±123.09	142.0 ± 0.00	141.0 ±91.43	152.4 ±73.97	177.6 ±77.04	166.8 ± 95.43
1970	178.8 ± 74.72	144.2 ±67.31	167.4 ±70.44	195.0 ±72.05	185.0 ±61.53	206.7 ±88.45	214.0 ±100.51	182.2 ± 91.78	209.1 ±109.64	105.1 ±96.29	188.2 ±77.63	157.9 ±94.22	173.8 ± 80.86
1971	158.9 ± 89.79	134.8 ±69.91	157.0 ±87.33	184.0 ±84.96	114.3 ±69.23	161.7 ±52.86	175.2 ± 70.93	139.1 ± 50.93	137.1 ±96.31	-	-	-	152.1 ± 77.76

Table 16. Size frequency of *Ophicephalus striatus*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	18	0	3	21	0.002
14.6 - 44.5	41	41	67	149	0.20
44.6 - 74.5	18	84	184	286	1.8
74.6 - 104.5	73	69	115	257	6.3
104.6 - 134.5	67	82	122	271	15.4
134.6 - 164.5	45	97	175	317	30.0
164.6 - 194.5	56	100	99	255	51.2
194.6 - 224.5	43	85	78	206	80.5
224.6 - 254.5	22	55	45	122	119.2
254.6 - 284.5	13	37	27	77	168.3
284.6 - 314.5	12	17	16	45	229.3
314.6 - 344.5	11	12	11	34	301.2
344.6 - 374.5	7	9	12	28	393.7
374.6 - 404.5	4	3	6	13	503.7
404.6 - 434.5	3	3	0	6	632.8
434.6 - 464.5	4	1	1	6	782.6
464.6 - 494.5	2	-	2	4	954.6
All size	439	695	963	2097	

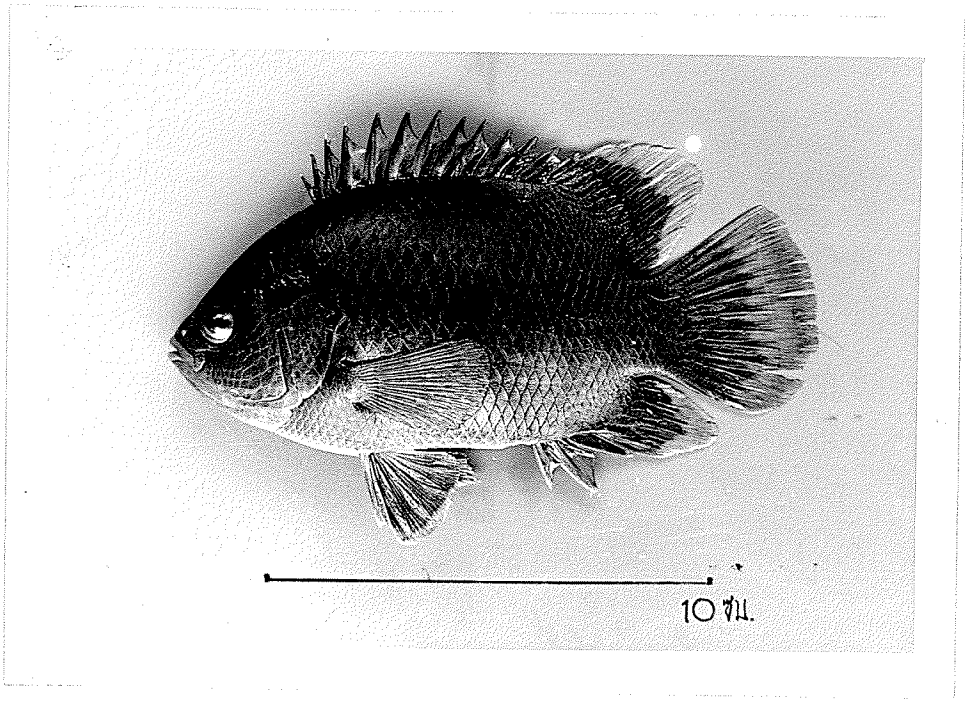

Plate 9. Pristolepis fasciatus (Bleeker)

Thai name: Pla mor chang yieb

Pristolepis fasciatus (Bleeker) Thai name: Pla mor chang yieb

Subclass Teleostomi

Order Percomorphi

Family Nandidae

Distribution and habitats

The range of this fish extends to Indo-China, Burma, Malaya, some East Indian islands and Thailand. In Thailand, it is found throughout the entire length and breadth of the country, in rivers, lakes, swamps, and ponds (Smith, 1945). The usual size of this species is about 90-120 mm. The largest fish observed by Smith (1945) in Thailand were about 150 mm long. Jensirisak (1973) recorded the largest size he has found in Ubol Ratana Reservoir was 197 mm long.

P. fasciatus is abundant in Ubol Ratana Reservoir. Its annual catch in 1969 was 37.8 tons, decreased to 8.1 tons in 1970 and became 21.5 tons in 1971 (Pholprasith *et al.*, 1969, 1970, and 1971).

Food habits

P. fasciatus is considered an insectivorous fish. Sungkakul *et al.* (1972) reported that *P. fasciatus* in Dome Noi Reservoir, Ubol Rajathani fed 75% on aquatic insect larvae, while the rest were zooplankton and plant detritus. Benjakan (1973) also reported that, in Ubol Ratana Reservoir this species fed 80-85% on aquatic insects and insect larvae, 10-15% on green algae (mostly protococcus), diatoms and tiny seeds of aquatic plants. However, Popituk (1970) reported that *P.*

fasciatus in Bung Borapet, Nakornsawan, in Central Thailand fed 90% on freshwater clams, while terrestrial insects constituted only 5%, the remainder being detritus.

Size at first maturity and spawning season

Jensirisak (1973) reported that *P. fasciatus* reached maturity at a length of 93 mm. Like most species in Ubol Ratana Reservoir, this fish spawns in the rainy season. At the Ubol Ratana fish landing place on July 17, 1973, most of the fish that were being cleaned had fully ripe gonads. Ripe ovaries of this species are a striking orangish-yellow. In addition, Pinyoying (1971) reported that, in Bhumipol Reservoir at Tak, Northern Thailand, this species carried ripe gonads in the middle of July. Jensirisak (1973) reported that the fish in Ubol Ratana Reservoir spawned during May-June.

Trends of mean length

This species has an irregular seasonal trend of mean length. Times of reaching maximum and minimum mean lengths and patterns of fluctuation were different in the three years. The range of mean length in the samples was narrow, around 55 -106 mm (Table 17).

Mean length of the fish captured in 1971 was greatest in the three years, being 10.6 mm greater than the fish captured in 1970 and 15.1 mm greater than the fish captured in 1969 (Table 17).

Length frequency showed a unimodal pattern although similar numbers of fish were captured over a fairly wide range of sizes (15-135 mm) (Table 18).

Table 17. Monthly mean length data of *Pristolepis fasciatus*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	72.8 ±29.21	87.1 ±27.74	93.1 ±29.76	-	95.7 ±24.83	66.6 ±47.68	81.9 ±30.78	55.2 ±18.86	60.5 ±26.18	80.5 ±32.68	76.8 ± 33.93
1970	69.7 ±30.45	74.4 ±30.98	83.6 ±28.66	77.5 ±34.86	84.7 ±30.95	89.0 ±33.29	86.1 ±32.25	72.6 ±30.92	63.1 ±26.98	84.1 ±27.62	97.1 ±22.29	82.1 ±24.66	81.3 ± 30.93
1971	93.0 ±34.02	94.9 ±25.51	80.8 ±27.94	87.3 ±24.32	98.3 ±32.35	89.6 ±30.57	106.9 ±25.92	88.3 ±30.81	94.4 ±31.41	-	-	-	91.9 ± 29.67

Table 18. Size frequency of *Pristolepis fasciatus*.

Size category mm	No. indiv each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	423	11	38	472	0.006
14.6 - 44.5	1099	419	936	2054	1.2
44.6 - 74.5	826	434	661	1921	4.5
74.6 -104.5	1031	686	450	2167	16.2
104.6 -134.5	558	445	783	1786	40.1
134.5 -164.5	92	62	138	292	80.7
164.6 -194.5	18	10	16	44	141.6
194.6 -224.5	6	0	2	8	229.8
224.6 -254.5	3	2	3	8	347.5
254.6 -284.5	-	1	3	4	500.5
284.6 -314.5	-	-	1	1	767.8
314.6 -344.5					
344.6 -374.5					
374.6 -404.5					
404.6 -434.5					
434.6 -464.5					
All size	4056	2070	3030	8757	

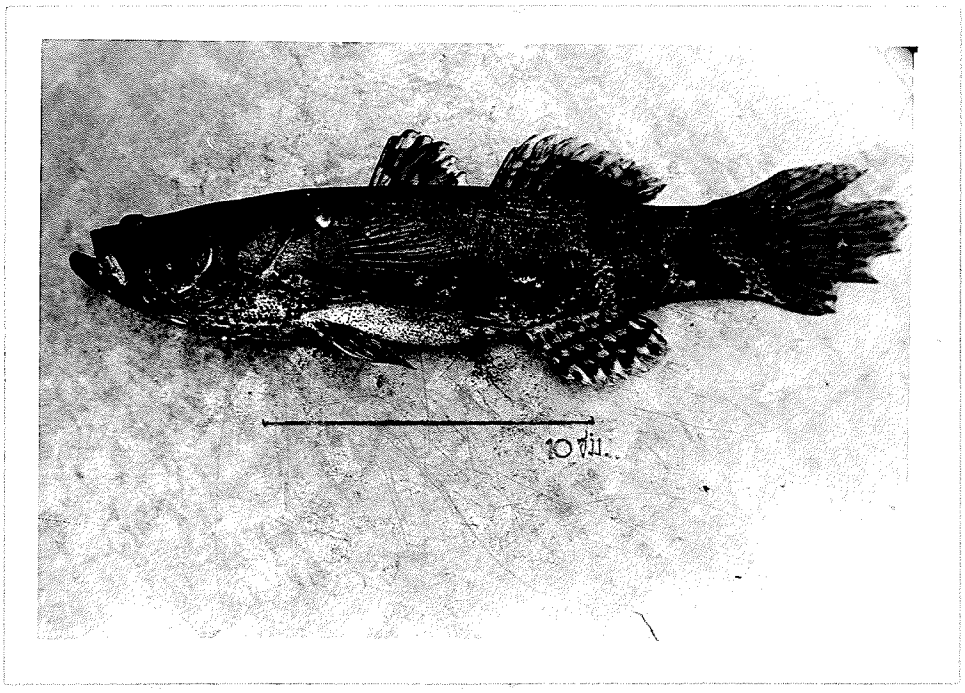

Plate 10. Oxyeleotris marmoratus (Bleeker)

Thai name: Pla bu

Oxyeleotris marmoratus (Bleeker) Thai name: Pla bu

Subclass Teleostomi

Order Gobioidea

Family Eleotridae

Distribution and habitats

The range of this species covers Borneo, Sumatra, Malaya and Thailand. It is the inhabitant of rivers, lakes, swamps, irrigation tanks and ponds. In Thailand, as Smith (1945) reported, this fish has been found throughout the Menam Chao Phya as far north as Paknampo in ung Borapet, and also from Central Thailand extending to southern Thailand. There was no report at that time from north and northeastern Thailand. It has now been found in Khon Kaen and nearby provinces in the northeast. Therefore, this area should be added to the range of this species.

This species is not only the largest of the local gobies, but it is also one of the largest in the world. Fish 300-400 mm are frequently met, and a maximum length of 500 mm is reported (Smith, 1945).

Because of its price, it is one of the most valuable fishes in Ubol Ratana Reservoir. Its annual catch in 1969 was 55.3 tons, decreased to 17.7 tons in 1970, then rose to 86.3 tons in 1971 (Pholprasith *et al*., 1969, 1970, and 1971).

Food habits

Popituk (1970) reported the sand goby in Bung Borapet was carnivorous as the whole of its stomach content was composed of fresh-

water shrimps and fishes.

Potongkum (1971) also stated that this species in Bangkok and its vicinity was a carnivorous fish. Adult sand gobies fed mainly on small fish and small amounts of freshwater crabs. Young gobies fed mainly on fish fry while insect larvae were its secondary food. Besides these, small amounts of plant detritus were also found. However, Benjakarn (1973) reported the sand goby in Ubol Ratana Reservoir at lengths of 200 mm upward, fed 50% on freshwater shrimps, 28% on insects and 14% on fish. Besides these, a small amount of aquatic plants were also found.

Size at first maturity and spawning season

This species reaches first maturity when it is 125 mm for female, or 145 mm for male. Fecundity ranged from 5,000 to 40,000 for the fish in Bangkok and its vicinity (Potongkum, 1972). Kamolratana *et al*. (1972) reported that *O. marmoratus* in Ubol Ratana Reservoir reached first maturity when it was 160 mm long, and that fecundity varied from 9,000 to 43,000. Eggs of the goby are pale yellow, tear-drop in shape, about 2.2 mm long and 0.6 mm wide. Fertilized eggs hatch out after 38 hours at water temperature of 25°C. Yolk sac is absorbed after two days at which time the fry start feeding on zooplankton and phytoplankton (Kamolratana, 1972). Near Bangkok the spawning season of this species, as reported by Potongkum (1971), fell in the period of May-October. But for the fish in Ubol Ratana Reservoir, as reported by Kamolratana *et al*., (1972), it fell in the period of July-October.

Table 19. Monthly mean length data of *Oxyeleotris marmoratus*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	73.1 ±29.51	87.3 ±28.90	94.6 ±34.37	-	95.7 ±24.88	66.4 ±47.51	81.9 ±30.78	55.1 ±18.95	60.4 ±26.18	80.5 ±32.68	77.0 ± 34.51
1970	69.7 ±30.41	74.4 ±30.98	83.6 ±28.63	77.8 ±35.50	84.7 ±30.94	89.0 ±33.53	85.1 ±32.78	68.6 ±33.20	63.4 ±27.69	83.6 ±28.28	97.1 ±22.68	83.8 ±27.18	80.8 ± 31.63
1971	93.0 ±34.26	94.6 ±25.43	81.2 ±28.59	87.5 ±25.08	99.2 ±35.01	90.8 ±32.32	108.3 ±30.02	90.1 ±32.93	94.3 ±31.47	-	-	-	92.6 ± 31.06

Table 20. Size frequency of *Oxyeleotris marmoratus*.

Size category mm	No. indiv. each year 1969	1970	1971	All years	$\bar{x}$ wt at size
0 - 14.5	427	150	38	615	0.002
14.6 - 44.5	117	465	948	1530	0.22
44.6 - 74.5	843	450	715	2008	2.2
74.6 - 104.5	1034	694	505	2233	8.4
104.6 - 134.5	567	450	797	1814	21.4
134.6 - 164.5	98	73	150	321	44.4
164.6 - 194.5	20	11	24	55	77.1
194.6 - 224.5	7	2	12	21	128.7
224.6 - 254.5	4	2	5	11	200.5
254.6 - 284.5	2	1	6	9	296.6
284.6 - 314.5	0	-	2	2	420.9
314.6 - 344.5	1	-	1	2	574.0
344.6 - 374.5	-	-	-	-	
374.6 - 404.5					
404.6 - 434.5					
434.6 - 464.5					
All size	3110	2298	3213	8610	

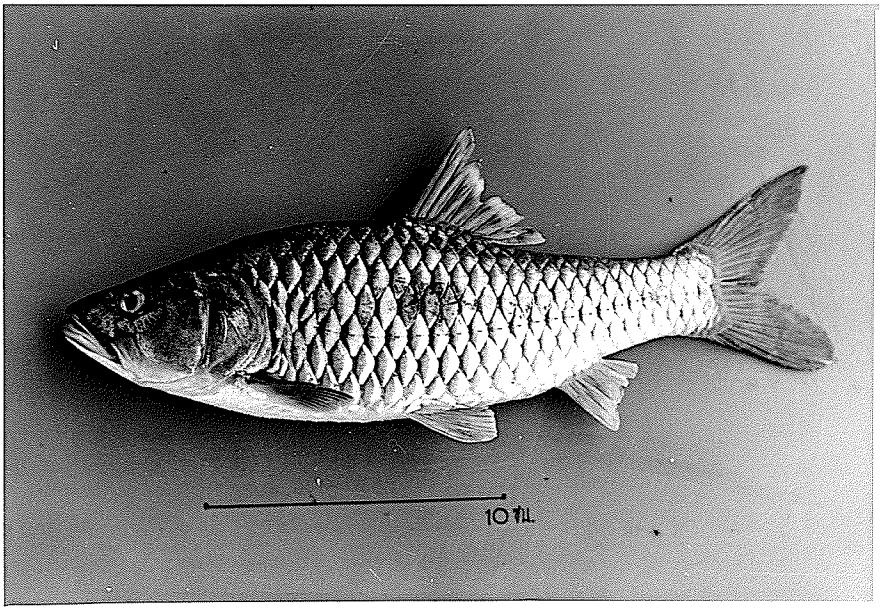

Plate 11. Hampala dispar H.M. Smith

Thai name: Pla kasoob

Trends of mean length

O. marmoratus showed an irregular seasonal trend of mean length which was very similar to that of P. fasciatus. Mean lengths fluctuated in different patterns between a narrow range of 55.1-108.3 mm (Table 19).

Mean length of the fish captured in 1971 were greatest in the three years, being 11.8 mm greater than the fish captured in 1970 and 15.6 mm greater than the fish captured in 1969 (Table 19).

Length frequency showed a unimodal pattern, most fish falling into 74-104 mm size class in 1969 and 1970, and the 14-44 mm size class in 1971 (Table 20).

Hampala dispar H.M. Smith Thai name: Pla kasoob

Subclass Teleostomi

Order Eventognathi

Family Cyprinidae

Distribution and habitats

This species is known from the Seamreap River which flows into the Tonle Sap or Grand Lake in Cambodia and Thailand (Smith, 1945). In Thailand, it is more abundant in streams and lakes in the north-eastern than in other parts of Thailand. The usual size of adult specimen in recent years has been 150 to 170 mm. Its annual catch from the reservoir in 1969, 1970 and 1971 was 28.5, 36.2, and 66.4 tons respectively (Pholprasith *et al.*, 1969, 1970-1971).

Food habits

This species is a predator in Ubol Ratana Reservoir. Elsewhere

the young feed mainly on crustaceans and aquatic insects (Potaros and Chareonpitaya, 1970), and freshwater shrimp is the staple food of older fish while insects and small fish second and third in importance (Koanantakul, 1972). Benjakarn (1973) reported that stomach contents of the fish in Ubol Ratana Reservoir are composed of 80% small fish, 10% freshwater shrimp, 7% insects while the rest were nematodes and crustaceans.

Size at first maturity and spawning season

The fish in Ubol Ratana Reservoir will reach first maturity at a length of 150 mm (Jensirisak, 1973). However, Koanantakul (1972) stated that the fish in Mahasarakam, the nearby province, reached its first maturity when it was only 120 mm long. Fecundity ranges from 3,400 (of 145 mm fish) to 27,000 (of 345 mm fish). The eggs are round, about 1 mm in diameter, yellow and adhesive (Koanantakul, 1972).

In Thailand, this species appears to have a long spawning season, spawning from January to September, but with most activity during May-September (Titibulrat, 1970 and Koanantakul, 1972). In Ubol Ratana Reservoir the peak of spawning falls in July (Jensirisak, 1973).

Trends of mean lengths

Mean lengths of the fish captured in 1969, 1970 and 1971 have a similar seasonal trend. There were two periods of high mean length in January and July with intervening lows in May and September. The range of mean length is 51.4-118.9 mm (Table 21).

The mean length of fish was greatest in 1970 being 15.2 mm longer than that in 1969 and 2.4 mm longer than 1971 (Table 21).

Table 21. Monthly mean length data of *Hampala dispar*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	110.6 ±38.00	106.3 ±47.83	68.1 ±46.59	-	111.8 ±35.66	57.5 ±42.71	51.4 ±28.44	52.0 ±15.16	87.8 ±34.34	100.5 ±29.19	75.0 ± 41.83
1970	104.0 ±22.27	95.9 ±19.99	107.2 ±43.92	92.1 ±48.35	85.4 ±38.08	74.7 ±44.24	89.4 ±51.98	67.0 ±37.22	78.2 ±43.36	103.6 ±29.30	105.6 ±50.12	87.6 ±60.76	90.2 ± 40.35
1971	118.9 ±33.77	117.7 ±38.95	101.9 ±50.29	90.5 ±63.01	85.1 ±52.67	72.8 ±35.21	85.7 ±34.57	93.0 ±41.66	67.5 ±26.54	-	-	-	87.8 ± 42.76

Table 22. Size frequency of *Hampala dispar*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	62	10	7	79	0.01
14.6 - 44.5	303	120	222	645	0.5
44.6 - 74.5	178	113	180	471	3.0
74.6 - 104.5	136	131	177	444	9.0
104.6 - 134.5	84	68	76	228	19.5
134.6 - 164.5	28	22	41	91	42.6
164.6 - 194.5	6	10	14	30	72.4
194.6 - 224.5	3	-	1	4	113.5
224.6 - 254.5	3	2	2	7	166.5
254.6 - 284.5	-	1	3	4	235.9
284.6 - 314.5	-		1	1	319.4
314.6 - 344.5					
344.6 - 374.5					
374.6 - 404.5					
404.6 - 434.5					
434.6 - 464.5					
All size	803	477	724	2004	

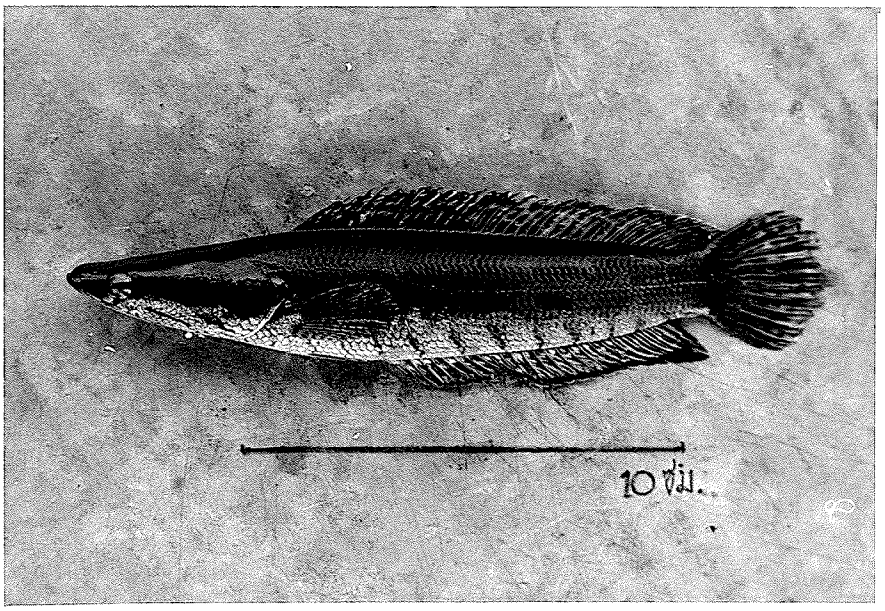

Plate 12. Ophicephalus lucius Cuv. & Val.

Thai name: Pla kasong

Length frequency distribution showed a unimodal pattern, number of fish in the 14-44 mm size class was the greatest in 1969 and 1971, and the 74-104 mm were the greatest of 1970 (Table 22).

Ophicephalus lucius Cuv. & Val. Thai name: Pla kasong

Subclass Teleostomi

Order Labyrinthici

Family Ophicephalidae

Distribution and habitats

This species is distributed widely through Java, Sumatra, Borneo and other islands of the Indo-Australian Archipelago, Malaya, Indo-China, China, and Thailand. In Thailand, Smith (1945) reported that its range covered most of Central Thailand and extended to the southern districts only. Recently, it has been found in Ubol Ratana Reservoir, Khonkaen, and also in the Mekong River (Sidthimunka et al., 1970). Therefore, the northeastern district of Thailand should be included in the range of this species.

The usual length of this species is 220-250 mm and may attain a maximum length of 350-400 mm (Smith, 1945).

In Ubol Ratana Reservoir, O. lucius as well as O. striatus has been found in shallow water where floating aquatic plants abound. Annual catch of this species in 1969 was 2.2 tons, then increased to 6.9 tons and 19.7 tons in 1970 and 1971 respectively (Pholprasith et al., 1969, 1970 and 1971).

Food habits

Sungkakul *et al*. (1972) reported that *O. lucius* in Lam Dome Noi Reservoir, in Ubol Rajathani Province, northeast of Khonkaen, was a carnivorous fish, feeding mainly on fish and shrimps. I examined 30 stomachs of *O. lucius*, length ranging from 150 to 291 mm from Ubol Ratana Reservoir, on June 18, 1973 and found that for 24 fish out of 30 small fish constituted 93 to 99% of the food composition, while 1 to 4% were higher aquatic plants. Another six fish of 30 fed mostly on terrestrial insects (90 to 95% of the stomach contents). The rest were higher aquatic plants which might not be taken on purpose.

Size at first maturity

From a small sample of 50 fishes which were inspected for gonad development on 20 June, 1973, 22 fishes having total length below 200 mm were immature. One fish of 207 mm total length had a nearly ripe gonad. There were three fishes with spent ovaries, and 21 fishes in total length from 204 to 291 mm with developing gonads. Presumably, the spawning season of *O. lucius* should fall into the same period as *O. striatus*, that is during the period of June-August in the rainy season.

Trends of mean length

Mean lengths of the fish captured in 1969, 1970 and 1971 tend to fluctuate in different patterns, so that the times of reaching maximum and minimum mean lengths in the three years were inconsistent. The range of mean length was 122.4-237.3 mm.

Mean length of the fish captured in 1969 were greatest of the three years, being 1.13 mm greater than the fish captured in 1970 and

Table 23. Monthly mean length data of *Ophicephalus lucius*.

Month / Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	172.3 ±74.41	212.9 ±87.56	237.3 ±72.00	-	165.2 ±112.67	141.6 ±111.34	198.6 ±92.58	148.1 ±89.37	171.5 ±77.01	180.3 ±75.75	182.6 ±89.32
1970	181.5 ±82.47	143.1 ±68.16	165.6 ±72.92	188.7 ±68.76	181.1 ±60.63	202.9 ±77.31	216.7 ±98.75	185.7 ±91.55	204.6 ±90.83	146.9 ±109.60	192.1 ±84.35	164.0 ±94.67	175.4 ±80.61
1971	157.9 ±85.95	133.3 ±69.02	156.1 ±83.25	202.8 ±81.82	122.4 ±66.23	160.3 ±52.69	172.0 ±67.92	142.5 ±53.31	148.0 ±94.70	-	-	-	153.4 ±76.33

Table 24. Size frequency of *Ophicephalus lucius*.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.5	18	1	4	23	0.003
14.6 - 44.5	41	44	69	154	0.21
44.6 - 74.5	22	97	214	333	1.8
74.6 -104.5	80	87	154	321	6.3
104.6 -134.5	78	102	145	325	15.2
134.5 -164.5	64	126	196	386	30.1
164.6 -194.5	91	121	127	339	52.7
194.6 -224.5	81	96	96	273	84.6
224.6 -254.5	53	69	65	187	138.7
254.6 -284.5	40	49	34	123	199.6
284.6 -314.5	22	23	20	65	276.5
314.6 -344.5	14	15	12	41	371.3
344.6 -374.5	8	11	12	31	445.4
374.6 -404.5	4	5	6	15	673.1
404.6 -434.5	3	3	0	6	778.7
434.6 -464.5	4	1	1	6	964.0
464.6 -494.5	2	-	2	4	1177.0
All sizes	625	850	1157	2632	

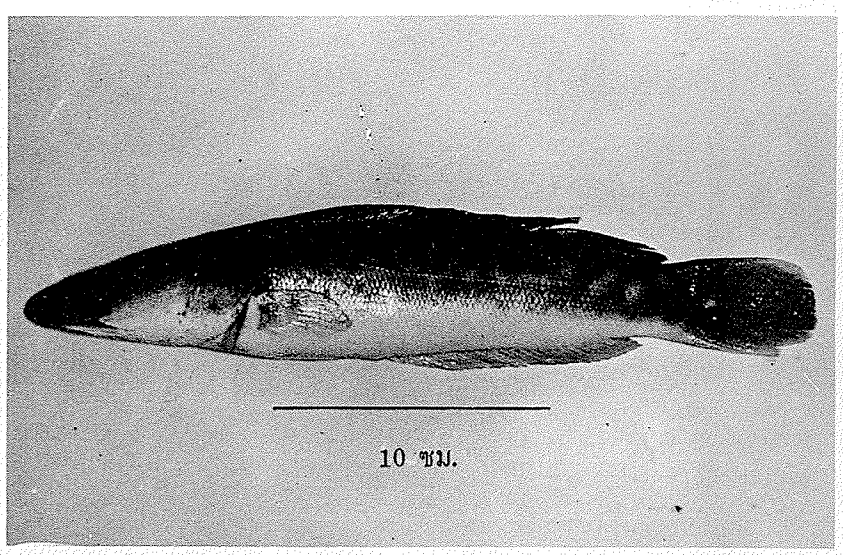

Plate 13. Ophicephalus micropeltes (Cuv. & Val.)

Thai name: Pla chado

5.53 mm greater than the fish captured in 1971 (Table 23).

Length frequency distribution showed a very weak bimodality. Similar numbers of fish were caught over a wide range of size classes (74-224 mm) (Table 24).

Ophicephalus micropeltes (Cuv. & Val.) Thai name: Pla chado

Subclass Teleostomi

Order Labyrinthici

Family Ophicephalidae

Distribution and habitats

The range of this species embraces Indo-China, Malaya, the East Indian islands, Burma, India, and Thailand. It inhabits all parts of Thailand. It is primarily an inhabitant of the larger streams and canals (Smith, 1945).

Smith (1945) stated that this species was the largest of the ophicephalids. It reaches a length of nearly a meter and a weight of more than 20 kilograms in Thailand.

O. micropeltes in Ubol Ratana usually inhabits the litteral zone where floating aquatic plants are abundant as does O. striatus and O. lucius. However, it seems to prefer such habitat in deeper water and farther from the shore than the latter two species. Its annual catch was 67.0 tons in 1969, and decreased to 45.8 tons in 1970 and 44.4 tons in 1971 (Pholprasith et al., 1969, 1970, and 1971).

Food habits

Smith (1945) noted that O. micropeltes was one of the most predaceous of the local freshwater fishes. It consumed fishes of all kinds and sizes and also killed more than its actual needs. Sithinumka (1972) also reported that O. micropeltes was a carnivorous fish, fishes and freshwater shrimps being its basic food. I inspected a few specimens from Ubol Ratana Reservoir for food composition and gonads in late June, 1973, and found that four O. micropeltes of 150-250 mm length fed 67% on small fish, 23% on freshwater shrimps, and 10% on insects. In addition, three larger specimens of 251-350 mm length fed on 77% small fish, 16% freshwater shrimps and 7% insects.

Size at first maturity and spawning season

From the same specimens, four fishes 150-250 mm long were immature, and three fishes 251-350 mm long had developing gonads. Owing to the scarcity of specimens and literature, size at first maturity of this species needs still to be ascertained, but is probably about 350 mm.

Pholprasith (1969 and 1970) concluded that most of the fish fry of various species including O. micropeltes were abundant in the time of rainy season, that is the period of June-October. Furthermore, a female O. micropeltes (426 mm long) with her brood of 30-40 mm long fry were caught in the area of the fishing station at Ubol Ratana Reservoir on July 11, 1973. Therefore, spawning of O. micropeltes presumably takes place during July-August

Trends of mean length

Times of reaching maximum and minimum mean length for this species, as well as patterns of fluctuation were different in the three years.

The range of mean length is 122.4-237.3 mm (Table 25).

Mean length of the fish captured in 1969 were greatest of the three years, being 1.48 mm greater than the fish captured in 1970 and 5.54 mm greater than the fish captured in 1971 (Table 25).

Length frequency distribution suggested a very weak bimodality. Similar numbers of fish were caught over a wide range of size classes (74-284 mm) (Table 26).

Table 25. Monthly mean length data of *Ophicephalus micropeltes*.

Month Year	J	F	M	A	M	J	J	A	S	O	N	D	All Months
1969	-	-	171.5 ±76.96	210.7 ±88.77	237.3 ±72.00	-	185.8 ±125.44	142.6 ±113.76	232.6 ±105.62	148.3 ±88.66	177.5 ±80.80	182.2 ±77.58	185.1 ±92.24
1970	177.8 ±83.57	143.1 ±68.16	164.6 ±73.45	188.7 ±68.76	181.1 ±60.63	206.5 ±82.66	209.3 ±102.50	184.8 ±93.23	214.5 ±82.70	150.1 ±109.28	192.1 ±84.35	164.0 ±94.67	175.7 ±81.48
1971	156.7 ±86.21	133.3 ±69.02	156.4 ±83.16	209.3 ±87.78	122.4 ±66.23	161.7 ±53.84	171.3 ±65.74	145.0 ±55.71	170.9 ±127.96	-	-	-	155.1 ±79.47

Table 26. Size frequency of Ophicephalus micropeltes.

Size category mm	No. indiv. each year 1969	1970	1971	All year	$\bar{x}$ wt at size
0 - 14.6	20	1	4	25	0.008
14.6 - 44.5	45	48	72	165	0.4
44.6 - 74.5	26	99	214	339	2.4
74.6 - 104.5	80	87	154	321	5.4
104.6 - 134.5	80	102	145	327	24.7
134.6 - 164.5	69	127	199	395	29.8
164.6 - 194.5	96	97	129	322	49.0
194.6 - 224.5	85	73	98	256	83.7
224.6 - 254.5	59	49	65	173	124.7
254.6 - 284.5	44	25	35	104	177.2
284.6 - 314.5	26	15	21	62	242.6
314.6 - 344.5	17	11	14	42	322.4
344.6 - 374.5	9	5	12	26	417.9
374.6 - 404.5	4	3	6	13	522.8
404.6 - 434.5	4	2	1	7	664.0
434.6 - 464.5	4	-	2	6	829.6
464.6 - 494.5	3	-	2	5	954.5
494.6 - 524.5	1	-	1	2	1165.3
All sizes	672	866	1174	2712	

Table 27. Stomach contents of the fish studied in Ubol Ratana Reservoir and their relative importance in the diet. x = 1-20%; xx = 20-40%, etc. * = small amount.

Food items / Name of fish	Aquatic plants	Phyto-plankton & diatoms	Zoo-plan-kton	Beetles	Insects	Worms	Shrimp	Fish	Miscellaneous
C. jullieni	xx	xxx							*
P. gonionotus	xxx	x		x					
O. hasselti	x	xxx				*			
M. chrysophekadion		xxxx	*						*
C. apogon		x	xxx						x
N. notopterus					xxx		x	x	
O. bimaculatus					xxx		x	x	
O. striatus					xxx		x	x	
P. fasciatus		x			xxxx				
O. marmoratus	*				x		xxx	x	*
H. dispar			*		*	*	x	xxxx	
O. lucius	*				x		*	xxxx	
O. micropeltes					*		x	xxxx	

Table 28. Spawning season of the fish studied in Ubol Ratana Reservoir. xx = peak of spawning in this reservoir.

Month / Species	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
C. jullieni							x	x	x			
P. gonionotus					x	x	x					
O. hasselti							xx	x	x	x		
M. crysophekadion							x	x	x	x		
C. apogon	xx						xx	xx				xx
N. notopterus				x	xx	xx	x	xx	xx			
O. bimaculatus									x	x		
O. striatus						xx	x	x				
P. fasciatus					xx	xx	x					
O. marmoratus							x	x	x	x		
O. dispar					x	x	xx	x	x			
O. lucius						x	x	x				
O. micropeltes							xx	x				

REPRESENTATIVENESS OF SAMPLES TAKEN BY ROTENONE POISONING

1. In the method section, 3 criteria were set up for deciding whether samples taken in the shallow littoral were representative of the populations in the reservoir. The size frequency distribution may also be used in deciding whether or not the samples collected by this method were representative. Generally, small fish were under represented in the samples. But for some species the size frequency distribution was bimodal which indicated that intermediate size classes were also under represented.

2. The information on all 13 species will be discussed in relation to these four criteria and decision will be made about the representativeness of the samples.

Maximum size in rotenone samples compared with maximum size in commercial catch

The maximum size of the fish in rotenone samples and those in commercial catch were compared (Table 29). The maximum size of *C. jullieni*, *C. apogon*, *O. bimaculatus*, and *O. lucius* in samples was greater than those in the commercial catch. The maximum size of *P. fasciatus* in samples was the same as that in the commercial catch. Species which had a maximum size in the survey samples as large or larger than the fish in commercial catch were considered to be thoroughly sampled by the rotenone method and their samples were representative. For *P.*

Table 29. Comparison of maximum size of fish captured by rotenone sampling and in the commercial fisheries.

Species	Maximum size caught by	
	Rotenone (mm)	Commercial (mm)
Cirrhinus jullieni	224.5	195.0
Puntius gonionotus	224.5	555.0
Osteochilus hasselti	254.5	276.0
Morulius chrysophekadion	404.5	740.0
Cyclocheilichthys apogon	314.5	175.0
Notopterus notopterus	344.5	580.0
Ompok bimaculatus	284.5	255.0
Ophicephalus striatus	494.5	700.0
Pristolepis fasciatus	314.5	320.0
Oxyeleotris marmoratus	344.5	650.0
Hampala dispar	314.5	670.0
Ophicephalus lucius	494.5	335.0
Ophicephalus micropeltes	524.5	880.0

gonionotus, O. hasselti, M. chrysophekadion, N. notopterus, O. striatus, O. marmoratus, H. dispar, and O. micropeltes the maximum size in the survey samples was smaller than in the commercial catch, indicating that the largest size classes were not available to the rotenone sampling.

Seasonal changes in mean size of fish captured by rotenone poisoning

Because most species are inshore spawners, although the bigger fish may be absent at some times of year they should move to the shallow water at spawning season. Therefore, the samples taken in this period should be representative, even if they are not so at other times of year.

Species whose mean length increased obviously in spawning time are C. jullieni, O. hasselti, M. chrysophekadion, H. dispar, and P. gonionotus. These species may, therefore, only be representatively sampled at spawning time. O. bimaculatus, P. fasciatus, C. apogon, and O. marmoratus had no large change in mean length throughout the year, so the sampling of these species might be representative throughout the year. O. striatus, O. lucius, O. micropetes and N. notopterus had a large second change in mean length which was not consistent from year to year. These species may, therefore, never be representatively sampled in the rotenone samples.

Comparison of annual catches in rotenone sampling and commercial catches

If sampling is representative, the increase or decrease of catches

from year to year in both rotenone method and commercial catches should have a similar pattern. C. jullieni, O. hasselti, O. bimaculatus, P. fasciatus, C. apogon, and O. lucius have a same trend in catch in both rotenone sampling and commercial catches (Table 30). These species were considered to be sampled representatively in accordance with this criteria.

Size frequency distribution of fish from rotenone sampling

Most sampling method under sample the small fish and this is true of the samples taken by rotenone sampling. Whether the larger fish are fully vulnerable can be examined by studying the size frequency distribution of the fish in samples. Where strong bimodality exists it is possible that intermediate size classes are also under sampled.

Fish having unimodality in size frequency distribution are O. hasselti, O. bimaculatus, P. fasciatus, H. dispar, N. notopterus, M. chrysophekadion, and O. marmoratus. While C. jullieni, C. apogon and P. gonionotus have bimodality and O. striatus, O. lucius, and O. micropeltes have a weak bimodality.

When all 4 criteria are considered, 4 species appear to be reasonably well sampled, those are C. jullieni, O. hasselti, O. bimaculatus, and P. fasciatus. One species in which a small part of the size range may be representative is C. apogon. Since the size of fish captured in the commercial fishery was intermediate and all size groups are represented in the survey sampling it is probable that the larger size

groups are adequately represented in the survey sampling but that the small and intermediate sizes are not. Eight species appear to be poorly sampled by rotenone method.

The conclusion based on these criteria seem to be the most suitable way in considering the representativeness of the samples taken by rotenone technique. They can point out some inadequacies of the samples which could be due to the selectivity of the sampling method, environmental conditions of the lake, and behaviour of each species of fish sampled as noted by Lagler (1971).

Poor sampling of the fish in genus Ophicephalus is a good example of how insufficient knowledge of the biology of a fish can suggest wrong conclusions. These species were expected to be the representatively sampled, since we had observed that they were littoral fish and spent most of their lives in shallow water. They tend to move inshore at night, however, so that the survey samples, taken in daytime, were not representative.

Another unexpected result was the existence of bimodality in size frequency distribution of some fish such as C. apogon. The dip in size frequency curve at the intermediate size classes may indicate a pelagic phase in their life history. Incidentally, the size groups poorly represented in the survey samples are the sizes which occur most frequently in the commercial gill net fishery.

Table 30. Comparison of survey and commercial catches. Survey catch in gm/ha and commercial catch in metric ton.

Species	Rotenone Method			Annual Commercial Fishing			1969		1970		1971	
	1969	1970	1971	1969	1970	1971	R	C	R	C	R	C
C. jullieni	61.6	268.6	1,084.3	23	73	444	+	+	+	+	+	+
P. gonionotus	119.4	348.5	1,297.0	30	17	48	+	+	+	-	+	+
O. hasselti	3,189.7	1,358.2	3,722.4	266	92	237	+	+	-	-	+	+
M. chrysophekadion	3,783.0	1,138.7	3,233.4	98	62	112	+	+	-	-	+	+
C. apogon	2,285.9	1,963.1	4,660.8	469	631	513	+	+	-	+	+	-
N. notopterus	2,674.4	1,572.0	1,903.8	104	164	194	+	+	-	+	+	+
O. bimaculatus	339.5	367.3	1,185.1	15	31	73	+	+	+	+	+	+
O. striatus	8,021.6	9,308.4	13,083.0	48	58	63	+	+	+	+	+	+
P. fasciatus	14,657.8	7,764.6	15,308.0	38	8	22	+	+	-	-	+	+
O. marmoratus	8,573.2	4,770.7	10,153.1	55	18	86	+	+	-	-	+	+
H. dispar	1,628.6	1,057.1	2,182.0	28	36	66	+	+	-	+	+	+
O. lucius	14,986.2	13,189.0	17,437.5	2	7	20	+	+	-	+	+	+
O. micropeltes	16,104.9	12,162.5	17,147.2	67	46	44	+	+	-	-	+	-

SURVIVAL AND BIOMASS DISTRIBUTION

By applying these four criteria, sampling was shown to be reasonably representative for four species at least during part of the sampling period, and probably representative over part of the size range for C. apogon. For the remaining 8 species sampling was considered not representative by one or more of the four criteria.

For all 5 species survival can be calculated over appropriate size range. But for C. jullieni and O. hasselti only data at spawning season can be used as larger members of the population were absent at other times. Unfortunately, numbers captured at spawning season were too small to calculate survival. Survival of C. apogon ranged from 0.167 to 0.208 for fish larger than 40 mm. Survival of O. bimaculatus ranged from 0.781-0.814 for fish larger than 45 mm. Survival of P. fusciatus ranged from 0.172 to 0.431 for fish larger than 75 mm (Table 31).

Only data for O. bimaculatus and P. fasciatus for which sampling was representative over most of the size range and sample size was adequate were used in biomass calculation. For O. bimaculatus similar percentages of biomass occurred over a wide range of sizes (104-194 mm). The highest percentage biomass (35%) occurred in the size class 134.6-164.5 mm. For P. fasciatus a very high percentage of total biomass (46%) was concentrated in the size class 104.6-134.5 mm (Table 32).

Table 31. Survival between 30 mm size class for 3 species in Ubol Ratana Reservoir.

Species	Year		
	1969	1970	1971
C. apogon	0.176	0.167	0.208
O. bimaculatus	0.814	0.781	0.787
P. fasciatus	0.375	0.431	0.172

Table 32. Biomass (gm/hectare) and percentage distribution of biomass for 2 species from Ubol Ratana Reservoir (from rotenone samples).

Size class mm	Species			
	O. bimaculatus		*P. fasciatus*	
	Biomass	%	Biomass	%
0 - 14.5	-	-	-	-
14.6 - 44.5	10.22	0.13	2464.80	1.58
44.6 - 74.5	310.70	4.23	8644.50	5.58
74.6 - 104.5	680.80	9.27	35105.40	22.65
104.6 - 134.5	1502.90	20.44	71618.60	46.20
134.6 - 164.5	2565.10	34.89	23564.40	15.20
164.6 - 194.5	1402.20	19.08	6230.40	4.02
194.6 - 224.5	511.00	6.70	1838.40	1.19
224.6 - 254.5	271.20	3.69	2780.00	1.79
254.6 - 284.5	97.20	1.32	2002.00	1.29
284.6 - 314.5	-	-	767.80	0.50

DISCUSSION

Although thirteen species of greatest commercial importance are discussed in this thesis, there are about 40 out of 74 species also harvested from this reservoir.

The 13 species studied can be divided into 3 groups based on the food habits of adult fishes (after Nikolsky 1963):

1. Herbivorous and detritophagic, those which feed on plants and plant detritus as their basic food, such as *Cirrhinus jullieni*, *Puntius gonionotus*, *Osteochilus hasselti* and *Morulius chrysophakadion* (Table 27).

2. Carnivores, which feed mainly on invertebrates, like *Notopterus notopterus*, *Cyclocheilichthys apogon*, *Ompok bimaculatus*, *Ophicephalus striatus*, *Pristolepis fasciatus* and *Oxyeletris marmoratus* (Table 27).

3. Predators, which feed mostly on fishes such as *Hampala dispar*, *Ophicephalus lucius*, and *Ophicephalus micropeltes* (Table 27).

Most abundant commercial species is *C. apogon* which is a zooplankton feeder. Herbivores contributed substantially to commercial catch but predators were by no means least in importance in numbers in the catches. And because their prices were usually higher than those of herbivorous and carnivorous fishes they have a very high overall importance in the fishery. Consequently, all trophic levels are presently important in the reservoir fishery as opposed to the general dominance of upper trophic levels in temperate zone.

Of the 13 species, *H. dispar* is the only species

which appeared to have a restricted zoogeographic distribution. Others, because of their wide distribution are probably important commercial species elsewhere in the country. However, detailed information in species composition of commercial catch for the whole country is not available.

Spawning season for most species falls in the rainy season, however, there is a considerable variation among species in length of spawning season, and time of peak spawning (Table 28). P. gonionotus, O. striatus, P. fasciatus spawn early at the beginning of rainy season. While C. jullieni, O. hasselti, M. chrysophekadion, O. bimaculatus, O. marmoratus and O. micropeltes spawn later at the end of rainy season. H. dispar and O. lucius spawn mainly in the mid-season, but H. dispar appeared to spawn throughout the rainy season. N. notopterus and C. apogon appear to spawn more than once in the year. No relationship between trophic status and timing of spawning was found.

Among the 13 species size at first maturity shows a wide range from 93 mm in P. fasciatus to 400 mm in M. chrysophekadion. Fecundity is also extremely variable. Fish which matured at a small size might have a high fecundity (e.g. C. apogon). Neither size at first maturity nor fecundity were related while fish which matured at a large size might have low fecundity to trophic status (e.g. M. chrysophekadion).

Seasonal fluctuations in mean length of the fish in samples may be divided into 3 patterns as follows:

a) slightly changed: mean length of the fish fluctuated little from sampling to sampling. The fish in this group are C. apogon, O.

bimaculatus, P. fasciatus, and O. marmoratus.

b) Wide and regular: mean length of the fish increased greatly at the spawning time then decreased sharply after this period. The fish in this group are C. jullieni, O. hasselti, P. gonionotus, M. chrysophekadion, and H. dispar.

c) Wide and irregular, mean length of the fish fluctuated widely and unpredictably. The fish in this group are N. notopterus, O. striatus, O. lucius, and O. micropeltes.

Size frequency distribution of the fish in samples may be divided into:

a) Unimodal; which is the characteristic of O. hasselti, M. chrysophekadion, N. notopterus, O. bimaculatus, P. fasciatus, H. dispar, and O. marmoratus.

b) Bimodal; as in C. julliani, P. gonionotus, C. apogon, O. striatus, O. lucius, and O. micropeltes.

Size composition of the fish captured by commercial fishing and rotenone method were compared and resulted in:

a) Maximum size of the fish in commercial fishing larger than that of rotenone method. Fish in this group are P. gonionotus, M. chrysophekadion, N. notopterus, O. striatus, O. marmoratus, H. dispar, and O. micropeltes.

b) Maximum size of the fish in both catch are equal. The species in this category are P. fasciatus, C. jullieni, O. hasselti, and O. bimaculatus.

c) Maximum size of the fish captured by commercial fishing

smaller than that of rotenone method. The fish in this group are C. apogon, and O. lucius.

Together these three pieces of information suggest certain patterns of distribution and migration of size classes of fish in the reservoir. The combination of the 8 factors noted above was unique for virtually all 13 species. The interpretation of these results will therefore be presented separately for each species.

Cirrhinus jullieni: This species showed wide and regular fluctuations in mean size in survey samples. The maximum size of fish in the survey samples was similar to that in the commercial catch and the size frequency distribution for this species was unimodal. This suggests that the shallow littoral is the common nursery area for this species. The larger fish tend to move into deeper water where they are not available to the survey sampling but return to the shallow littoral to spawn each year.

Puntius gonionotus: This species showed wide and regular fluctuations in mean size. The maximum size of the fish in rotenone catch was smaller than that in commercial catch. But size frequency distribution of bimodal. This suggests that small fish live in shallow water, intermediate size and larger fish move into deeper water and only the larger fish return to the shallow water to spawn each year. Or the range of distribution of small and larger fish are overlapped but that the intermediate sized fish are restricted to deeper water.

Osteochilus hasselti: This species also showed wide and regular fluctuations in mean size. The maximum size of the fish in the survey

sample was similar to that in commercial catch and the size frequency distribution for this species was unimodal. This suggests that this species has a similar behaviour to C. jullieni. The larger fish tend to move into deeper water and return to the shallow littoral zone to spawn each year.

Morulius chrysophekadion: This species showed wide and regular fluctuations in mean size. The maximum size of the fish captured by rotenone method was smaller than that in the commercial catch and the size frequency distribution was unimodal. This suggests that the larger fish move into deeper water where they are not available to the survey sampling and that although there is an onshore movement of larger fish at spawning time the major spawning area may be in deeper water.

Cyclocheilichthys apogon: This species showed a slight fluctuation in mean size. The maximum size of the fish captured by rotenone method was bigger than that in commercial catch. The size frequency distribution was bimodal. This suggests that the small and larger fish live in shallow water but the intermediate sized fish moved into deeper water. There is no seasonal migration of the larger fish. Alternately, the bimodality may partly be caused by the overlap between age classes because this species spawns more than once a year.

Notopterus notopterus: This species showed wide and irregular fluctuations in mean size. The maximum size of the fish in rotenone samples was smaller than that in the commercial catch. The size frequency distribution was unimodal. This suggests that larger fish tend to move into deeper water and return to shallow water to spawn and for other reasons but that their movement is unpredictable.

Ompok bimaculatus: This species showed a slight fluctuation in mean length. The maximum size of the fish in rotenone samples was similar to that in the commercial catch. The size frequency distribution was unimodal. This suggests that small and larger fish inhabit the shallow water while the intermediate sized fish move offshore where they are more available to the commercial fishery, and no seasonal migration of the larger fish.

Ophicephalus striatus: This species showed wide and irregular fluctuations in mean size. The maximum size of the fish in rotenone samples was smaller than that in the commercial catch. The size frequency distribution was weakly bimodal. This suggests that larger fish tend to move into deeper water, at least during the day time and that movements of larger fish into shallow water are unpredictable. Larger fish may be more common on shore at night since fishermen sometimes catch large numbers of this species at night by means of beach seines. The weak bimodality may be caused by the absence of intermediate sized fish in shallow water or the overlap of age classes from multiple spawning.

Pristolepis fasciatus: This species showed a slight fluctuation in mean size. The maximum size of the fish in rotenone samples was similar to that in the commercial catch. The size frequency distribution was unimodal. This suggests that all sizes of fish inhabit the shallow water and that there are no obvious seasonal migrations of the larger fish.

Oxyeleotris marmoratus: This species showed a slight fluctuation in mean size. The maximum size of the fish in rotenone samples was

smaller than that in the commercial catch. The size frequency distribution was unimodal. This suggests that the larger fish tend to move into deeper water and remain there.

Hampala dispar: This species showed wide and regular fluctuations in mean size. The maximum size of the fish in survey samples was smaller than that in the commercial catch. The size frequency distribution was unimodal. This suggests that the shallow water is the common nursery ground for this species. The larger fish tend to move into deeper water where they are not available to the survey sampling but return to the shallow littoral zone to spawn each year, although the largest fish may remain in water too deep to be sampled by the survey method used. Note that the information on this fish suggests an identical life history to M. chrysophekadion.

Ophicephalus lucius: This species showed wide and irregular fluctuations in mean size. The maximum size of the fish in rotenone samples was bigger than that in the commercial catch. The size frequency distribution was weakly bimodal. This suggests that shallow littoral is the nursery ground for this species. Ranges of distribution of small and larger fish may overlap, but the intermediate sized fish tend to move further to deeper water. Movements of the larger fish onshore and offshore is unpredictable.

Ophicephalus micropeltes: This species showed wide and irregular fluctuations in mean size. The maximum size of the fish in survey samples was smaller than that in the commercial catch. The size frequency distribution was weakly bimodal. This suggests that the shallow littoral

is the common nursery ground for this species. The larger and intermediate sized fish are likely to move into deeper water at least during the day but that the larger fish occasionally return to the shallow water at unpredictable times. Here again the data suggest very similar life histories for O. micropeltes and O. striatus.

These conjectures can be considered preliminary hypotheses about the life history and behaviour of the 13 species studied. Much remains to be learned but at least we now have a starting point and some differences and similarities to help us design future studies.

Survival and biomass distribution

Attempts to apply the standards and techniques of analysis of temperate zone populations failed in this study. The main cause of failure was the shortcoming in the data. However, it is difficult to judge how useful these techniques would be even if the data were adequate. The multiplicity of species and trophic levels exploited by the fishermen suggest that traditional species by species management as used in the temperate zone is unsuitable.

When the catch by the rotenone method was compared to the commercial catch there was correspondence in some species in both direction of change from year to year and the degree of change, for example, in C. jullieni, O. hasselti, and O. marmoratus. Furthermore, in some species, although the degree of change was not always comparable, the pattern of change was the same. Possibly littoral sampling may be used in

predicting the annual commercial catch of these species. The ranked abundance for the thirteen species captured in the survey samples does not follow the same pattern as in the commercial catch. For example *O. lucius*, *O. micropeltes*, *P. fasciatus*, *O. marmoratus* and *H. dispar* were relatively less abundant in the commercial catch than in the survey catches. This may suggest under utilization of these stocks, and that commercial catch could be increased if catching techniques were changed. However, considerably more work must be done to substantiate these two points.

LITERATURE CITED

Anon. 1969. Temperature records. Northeast Agri. Centre, Khonkaen, Thailand. (Unpublished)

Anon. 1972. Fishery record of Thailand. 1970. Dept. of Fish. Bangkok, Thailand. 46 p.

Anon. 1973. Extensive fish production in Ubol Ratana Reservoir Unit. Inland Fish. Div., Dept. of Fish. Bangkok, Thailand. 31 p.

Benjakarn, M. 1973. Stomach contents of some economic fishes in Ubol Ratana Reservoir. Ext. Fish Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. (in publishing in Thai).

Chookajorn, T. 1969(a). A study on life history of Cyclocheilichthys apogon (Cuv. & Val.). Ext. Fish. Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. 142 p. (in Thai).

_____. 1969(b). A study on life history of Osteochilus hasselti (Cuv. & Val.). Ibid.

_____. 1970. A study on life history of Nilem Osteochilus hasselti (Cuv. & Val.). Ext. Fish Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. 154 p. (in Thai).

Hayne, Don W., Gordon E. Hall and Hudson M. Nichols. 1967. An evaluation of cove sampling of fish populations in Douglas Reservoir, Tennessee. p. 244-297. A symposium on the reservoir fishery resources. South Division, Amer. Fish. Soc., Special publication.

Jaiyen, K. 1970. Food habits and spawning season of Nilem (Osteochilus hasselti) in Bung Kang Lava, Khonkaen. Fish. Res. Unit in Northeast Agri. Centre, Khonkaen, Thailand. Ann. rept. 118 p. (in Thai).

_____. 1971. Food habits and spawning season of Nilem (Osteochilus hasselti) in Bung Kang Lava, Khonkaen. Fish. Res. Unit, in Northeast Agri. Centre, Khonkaen, Thailand. Ann. rept. 66 p. (in Thai).

Jensirisak, S. 1971. Life history of Notopterus notopterus (Pallas). Ext. Fish. Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. 146 p. (in Thai).

_____. 1972. Life history of Notopterus notopterus (Pallas). Ext. Fish. Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. 136 p. (in Thai).

_____. 1973. Spawning season and size at first maturity of fishes in Ubol Ratana Reservoir. Ext. Fish Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. (in publishing in Thai).

Kamolratana, P. 1971(a). A study on food habits and spawning period of featherback (Notopterus notopterus (Pallas) in Bung Kang Lava, Khonkaen. Fish. Res. Unit in Northeast Agri. Centre, Khonkaen, Thailand. Ann. rept. 66 p. (in Thai).

_____. 1971(b). Some aspects of life history of Ophicephalus striatus Bloch. in Huey Taey irrigation tank. Ibid.

Kamolratana, P., S. Sookvibul, and P. Opasananta. 1972. Size at first maturity and spawning season of five species of fishes in Ubol Ratana Reservoir. Fish. Res. Unit. in Northeast Agri. Centre, Khonkaen, Thailand. Ann. rept. 118 p. (in Thai).

Koanantakul, K. 1972. Life history of Hampala dispar H.M. Smith. Mahasarakam Fish. Station. Dept. of Fish, Bangkok, Thailand. Ann. rept. 103 p. (in Thai).

Lagler, Karl F. 1971. Capture, sampling and examination of fishes. p. 7-45. In W.E. Ricker (ed). Method for assessment of fish production in fresh waters. Blackwell scientific Publications, Oxford and Edinburgh.

Nikolsky, G.V. 1963. The ecology of fishes. Academic Press, London and New York. 352 p.

Paohom, S. 1969. A preliminary study on life history of Puntius gonionotus (Bleeker) related to breeding and embryonic development. Chiangmai Fish. Station. Dept. of Fish. Bangkok, Thailand. Ann. rept. 66 p. (in Thai).

Pholprasith, S. 1969. A study on species of fishes in Ubol Ratana Reservoir. Ext. Fish. Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. 142 p. (in Thai).

_____. 1970. A study on species of fishes in Ubol Ratana Reservoir. Ext. Fish. Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish. Bangkok, Thailand. Ann. rept. 154 p. (in Thai).

_____. 1971. A study on species of fishes in Ubol Ratana Reservoir. Ext. Fish. Prod. in Ubol Ratana Reservoir Unit.

Dept. of Fish. Bangkok, Thailand. Ann. rept. 146 p. (in Thai).

Pholprasith, S., N. Waiwooto, and S. chantarasaka. Catch statistic in Ubol Ratana Reservoir. Ext. Fish. Prod. in Ubol Ratana Reservoir Unit, Dept. of Fish., Bangkok, Thailand. Ann. rept. 142 p. (in Thai).

_____. 1970. Catch statistics in Ubol Ratana Reservoir. Ext. Fish Prod. in Ubol Ratana Reservoir Unit, Dept. of Fish., Bangkok, Thailand. Ann. rept. 154 p. (in Thai).

Pholprasith, S., N. Waiwooto and S. Supawatwibul. 1971. Catch statistic in Ubol Ratana Reservoir. Ext. Fish Prod. in Ubol Ratana Reservoir Unit, Dept. of Fish., Bangkok, Thailand. Ann. rept. 146 p. (in Thai).

Pinyoying, S. 1971. Characteristics and fecundity of some kinds of fish. Tak Fish. Station, Dept. of Fish., Bangkok, Thailand. Ann. rept. 143 p. (in Thai).

Popituk, K. 1970. Stomach contents of some species of fishes in Bung Borapet. Nakornsawan Fish. Station. Dept. of Fish. Bangkok, Thailand. Ann. rept. 136 p. (in Thai).

Potaros, M., and P. Chareonpitaya. 1970. Preliminary study on feeding habits and food conversion of Hampala dispar H.M. Smith. Ext. Cult. Sect. Dept. of Fish., Bangkok, Thailand. Ann. rept. 285 p. (in Thai).

Potongkum, K. 1971(a). Embryonic and morphological development of snakehead fish, Ophicephalus striatus Bloch. Expt. Cult. Sect. Dept. of Fish., Bangkok, Thailand. Ann. rept. 208 p. (in Thai).

_____. 1971(b). Biology of sand goby Oxyeleotris marmoratus (Bleeker). Expt. Cult. Sect. Dept. of Fish., Bangkok, Thailand. Ann. rept. 208 p. (in Thai).

_____. 1972. Breeding and embryonic development of sand goby Oxyeleotris marmoratus (Bleeker). Expt. Cult. Sect. Dept. of Fish. Bangkok, Thailand. Ann. rept. 224 p. (in Thai).

Ricker, W.E. 1958. Handbook of computations for biological statistics of fish populations. Bull. Fish. Res. Bd. Canada, 119. 300 p.

_____. 1971. The production process, p. 1-6. In W.E. Ricker (ed) Methods for assessment of fish production in freshwaters. Blackwell Scientific Publications, Oxford and Edinburgh.

Shiraishi, Y., and S. Kimura. 1971. Distribution of fishes and environmental condition in artificial lakes of Thailand. Bull.

of Fish. Res. Lab., Fish. Agency. Tokyo. 21(1):47-58.

Sidthimunka, A., M. Potaros, C. Boonsom, and Oopathum Pawapootanon. 1968. Observation on the hydrology and fisheries of Ubol Ratana Reservoir (1965-1966). Dept. of Fish. Bangkok, Thailand. No. 6. 18 p.

Sidthimunka, A., et al. 1970. A report on the fisheries surveys of the Mekong River in the vicinity of the Pa Mong dam site. Dept. of Fish., Bangkok, Thailand. No. 8. 75 p.

Sidthimunka, A. 1972. Pre-impoundment fishery survey of Quae Yai Dam. Fish. Res. Unit. Dept. of Fish., Bangkok, Thailand. Ann. rept. 176 p. (in Thai).

Sidthimunka, A. 1973. Length-weight relationships of freshwater fishes of Thailand. Dept. of Fish. Bangkok, Thailand. 25 p.

Smith, H.M. 1945. The fresh-water fish of Siam, or Thailand. Smithsonian Inst., Washington. 622 p.

Sukomol, N. 1970. A study on life history of Cyclocheilichthys apogon (Cuv. & Val.). Ext. Fish. Prod. in Ubol Ratana Reservoir Unit. Dept. of Fish., Bangkok, Thailand. Ann. rept. 154 p. (in Thai).

Sunkakul, S., V. srisuwantat, V. Pokaew, and V. Madjutaseranee. 1972. Hydrobiological and fishery survey in Lam Dom Noi Reservoir. Fish. Res. Unit. Dept. of Fish., Bangkok, Thailand. Ann. rept. 176 p. (in Thai).

Swingle, H.S. 1953. Fish populations in Alabama rivers and impoundments. Tran. Amer. Fish. Soc. 83:47-57.

Swingle, H.S., and W.E. Swingle. 1967. Problems in dynamics of fish populations in reservoir. p. 229-243. A symposium on the reservoir fishery resources. South Division, Amer. Fish. Soc., Special publication.

Tarnchalanukit, W. 1970. Handbook on principle of hatchery management. Faculty of Fish. Kasetsart Univ., Bangkok, Thailand. 488 p. (in Thai).

Titibullrat, K. 1970. Life history of Hampala dispar (H.M. Smith). Mahasarakam Fish. Station. Dept. of Fish., Bangkok, Thailand. Ann. rept. 78 p. (in Thai).

Veerakawoot, I., and P. Jaiyen. 1970. A study on food habits of Morulius chrysophekadion (Bleeker). Khonkaen Fish. Station. Dept. of Fish. Bangkok, Thailand. Ann. rept. 118 p. (in Thai).