BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER
PN-AAK-574

2. SUBJECT CLASSIFICATION (695)
AM00-8100-G700

3. TITLE AND SUBTITLE (240)
Report on fisheries in Cambodia

4. PERSONAL AUTHORS (100)
Bardach, John

5. CORPORATE AUTHORS (101)
USAID/Khmer

6. DOCUMENT DATE (110)
1959

7. NUMBER OF PAGES (120)
58p.

8. ARC NUMBER (170)
CB 639.209596 B949

9. REFERENCE ORGANIZATION (180)
Khmer

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

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12. DESCRIPTORS (920)
Khmer
cambodia
fisheries
fishery products
fishing grounds
food supply
tables

13. PROJECT NUMBER (150)

14. CONTRACT NO.(140)
unknown

15. CONTRACT TYPE (140)

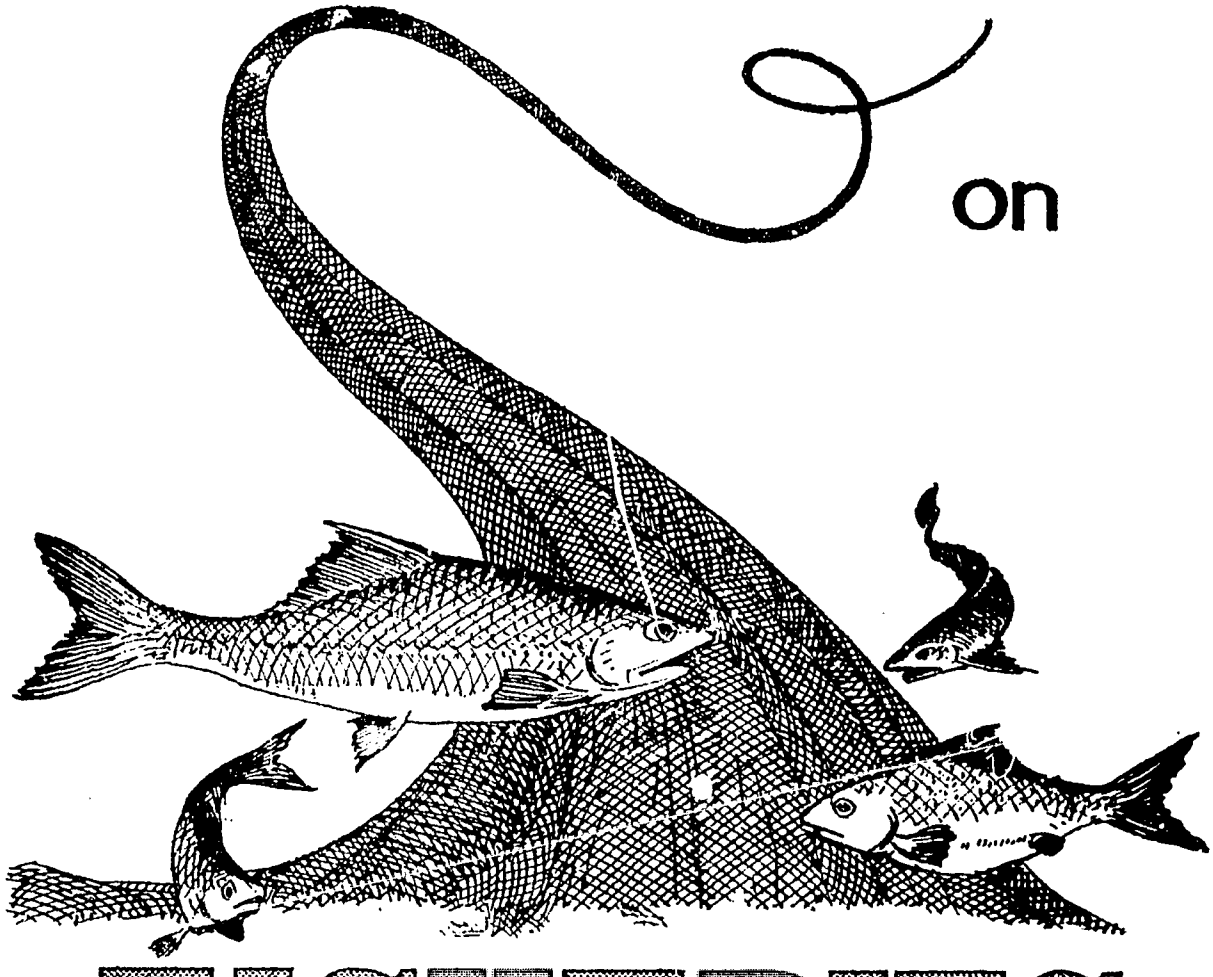
16. TYPE OF DOCUMENT (160)

CB
639.209596
B949

PN-AAK-574 Food

FE AREA-S/FOOD
FILE

REPORT on



FISHERIES IN CAMBODIA

BY

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PHNOM PENH
JUNE 1959

A.I.D.
Reference Centre
Room 1656 NS

PRINTED BY USOM/CAMBODIA

REPORT ON CAMBODIAN FISHERIES

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INTRODUCTION

The following report on Cambodian Fisheries is primarily intended for use by Cambodian Fisheries Service and other government personnel and interested technicians of any agency such as foreign aid and UN missions. Inasmuch as it is the first somewhat detailed English language report on several aspects of Cambodian fishes and fisheries, it is hoped that it may even find wider distribution and interest than that suggested above.

Cambodian fresh waters are among the most productive natural waters in the world. Fish is the most important food in Cambodia; in some river and lake regions of the country the yearly per capita fish intake is reported to exceed 20 kg, a very high fish consumption indeed (the comparable average US consumption is 5 kg). In the past Cambodia derived important foreign currency earnings from her fish exports. Mainly the exports but possibly also the overall fish production has declined in recent years. The cause for the lowering in fish exports are mainly political and economic; the causes for a general decline in production would be due to some conservation and land use problems which will be discussed in the body of this report.

The report, it is hoped, will be instrumental in maintaining Cambodian fish production, in pointing to certain conservation problems now prevailing and in suggesting some measures by which production for home consumption and export could be increased.

Among the publications used in the preparation of this report Chevey et Le Poulain's Pêche dans les Eaux Douces du Cambodge (1940) and Blache and Goossens Monographie Piscicole d'une Zone de Pêche au Cambodge (1954) retain a great deal of pertinence; an extensive bibliography of publications dealing with Cambodian waters, fishes, and fishery problems is included.

HYDROGRAPHIC FEATURES UNDERLYING CAMBODIAN FISHERIES *

A. The Great Lake

The Mekong River, during the lower part of its course, divides into two main branches: the Western branch or Bassac and the Eastern branch or the Mekong properly speaking. At the point of the division, the Tonlé Sap, an important tributary which has its source in the Great Lake of Cambodia, joins the two other rivers and flows into them. As a result of this there is a four-branch river formation, on the bank of which the town of Phnom Penh, the capital of Cambodia is situated. It should be added to this purely geographical description, that this four-branch formation is due to a phenomenon of stream capture. The Bassac is really only the lower part of the Tonlé Sap. In the past, the western hydrographical system (Tonlé Sap, Bassac) was completely independent from the Eastern (Mekong) river network.

During the dry season, the Tonlé Sap drains the waters of the Great Lake. The Mekong, coming from far-off Tibet, more or less mixes its waters with the four branches, and carries them away by two great independent arteries which link this point with the sea. At the end of spring, when the rainy season comes, water, accumulated by the melting of the snows from the high regions of Tibet, and above all by the immense quantities of runoff gathered up by the Mekong over its long course, causes such an inflow that the amount of flow rises from 15,000 m^3 to 60,000 m^3. The flow is four times more than normal and at certain points there are 30 meters of water above the river bed; 12 meters at Kompong Chhnang, 18 meters at the Four-Branches point, 30 meters towards Kompong Cham.

This formidable mass of water exceeds the capacity of the river bed especially in its lower course. It pushes back the waters from one pocket to another, invades all the complex hydrographical network of Vietnam and Cambodia, and finally reverses the course of the Tonlé Sap from one end to the other so that the waters of this river now run towards the Great Lake instead of draining it.

* The material in this chapter is taken largely from Chevey and Le Poulain (1940).

It is not only by this mechanism that the Great Lake becomes full at this time and covers three times more surface than at low water periods. At the entrance of the lake, at a spot called "Snoctru", a "step" or threshold of silt exists, emerging from the very low waters and preventing the lake from emptying entirely during the dry season. The existence of this silt dam or threshold is explained by the fact that there are two opposing currents meeting at this particular point and leaving behind them the sediments that they contained; there are the waters coming up the Tonlé Sap that have flowed from Phnom Penh and the outgoing water which drains the vast basin formed by the Great Lake, bordered by the Dangrek heights, the Cardamones and the Elephant Mountain Chain. The rising back current of the Tonlé Sap forms a closure as tight as any lock-gate and forces water to accumulate within the Great Lake whose level rises in the same proportions as that of the Tonlé Sap itself.

The surrounding area which is covered for a large part by forests, is submerged by this yearly flooding. The forests are plunged into water whilst in full vegetation. At this time (July), the fish are ready to spawn or have just spawned and they spread into the forest in order to deposit their eggs and to feed after spawning. In the midst of this veritable plant and animal "culture medium" which is thus formed, the water becomes the color of tea.

The forest consists largely of shrubs and low trees. The following list of most important species is included because no such listing exists in the literature and because detailed botanical studies of certain species might one day have to be attempted in order to conserve and optimally utilize the inundated forest areas. (The list has been prepared by Mr. Yeu-Kim-Chhon, Fisheries Division Chief of Banam Province).

PRINCIPAL SPECIES OF SHRUBS & TREES IN THE INUNDATED FORESTS OF CAMBODIA

(ESSENCES DES FORETS INONDEES DU CAMBODGE)

No. d'ordre d'importance	Noms Cambodgiens	Noms Latins
1	Reang Tuk	Barringtonia acutangula (Combretacées)
2	Tacur	Terminalia chebula (Combretacées)
3	Ateang	Homalium annamensis (Samydacées)
4	Phnom Phnèng	Hymenocardia Wallichir (Euphorbiacées)
5	Trâs	
6	Nho	
7	Tranom Bat	
8	Day Khla	Wrightia annamensis
9	Sdey	Creudia chrysanthe
10	Phtuol	Menucylon
11	Sandan Sâr	Sopthopetalem Mightearum
12	Sandan	Garcinia Soureiri (Guttiferes)
13	Anchanh	Gmelina asiatica (Var-Vallosa-Verbénacées)
14	Krabas Prey	Coelodiscusa annamiticus (Euphorbiacées)
15	Khlé	
16	Slàt	
17	Changkeng	
18	Tien Prey	

Signs of fish migration can be observed in the flooded forest during the dry season. When the waters have retreated, even a superficial survey shows fish scales, bones and various pieces of fish skeletons at considerable distances from the lake. This attraction of the fish by the submerged forest area is exploited by the lake fishermen at the low water stage when the fish are obliged to regain the free waters of the open lake. There the fishermen have immersed extensive piles of dead brushwood and from over very large areas the fish swim into them to take refuge. Then fishermen need only to surround the submerged brushwood with palisades (sometimes the palisades are several kilometers long) in order to capture all the animal life which is enclosed in the interior (Samra fishing).

B. Great and Smaller Rivers

Besides the Mekong, Bassac and Tonlé Sap rivers there are a number of other tributaries and some independent streams which complete the hydrographic network of Cambodia.

River Basins. It is difficult to determine smaller drainage basins. Sooner or later a flowage map should be drawn up, at any rate for the use of Fisheries. Generally, the waters first recede from the up river land which was the first to be flooded. There are, however, numerous exceptions.

Broadly speaking the waters of Cambodia can be divided into two big areas: the area north of the Four-Branches and the area south of the Four-Branches. These two big areas can be sub-divided into two sections: tributaries of the Four-Branches and rivers independent of the Four-Branches.

1. Region North of the Four Branches:

   a. Tributaries of the Four-Branches -

      On the left river bank: The Tonlé Tauch and its tributaries.

      On the right river bank: The Muk Kampul, the Sala Prean, Prek Kraboa and their various arteries.

All the numerous preks and bengs that are connected with the Mekong, the Bassac and the Tonlé Sap have the same flood regime; they are fully flooded at about the 15th of October and have begun to empty on the 15th of January.

b. Independent Rivers Flowing into the Four-Branches:
The Stung Chinit and the Stung Sen on the Tonlé Sap.

These two rivers and their numerous tributaries have conditions particular to their river basin and the most important period for their lowering is in January.

2. Region South of the Four-Branches:

a. Tributaries of the Four-Branches -
In the Southern region as in the North, we have two main arteries. These are:
On the left bank of the Mekong, the Stung Banam, and on the right bank of the Bassac, the Stung Samranh; both of these rivers end at Chaudoc. To these must be added the Lue-Bac-Nam which serves as a regulator for the big lowland area which is situated between the Bassac and the Mekong. From all these rivers the water does not begin to recede before the middle of January or the beginning of February.

b. Rivers Independent of the Four-Branches:
On the right bank of the Bassac, the Takmau and the Takeo which have falling waters in November.
On the left bank of the Mekong near Banam, the Anlong Reank Prek, the Ksach Sar Prek, and the Andong Kol Prek.
To the South on the Vietnamese frontier, the Prek Trabek, the the Song Ho Ha, the Rach Don, and the Rach Tam.
The waters of all these rivers recede in January.

LEADING FEATURES OF THE FISH FAUNA *

A fresh-water fauna of great variety and abundance has developed in Cambodia as a result of peculiarly physical and biological conditions. The annual inundation of the vast central plain of Cambodia is an event of great importance in the life of all the fishes. As the streams begin to rise and fill their beds, and flow into the connecting canals and the tributary ponds, the lakes, swamps and marshes that had become reduced during the protracted dry season become accessible to the fishes which follow the flood waters. By the time the indundation has reached its height the vast majority of the free-swimming fishes have spawned. With the falling of the flood waters, the adults move back into the river channels, leaving the young to follow in accordance with their rate of growth and respective needs. The flood waters give protection to the young, which in general have a rapid growth and many attain maturity in one year.

Outstanding among the fresh-water fishes are the Cyprinidae (minnows) which are the most numerous as regards genera and species and the most abundant as regards individuals. Some of the genera are peculiar to Cambodia, some range into the contiguous countries, and the Indo-Australian Archipelago. There is no brook, rivulet, river, canal or lake in which the family is not represented; and a net or trap may hardly be drawn anywhere at any time without yielding one or more species. Some species occur in incredible numbers in certain places at certain times, others may be found only singly, and several striking species are as yet known from only single specimens. The whole gamut of size among cyprinoid fishes is run by the family in Cambodia from the most diminutive, only 2 cm. long, to the colossal Catlocarpio siamensis, peculiar to Thailand and Cambodia, which attains a length of 3 meters and may be the largest member of the family. From the viewpoint of the domestic food supply, the family is of incalculable importance.

A very prominent element in the fresh-water fish fauna is the loaches (Cobitidae). Several genera are peculiar to Cambodia, and a number of species belonging to genera widely distributed in southern Asia and the

* This chapter is largely based on H. M. Smith (1945), The Freshwater Fishes of Siam or Thailand.

Indo-Australian Archipelago are known only from Cambodia and closely adjacent regions. These fishes are characteristic of mountain streams, where they bury themselves in sand and gravel. Some, however, lacking the burying habit, are found in large, muddy rivers and even in lakes. They also enter into the local catches.

Another very conspicuous feature of the fauna is the abundance of catfishes (Nematognathi or Siluri) as regards both species and individuals. Some of them are found only in mountain brooks, some only in the large rivers, and some throughout certain river basins from their headwaters to their brackish-water mouths. Two Pangasiids are among the largest catfishes in the world; one species, Amblyceps mangois, is amongst the smallest.

In one family (Sisoridae) some genera have a thoracic adhesive apparatus enabling the fish to cling to stones in swift currents; other genera have the whole underside of the head and the pectoral and ventral fins modified so as to serve as an adhesive organ. All members of one family (Clariidae) have an accessory breathing organ, occupying a cavity on each side of the head above the gills. In one family (Heteropneustidae), genus Saccobranchus) there is a supplementary respiratory apparatus consisting of two long hollow cylinders extending among the muscles of the back. In at least three genera of one family (Tachysuridae) comprising several species the eggs are incubated in the mouth of the male.

The tendency of certain kinds of flatfishes in various parts of the world to establish themselves in fresh water is manifested in a striking manner in Cambodia where representatives of several soleid genera are found far in-land in places where the water is always fresh; some of these fishes are met with several hundred miles from the sea. No observations have been made on the spawning habits, eggs, hatching and development of the young of these freshwater flatfishes, which are worthy of special study.

Everywhere observable and constituting a salient feature of the fish life of streams, lakes, swamps and marshes are the serpent or snake-head fishes, the Ophicephalidae, which are represented by at least six species.

The Anabantidae (the family of the climbing perch) are largely represented in Cambodia. In some of the local genera, the gills appear inadequate to maintain the necessary respiratory functions, and the fishes are dependent on atmospheric oxygen, which they are able to appropriate by means of accessory breathing organs developed from the branchia arches and occupying special cavities in the head. These fishes are monogamus and blow masses of glutinous bubbles for the reception of their eggs. Several members of the family are among the choicest of Oriental food fishes and several are among the most attractive of aquarium fishes.

In a preceding paragraph reference was made to the development in two families of catfishes, the Clariidae and the Heteropneustidae, and in the Anabantidae of respiratory apparatus accessory to the gills. In the Clariidae the accessory organ, occupying a large chamber above each gill cavity, is an outgrowth of the fourth gill arches and consists of an arborescent structure that provides a large surface for the absorption of the atmospheric air reaching it through the mouth. In the Anabantidae, a similar organ, arising from the fourth gill arch is composed of a set of superimposed leaflike plates, which afford a large absorptive surface. In the Heteropneustidae, gen. Saccobranchus, an entirely different accessory breathing organ is found. Extending from the pharynx among the muscles of the back on each side of the vertebral column is a long cylindrical tube, richly supplied with blood vessels and serving as a primitive lung. These tubes, into which both water and air are taken and from which water and air are forced by muscular action, enable the fish to obtain the requisite quantity of oxygen while living in hot, shallow, stagnant ditches and in other places where the water does not contain enough air to support life.

Although the Ophicephalidae lack the elaborate air-breathing organs met within the aforementioned families, they have a large suprabranchia cavity lined with puckered vascular epithelium, which serves the same purpose.

It has been shown by repeated observation and experimentation on the Clariids and Anabantids that even in well-aerated water the gills may not provide enough oxygen to satisfy the requirements of the system, and death may ensure in a comparatively short time (20 to 30 minutes in some cases)

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if the fish are prevented from going to the surface to expel vitiated air and take in gulps of fresh air. We may recognize here an evolutionary process that in time may eliminate the gills and make these fishes entirely airbreathing.

Associated with possession of air-breathing apparatus is the ability of some kinds of fishes to live out of water for protracted periods, if the respiratory chambers remain moist. Under the stress of drought, when the waters gradually evaporate and ponds and small streams disappear until the return of the rainy season, some of these fishes habitually go deeper and deeper into the mud and ultimately occupy damp pockets, at depths up to a meter, where they aestivate. Aestivation in the case of Cambodian air-breathing fishes consists of enforced inactivity and greatly reduced metabolism while they are buried under parched earth in a stratum of damp mud during the dry season, the limited nutritional needs of the system being supplied by the absorption of stored fat and other food material and the vital processes being maintained largely by the utilization of atmospheric air, which reaches the respiratory chambers through the cracked or porous overlying earth. One can imagine the subterranean tragedies that may occur when the desication of the soil is continued beyond the muddy pockets in which the fishes have taken final refuge.

One of the striking phenomena connected with fresh-water fishes in Cambodia as in other Oriental countries, is the sudden appearance of good-sized fishes after a torrential downpour at the beginning of the rainy season in a field or swamp bed that has been dry for months and cut off from any watercourse. While this is mystifying to the uninitiated, it is easily explained when one recognizes the presence of buried aestivating fishes, which eagerly make their way to the surface when a copious rain floods and softens the dry soil.

The ability to breathe atmospheric air and to exist out of water for a considerable time has led to another extraordinary habit in Clarias, Anabas, Ophiocephalus and other fishes, namely, the voluntary leaving of the water and traveling on land, sometimes across dusty roads, sometimes over dry lawns. The impelling influence may be a desire to find improved physical conditions, to seek a better food supply, or to escape enemies. Progress

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out of water is by lateral movements of the tail as in swimming, while the body is maintained in an upright position by the paired fins. Detailed accounts of actually observed performances of Clarias batrachus and Anabas testudineus can be found in the appropriate systematic discussions.

Mention has been made of the practice of oral incubation in the Cambodian catfishes of the family Tachysuridae (Ariidae). Associated with this habit is the existence of secondary sexual characteristics in both sexes, consisting in the male of a longer head, larger oral cavity, more posteriour insertion of pectoral and ventral fins, and smaller ventral fins, and the development in the female on the inner ventral rays of peculiar pads whose shape varies with the species. A consequence of oral incubation is that the male, having taken in a batch of eggs, is prevented from feeding until hatching ensues and the young leave his mouth after the absorption of the yolk-sac. Similarly, in the female feeding becomes more and more difficult with the growth of the enormous eggs, and a point is reached when the digestive organs are so compressed that they become nonfunctional, and no food can enter the stomach or intestines. It naturally follows that by the time the eggs are laid and the protracted hatching period is over both parents become much emaciated.

Only highlights of the great diversity of Cambodian fishes could be given here. The composition of the entire freshwater fauna of Indochina suggests that a connection existed in the past between the East Indies, the Malay Peninsula and Indochina. A great river system, the North Sunda River drained Borneo, Sumatra, and Malaya, and another drained the Indochina peninsula: the flow was Northwest to Southeast. Fish distribution suggests that stream capture took place between these large river systems. These phenomena and the subsequent climatic and edaphic changes produced a fish fauna in Cambodia which is one of the most varied and interesting in the world. It can be seen from the table below that the number of commercially-utilized species is very large, larger than in most other fisheries of the world. Nevertheless, the principal species in the catch (marked ** in the table) comprise perhaps only 15 or so, mainly minnows and catfishes.

CAMBODIAN FRESH WATER FISH 1/

Family and species name	English name	Vietnamese name	Cambodian name
CARCHARINIDAE			
Scoldiodon sorrakowah ..... (Russel.)	Shark	Ca nhan	ត្រីឆ្លាម Trey chhlam
PRISTIDAE			
Pristis microdon Latham	Saw-fish ...	Ca dao, Dao ngu	ត្រីជ Trey Thka
DASYBATIDAE			
Dasybatus imbricatus ..... (Schneider)	Sting ray...	Cá duôi.....	ត្រីប្រតិបល Trey Trabel
Dasybatus Krempfi Chabanaud.	id.	id.	id.
T E L E O S T E I			
NOTOPTERIDAE			
Notopterus notopterus ..... (Pallas) x/	Featherback.	Ca that lat...	ត្រីស្ពាត Trey Slat
Notopterus chitala (H.B.)x/	id.	Ca com.....	ត្រីក្រូស Trey kros
CLUPEIDAE			
Setipinna melanochir ..... (Blkr) x/	Anchovy	Ca top tuoi...	
Lycothrissa crocodilus ..... (Blkr) x/		Ca tóp.....	ត្រីក្ងាន Trey chmar
Coilia macrognathos nequidentala Chabanaud.....		Ca mong gà....	ត្រីចន្ទាញ្ញាមាន់ Trey chon lonh mon
Corica (Clupeichthys) goniognathus (Blkr)		Ca com.....	
Clupeoides bornaensis (Blkr)		Ca com.....	
Clupea (Alosa) kanagarta ... (Blkr)	Alosa	Ca mòi dâu....	ត្រីប្រលុង Trey pralung
Clupea (Alosa) Thibaudeaui.. J. Durand x/	id.	Ca mòi.....	ត្រីកាមយ Trey ca moi
COBITIDAE			
Botia hymenophysa (Blkr)x/..	Loach	Ca heo rung...	ត្រីកញ្ជ្ជ Trey kanchrut
Botia modesta (Blkr).....	id.	Ca heo.....	ត្រីកញ្ជ្ជ Trey kanchrut
Botia Morleti (Tirant)	id.	Cá heo	ត្រីដំរី Trey damrey
Acanthopsis choirorrynchus.. (Blkr)	id		

x/ Species of some economic importance. xx/ Principal commercial species
1/ See at end of list.

Family and species name	English name	Vietnamese name	Cambodian name
CYPRINIDAE			
Chela oxygastroides (Blkr)	Bleak	Ca la tre.....	ត្រីចន្ទាសណ្ដាត Trey Chéanteas chhuc
Paralaubuca typus (Blkr)x/	id.	Ca thiêu.....	ត្រីស្រាយកា Trey Shay ka
Paralaubuca siamensis (Gunther)	id.		
Macrochirichthys macrochirus (C.V.) x/		Ca rua.....	ត្រីដង្ហុង Trey dang ktong
Rasbora argyrotaenia (Blkr)x/		Ca lòng tong....	ត្រីចន្ទាមួល Trey Chan war muol
Rasbora aurotaenia Tirant			
Luciosoma sp.		Ca lòng tong.... muong	
Esomus lanrica (Ham.Buch.)			
Leptobarbus Hoevenii (Blkr)xx/		Ca chày.....	ត្រីប្រលង Trey pralung
Catlocarpio siamensis (Boulanger) x/		Ca hô	ត្រីកាហូ - ត្រីកល់ក្រាង Trey kaho, trey kolrcang
Amblyrhynchichthys altus Vaillant		Ca trâu-trâu....	
Amblyrhynchithys truncatus (Blkr)		id.	ត្រីរាល Trey real
Xenocheilichthys Loppei J. Durand			
Albulichthys Kreampfi Pellegrin et Chevey		Ca kay.....	ត្រីរាល Treal real
Dangila siamensis Sauvage xx/		Ca linh ria.....	ត្រីលេញ - ត្រីអាច់ Trey lenh, Trey étóok
Thynnichthys thynnoides (Blkr) xx/		Ca linh banh....	ត្រីប្រកដមមាយ Trey kroc mamay
Osteochilus brachynotopterus (Blkr)			
Osteochilus melanopleura (Blkr) xx/		Ca mè.....	ត្រីគ្រ Trey kron
Osteochilus Schlegeli (Blkr)		Ca mè trang.....	
Osteochilus vittatus (C.V.) /Blkr/		Ca lui	ត្រីគ្រ Trey krom
Osteochilus Hasselti (C.V.)xx/		Ca mè trang.....	id.

Family and species name	English name	Vietnamese name	Cambodian name
Osteochilus triporus (Blkr)			
Osteochilus spilopleura Fowler		Ca linh son....	
Cirrhinus auratus Sauvage xx/		Ca duông.....	ត្រីប្រូល Trey pruol
Cirrhinus Jullieni Sauvage x/		Ca linh nho....	ត្រីលេញ Trey lenh
Cosmochilus Harmandi Sauvage		Ca duông bay...	ត្រីកំពូលឆ្នាយ Trey damnal bay
Cosmochilus Pellegrini J. Durand		id.	id.
Hampala macrolepidota (C.V.) xx/		Ca ngua.....	ត្រីខ្មៅ Trey khmau
Cyclocheillichthys enoplos (Blkr) x/		Ca côc	ត្រីឆ្ការ Trey chkok
Cyclocheilichthys apogon (C.V.)			
Cyclocheilichthys repasson Blkr.			
Cyclocheilichthys siaja Blkr.			
Cyclocheilichthys armatus (C.V.)			
Cyclocheilichthys mekongensis Fowler			
Puntioplites proctozysron (Blkr.) x/		Ca danh	ត្រីច្រកែង Trey chakeng
Puntius binolatus			
Puntius brevis (Blkr)			
Puntius bulu (Blkr)		Ca danh-bong .	
Puntius orphoides (C.V.)		Ca do mang ...	
Puntius bramoides (C.V.) x/		Ca tra dinh ..	
Puntius javanicus (Blkr) x/		Ca tra dinh ..	
Puntius elongatus (Seale)			
Puntius chola (H.B.)			
Puntius altus (Gunther) x/		Ca he	ត្រីកាហ៊ីង Trey kaho
Probarbus Jullieni Sauvage		Ca tra sôc ...	ត្រីត្រសក់ Trey tra sak

Family and species name	English name	Vietnamese name	Cambodian name
Balantiocheilus melanopterus (Blkr)		Ca hoc trò	
Barbichthys laevis (C.V.)		Ca ba luoi	
Labeo erythrura Fowler			
Labeo (Morulius) chrysophe-kadion (Blkr) xx/		Ca et	ត្រីកហុក Trey kahôk
Labeo erythropterus (C.V.)			
Labeo pleurotaenia (Blkr) /Labeo pruol Tirant, synonyme probable de Cirrhinus auratus Svge._7		Ca duông	ត្រីប្រួល Trey pruol
Varicorhinus dyocheilus (Mc. Clelland)			
Tylognathus bo Popta		Ca linh dât	
Tylognathus Lehat Blkr			
Tylognathus falcifer (C.V.)		Ca linh dât	
Gyrinocheilus Aymonieri (Tirant)			
Gyrinocheilus pustulosus Vaill		Ca mey,Ca ông	ត្រីស្មុក Trey samoc
Gyrinocheilops Pennocki Fowler		Ca mey, Ca ông	ត្រីស្មុក Trey samoc
Crossochilus latius (H.B.)			
Crossochilus cobitis (Blkr)		Ca linh rut	
Crossochilus gnathopogon (Weber et de Beaufort)			
Crossochilus cambodgiensis Tirant			
CLARIIDAE			
Clarias batrachus (L.) xx/	Cat fish	Ca trê	ត្រីអណ្ដែង Trey an[illegible]
Clarias Nieuhofi C.V.			
SILURIDAE			
Wallago attu (Bl. Schn.) xx/		Ca leo	ត្រីសណ្ដាយ Trey Sanday
Wallago Leerii Blkr.		id.	id.

Family and species name	English name	Vietnamese name	Cambodian name
Belodontichthys dinema (Blkr) x/		Ca chèn rang ...	Trey klang hau ត្រីខ្លាដំហរ
Fenesilurus bokorensis Pellegrin et Chevey			
Silurodes hypophthalmus (Blkr)	Sheat fish	Ca chèn la	
Callichrous bimaculatus (Bl.) x/		Ca chèn bâu	
Cryptopterus schilbeides (Blkr) x/		Ca chèn mù	
Cryptopterus cryptopterus (Blkr) x/			
Cryptopterus Chevayi J. Durand			
Cryptopterus apogon (Blkr) xx/		Ca kết	ត្រីកែ Trey kès
Cryptopterus micronema (Blkr)		Ca chen	
Cryptopterus bicirrhis (C.V.)			
PLOTOSIDAE			
Helicophagus Waandersi Blkr		Ca tra chuốt ...	
Pangasius nasutus (Blkr)		Ca hu	
Pangasius pangasius (Ham. Buch.) x/		Ca dua	ត្រីប្រា Trey pra
Pangasius polyuranodon Blkr			ត្រីស្វៃ
Pangasius macronema Blkr xx/		Ca sát	Trey shveat
Pangasius Sutchi Fowler xx/		Cá tra	ត្រីប្រា Trey pra
Pangasius furcini Fowler		Ca vô dim	ត្រីពង Trey po
Pangasius Larnaudi Bocourt xx/		Ca vô	ត្រីពង Trey po
Pangasius Sanitwongsei Smith x/		Ca vô cò	ត្រីពងក្រូច Trey po pruy
Pangasius Beani Smith			
Pangasius micronema Blkr x/			ត្រីប្រា Trey pra
Pangasius altifrons J. Durand			
Pteropangasius cultratus (Smith)		Ca sat bo	

Family and species name	English name	Vietnamese name	Cambodian name
Pangasianodon gigas Chevey x/		Ca hat, Ca dâu	ត្រីរាជ Trey reach
BAGARIDAE			
Glyptosternum sp.			
ARIIDAE			
Arius microcephalus Blkr			
Hemipimelodus Daugueli Chevey		Ca uc	ត្រីកញ្ចប់ កណ្ដ ០ Trey kanchoc kandor
Hemipimelodus cochlearis Fowler			
Hemipimelodus siamensis Sauvage		Ca uc	
Hemipimelodus borneensis (Blkr)		Ca uc	
Hemipimelodus macrocephalus Blkr.		Ca uc	
Osteogeneiosus militaris (L.)		Ca uc	
Batracocephalus mino (Ham.Buch.)		Ca uc gao	
BAGRIDAE			
Macrones nigriceps (C.V.)		Ca chốt	
Macrones micracanthus Blkr		Ca chốt	
Macrones vittatus (Bl.) x/		Ca chốt	
Macrones Wolffi (Blkr)		Ca chốt trâu ...	
Macrones Myckii (Blkr)		Ca lang	
Macrones nemurus (C.V.) x/		Ca lang	ត្រីឆ្លាង - ត្រីតាទ ០ Trey chhlang, Trey tasel
Macrones planiceps C.V.		Ca lang	
Bagrichthys hypselopterus (Blkr)		Ca chốt	
Bagroides macropterus Blkr.		Ca chốt	
Bagroides macracanthus Blkr.		Ca chốt	
Heterobagrus Bocourti Blkr.x/		Ca chốt	
Leiocassis albicollaris Fowler		Ca chốt	

Family and species name	English name	Vietnamese name	Cambodian name
SYNBRANCHIDAE			
Monopterus albus (Zuiew)	Eel	Con luon	អន្ទង់ Antong
Synbranchus bengalensis Mc.Clell x/	id.	Con luon	id.
OPHICHTHYIDAE			
Ophichthys rhytidoderma (Blkr) x/	Snake eel	Ca chình	
SYNGNATHIDAE			
Microphis boaja (Blkr)	Pipe fish	(Ca ngua .....) (Ca rei .....)	ត្រីកាបូ Trey kabo
SCOMBRESOCIDAE			
Tylosurus strongylurus v. Hass	Needle fish	Ca nhai	ត្រីផ្ទោង Trey phtoung
Zenentodo canciloides (Blkr) x/	id.	Ca nhai	id.
Hemiramphus Hocquardianus Thorinot	Half beak		
Zenarchopterus ectuntio (Ham.Buch)	Half beak	Ca kìm	
Zenarchopterus Buffoni (C.V.)	id.	Ca kìm	
POLYNEMIDAE			
Polynemus longipectoralis Weber et De Beaufort x/	Thread fin	Cá chet, ca phèn	
Polynemus borneensis Blkr.		Ca chet, ca phèn	
OPHIOCEPHALIDAE			
Ophiocephalus gachua Ham.Buch.	Snake head		
Ophiocephalus striatus Bl. xx/	id.	Ca loc	ត្រីរស់ Trey ras
Ophiocephalus micropelte (C.V.H.) C.V.		Ca bông	ត្រីផ្ការ Trey chhdor
Ophiocephalus melanopterus Blkr.	Snake head		
Ophiocephalus siamensis Günther	id.		
Ophiocephalus lucius (C.V.H.) C.V.	id.		

Family and species name	English name	Vietnamese name	Cambodian name
ANABANTIDAE			
Anabas testudineus (Bl.) xx/	Climbing perch	Ca rô đồng ...	ត្រីក្រាញ់ Trey kranh
Osphronemus siamensis Gunther x/	Gusami		
Trichopodus trichopterus (Pall)		Ca sat	ត្រីកន្ទ្រាញ Trey kontrâng
Trichopodus microlepis (Gunther)		Ca sat	
Ctenops vittatus (C.V.)			
CENTROPOMIDAE			
Lates calcarifer (Bl.)		Ca chem	ត្រីស្លែង Trey sleng
Ambassis Wolffi Blkr. x/		Ca con	ត្រីកន្ត្រង់ចន្ទ្រង Trey kantrang [illegible]
Ambassis ranga (H.B.) x/		Ca con	
SCIAENIDAE			
Pseudosciaena soldado (Lac.) xx/	Drum	Ca suu	ត្រីប្ដមា Trey bama
MAGILIDAE			
Mugil nebulosus (Gray)		Ca huong lai ..	
Pristolepis fasciatus (Blkr)		Ca rô biên	ត្រីក្រាញ់ Trey kranh
LOBOTIDAE			
Datnioides microlepis (Blkr)		Ca huong vên ..	ត្រីក្ឡា Trey kla
TOXOTIDAE			
Toxotes chatareus (H.B.) / Toxotes microlepis (Gunther)	Shooting fish	Ca mang rô	
SCOMBRIDAE			
Cybium cambodiense J. Durand	Mackerel	Ca thu	
SOLEIDAE			
Synaptura orientalis (Bl.Schn.) x/		Ca lon bon	
Synaptura Kerrefi J. Durand		Ca la mit	
Cynoglossus microlepis (Blkr) x/	Tongue fish	Ca luoi trâu ..	
GOBIIDAE			
Oxyeleotris marmorata (Blkr) xx/	Sleeper	Ca bong	ត្រីដង្គី Trey damrey
Ilossogobius giuris (Ham.Buch)	id.	Ca bong mu ...	

Family and species name	English name	Vietnamese name	Cambodian name
RHYNCHOBDELLIDAE			
Mastacembelus armatus Lacépède	Spiny Eel	Ca chach	ត្រីឆ្ពាញ Trey chhlaunh
Mastacembetus favus (Hora)		Ca chach	
Mastacembelus argus (Gunther)		Ca chach	
Rhynchobdella aculeata (Bl.)		Ca chach	
TETRODONTIDAE			
Tetrodon (Crayracion) cambodgiensis Chabanaud	Puffer	Ca noc	ត្រីក្រពត Trey krepot
Chonerhinus modestus Blkr.		Ca noc	ត្រីក្រពត Trey krepot

1/ The system of classification used here is that found in Chevey & Le Poulain (1940) since no references for establishing later synonomics were available.

FISHING METHODS

Fishing tools and methods in any fishing industry, whether highly or little industrialized (Cambodia) develop in response to the specific conditions of the waters and the biology of the fishes of a region. It is, therefore, not surprising that one may find in Cambodia some very special and very ingenious fishing implements to capture the many species already described. Some are found only Cambodia, others are either the same or similar to those used in South East Asia in general.

While it is difficult to draw a strict dividing line between subsistence fishing, exercised by almost every rural Cambodian, and commercial fishing proper one may observe that the diversification of tools applies mostly to the subsistence segment of the industry. In contrast, commercial fisheries employ a few, often large scale, types of installations. The tools of subsistence and artisanal fishing will be discussed first.

Subsistence Fishing Tools

Harpoons. Five, three, two and one pronged harpoons are used. The five pronged type made of flexible bamboo strips is supposed to scoop rather than to spear fish; the three pronged harpoon resembles the Eskimo leister and is used to grasp rather than to spear the prey. Two and one pronged harpoons are mainly employed for spearing the larger catfishes.

Handlines. Various methods of hook and line fishing are practised in Cambodia; from the minute barbless hook for small minnows which are flicked into the boat or onto the dock to large hooks for two to three foot snakehead specimens. Live and dead bait is used.

Trotlines. These consist of a central line from which there arise a number of leaders with a hook usually at one meter intervals. The lines may attain a length several hundred meters; they may be set at the bottom or in midstream, supported by floats. The bait varies but frequently consists of small freshwater cray fish.

Fish Traps

(a) Moving Traps. These are sieves of bamboo or netting, of various designs, with or without a handle. There are also circular bamboo retaining devises (Angruth) of one to two feet diametere, open underneath, which confine the fish during communal fish drives at low water. A row of wading fishermen causes the fish to jump or otherwise betray their presence. The Angruth is lowered quickly on the spot where a movement was observed and the fish is extracted by hand through the narrow neck of the trap and placed in a creel.

(b) Stationary Traps. All follow the basic principle of a maze: the fish can enter in one sense, but should it find the entrance again, it is prevented to use it for escape by bamboo prongs pointing into the trap. Some have simple entrances, like the cylindrical lop. Some have a double or triple entrance chamber (Sonr Trey-Kauche). They vary in size from 20 cm. in height to several meters and they are mostly used in conjunction with bamboo barrages which serve as wings to direct the fish into the traps.

Cast Nets. This type of net is found in Polynesia, in the Caribbean as well as in South East Asia. The netting is light, the edge is weighted and has a purse string for closing once the net is thrown over a school of fish often spotted from the prow of a boat.

Lift Nets. Netting is suspended in pocket or bag fashion from a fork of wood. The lift net is worked either from a position on the shore, or from the bow of the sampan. Large square liftnets, with sides of 10 meters, were observed around Kratie and Stung Treng; they already serve for small scale commercial fisheries.

Gill Nets. Floating or anchored barriers of fine netting are placed in the water like a fence in which the fish entangle their gill covers (Mong). They are used in familial or subsistence fishing as well as in commercial operations and come in various sizes up to 40 cm. stretch mesh for large catfishes (Mong Reach and Mong Kolreane).

These are the principal basic types of subsistence fishing gear but it must be remembered that they differ slightly in different regions and that there are many variations on the basic types.

Commercial Fishing Gear

There are four principal types of commercial fishing gear and methods in Cambodia: the Seine, the Barrage, the Day and the Samra.

Seines. Large haul seines with or without bags of up to two kilometers length (Uon) are used on the Great Lake and on the Mekong between Kompong Cham and Phnom Penh. Emplacements for movable capstan heads exist along the river shore and groups of coolies who may share-crop the catch move down the river to draw in the seine after it had been laid out by boats.

Almost all nets are made of Ramie fibers (Boehmeria nivea, Thney, in Khmer) and are treated with betel chalk and the bark of Smach (Melaleuca leucodendron) and diverse cold rinsing and boiling procedures. No regulations for mesh size of the seines exist and many "young of the year" are therefore captured.

Nets are dried on drying racks on posts in the river or lake or on shore. One kilometer of net requires 500 meters of rack, a proportion not often adhered to.

Nylon nets were tried by a few fishermen and discarded as less suitable than Ramie nets. The reason given was that nylon breaks more easily and inflicts greater damage on the fish. The first of these observations can be doubted unless the nylon nets in question were exposed to the sun which renders the fiber brittle. The observation of damage to fish may rest on good grounds. Since Cambodian commercial fishermen try to keep many of their fish alive in holding cribs, Nylon thread certainly can inflict deeper and sharper net marks than the thicker netting of vegetable fiber. Fish thus wounded soon become fungus infected and die from osmotic stress.

Recommendation 1

It is recommended to study the feasibility of regulating mesh sizes to allow greater escapement of "young of the year" of large species.

Barrages. Many thousand tons of split bamboo are used annually in the more than 1,000 kilometers of barrages put up in Cambodia every year. Bamboo fences, large and small are clearly the most important fish catching

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device in Cambodia; their use poses one serious conservation problem which will be mentioned after a description of several barrage types.

Bamboo barrages are made in sections and are strung across smaller rivers, across arms of the Tonlé Sap and across many a prek or lake outlet. In the large rivers they are supported by large wooden posts, in the lakes and on the fishing concessions which they enclose, their support consists of smaller poles placed at intervals, with bamboo fences in between. Different-sized traps are placed along them at intervals and at all depths in order to capture surface-midwater and bottom dwelling fishes.

Some of the larger river installations cost more than one million riels ($35,000) to erect every year. The surrounding of large areas of inundated forest for other than river fishing, may be equally costly.

Besides barrages which enclose an area or stretch across a flowage Cambodians also use bamboo barrages as wings and leaders for entrapment devices somewhat along the lines of large Fyke or Hoopnets; the net portions being replaced entirely by bamboo.

All barrages must be (but are not always) taken down at the end of the fishing season in May or June respectively, to allow upstream migration of the fishes at the onset of the rainy season, and all river barrages must provide a passage for sampans.

It would be a worthwhile applied research project for RKG Fisheries Technicians to find out whether some of the bamboo installations could be replaced by netting. This has the advantage of being more easily removable nets may also not need to be renewed every year, they may even last three or four years. Their initial purchase price is, of course, much higher than the annual cost of bamboo. It is possible that their use could be advised in some places where barrages are used now.

Considering the nature of Cambodia's fishing waters barrages are a natural and efficient way of capture. They are even too efficient, because the individual staves in the bamboo fences are placed at two to three (at most 4) cm. intervals, sometimes even narrower. Thus all or almost all the fish in a region are fenced in and captured and no distinction can be made between "young of the year" of the species where a percentage should be allowed to escape and the small short lived species which should be

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utilized. No easy solution exists for this problem; detailed information - as yet nonexistent - on the life histories of the various species in the catches may suggest that the fishing campaign be divided into a portion where the taking of all fishes is permitted and one where some escapement for young of the year must be provided even at the cost of loosing the catch of small fishes at this time.

Another possibility for conservation may lie in fishing with small meshed nets for the small shortlived species in one area and in other locations to erect barriers with widely spaced staves for the capture of migrants.

It must be reiterated and stressed that these very tentative suggestions for a solution of the non-selectivity of barrages are not as yet supported by adequate studies, that these studies would require several years of work by trained fisheries technicians. I am convinced that the problem will require attention within the next 10 years in order to safeguard adequate spawning stock of certain larger species.

It can be seen that this spawning stock is in danger if one examines the percentage of immatures in the catch.

Seasonal descent of fish with the waxing moon	Immature fish in catch (per cent)
1st	3.4
2nd	11.6
3rd	1.8
4th	1.3
5th	3.0

This is a surprisingly good record for as heavy an exploitation as the Cambodian fishery is supposed to be. The picture changes, however, when one examines certain species which are in great demand and fetch high prices on the local markets; there the percentage of immatures in the catch is alarming and spells great danger to the persistence of the species as a commercially important fish, to wit:

Species	Descent	Immatures (%)
Cyclocheilichthys enoplos	1st	15.6
	2nd	89.2
	3rd	40.0
	4th	100.0
Labeo chrysophekadion	1st	37.2
	2nd	50.9
	3rd	88.2
	4th	54.2
Catlacarpio siamensis	all	100.0

In 1958 the percentage of immatures at the 3rd and 4th lunar periods had increased over those of 1950 for the first two species while not a single specimen of the last, mature or immature, was observed.

The same trend, though not documented by percentages, seems to apply to Puntioplites proctozysron, Osteochilus melanopleura, Hampala macrolepidota, Kryptopterus apogon, and some species of Pangasius.

Recommendation 2

It is recommended that the above mentioned problem receive serious study with a view to regulate distance between barrage staves, again to secure escapement for future spawning and catches of larger fish.

Days. This net is typical of the larger Cambodian rivers. It is now forbidden in all but a few locations on the Tonlé Sap where most of its catches are turned into Prahoc (fish paste). It is essentially a stationary trawl with a small meshed bag. The net is kept open by the river current instead of the resistance-to-pull, as in the true trawl. The nets are anchored and junks are used as stabilizers and fishing headquarters. A series of Days (five to ten), each with an opening of 15 meters and 30-60 meters long, are joined in line between the boats. These installations stretch across half or three quarters of the river and alternate in their approaches to the shore so that passing boats have to navigate in a zig-zag path.

Days are immersed from November to February but the catches are made each month during the 5th and 15th days of the Vietnamese calendar - the period of the waxing moon. Then the fish descend in waves from the Great

Lake, lakes and bongs with the rapidly flowing waters of the Tonlé Sap. Day fishing ceases in February as the current diminishes.

The meshes of the nets begin with 10-15 cm. at the entrance and diminish to a square mesh of 1 cm. in the bag - obviously a gear that takes all the fish that enter. The larger ones go to the Phnom Penh market and the smaller ones to the camp sites of villages on the shore who make their traditional fish paste or prahoc in the proximity of the Days.

It can be seen from the following table that a fair number of the fish captured in the days are immature specimens of medium sized to large species.

PRINCIPAL FISH SPECIES CAPTURED BY DAYS

Family & Sub-Family	Scientific Name	Cambodian Name	Dimensions of Fish Caught	Adult Dimensions	Observations
Clupeinae	Alosa Thibaudeaui	Trey Pra-lung	200-300 mm		Abundant toward 20th day of Vietnamese month.
SILURIDAE	Belodontichtys dinema	Trey Khlang Hay	100-500 mm	550mm	Abundant, generally of good dimensions.
PANGASIDAE	Pangasius macronema	Trey Shveat	135-180 mm	180mm	Very abundant.
PANGASIDAE	Pteropangasius Cultratus		190-210 mm		Fairly abundant.
Abramidinae	Paralaubuca typus	Trey Sbay Ka	120-130 mm*	200mm	Very abundant at the time of the waxing of the moon. Good for prahoc.
Abramidinae	Macrochirichthys macrochirus	Trey Jang Khton	190-500 mm	500mm	Very abundant, usually of adult dimensions.
Cyprininae	Leptobarbus Hoeveni		300-400 mm	410mm	Fairly abundant.
Cyprininae	Danvila siamensis	Trey Lenh, Trey Eteok	80-135 mm	200mm	Very abundant at time of the waxing of the moon.
Cyprininae	Thynnichthys thynnoides	Trey Kros Kenay	100-170 mm	230mm	Same as above.
Cyprininae	Osteochilus melanopleura	Trey Krom	90-400 mm	500mm	Abundant, few young, generally 3/400mm.
Cyprininae	Osteochilus vittatus	Trey Krom	75-140 mm	260mm	Abundant at time of the waxing of the moon.
Cyprininae	Cirrhinus auratus	Trey Proul	140-360 mm*	400mm	Same as above.
Cyprininae	Cirrhinus Julliani	Trey Real, Trey Lenh	68-165 mm	200mm	The most abundant at the waxing moon.
Cyprininae	Hampala macrolepidota	Trey Khnau	100-250 mm*	700mm	Very abundant of medium size.
Cyprininae	Cyclocheilichthys		55- 90 mm*		Fairly abundant, seem to be the young of Cyclocheilichthys enoplos.
Cyprininae	Puntius altus	Trey Kahe	65-250 mm	250mm	Abundant, large proportion of young, 70/100mm.
Cyprininae	Puntius bramoides		300-400 mm	300mm	Fairly abundant generally of medium size.

Family & Sub-Family	Scientific Name	Cambodian Name	Dimensions of Fish Caught	Adult Dimensions	Observations
Cyprininae	Puntius javanicus		170-300 mm	330mm	
Cyprininae	Puntioplites proctozysron	Trey Cha-kreng	60-200 mm	250mm	Fairly abundant, large proportion of young.
Cyprininae	Balantiocheilus melanopterus		90-300 mm	350mm	Fairly abundant, of varying sizes.
Cyprininae	Labeo (Morulius chrysophekadion	Trey Kahek	75-300 mm*	600mm	Abundant, especially the young.
SOLEIDAE	Cynoglossus microlepis		250-290 mm	350mm	Abundant at night, especially around the 15th of Vietnamese month.
CENTROPO-MIDAE	Ambassis Wolffi		45-150 mm	200mm	Abundant toward the end of the waxing of the moon. Without great economic importance.
CENTROPO-MIDAE	Ambassis ranga		45- 60 mm	75mm	Same as above.

* Immature specimens.

Recommendation 3

That gear research be performed to increase the selectivity of the Day, to capture the small species with other tools than the Day and to eliminate Day fishing eventually.

The days are as non-selective as are the barrages. Their suppression in other locations than the Tonlé Sap represents an advance in conservation practices but one should consider replacing them even there with fishing tools which permit a greater selectivity of the catch. Such advances will have to await the formation and education of Cambodian personnel in fishing gear technology. This year a group of RKG Fisheries officials is to study fishing gear design in Japan under ICA auspices, they may later initiate developments along these lines.

The Samra. The Samra is another indigenous fishing gear and method; it is the product of the peculiar complex of Cambodia's inundated forest, the Great Lake and the yearly water pulse.

When the waters recede the fish have to leave inundated forest and return to the lakes; there they find an artificial inundated forest in the form of large areas of brush weighted and immersed, lakewards from the low-water shore. They have been placed there by the fishermen for the fish to hide and feed. At low water in April and May these brush shelter areas are surrounded by bamboo barrages, subdivided into smaller areas by the same means, for they may attain 500 ha., and finally the fish are driven into capturing chambers which also serve as reservoirs for live fish.

Samra fishing was a natural development but it has become a serious problem for several reasons:

a) The inundated forest is disappearing through the cutting of samra-wood. The cutting of branches only is permitted but the law is often disregarded and the entire tree is removed. It takes 50-100 junk loads of brush to make a 500 ha. Samra.

b) The number of Samras has increased so much that the entire lake is girdled by a mile-wide bed of brush shelters and fishing is, no doubt, too heavy for the stocks which remain in the lake.

c) By far the worst aspect of Samra fishing is that it contributes to rapid siltation of the lake.

The sediment which enters the lake is carried (1) by the Tonlé Sap at rising waters and (2) by the tributaries to the lake. Sediment which leaves the lake is only carried out by the Tonlé Sap when its waters begin to drain the lake in October. The yearly average sediment inflow between 1949-53, only through the Tonlé Sap was 5.68 sedimentation units; the equivalent figure for the outflow is 4.66 sedimentation units.* (From ICA Recon. Report Lower Mekong River Basin, US Dept. of Int. 1956). Even without obstructions to water flow, this regime would tend to fill up the lake in the future.

Brush shelters, for they stay in place till they decay, prevent the incoming Tonlé Sap water from carrying part of its silt load into the inundated forests at rising waters, they add to the sedimentation when they decompose, they slow down flash flood scourings by the rivers and they generally slow the speed of the water through the lake.

All this means a more rapid rate of deposition of suspended material hence a more rapid rate of lake extinction (Verlandung) than would be natural.

In 1923 French Geographers estimated that the lake would have water in it at its low water stages for another 200 years. The lake now produces over 30,000 tons of fish a year, representing a value to the producer of close to 100 million riels. When extinct, it will be a lake only during the rainy season. It is not known on what measurements the 1923 estimates were based but recent estimates by fishermen not supported by measurements, however give the lake not more than 50 years before its disappearance as a permanent body of water.

Perhaps it is too late even now to prolong the life of the lake because the removal of the brush requires large expenditures, nevertheless, I feel that Samra fishing in the Great Lake is a practice which should be forbidden just as it is in other Cambodian waters; the reasons for this recommendation are cogent and self-evident. A study of lake sedimentation rates should also be made and thereafter thought should be given to a lake improvement program.

* Metric tons x 10^6 for a flow period

d) Samras also are a hazard to navigation since the lake is very shallow at low water - not over 50 to 80 cms. over most of its surface, and Samra branches either emerge or lie just under the surface.

This difficulty can, however, be settled by marking and clearing navigation channels.

Serious study must also be given to the consequences of damming Great Lake and Tonlé Sap waters to regulate the flow of the Mekong as it is planned in the development of the Lower Mekong River Basin.

If these installation or installations retain water in the Great Lake for most of the year at a depth of 3 meters Samra fishing would become either impossible or far more costly than netting. Such a change is very much to be desired in the interest of extending the life of the lake; it is possible that two barrages, one at Suoc Trou and one at the confluence of Mekong and Tonlé Sap rather than one only, as now planned close to the latter location would be needed to achieve this result.

The most serious fishery problem which faces barrage builders is to allow fish migrations to pass up and down stream. This is particularly serious in Cambodia since both lake and river fisheries depend on migrations.

Basic information to be secured before barrages are built is listed in: "Rapport sur les études nécessares a la planification du developpement de l'agriculture de Fôrets et des pêches dans le bassin interieur du Mekong", FAO(Mimeo.), Rome, Février 1959.

Recommendation 4

That Samra fishing on the Great Lake be forbidden after suitable warning period to fishermen who may shift to other methods of capture (fish nets, traps and seines are obvious suggestions). That the fishermen receive technical aid from Fisheries Department personnel in making this change. That a sedimentation study be made on the Great Lake.

Addendum 1

The take of fish in the Great Lake seems indeed to have declined during recent years, especially in certain areas.

Reports of fishermen suggest that this decline is real - e.g. the Siem Reap region. There are undoubtedly climatic changes perhaps of a recurrent or even cyclic nature which profoundly influence the productivity of a body of water such as the Great Lake. The man-induced acceleration of siltation has already been mentioned. It may primarily be a cause of reduction among bottom feeding fishes whose animal food is affected. The nature induced downward trend can be accelerated by man's interference and stocks can decline very rapidly. Ceasing to immerse fresh Samras would be a step in the right direction though it is doubtful that the effects of such a measure could be felt before several years have elapsed. Artificial removal of Samras is economically and technically impossible.

In this area of the fishing industry Recommendation 7 - concerning optimal land use - is of prime importance if coupled with Recommendation 4 - on the use of Samras.

It is even possible that a fair number of fishermen may seek to enter an alternative profession during the next few years. Problems involving the relocation and employment of members of a special profession are difficult and may well require the joint efforts of several government departments.

SPAWNING LOCATIONS AND MIGRATIONS

Previous chapters will have suggested that Cambodia's fish fauna could conveniently be divided into two groups of fishes, those that can tolerate low waters, reduced oxygen and even temporary dryness and those that have no such adaptations. The former are more or less permanent residents of the bodies of water where they are caught while the latter migrate to avoid the unfavorable seasonal drought. They are called "poissons noirs" (Black fishes), and "poissons blancs" (White fishes), respectively, perhaps because some of the latter are more silvery in appearance than the former. Many common representatives of these groups are listed below:

Liste des "poissons noirs" du Cambodge

TABLEAU DE CORRESPONDANCE DES NOMS DE POISSONS

Nom Scientifique	Nom Khmer	Nom Vietnamien
Clarias batrachus	Trey andòng	Ca trê
Bagarius bagarius	Trey krabey	Ca lăng trâu
Heteropneustes divers	Trey kâok	Ca uc
" borneensis (Bbl.)	-	-
Bagroides macracanthus	Trey chék tum	Ca chốt chuôi
" macropterus	-id-	-id-
Heterobagrus Jocourti	Trey kanchos kdaung	Ca chốt
Leiocassis siamensis	Trey kanchos tmâr	Ca chot bong
Macrones nemurus	Trey chhlang	Ca lăng
" vittatus	Trey kanchos	Ca chốt
" nigriceps	Trey kanchos chhnaut	-id-
" (rubicauda) probablement espèce nouvelle pour la science	Trey khya	Ca lăng nha
Synbranchus bengalensis	Antong	Con luon
Ophiocephalus lucius	Trey kanchon chey	Ca dây
" micropeltes	J. Trey diep A. Trey chhdor	Ca bông -id-
" striatus	J. Trey phtuok A. Trey râs	Ca lóc
Anabas testudineus	Trey kranh	Ca rô đồng
Datnioides microlepis	Trey khla	Ca hường
Nandus nebulosus	Trey khla	Ca hường
Pristolepis fasciatus	Trey kantron	Ca rôbiên
Trichogaster microlepis	Trey kâmphleanh phluk	Ca sặt
" pectoralis	Trey kantho	Ca sặt
" trichopterus	Trey kamphleanh saurô	-id-

Oxyelectris marmorata	Trey damrey	Ca bong
Macrognathus Maculatus	Trey chlaunh	Ca chach con
Mastacembelus maculatus	Trey khchoeung	Ca chach
" circumcinctus	-id-	-id-
" armatus	-id-	-id-
" favus	-id-	-id-

Liste des "poissons blancs" au Cambodge

TABLEAU DE COORESPONDANCE DES NOMS DE POISSONS

Nom Scientifique	Nom Khmer	Nom Vietnamien
Pristis microdon	Thkâ	Ca dao
Dasybatus Krempfi J.Durand	Trey pâbel	Ca đuôi
Notopterus chitala	Trey kray	Ca com
" notopterus	Trey slat	Ca tha lat
Coilia macrognathos	Trey chonluonh mean	Ca mong mà
Lycothrissa crocodilus	Trey chhmar	Ca top
Setipinna melanochir	-id-	Ca tôp xuôi
Clupea (Alosa) thibaudeaui	Trey kabâk (ou sam lôi)	Ca moi
Clupeoides borneensis	Trey bândaul amauv	Ca com
Corrica(clupeichthys)genicognatus	-	
Acanthopsis choirorynchos	Trey ruschâk ?	Ca ếê chuôi ?
Botia hymenophysa	Trey kânchrouk	Ca heo
" modesta	-id-	-id-
Chela mouthoti	-id-	-
" coeruleostygmata	-	-
Cutrops siamensis	-	-
Macrochirichthys macrochirus	Trey dankhténg	Ca rua
Paralaubuca harmandi	Trey chanteas phluk	Ca la tra
" stigmabrachium	-id-	-id-
" typus	-id-	-id-
Oxygaster oxygastroides	Trey slek russey	Ca thieu
Esomus danrica	Trey changvar phlieng	Ca long tong bai
Lucioscia bleekeri	Trey dang dau	Ca long tong mion
" setigerum	-id-	-id-
Rasbora argyrotaenia et divers	Trey changvar moul	Ca long tong
Albulichthys krempfi	Trey chhok tituy	Ca kay
Amblirychichthys truncatus	Trey kombot chrâmos	Ca trau trau
Balantiochailus melanopterus	Trey kiet srong	Ca hoc tro
Barbichthys laevis	Trey pruol thnâr	Ca hay luov
Barilius guttavus	Trey srâka kéo	Ca nhong
Catlacarpio siamensis	A. Trey kolréang J. Trey kaho	Ca ho
Cirrhinus jullieni	Trey riel	Ca linh vo
" auratus	A. Trey pruol J. Trey kanlâng	Ca đuom Ca kang

Nom Scientifique	Nom Khmer	Nom Vietnamien
Cosmochilus Harmandi	Trey kâmpoul bay	Ca duông bay
" Pelligrini	Trey kâmpoul bay	Ca duông bay
Cyclocheilichthys apogon	Trey srâka kdam	Ca ba ky
" armatus	-id-	-id-
" enoplos	Trey chhok	Ca coc
Dangila Cuvieri	Trey ach kok	Ca linh riâ
" spilopleura	-id-	-id-
Girinocheilus Aymonieri	Trey bandaul chek	Ca ông
" pustulosus	-id-	-id-
Hampala macrolepidota	Trey khman	Ca ngua
Labeo erythropterus	Trey kuol chek	Ca ba bâng
" erythrura	-id-	-id-
" stygmapleura	Trey phkâ kô	Ca do ky
Leptobarbus Hoeveni	Trey J. Trey chrâlang J. Trey knuoch A. Trey praloung	Ca chày
Osteochilus melanopleura	Trey kroum	
" Hasselti	Trey kros	Ca lui
" Schlegeli	Trey rolôk sâ	Ca mè trang
" vittatus	Trey kros	Ca lui
Probarbus Jullieni	Trey trâsâk	Ca tra soc
Puntioplites proctozysron	Trey chakèng	Ca danh
Puntius altus	Trey kahô	Ca he
" bramoîdes	Trey chpin	Ca tra yinh
" brevis	Trey ânko-prak	Ca hôt mit
" bulu	-	-
" javanicus	Trey chpin	Ca tra yinh
" orphoides	Trey ampil tum	Ca do mang
Thynchthys thynnoîdes	Trey lenh	Ca linh ban
" bo	Trey changvar ronung	Ca nuoc ruoi
Xenocheilichthys loppei	-	-
Pangasianodon gigas	Trey riech	Ca dâu
" Sutchi	Trey pra	Ca tra
Pangasius Larnaudi	Trey pô thmau trâchiek	Ca vô
" macronemus	Trey chhviêt	Ca sat
" nasutus	Trey kè	
" sanitwongeti	Trey pô pruy	Ca vô co
Helodontichthys dinema	Trey khlang hay	Ca trèn râng
Callichrous bimaculatus	Trey krâmân	Ca trèn bâu
Cryptopterus apogon	Trey kes	Ca kêt
" schilbeides	Trey komphliev	Ca trèn mo
Wallago attu	J. Trey krâpoat	Ca leo la
	A. Trey sanday	Ca leo
" microstoma	Trey khtuok	Ca trèn gioc
Microphis boaja	Trey chay krâpoeu	Ca roi
Synanthus specifer	-id-	-id-
Tylosurus strongulatus	-	-

Nom Scientifique	Nom Khmer	Nom Vietnamien
Hemiramphus Bocquardianus	Trey Phtaung	Ca lim kim
Polynemus longipectorialis	Trey priem	Ca phèn
Lates calcarifer	Trey spong	Ca chem
Ambassis Wolffi	Trey kantrâng prèng	Ca sơn
" ranga	Trey kânchanbchras	-id-
Pseu-dosciaena soldado	Trey pama	Ca suu
Toxotes chatareus	Trey koncheak sla	Ca mè rô
" microlepis	id-	-id-
Cybium cambodgiense	Trey sbaika	Ca thu
Synaptura orientalis	-	-
Cynoglossus microlepis	Trey andat chhkê	Ca-luoi trâu
Glossogobies giuris	Trey khoan	-
Chonerhinus modestus	Trey kropport	Ca noc
Tetrodon cambodiense	-id-	-id-

The protection of spawning grounds, and subsequently of fry and fingerlings is undisputedly one of the efficient tools of fish conservation.

In the following pages there follows a discussion on the spawning habits of Cambodian fishes in general and detailed maps with fuller data on certain species of commercial importance. This discussion includes mention of certain conservation problems.

Microfilmed From
Best Available Copy

In the temperate zones of the Globe, the sexual periodicity of fishes, like that of the majority of animals, is regulated by the seasons and the aestivo-hivernal rhythm. ✱

Accordingly, as its thermic or respiratory demands predominate, fishes spawn during the Summer - the minnows, for instance; or during the Fall, as do the salmon. In all cases, the spawning period is easy to determine. Each spawning season is always followed by a long period of sexual quiescence before the next spawning period begins at nearly the same time the following year.

The conditions are quite different in the inter-tropical zones, where winter does not occur. Here there are mature females at all seasons of the year, and a preliminary examination of the problem leaves an impression of confusion.

The Oceanographic Institute of Indochina has made a three year study of the spawning of fresh water fishes in Cambodia.

Thirteen stations were set up on the Great Lakes, the Tonle Sap, and the Bassac: the Mekong, above and below the Four Arms Junction, was included. Samples were taken four times a year throughout two years. Thirty-four species of the following families were included in the study: 2 Notopteridae; 1 Clupeidae; 12 Cyprinidae; 12 Siluridae; 4 Labyrinthidae; 1 Sciaenidae; 1 Nandidae; 1 Gobiidae. The state of the gonads was checked by fertilisation tests or by anatomical examination.

Nearly 600 specimens were examined, over 9,500 slides have been prepared and charts have been made of sexual maturity for each species which will be published in a definitive work. @

✱ From: "On the Sexual Periodicity of Fishes in Fresh Water" Notes of M. P. Chevey Presented by Mr. Louis Bouvier. C. R. Académie Sciences, Tome 210, No. 11, Paris 1940.

@ The Author of this article did not live to write the definitive study he announced. I have been permitted, however, to use his unpublished manuscripts from which I was able to establish the spawning maps of 24 species. I wish to thank Mr. R. Serene of the Oceanographic Institute at Nhatrang for this valuable source material.

Microfilmed From
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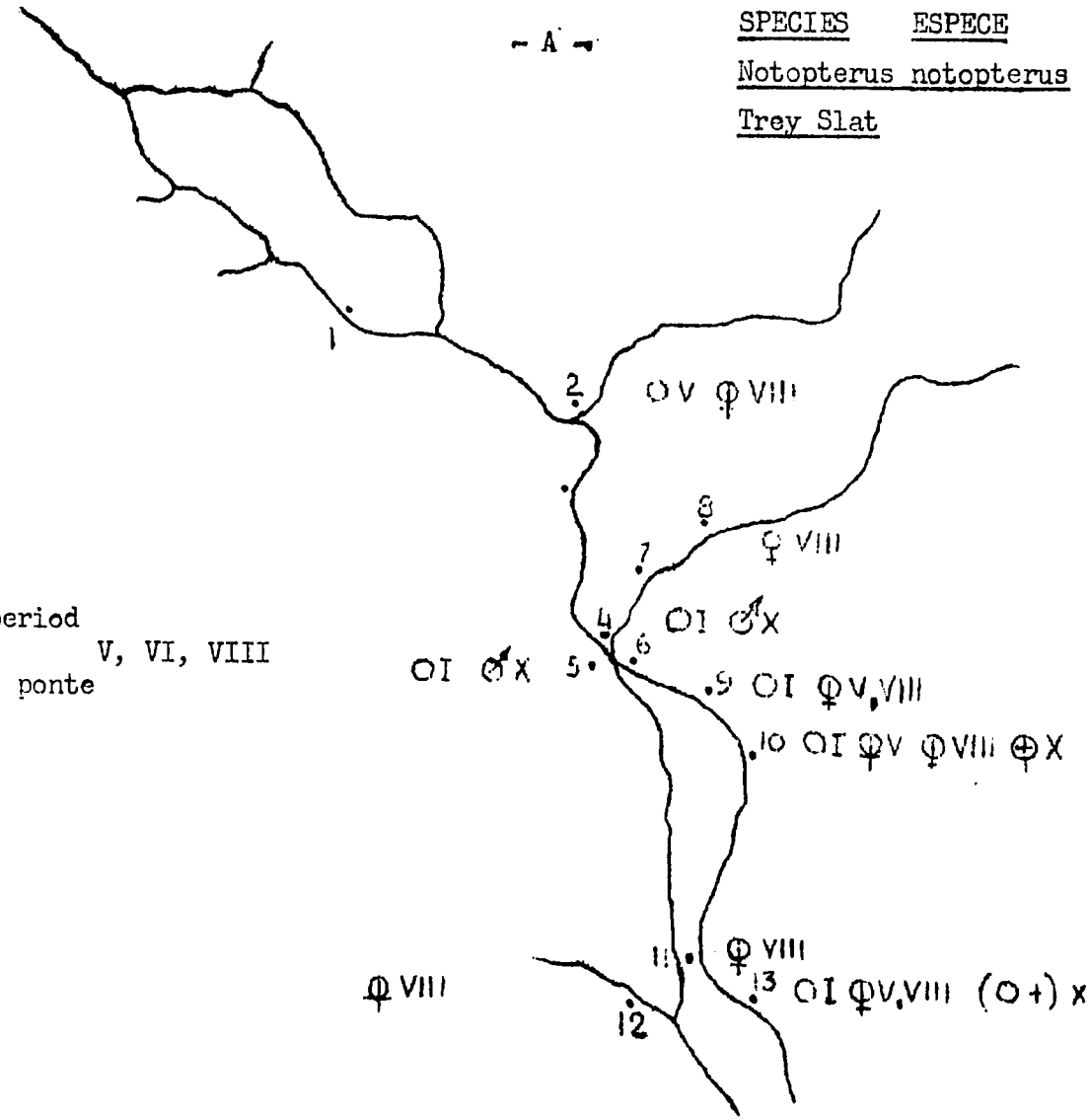
No geographical variations of spawning seasons have been established as yet. Fishes of several degrees of maturity can be found at the same time and in the same place nearly the whole year around. In closer examination, and especially when one looks at the ratio of immature to mature animals, one recognizes a principal spawning period for the whole fish population in June immediately after the end of the low water stage. Spawning continues throughout the year, slowly abating by the month of March. A short period of sexual quiescence in April and May corresponds to the period of physiological stress described previously. At this period the waters of Cambodia are at their lowest and fish food is relatively scarce. It is at this time also that a mark forms on the scales of many Cambodian freshwater fishes.

In conclusion, the examination of single fish did not give any information of value on the sexual periodicity of fishes in the inter-tropical region; each fish has its individual rhythm which is not necessarily synchronous with that of its species mates. It is necessary to consider the entire fish population in order to establish a pattern. One can not predict that such and such a fish will be ripe at such and such a period and sexually inactive at another; but it can be said that there are, in any one species, a maximum number of mature individuals at one period and a minimum at another. In the tropics then, the concept of sexual maturity has a different emphasis than in the temperate regions.



Spawning period
V, VI, VIII
Periode de ponte

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Mak Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

○ Immature, sexe indiscernable.

⊕ Femelle immature, ovules petits et égaux.

⊕ Femelle en debut de maturation, ovules légèrement inégaux.

♀ Femelle en maturation, ovules franchement inégaux.

♀ Femelle en fin de maturation, ovules presque tous de grande taille.

♀ Femelle mûre, ovules gros et égaux, sortant à la pression.

(○+) Femelle ayant pondu, ovaire flasque et vide.

♂ Mâle immature, majorité de spermatocytes.

♂ Mâle en maturation, spermatocytes nombreux.

♂ Mâle en fin de maturation) Spermatozoïdes

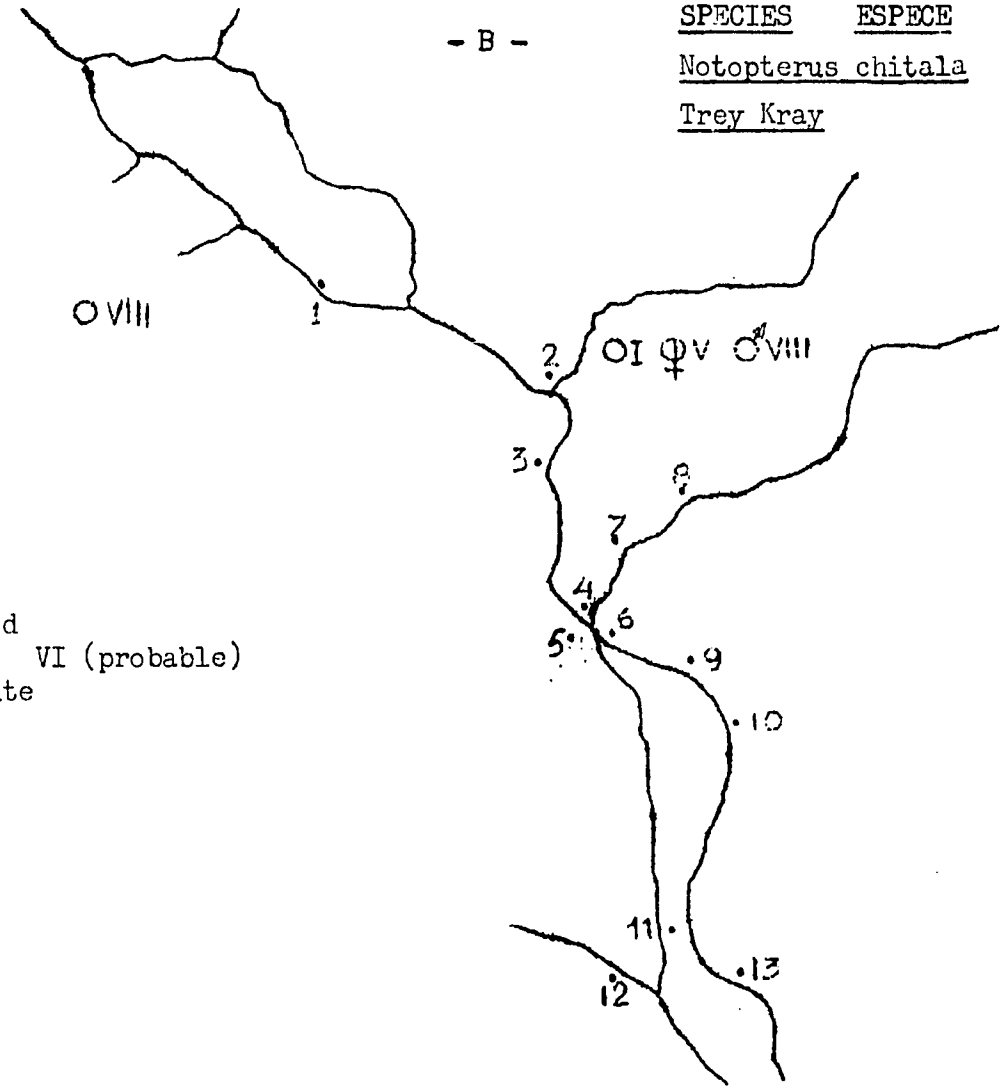
♂ Mâle mûr) nombreux.

L Stages larvaires

SPECIES ESPECE

Notopterus chitala

Trey Kray



Spawning period

VI (probable)

Periode de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rokakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

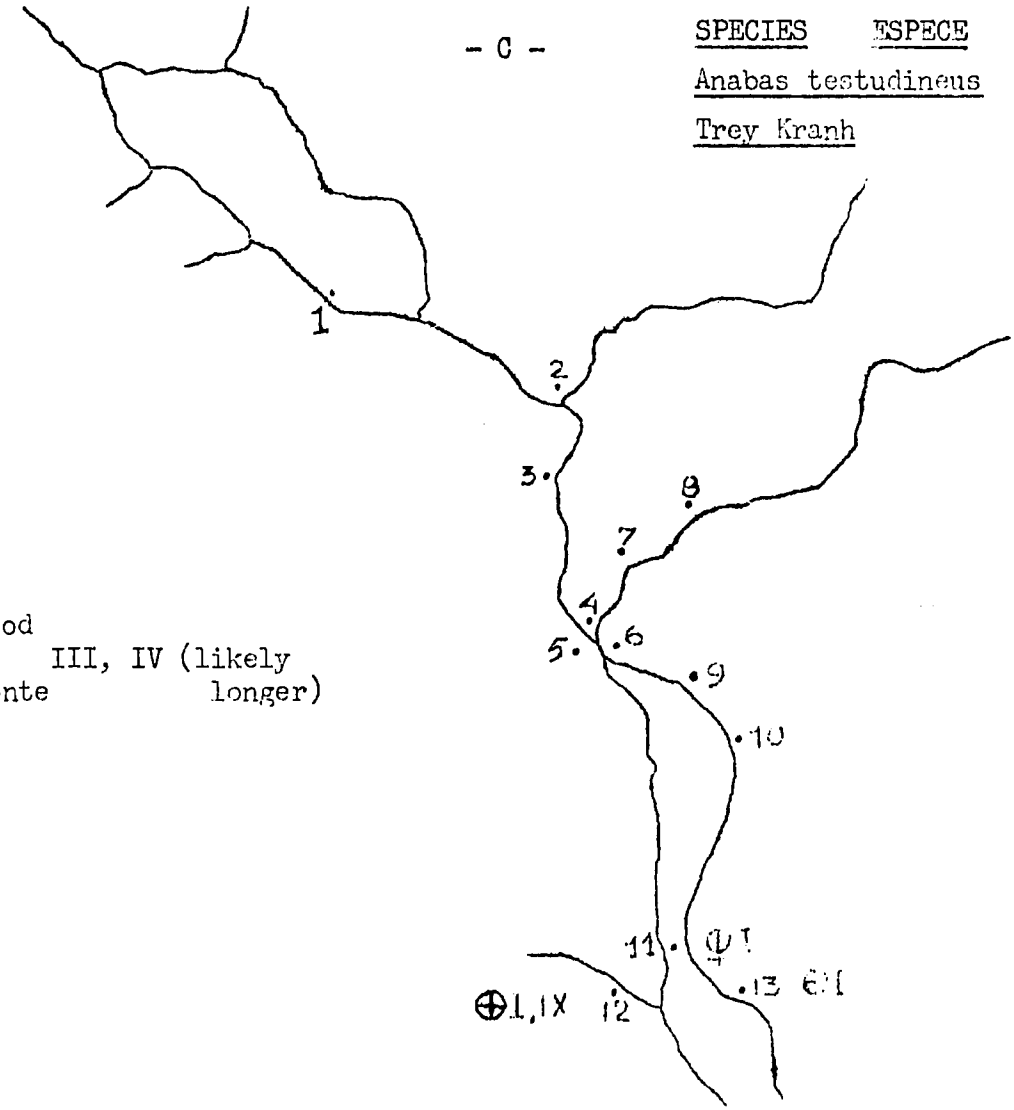
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en debut de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(O+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux
L	Stages larvaires

SPECIES ESPECE

Anabas testudineus ≠ 12 cm.

Trey Kranh



Spawning period
III, IV (likely
Periode de ponte longer)

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

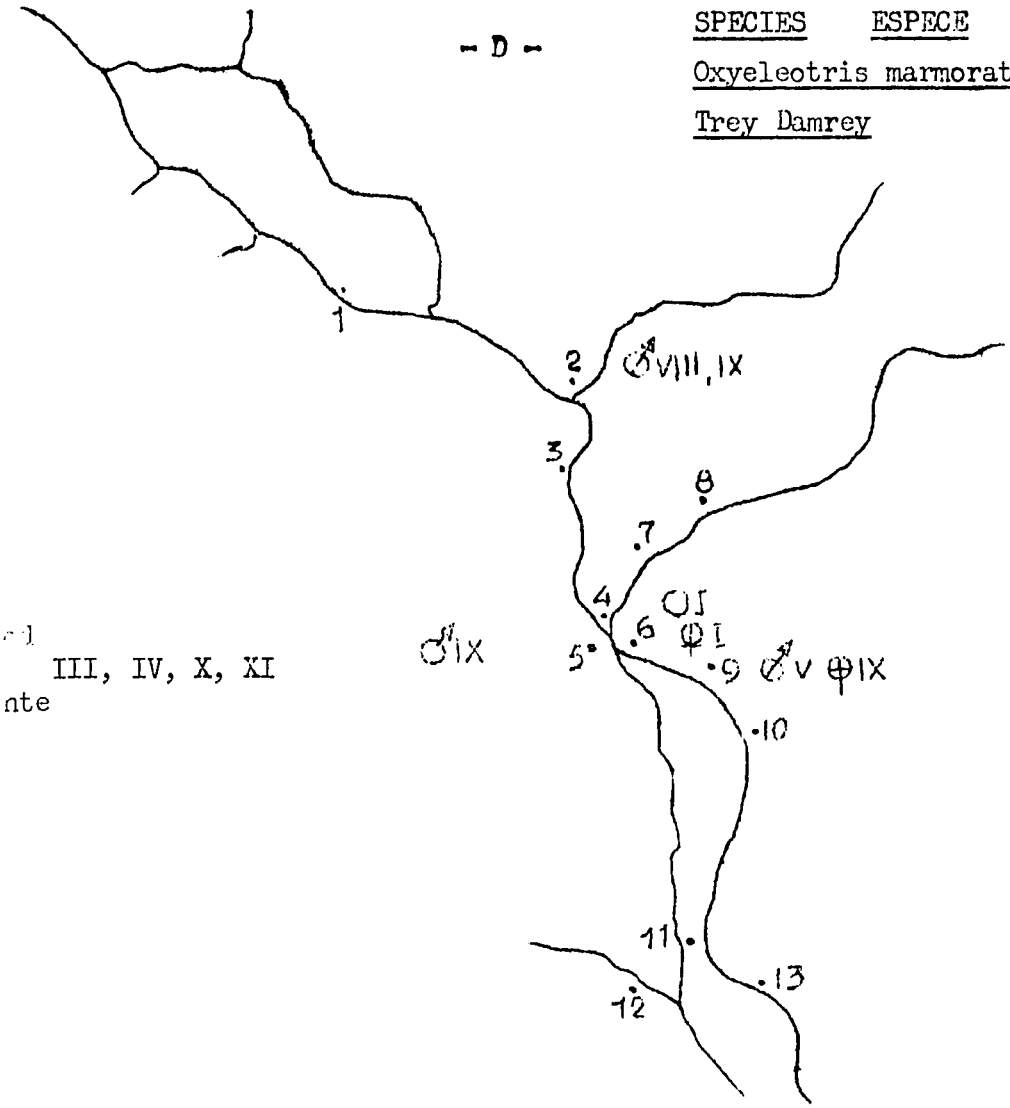
○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en debut de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux.
L	Stages larvaires

- D -

SPECIES ESPECE

Oxyeleotris marmorata 17-43 cm.

Trey Damrey



Spawning period

III, IV, X, XI

Periode de ponte

COLLECTION SITES

LISTE DES ZONES DE COLLECTION

1. Kg. Lucie des Lacs
2. Stung Mirit
3. Phat Sanday
4. Prek Mik Kampul
5. Prek Pnau
6. Arey Kiri
7. Rockal
8. Peam Chikeng
9. Prek Mo
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Month (roman) in Roman numerals.

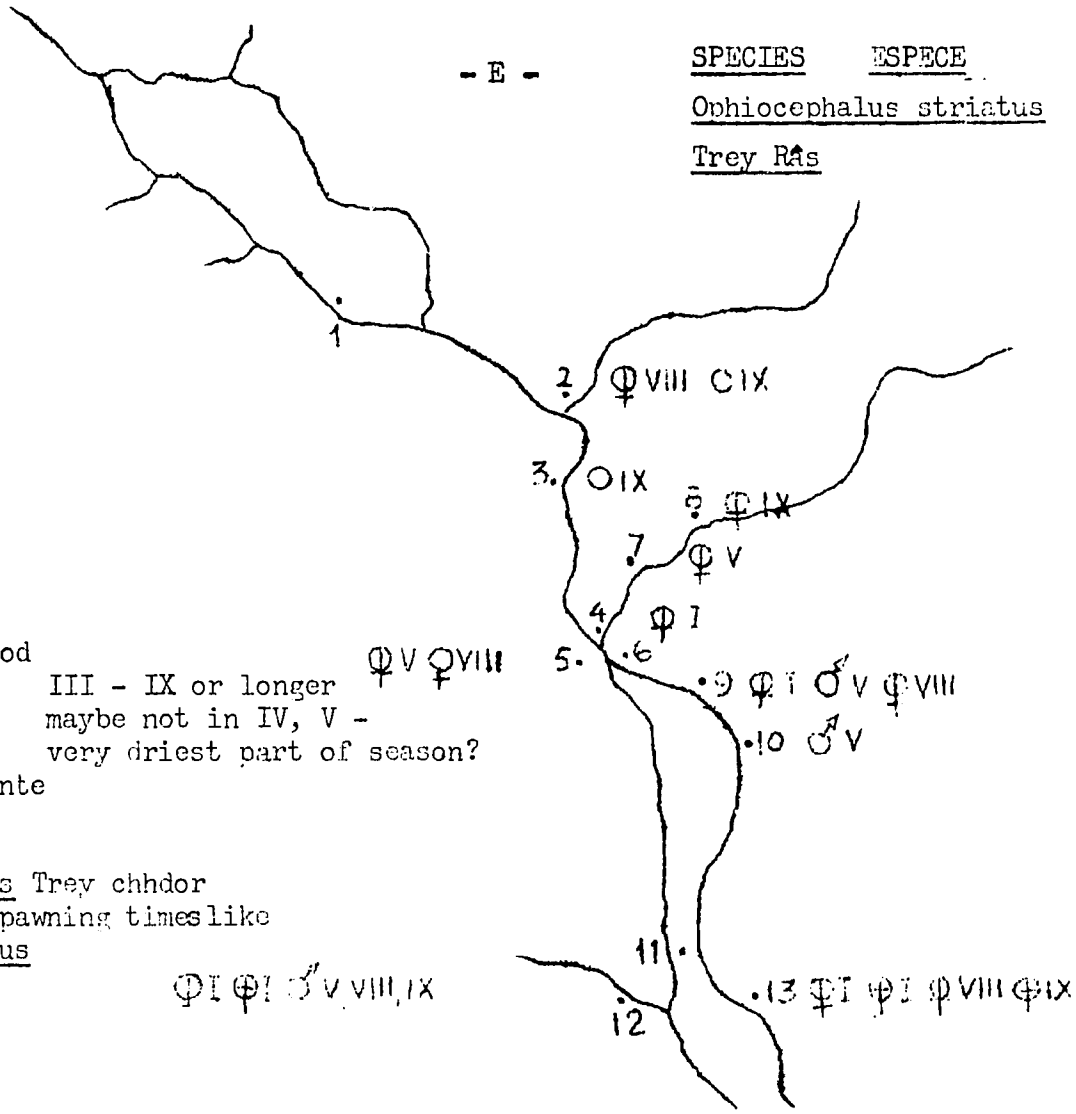
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en debut de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊗	Mâle immature, majorité de spermatocytes.
♂	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux
L	Stages larvaires

SPECIES ESPECE

Ophiocephalus striatus

Trey Râs



Spawning period

III - IX or longer
maybe not in IV, V -
very driest part of season?

Periode de ponte

O. micropeltes Trey chhdor
samples and spawning times like
for O. striatus

♀I ♀I ♂V VIII, IX

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rokakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

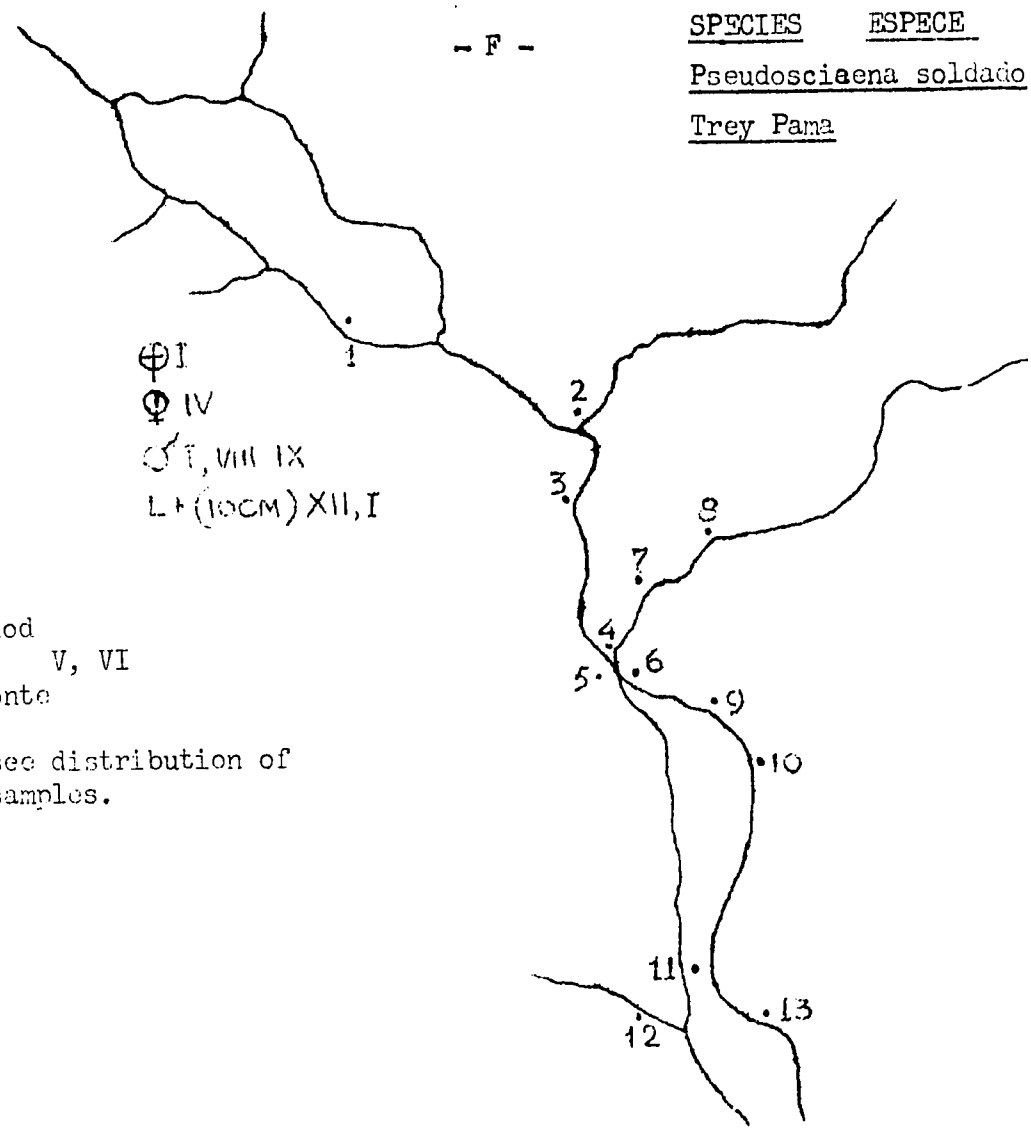
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en debut de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux
L	Stages larvaires

SPECIES ESPECE

Pseudosciaena soldado

Trey Pama



Spawning period
V, VI
Periode de ponte

Migration - see distribution of samples.

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs.
2. Stung Chinit
3. Phat Sonday
4. Prek Muk Kamoul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Ken
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

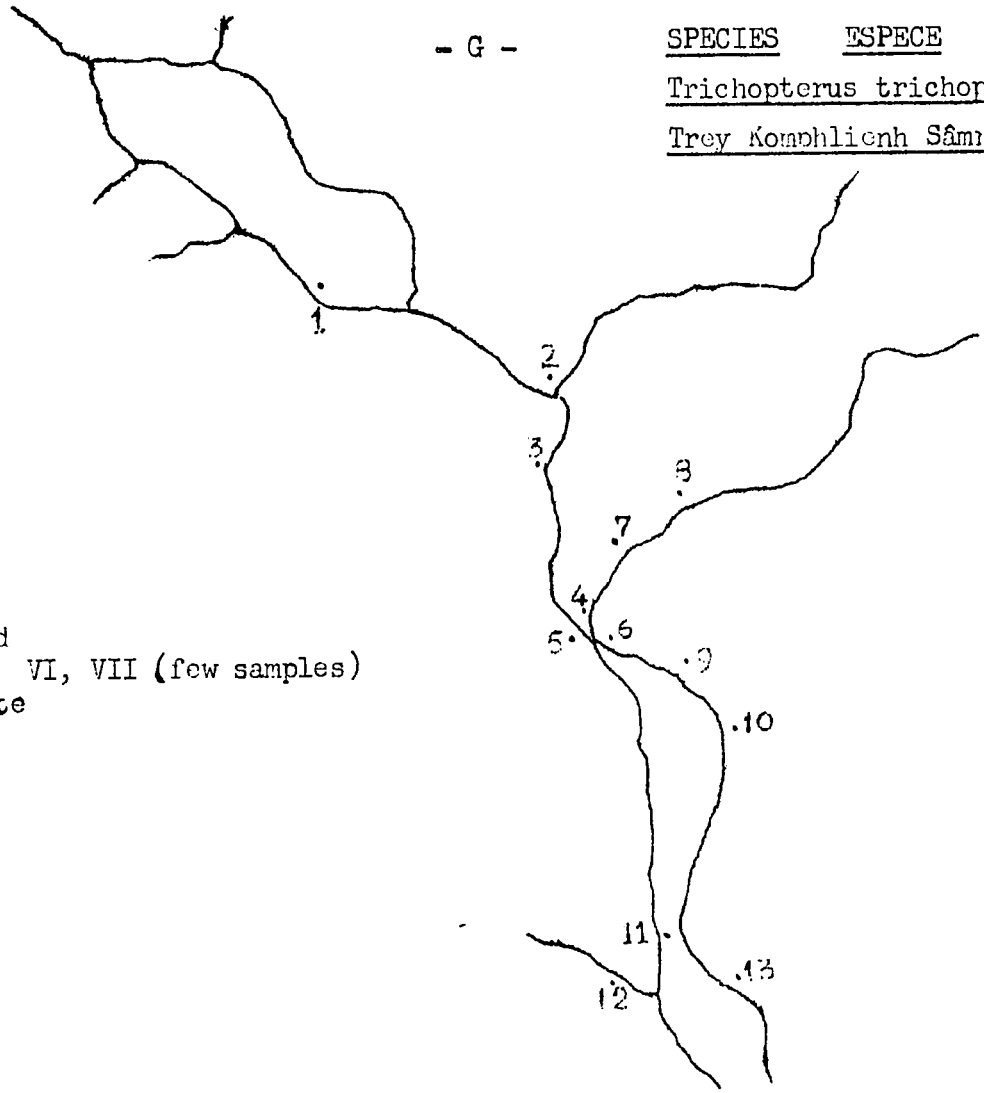
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en debut de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes rares.
♂	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires

SPECIES ESPECE

Trichopterus trichopterus

Trey Komphlienh Sâmê



Spawning period

VI, VII (few samples)

Periode de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Ham
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

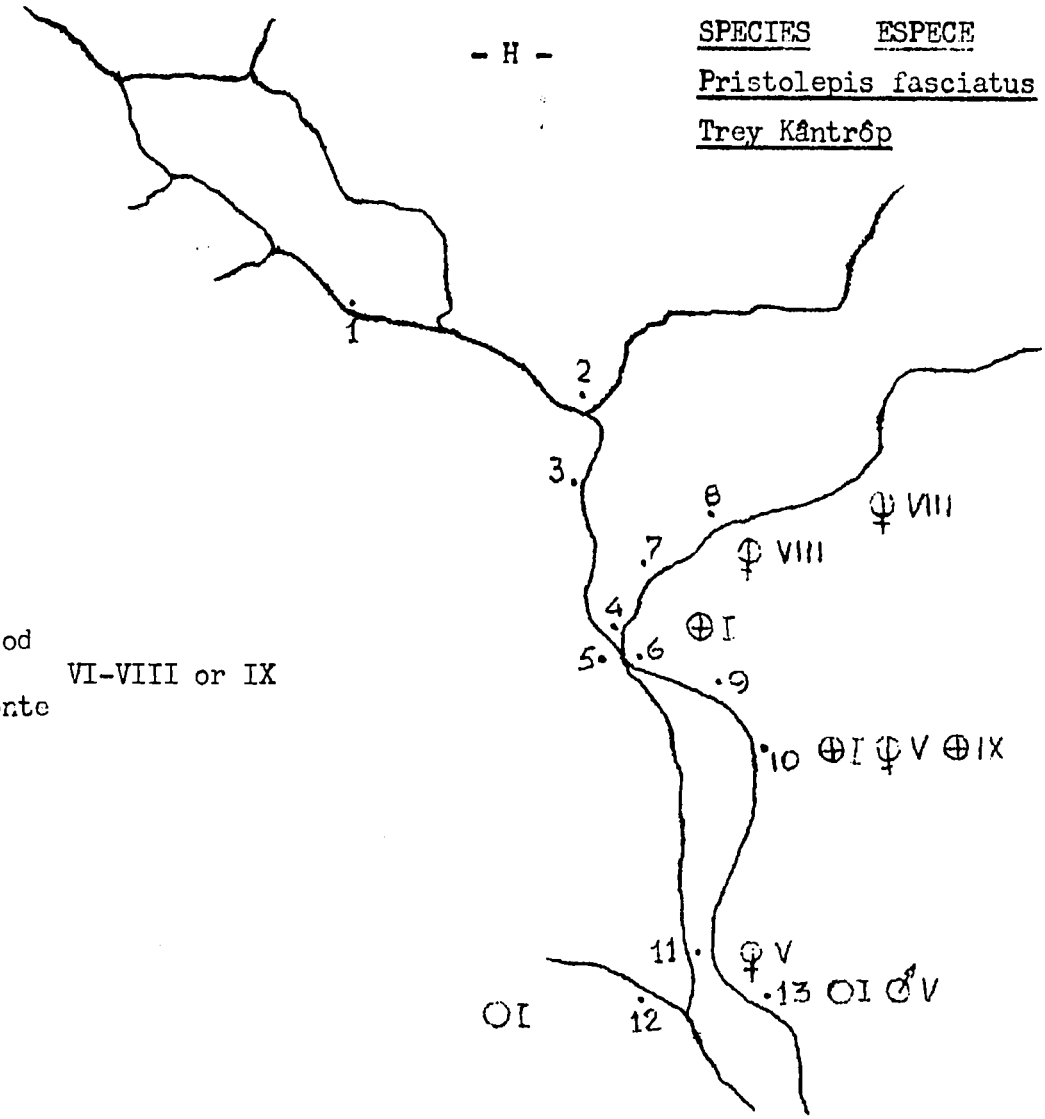
○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
♀	Femelle en debut de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortent à la pression.
(○ +)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.

Stages larvaires.

SPECIES ESPECE

Pristolepis fasciatus

Trey Kântrôp



Spawning period

VI-VIII or IX

Periode de ponte

COLLECTION SITES

LISTE DE POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

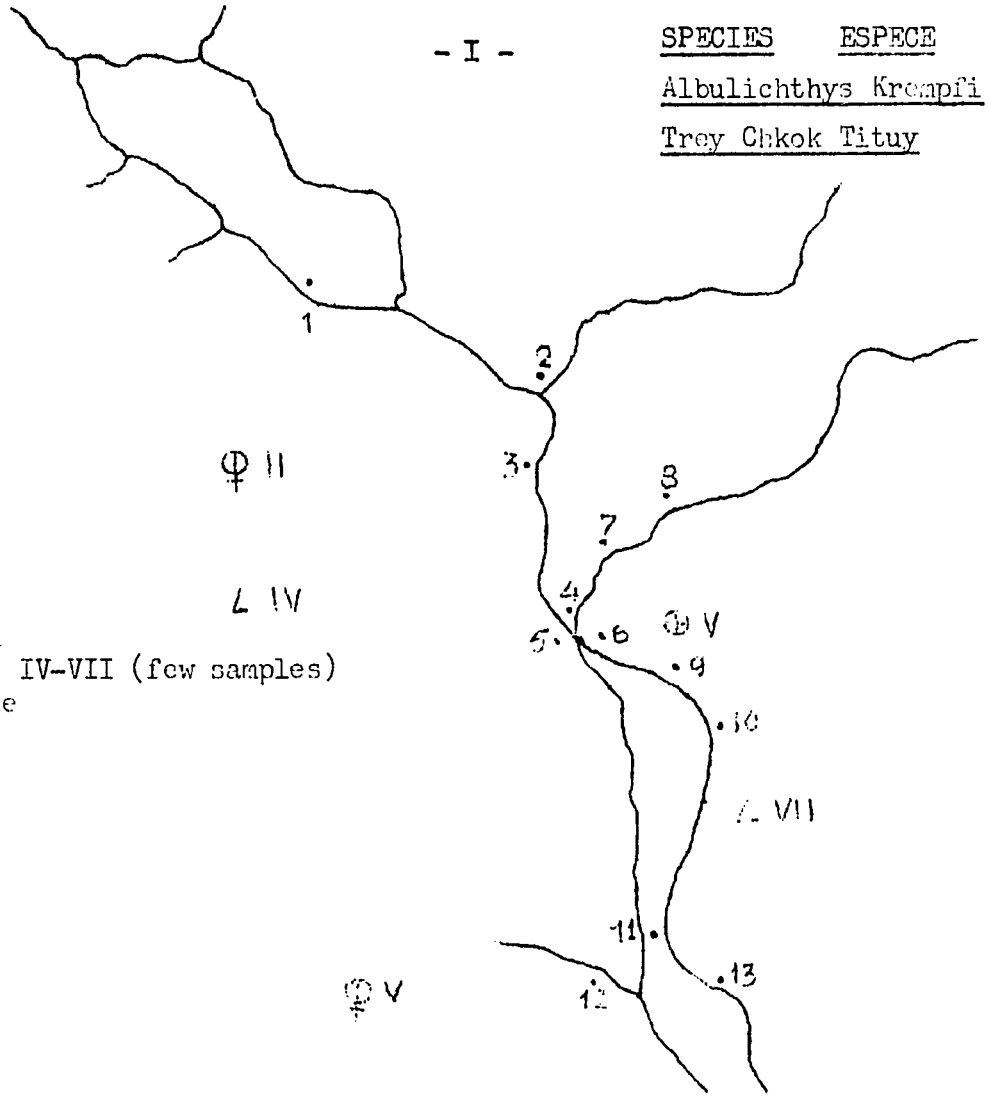
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
♀	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
♂	Mâle immature, majorité de spermatocytes.
♂	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr nombreux.
L	Stages larvaires.

SPECIES ESPECE

Albulichthys Krempfi

Trey Chkok Tituy



Spawning period

IV-VII (few samples)

Periode de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

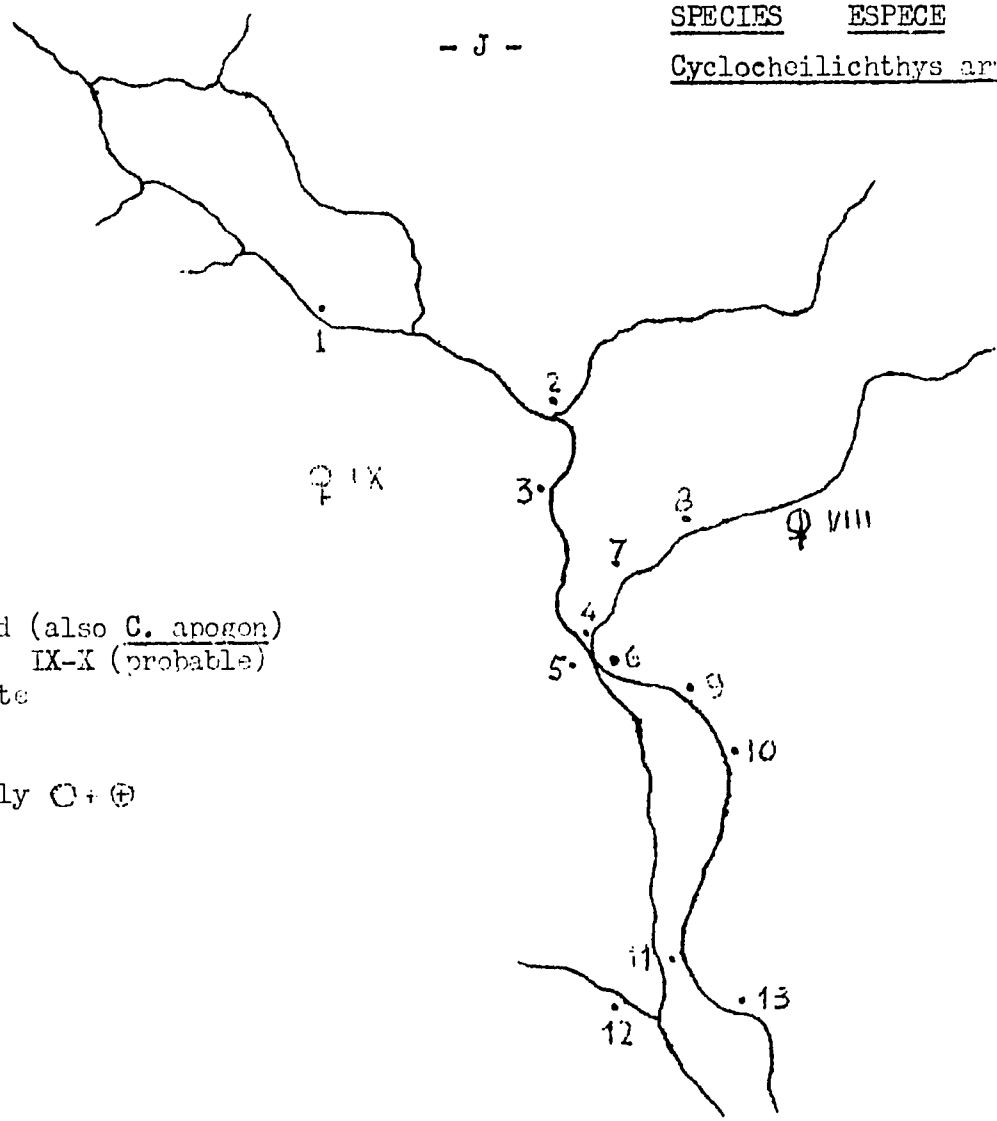
Months (mois) in Roman numerals.

SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
♀	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortent à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Cyclocheilichthys armatus ≠ 50 cm.



Spawning period (also C. apogon)
IX-X (probable)
Periode de ponte

C. enoplos only ○ + ⊕

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

○ Immature, sexe indiscernable.

⊕ Femelle immature, ovules petits et égaux.

⊕ Femelle en début de maturation, ovules légèrement inégaux.

♀ Femelle en maturation, ovules franchement inégaux.

♀ Femelle en fin de maturation, ovules presque tous de grande taille.

♀ Femelle mûre, ovules gros et égaux, sortant à la pression.

(○+) Femelle ayant pondu, ovaire flasque et vide.

⊘ Mâle immature, majorité de spermatocytes.

⊘ Mâle en maturation, spermatocytes nombreux.

⊘ Mâle en fin de maturation) Spermatozoïdes

♂ Mâle mûr) nombreux.

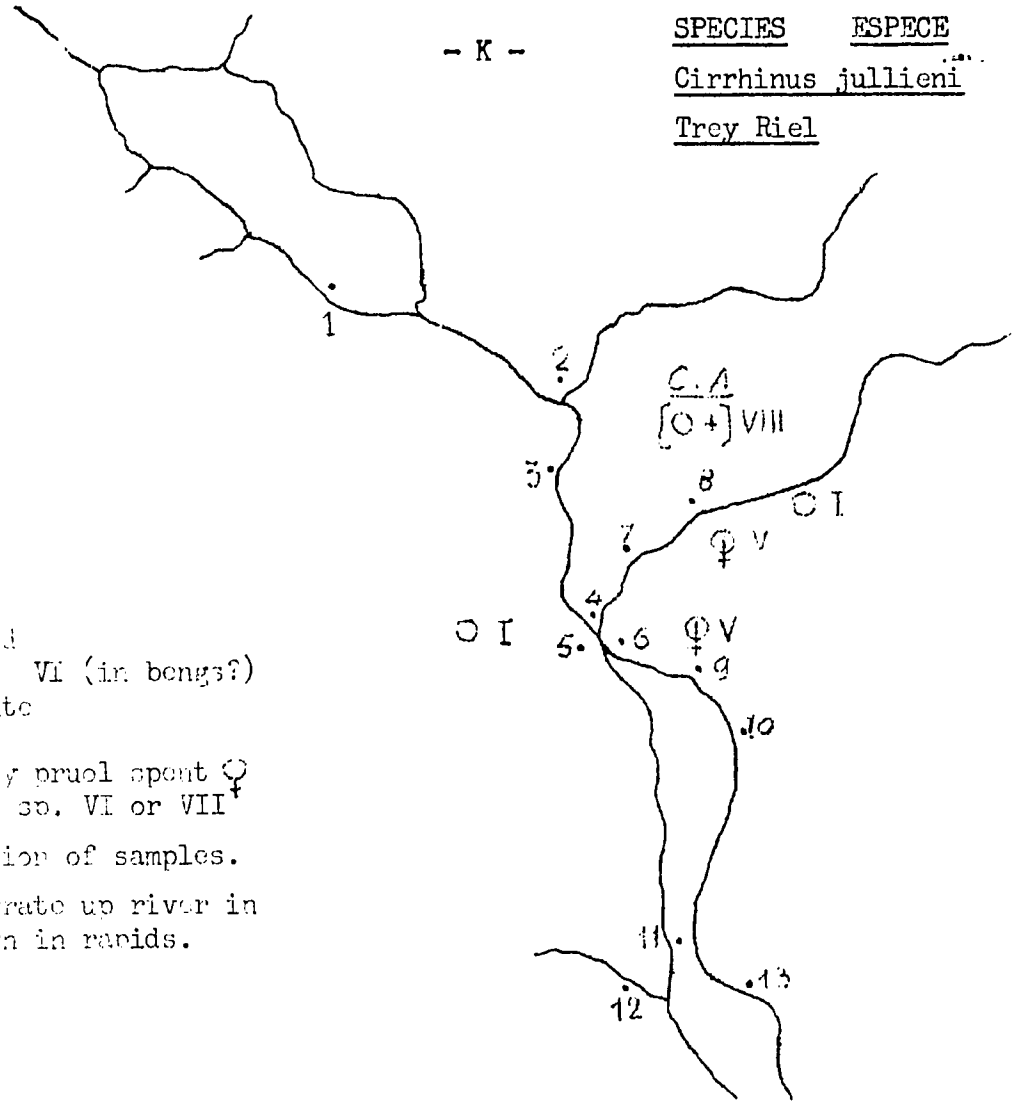
L Stages larvaires.

- K -

SPECIES ESPECE

Cirrhinus jullieni -18 cm.

Trey Riel



Spawning period
VI (in bongs?)
Periode de ponte

C. auratus Trey pruol spent ♀ VIII indicates sp. VI or VII

Note distribution of samples.

Reputed to migrate up river in Mekong to spawn in rapids.

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Ke. Luong des Lacs
2. Stung Chinit
3. Phat Sonday
4. Prek Tak Kampul
5. Prek Khnau
6. Arey Kent
7. Rockakong
8. Peam Chikong
9. Prek [illegible]
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So ha-Kaskos

Months (no[illegible] in Roman numerals.

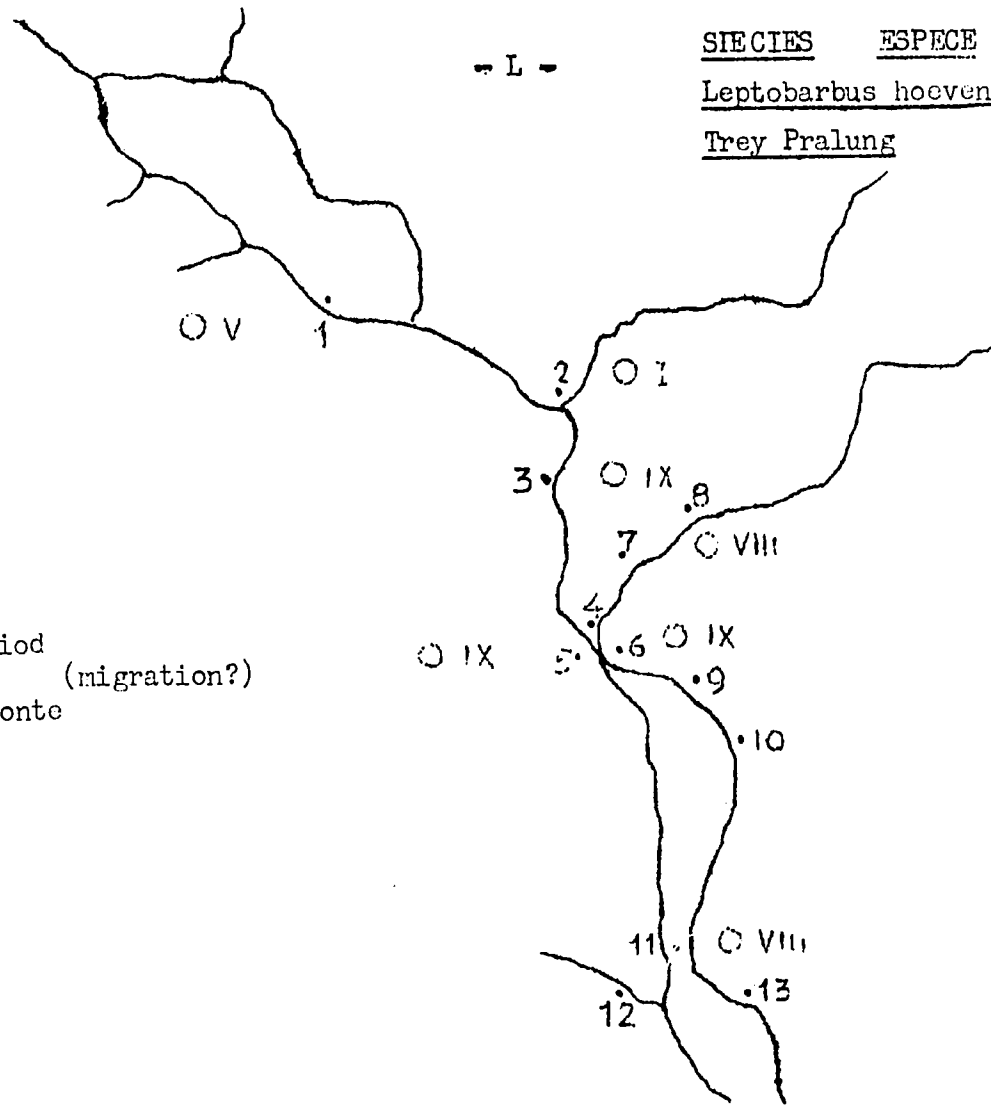
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(O+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SIECIES ESPECE

Leptobarbus hoeveni 18-47 cm.

Trey Pralung



S wn ng period (migration?)

I io de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

. K . Luong des Lacs
. S ung Chinit
. F at Somday
. F ek Muk Kampul
. F ek Phnau
. A ey Ksat
. F ckakong
. F am Chikang
. F ek Men
. F eyveng
. F ek Bac Nam
. C nfluent Takeo-Chaudoc
. C nfluent Song So Ha-Kaskos

nt (mois) in Roman numerals.

SYMBOLS SIGNES

O Immature, sexe indiscernable.

⊕ Femelle immature, ovules petits et égaux.

⊕ Femelle en début de maturation, ovules légèrement inégaux.

♀ Femelle en maturation, ovules franchement inégaux.

♀ Femelle en fin de maturation, ovules en série tous de grande taille.

♀ Femelle mûre, ovules gros et égaux, sortant à la pression.

(O+) Femelle ayant pondu, ovaire flasque et vide.

⊘ Mâle immature, majorité de spermatocytes.

♂ Mâle en maturation, spermatocytes nombreux.

♂ Mâle en fin de maturation) Spermatozoïdes

♂ Mâle mûr) nombreux.

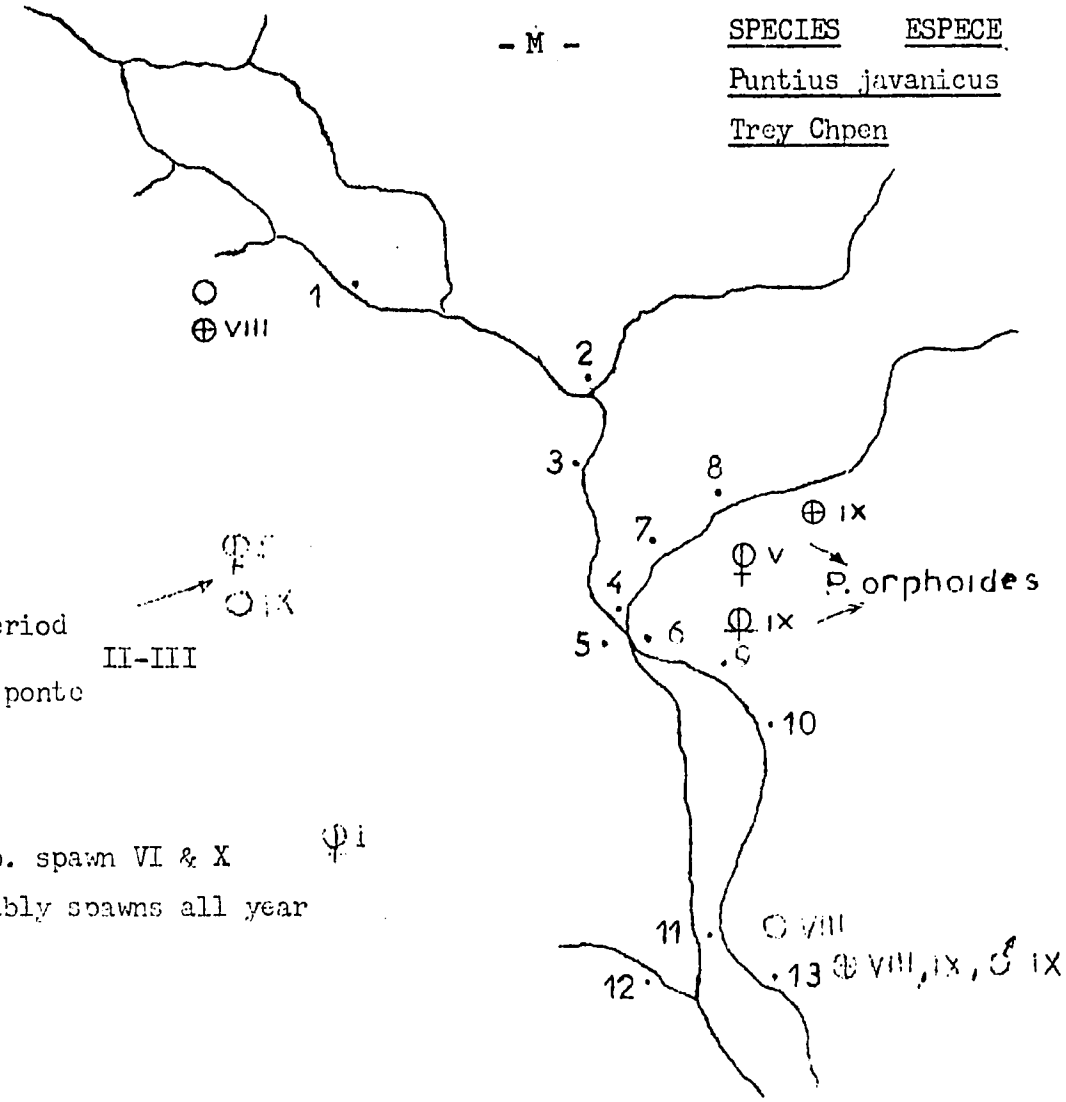
L Stages larvaires.

Microfilmed From Best Available Copy

SPECIES ESPECE

Puntius javanicus

Trey Chpen



Spawning period II-III

Periode de ponte

P. Altus
Trey Kahé

related spp. spawn VI & X

genus probably spawns all year

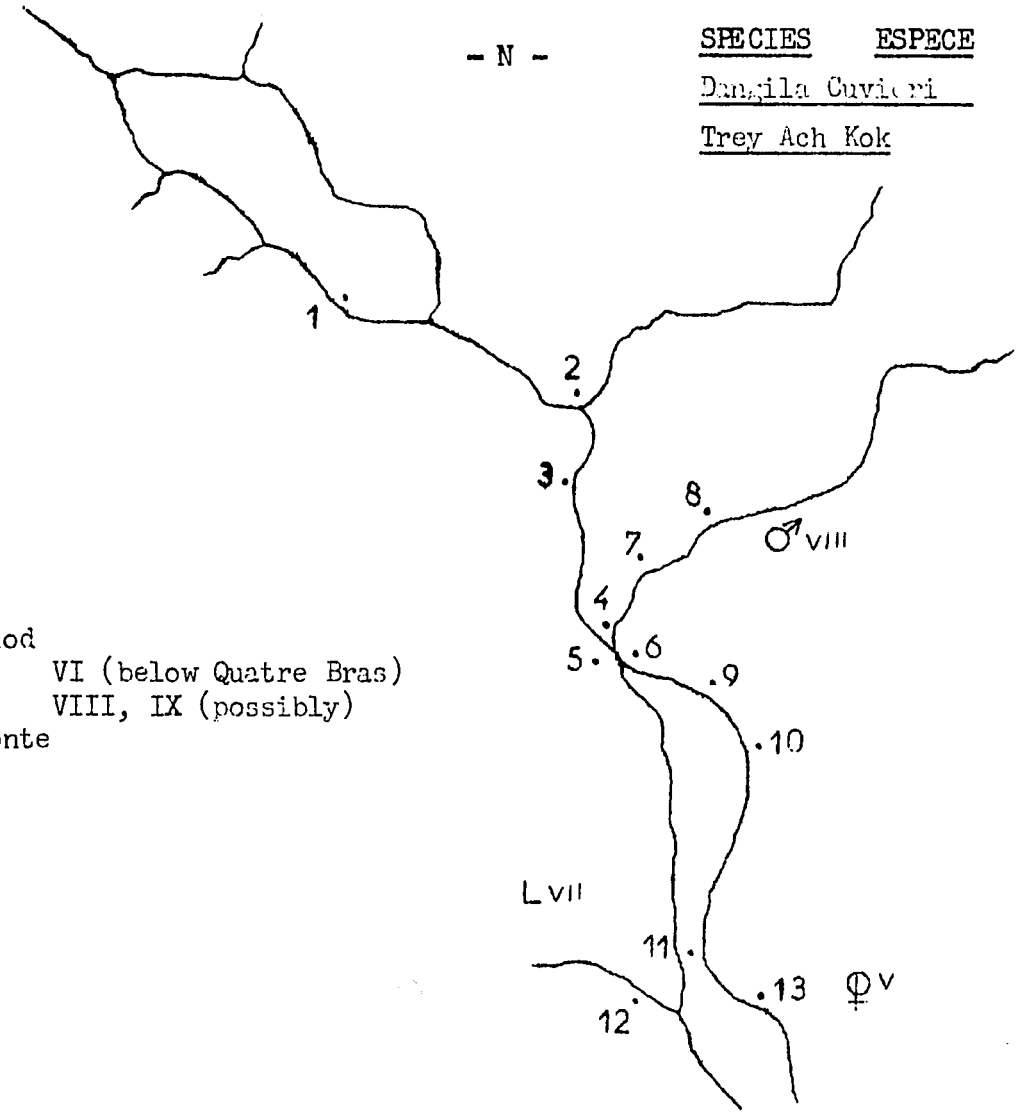
COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
♀	Gemelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⚥	Mâle en maturation, spermatocytes nombreux.
⚥	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux
L	Stages larvaires



SPECIES ESPECE

Dangila Cuvieri 23 cm.

Trey Ach Kok

Spawning period

VI (below Quatre Bras)
VIII, IX (possibly)

Periode de ponte

Microfilmed From Best Available Copy

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

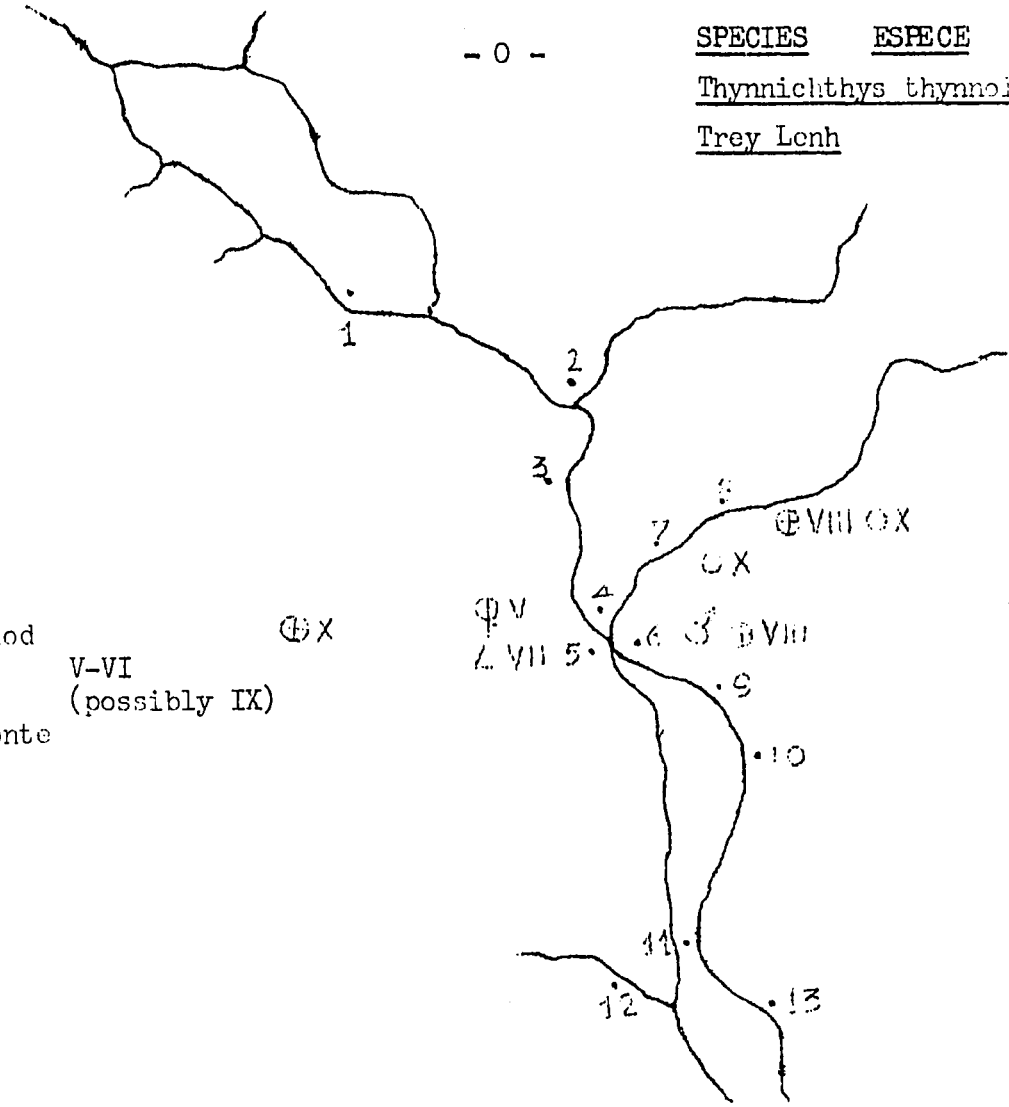
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
♀	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Thynnichthys thynnoides L=-23 cm

Trey Lonh



Spawning period V-VI (possibly IX)

Periode de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Kset
7. Rockakong
8. Peam Chikang
9. Prek Mea
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

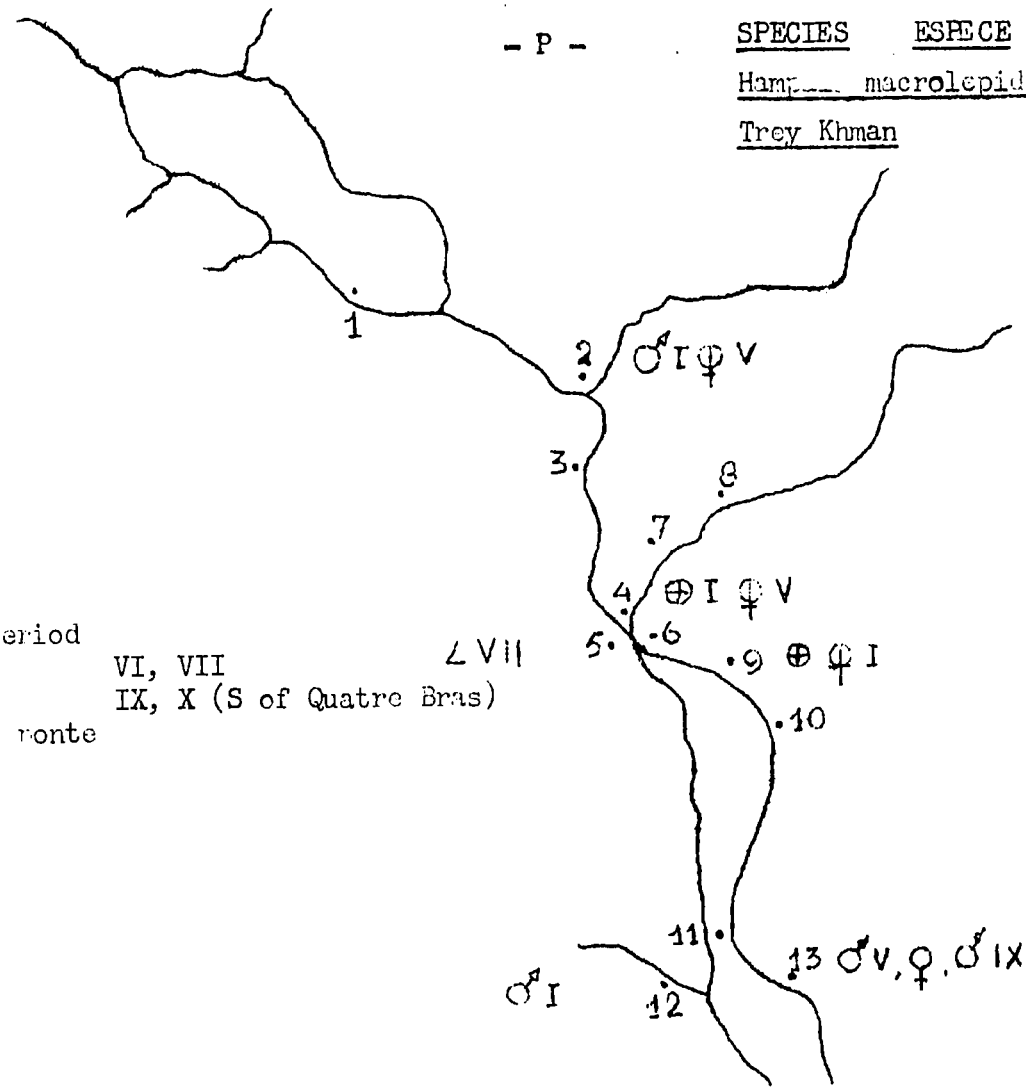
SYMBOLS SIGNES

⊖	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, voules légèrement inégaux.
⊕	Femelle en maturation, ovules franchement inégaux.
⊕	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(⊖+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Hamp... macrolepidota 70 cm.

Trey Khman



Spawning period

VI, VII

IX, X (S of Quatre Bras)

Periode de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Bockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

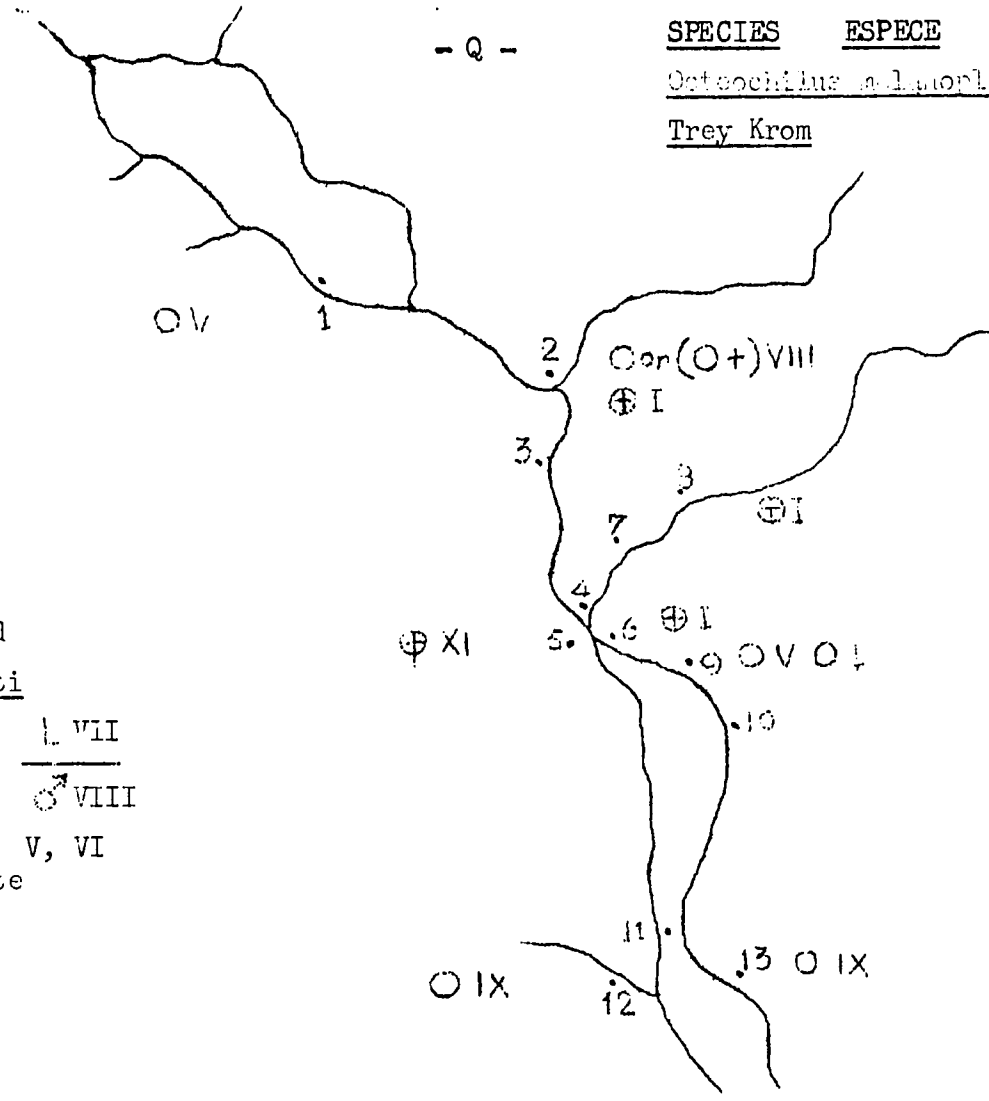
SYMBOLS SIGNES

O	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(O +)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Osteochilus melanopleura 37 cm.

Trey Krom



Spawning period

C. Hasselti

Trey Kros L VII

♂ VIII

V, VI

Periode de ponte

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Ka Trong des Lacs
2. Stung Chinit
3. Phat Sonday
4. Prek Tuk Kampul
5. Prek Pnau
6. [illegible]
7. Ro [illegible]
8. Prek [illegible]kang
9. Prek [illegible]
10. Preyrang
11. Prek Lac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

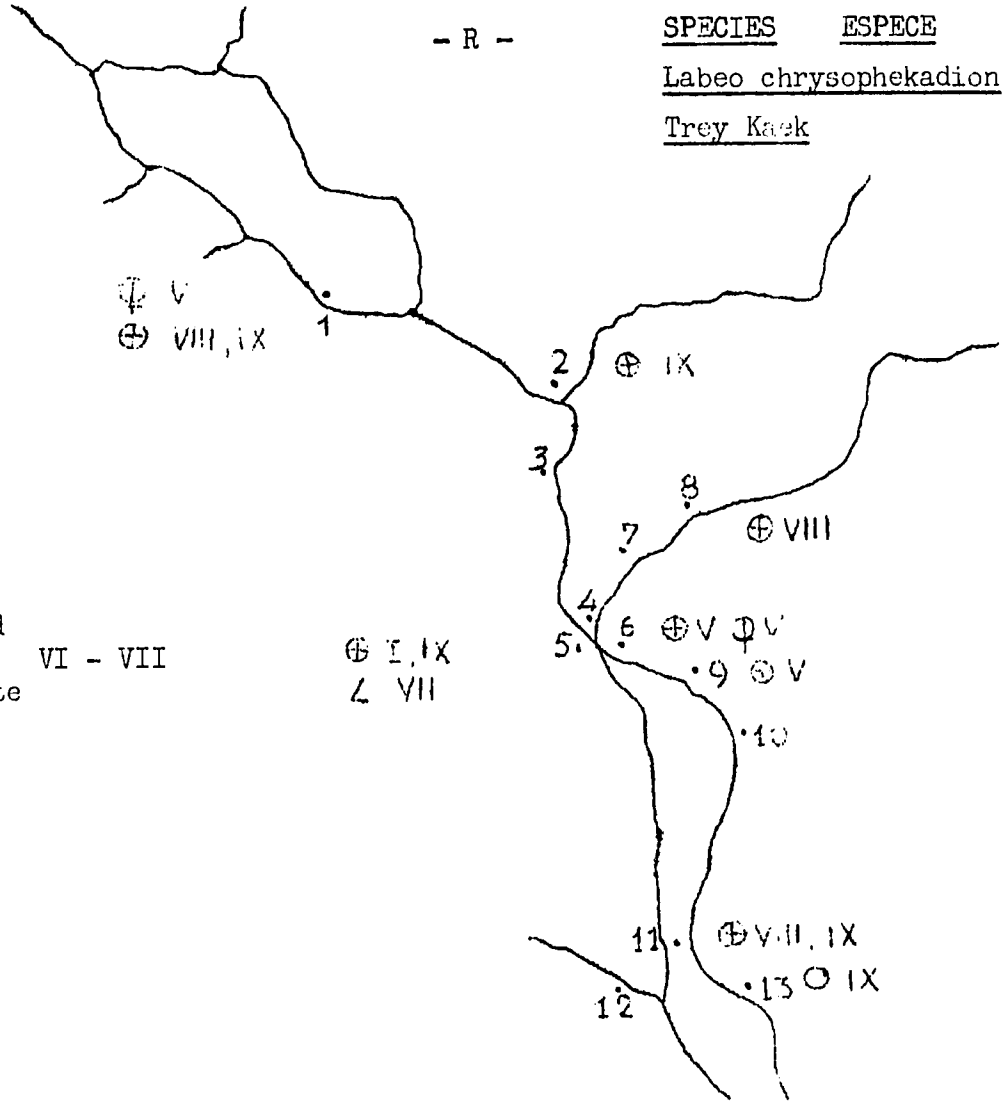
SYMBOLS SIGNES

O	Immaute, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
⊕	Femelle en maturation, ovules franchement inégaux.
⊕	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(O +)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Labeo chrysophekadion 10-60 cm.

Trey Kaek



Spawning period

Periode de ponte VI - VII

I, IX

L VII

COLLECTION SITES

LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

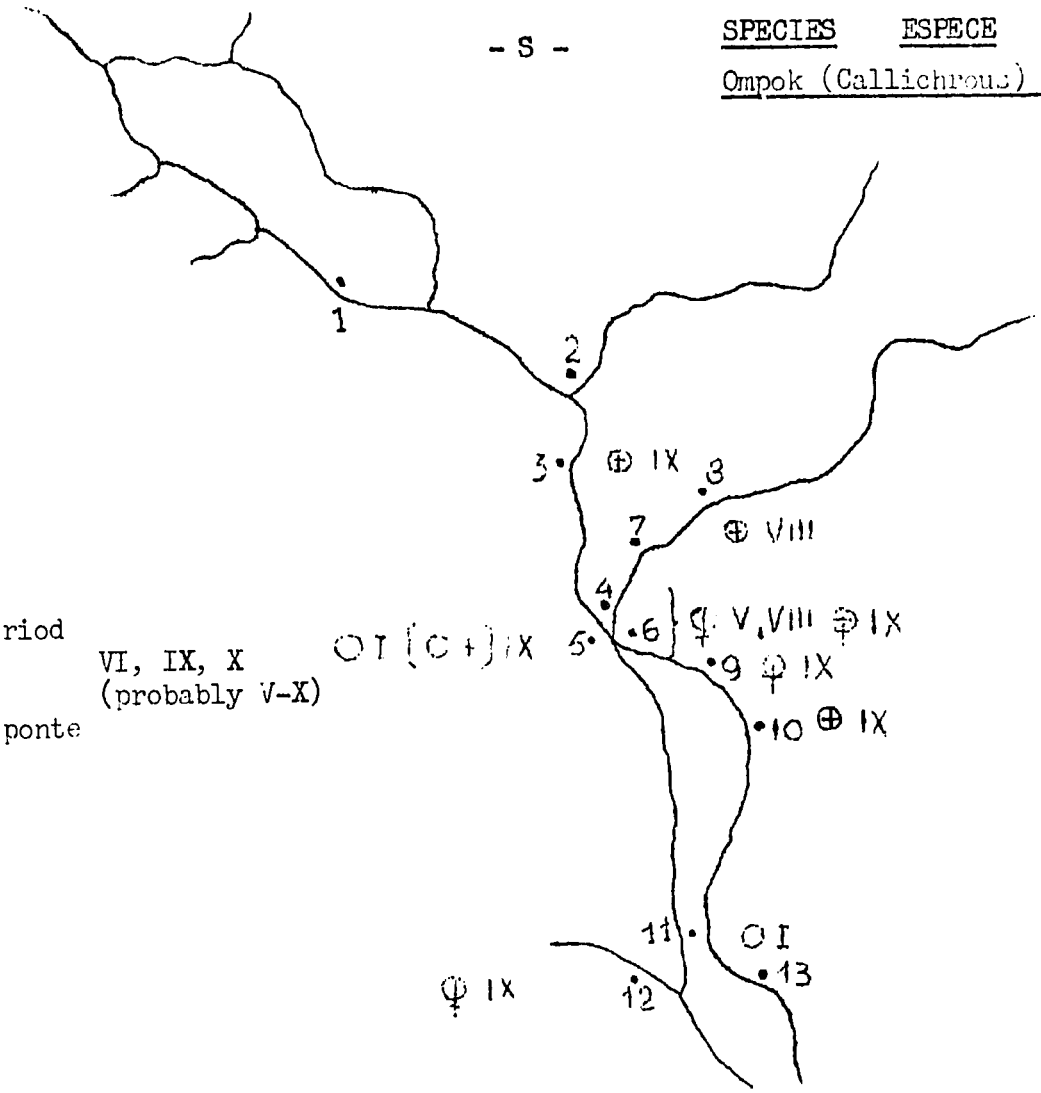
Months (mois) in Roman numerals.

SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○ +)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux
♂	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Ompok (Callichrous) bimaculatus



Spawning period

VI, IX, X
(probably V-X)

Periode de ponte

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

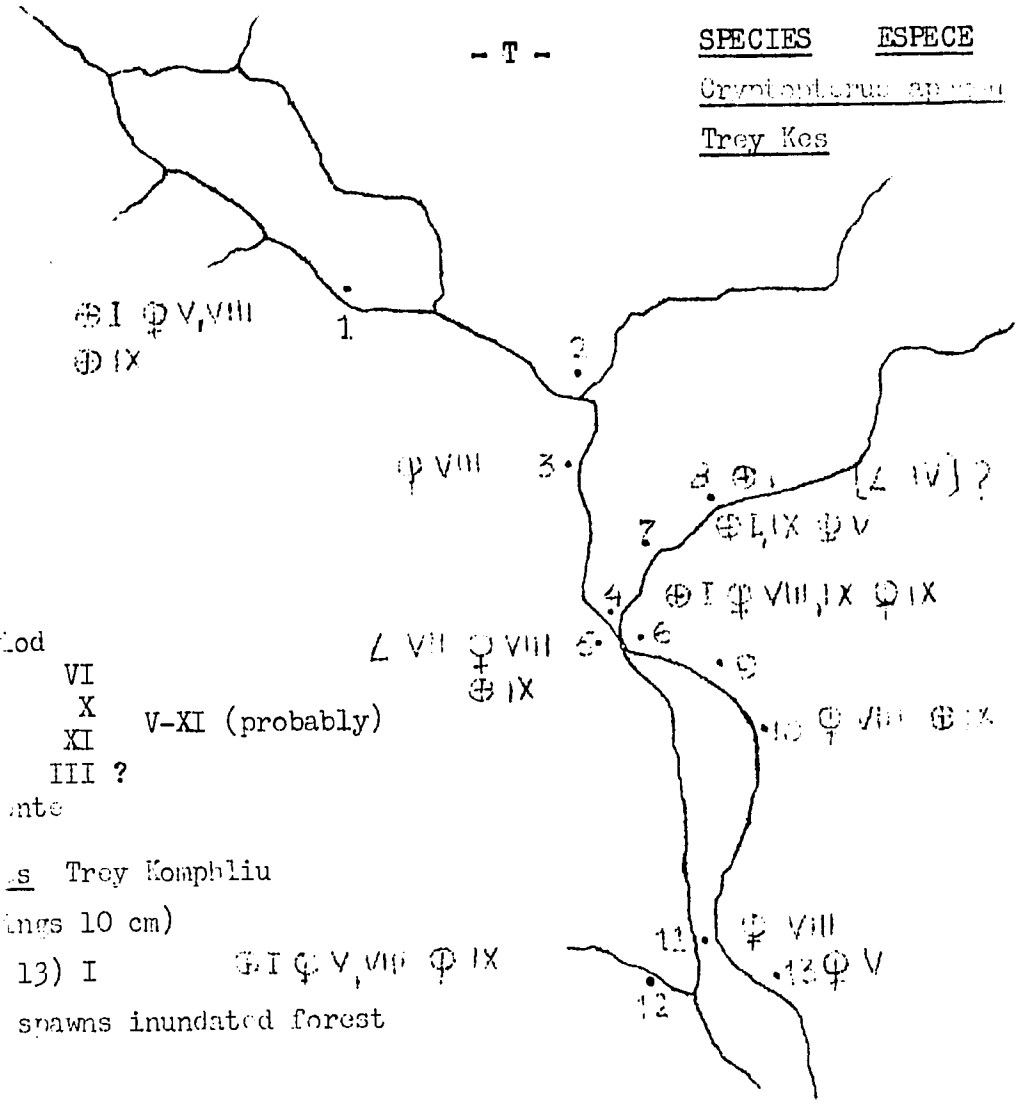
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Cryptopterus apogon 60 cm.

Trey Kos



Spawning period

VI
X
XI V-XI (probably)
III ?

Periode de ponte

C. schilbeides Trey Komphliu

(fingerlings 10 cm)

(11, 12, 13) I

probably spawns inundated forest VI-X

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Sonday
4. Prek Mut Kampul
5. Prek Phau
6. Arey Kso
7. Rockakong
8. Peam Chikang
9. Prek Me
10. Preyveng
11. Prek Bau Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

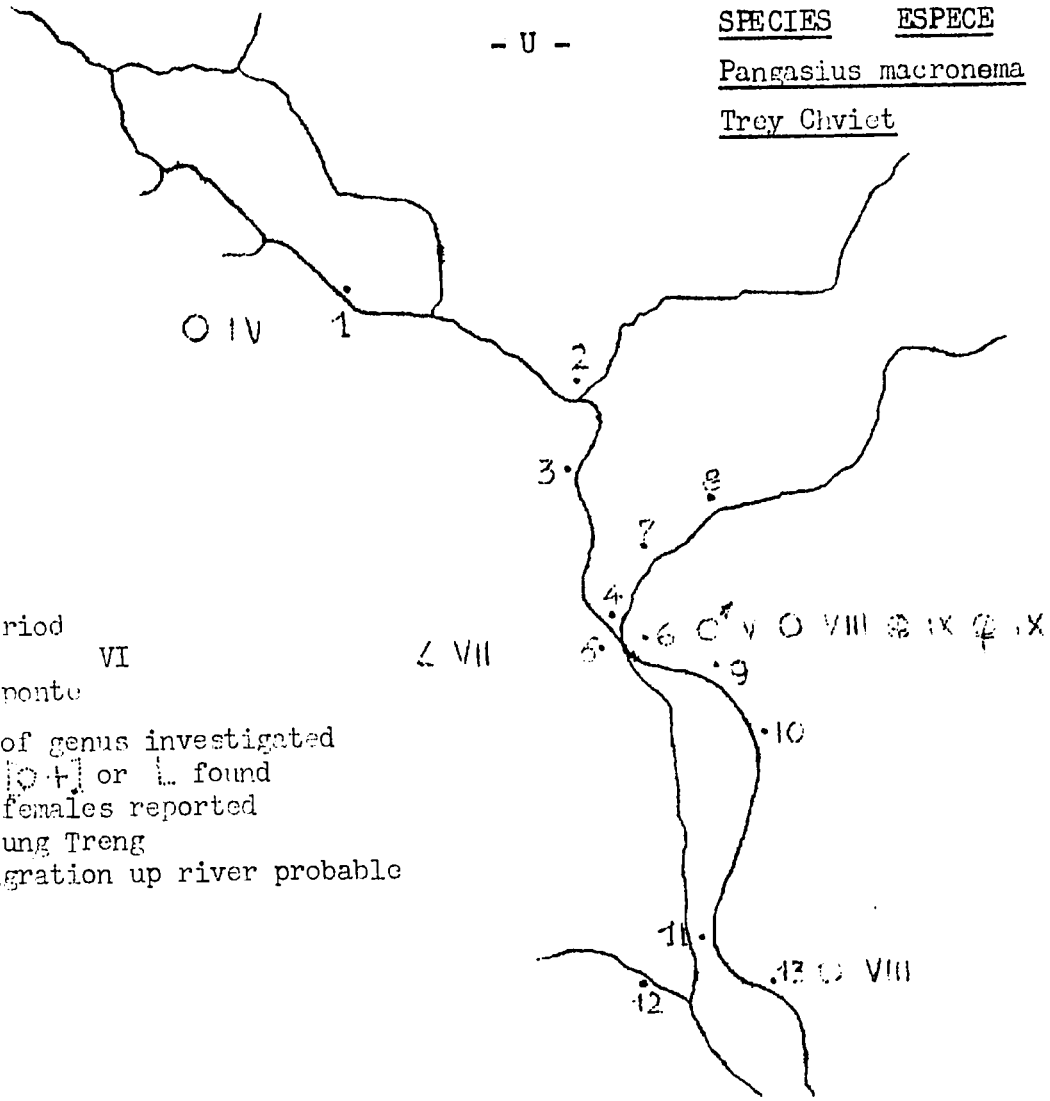
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Pangasius macronema 26 cm.

Trey Chviet



Spawning period

VI

Periode de ponte

Other spp. of genus investigated but no ♀ or |O+| or L found
large ripe females reported
Kratie & Stung Treng
Spawning migration up river probable

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

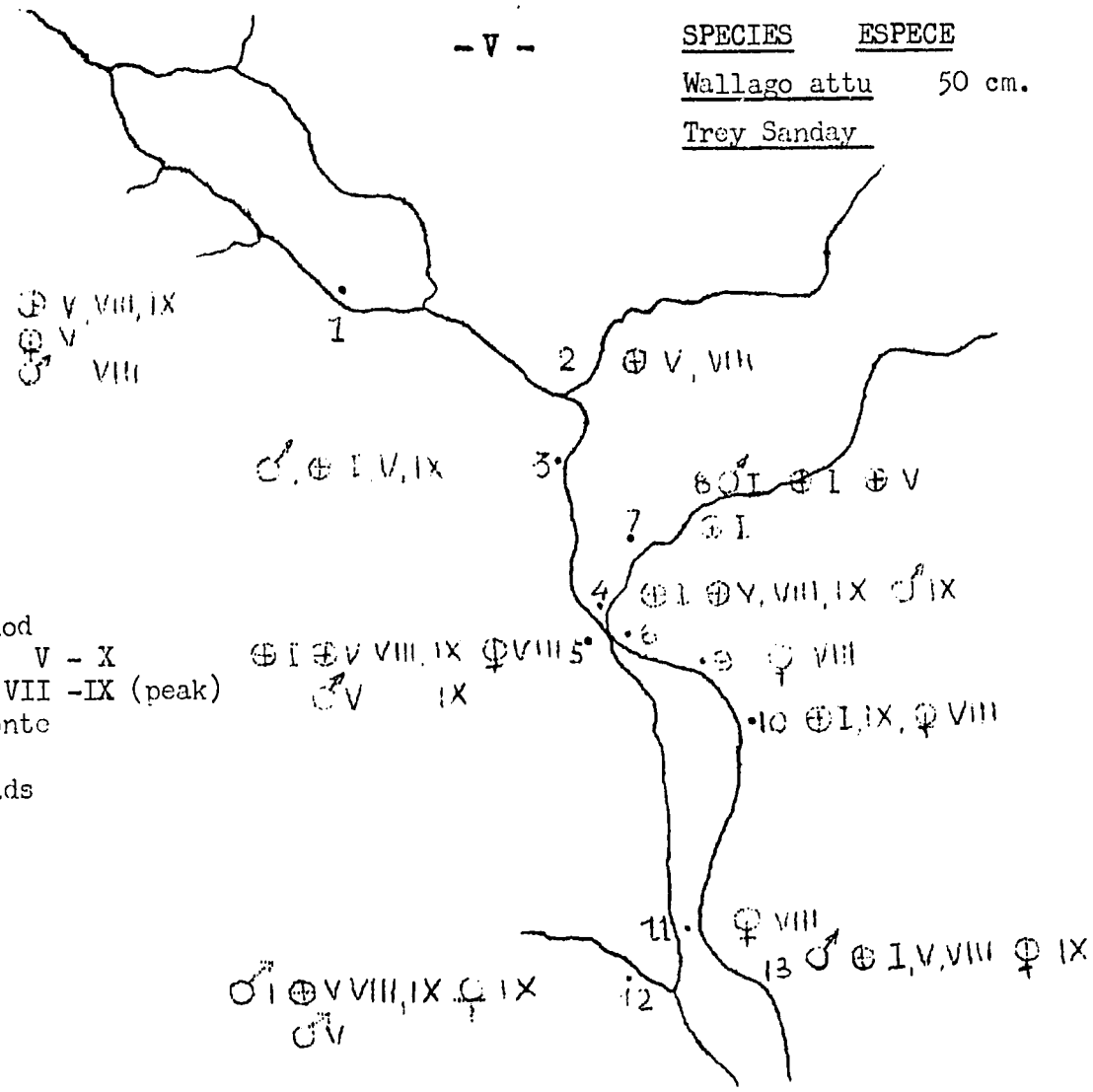
SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(O+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
♂	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux.
L	Stages larvaires.

SPECIES ESPECE

Wallago attu 50 cm.

Trey Sanday



Spawning period
V - X
VII -IX (peak)
Periode de ponte

Maturing gonads
all year

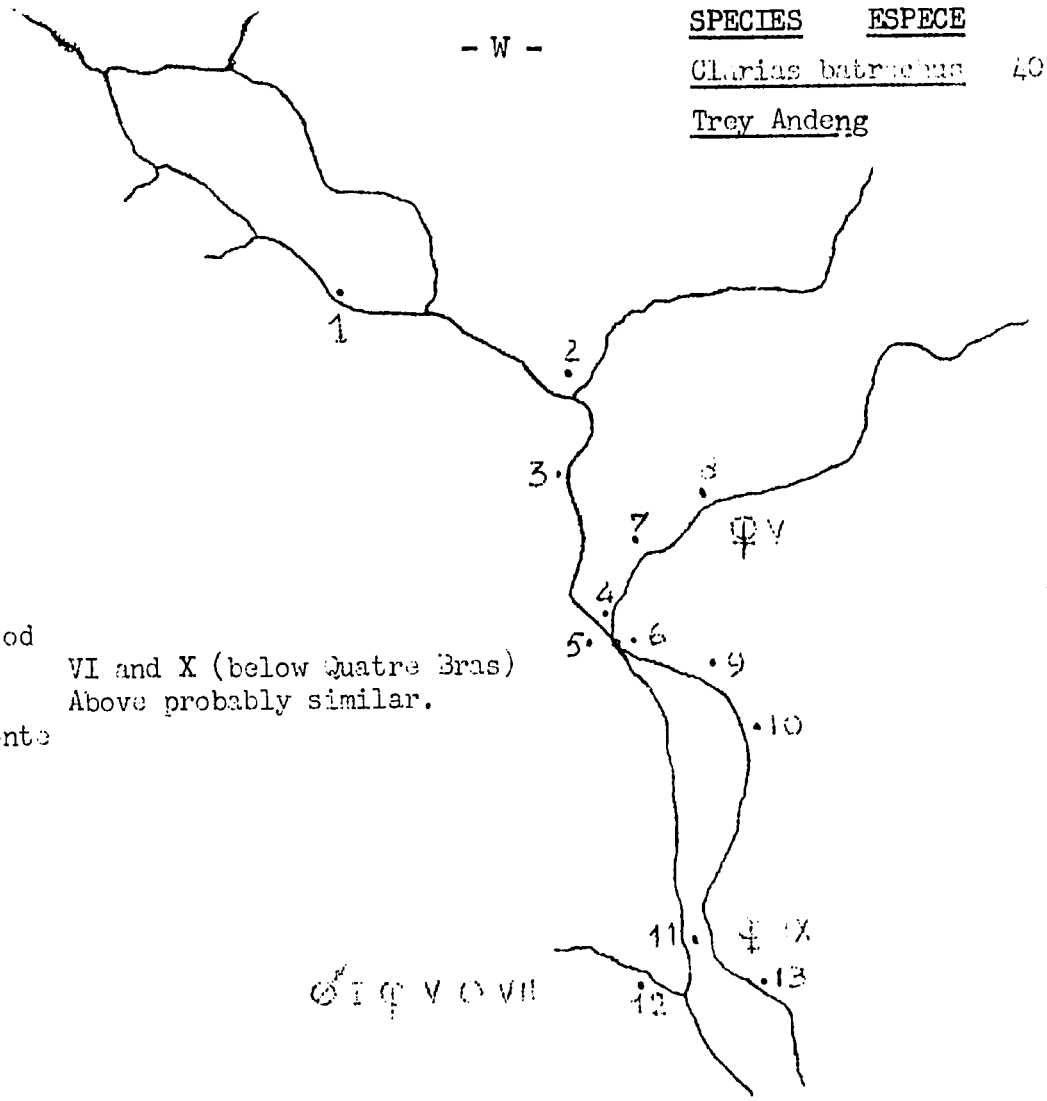
COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

○	Immature, sexe indiscernable.
♀	Femelle immature, ovules petits et égaux.
♀	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoides
♂	Mâle mûr) nombreux
L	Stages larvaires.



Spawning period

VI and X (below Quatre Bras)
Above probably similar.

Periode de ponte

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Mer
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

○ Immature, sexe indiscernable.

⊕ Femelle immature, ovules petits et égaux.

⊕ Femelle en début de maturation, ovules légèrement inégaux.

♀ Femelle en maturation, ovules franchement inégaux.

♀ Femelle en fin de maturation, ovules presque tous de grande taille.

♀ Femelle mûre, ovules gros et égaux, sortant à la pression.

(○+) Femelle ayant pondu, ovaire flasque et vide.

⊘ Mâle immature, majorité de spermatocytes.

⊘ Mâle en maturation, spermatocytes nombreux.

⊘ Mâle en fin de maturation) Spermatozoïdes

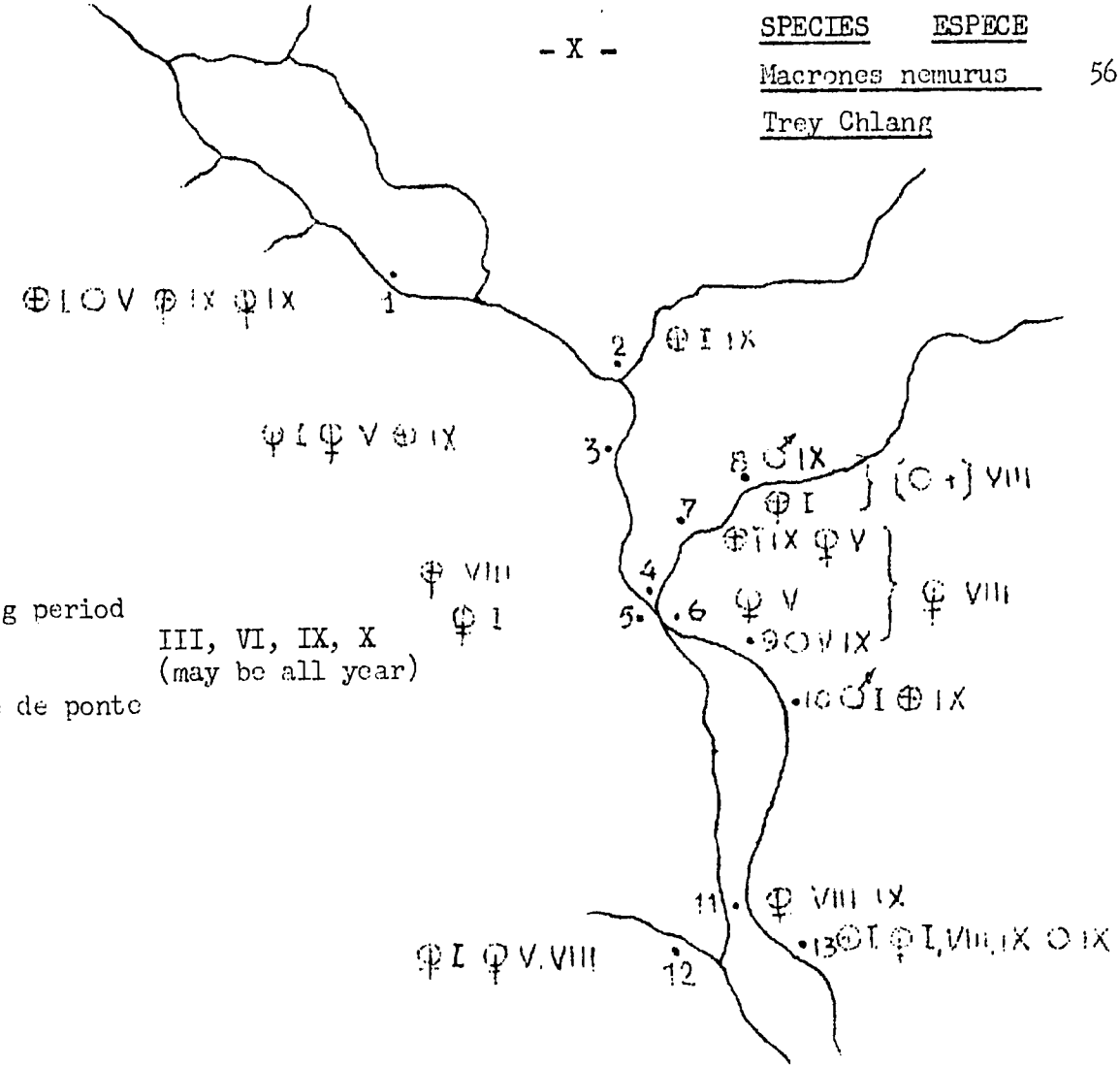
♂ Mâle mûr) nombreux.

L Stages larvaires.

SPECIES ESPECE

Macrones nemurus 56 cm.

Trey Chlang



Spawning period

III, VI, IX, X
(may be all year)

Periode de ponte

COLLECTION SITES
LISTE DES POSTES DE COLLECTION

1. Kg. Luong des Lacs
2. Stung Chinit
3. Phat Somday
4. Prek Muk Kampul
5. Prek Phnau
6. Arey Ksat
7. Rockakong
8. Peam Chikang
9. Prek Men
10. Preyveng
11. Prek Bac Nam
12. Confluent Takeo-Chaudoc
13. Confluent Song So Ha-Kaskos

Months (mois) in Roman numerals.

SYMBOLS SIGNES

○	Immature, sexe indiscernable.
⊕	Femelle immature, ovules petits et égaux.
⊕	Femelle en début de maturation, ovules légèrement inégaux.
♀	Femelle en maturation, ovules franchement inégaux.
♀	Femelle en fin de maturation, ovules presque tous de grande taille.
♀	Femelle mûre, ovules gros et égaux, sortant à la pression.
(○+)	Femelle ayant pondu, ovaire flasque et vide.
⊘	Mâle immature, majorité de spermatocytes.
⊘	Mâle en maturation, spermatocytes nombreux.
⊘	Mâle en fin de maturation) Spermatozoïdes
♂	Mâle mûr) nombreux
L	Stages larvaires

The outstanding problems are presented by species of unknown or restricted spawning locations which are, at the same time, highly valued food fishes; namely, several species of Pangasius (Trey Pô Prui, Trey Kòè, Trey Pô Khman) and Cirrhinus auratus (Trey Proul) as well as Pseudosciaena soldado (Trey Pama).

Recommendation 5

That research be done on the spawning locations and habit of the fishes of the Pangasid group (formerly Pangasidae), Cirrhinus auratus, and Pseudosciaena soldado (Trey Pama).

Some species of Pangasius are reported to migrate up the Mekong during low water and the dry season and to spawn in the Stung Treng and Khone falls region in June and July. Some spawning of P. Sutchi must also occur in the Stung Sangker north of Battambang since small fingerlings can be collected there for raising further south. Inundated forests around the lake have also been reported as spawning locations. P. Lernaudi (Trey pô) and P. Sutchi (Trey Pra) are of special concern in this regard because these two species are abundantly raised in bamboo holding cribs as well as in ponds. Some of the fry for this industry are captured south of Phnom Penh.

The speed of the Mekong during July and August makes it probable that newly hatched, yolk sac carrying larvae could cover the distance from Stung Treng to the Bassac region in from six to eight days. The sizes of the captured fry further suggest an upriver provenience. There exists a law Kram 303 NS 19-2-59 which now forbids the raising of these species in Cambodia. The law is based on the fear that in capturing fry, other species as well as the ones to be raised may be taken in too great numbers. Furthermore, since they are fed chopped up other fish it is feared that their culture taxes the fish supply very heavily.

Neither reason is valid; use of the larvae for fish culture raises their survival many thousand fold over that possible in nature and most of the kinds of fish used in feeding other fish are as valuable when used in this way as in others such as making fish pastes or sauces.

Revision of the above mentioned law seems advisable.

It is not known under what specific temperature and oxygen and other conditions the Pangasius species will spawn. A study on this group may be initiated by the Museum d'Histoire Naturelle de Paris through the French Economic Mission in Cambodia. This will, it is hoped shed further light on the question.

In the meantime one may expect that any change in the water regime of the Mekong due to River Basin development plans would affect the spawning facilities for these valuable species.

Cirrhinus auratus (Trey Proul, a large minnow with no English or French name) is believed to spawn in Mekong rapids from Sambor to Khone falls. At the descent of the waters they leave the Great Lakes and the Tonlé Sap regions in waves and migrate up the Mekong. Like in the case of all Cambodian migrating fishes, this migration coincides with the waxing moon, that is, it occurs between the fifth and the fifteenth day of the Vietnamese calendar. The fish return with the Mekong floods and slip into the Tonlé Sap in order to feed in the rich feeding grounds of the inundated forests.

There are reports that this fish shows four year cycles of abundance. It resembles the Salmonids in other respects also; it is a fast swimmer, a nervous and lively fish which will jump many feet into the air in order to clear obstacles. It appears that clearer water and bottom other than can be found in the Tonlé Sap are required for their spawning.

Here again it is evident that changes in the yearly water regime of the Mekong could profoundly affect the reproduction of this species, one of the most highly prized food fishes in Cambodia and also in Vietnam where it is imported.

The similarity of the habits of this fish with that of the salmon suggests that it might respond to similar conservation methods, to wit:

a) Protection of spawning sites.

b) Setting and enforcing an escapement quota (allowing a certain number of fish to complete the spawning run).

This is feasible because the fish schools appear in certain definite periods and are captured in large numbers in only a few locations.

In the case of salmon, escapement is set at 20% to 40% depending on years, species, and regions.

Microfilmed From
Best Available Copy

The reproductive potential of Cirrhinus auratus is unknown but it can be assumed to be as high as that of other tropical fishes. The setting of an escapement of 25% may be a good tentative beginning.

In practice this would be enforced as follows:

a) Fishing guards to be stationed at all commercial fishing sites (Barrages) where this species is fished - there are not more than half a dozen major ones.

b) These guards supervise the release of 25% by weight of the fish taken out of the catching chambers.

c) At a later date released fish might be marked or tagged at these sites to check on their survival rate in the following years.

Recommendation 6

That an escapement quota be set and enforced for Cirrhinus auratus in accordance with the research findings on the spawning habits and locations of this fish.

Pseudosciaena soldado (Trey Pava), a fresh water drum, is fished in the Great Lake and occurs in fair abundance. Spawning locations are unknown but distribution of samples suggests more circumscribed migratory habits than those of the bulk of the "White fishes" (listed above) which mostly move from inundated areas to rivers and back again.

The distance of migration of the large number of so called "White fishes" is not known, some certainly only moves several miles while others may displace themselves very much further from their rich feeding grounds.

The general problem of land use arises in connection with these fish movements Inundated forests both along the river courses and surrounding the Great Lake are absolutely essential for fish production. On the other hand these same areas were in the past (especially during Cambodia's period of insecurity), and will again be, tempting for agricultural expansion. The soils of inundated forests are reportedly not suited for agriculture and they should be retained or reforested wherever possible to maintain them as fish producing areas.

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Addendum 2

Since the completion of this report certain additional information was obtained on areas of declining fish production.

The harvest of fish has been most noticeably affected in fishing concessions close to larger population centers - especially Phnom Penh. Such declines result from the inevitable competition between land use for agriculture and fisheries.

Some losses of wild lands are inevitable with the spread of urbanization but delimitation and retention of areas best suited to natural fish production is possible as suggested in Recommendation No. 7.

The effects of removing trees from these forests for brush-shelter fishing have been mentioned in the section on fishing methods.

When looking into the future it appears inevitable, however that many enclaves of inundated forests along the river courses will disappear as the population increases and as agriculture expands.

The soils and water resources study now initiated by the RKG Irrigation Service (Genie Rural) with USOM assistance will permit precision of lands definitely to be retained as inundated forest, because they are unsuited for agriculture. These areas are to be retained at all costs to stem a further decline in fish production. Fish culture may alleviate or even offset these inevitable losses of the future; this branch of fisheries will therefore be discussed in detail in another section of this report.

Recommendation 7

That all Services concerned (Forestry, Fisheries, Genie Rural, Agriculture) collaborate in the preservation of inundated forests where such cover represents the best land use. That severe measures be taken against defrauders in areas once delimited. That these measures be coordinated efforts by provincial as well as central authorities.

THE FOOD OF SOME CAMBODIAN FRESH WATER FISHES

The great diversification of fishes and aquatic habitats in Cambodia points to diversified feeding habits also. Tabulation of stomach contents taken wherever possible (from the notes of M. J. Blache, formerly of the Laboratoire Piscicole du Cambodge) illustrates this very well. Knowledge of natural fish foods becomes important when species are to be selected for fish cultural practices. There is also no doubt that fish culture will become more important in the future than it is at present.

THE FOOD OF SOME CAMBODIAN FRESH WATER FISHES

(Les Aliments de Certains Poissons d'Eau Douce Cambodgienne)

Scientific names	Cambodian names	Mud	Plant fragments	Seeds	Algae
Clupea (Alosa) Thibeaudaui Durand	Trey Keba				xxx
Lycothrissa crocodilus (Blkr.)	Trey Chhmar				
Notopterus notopterus (Pallas)	Trey Slat		x	x	
Symbranchus bengalensis (McClell.)	Antong	x	xxx		x
Macrochirichthys macrochirus(C.V.)	Trey Dang Kleng				
Paralaubuca typus Blkr.	Trey Chantoas Phluk			x	
Esomus Goddardi Fowler					xxx
Luciosoma Bleekeri Steindachner					
Hampala macrolepidota van Hass.	Trey Khnau				
Cyclocheilichthys apogon(C.V)(s.s.)	Trey Sraka Kdam				
Cirrhinus auratus Sys.	Trey Pruol		x		xx
Puntius altus Gunther	Trey Kahe(s)				
Puntius brevis (Blkr.)	Trey Angkat Prak	xx	x		
Puntioplites proctozysron(Blkr.)	Trey Chrakeng				
Bulanthiocheilos melanopterus(Blkr.)			xxx		
Thynnichthys thynnoides (Blkr.)	Trey Leah				xxx
Labeo(Cor.)Chrysophekadion(Blkr.)	Trey Kack	xx	xxx		
Gyrinocheilus Aymonieri Tirant		xx			x
Botia hymenophysa (Blkr.)					
Botia modestia Blkr.					
Wallago attu Bloch	Trey Sanday				
Wallago miostoma Vaillant					
Siluriodes hypophthalmus (Blkr.)			xx		
Krypteropterus apogon (Blkr.)	Trey Kes				
Clarias batrachus (L.)	Trey Andeng	xxx	xx	x	
Pangasius nasutus (Blkr.)					
Pangasius micronemus Blkr.					xxx (G.Lake)
Pangasius macronemus Blkr.	Trey Chviet	xx	xx		
Pangasius Larnaudii Bocourt	Trey Po Khnau	xx	xx		
Leiocassis siamensis Regan					
Macronema Wrekii Blkr.		x			
Macronema murnirus (C.V.)		x			
Macronema planiceps (C.V.)		x	x		
Heteropneustes borneensis (Blkr.)					x
Clarias cambodgienne Durand					
Ophiocephalus striatus Bloch	Trey Ras		x		
Mastacembelus chatareus (Hamilton)	Trey Kancheak Sla				
Ophiocephalus marmoratus (Blkr.)	Trey Damrey				
Tetraodon cambodgienne Chab.	Kropot				
(Dangerous, destroy young fishes)					

(s.s.) small sizes

@ Culicides

Plankton Crustacea	Flying Insects	Aquatic Insects Larvae	Mollusks Snails	Fish & large Crustaceans	M: macrophagi m: microphagi
x					m
				xxx	M
	xx	x			M
					m
					M
xx	x				
					m
	x @				M
				xxx	M
xx					m
					m
					m
					m
xxx					m
					m
					m
					m
					m
xx		xxx			M
xx		xxx			M
				xxx	M
				xxx	M
xx					
				xxx	M
xx	x	xx	x	xx	M
					m
			x		m?
			(T.Sap)		
					m
					m
	x	x		xx	M
x		xx		xx	M
				xx	M
x		xx			M
xx	x	xxx	x	x	M
				xxx	M
				xxx	M
	xxx	x			M
x					M
(s.s)				xxx	M

FISH CULTURE

General Problems

The natural fish harvest of Cambodia is so abundant that the raising of fish under controlled conditions has, so far, not been practised widely. Until ten years ago no fish were spawned in ponds and even now the bulk of fish raising consists mainly in hold-over operations to provide fish for the closed fishing season.

All Cambodian waters, even rice fields, produce some food fishes and some areas produce them abundantly. For this reason potential Cambodian fish farmers find difficulties in adjusting to the basic tenet that fish culture is just as demanding an agricultural endeavour as any other type of animal production. Living space limitations, fertilization, additional feeding, control of water quality, and selection of genetic strains are concepts which they grasp with difficulty unless they already happen to be successful raisers of other livestock. Such farmers have succeeded in fish culture proper, that is reproduction and raising of food fishes, but their number now does not exceed five in the entire country.

Water supply in Cambodia greatly varies with the seasons and some attempts at fish raising have failed because the ponds dried up. Selection of sites is, therefore, of paramount importance.

Cambodia has hardy predatory fish which stand desiccation; they are prone to invade ponds and gorge themselves on the fish there present. They can be eradicated or kept in check by periodic poisoning and tight bamboo, wooden or metal fences around the ponds.

Fish raising in rice fields is practised widely wherever rice grows. At present the short period during which the rice fields are under water in Cambodia prevents use of this means of supplementing food proteins. I have not found in Cambodia any region where introduction of fish culture in rice fields could be attempted. When the various irrigation projects (e.g. Barai Occidental) will have made possible more than one rice crop a year and hence a longer total period during which there is water in the fields, fish culture in rice fields may become feasible and perhaps desirable.

Cambodia has some areas of Mangrove swamps which could be turned into Milkfish (Bangos) ponds along the lines seen in the Philippines and Java. Milkfish have been taken on the Cambodian coast in the Gulf of Thailand though the spawning locations of this population is unknown. Even if no exploitable concentrations of fry can be found, establishment of Milkfish culture with fry from Java - there are now direct air connections - seems feasible. Acid waters may be a problem in some regions to be overcome by proper application of lime.

Wherever the food economy of a country necessitated establishment or intensification of fish culture the Government Services have spearheaded this development. Not so in Cambodia, in part because the Fisheries Services is very young and has now no technicians even cursorily trained in fish cultural practices hence with the know-how and the perseverance necessary to nurse this new endeavour through its period of infancy. In part this is also because in much of Cambodia there is really no need at present to supplement the natural fish harvest.

However,there are regions, between Kompong Thom and Kinot for example, where the population is sufficiently dense and where natural waters are sufficiently scarce to warrant a development of fishponds. This can only be successful once the Fisheries Service has designated one or more trained officials to take charge of this development as their sole responsibility.

Third country training of Cambodian Fisheries Department officials, in various fish cultural practices, among other technical skills to be acquired, is planned for FY 59 and subsequent years.

Recommendation 8

That fish culture receive special governmental attention to anticipate future increasing demands for fish. This attention may take the form of training officials, establishment of fish culture station(s), in one or two most suitable regions of Cambodia; later extension efforts at spreading successful practices may follow.

There now follows a detailed account of the past and present status of Cambodian fish culture.

Native Fishes

There are in certain regions small fish raising establishments which produce some highly prized species often as an annex to general farming. No spawning in ponds is attempted and the efforts at fish raising are mostly only a hold over from a season of plenty (December-February) to a season of fish scarcity beginning in May and lasting until November.

The fish are kept either in bamboo holding cribs in the larger rivers and in the Mekong and the Tonlé Sap or in small ponds close to a permanent water supply.

Several species of the migratory Pangasius (Catfishes) P. sutchi, Trey Pra; P. Larnaudi, Trey Po and P. micronema, Trey Po Khmau are raised in this manner. Most of the fry or fingerlings are collected in the Mekong near Kompong Cham and further South, they are fed with chopped fish of small species when available and at other times with rice bran, corn and other vegetable food.

The present Cambodian law forbidding the raising of Pangasius has already been discussed (See Spawning Locations and Migrations); the law (KRAM 303 NS 19-2-59) has been ratified at the date of this writing but I doubt that it can be applied. The law rests on a misconception of fish biology because the capture of fry and fingerlings is not a destruction but actually a saving from the natural mortality which at that stage in the life history may be as high as 90 to 95%.

The use of small fish for food is a good use of otherwise unused proteins. One might even advocate the use of low grade fish meal as protein admixture for these catfishes at a time of the year when fish are scarce.

It may be of interest in this context to mention that many catfish raisers are Vietnamese.

Recommendation 9

That the law forbidding the capture and raising of Pangasids in ponds and holding cribs be re-examined for its biological and conservation aims and rationale.

The second group of fishes that has, in the past, been raised in Cambodia consists of a species complex of non-migratory fishes which can live together in captivity: Clarias batrachus (Trey Andong), a catfish; Anabas testudineus (Trey Krunh), the climbing perch; and Ophiocephalus striatus (Trey Ras), one of the serpentheads.

These species are raised in the South of Cambodia in ponds and not in floating chambers. The capture of the young of these as well as of the migratory species discussed before has become a specialized trade. The food for this second group consists of crop seeds and roots but mainly of boiled corn and bran.

We do not, at present, know the weight of fish fed and held over in ponds and holding cribs in Cambodia but it is not believed to exceed 10% of the production of natural waters.

Introduced Species

Tilapia. In 1953 and 1954 Tilapia were introduced to Cambodia as a part of the US aid program; later, private introductions followed. Few of the fish culture establishments which set-out to raise Tilapia succeeded. The government-operated Tilapia ponds certainly did not prove successful. It is, however, interesting to note that the rubber plantation of Mimot has several highly productive Tilapia ponds in close proximity to the now abandoned effort by the Fisheries and Forest Service. Mimot is in a region where raised fish are a boon to the population, fish from natural waters being scarce and procurable only seasonally and at high cost because of distance from fishing waters. The successful establishment of Tilapia culture at the plantation with harvest of up to 6,000 kg. per hectare per year, required over two years of trial and error experimentation, a fact to be reckoned with in every new venture of this sort. The reasons for the failure of other Tilapia ponds has already been discussed under General Problems of Fish Culture.

Common Carp. The common carp, a minnow which originated in Southern China, has successfully been cultured as a food fish in many tropical and temperate countries. The methods of raising carp are well worked out and

this year one private fish farmer in Cambodia succeeded in spawning carp in his ponds. USOM Cambodia has handed to the Fisheries Service for distribution mimeographed detailed instructions on carp raising and a Fisheries Service-operated pond site, where Tilapia raising has failed, is now being prepared to produce carp.

Chinese or Grass Carp. With the establishment of a direct air connection between Phnom Penh and Hong Kong it became possible to ship fish fry in plastic bags. The way therefore was open for enterprising individuals to raise fish of the grass carp species complex. There are five species of large minnows secured as fry in the rivers of Southern China which are exported to all areas where there are large Chinese colonies. The fish are greatly sought by the Chinese and fetch a high price.

The raising represents little difficulty, and the fish make optimal use of their pond since the species complex consists of bottom, plankton and surface feeders. The latter are herbivores and are fed with extraneous leafy fodder - bamboo, banana or other. Some fertilisation and/or neutralisation with lime may be indicated depending on local water conditions.

The fish are now imported at 3 riels per fry; they reach a weight of 1 - 2 kg. after a year in the warm waters of Cambodia. Grass carp fetch as much as 100 riels per kilo on the local market; this high price is due to the fact that they are still a scarce luxury item. Four private pond owners in Cambodia have specialized in this type of fish culture. It should be noted, though, that the controlled spawning of these fish has so far only been achieved once in Japan and that with considerable difficulties. In all areas where these fish are raised farmers depend on Hong Kong or Chinese suppliers. Realization of controlled spawning in Cambodia seems unlikely in the reasonably close future both because Cambodian rivers are not a favorable spawning environment and because fish cultural skills are lacking. The market for these fish is pretty well limited to the wealthy Chinese segment of the population even in regions where raising techniques have been perfected far beyond those attained in Cambodia.

VOLUME OF PRODUCTION AND TRADE

Existing statistics are unreliable to the point of being of no value. Smaller quantities than those actually shipped or brought to market are recorded. This omission may be due to lack of personnel or it may be intentional in the case of export figures and clearly to the advantage of the shipper if not also of the recorder.

As a result, catch trade figures reflect only in part the quantities and values of fish involved. On the other hand, estimates given privately by officials or concessionaires tend to overestimate the catch, especially that for pre-war years, in order to demonstrate the importance of the industry. This is true of both freshwater and marine fisheries.

The Statistical Yearbook of Cambodia gives a figure of freshwater fish production of 130,000 MT in 1940. This figure is taken from the Chevey and Le Poulain Survey which covered only the Great Lake and five provinces. Moreover this survey did not take into account the yield of family or subsistence fisheries. For the same year I have seen other estimates as high as 250,000 MT. The figure of 147,000 MT of the following table is still an approximation, but the best that can be achieved from the reconciliation of all the data available.

FISHERIES YIELD AND FISH CONSUMPTION
(Weight of fresh fish in metric tons)

	1939	1957
A. Inland Fisheries		
Local consumption /1	50,000	95,000
Exported fresh /2	20,000	15,000
Dried and exported	77,000	20,000
	147,000 /3	130,000
B. Marine Fisheries		
Local consumption	5,000	3,000
Exports	15,000	9,000 /4
	20,000	12,000

/1 This includes the weight of fish transformed into prahoc or other derivatives for in-country use, such as fish oil.

/2 Mainly toward Vietnam. Most of 1957 exports probably represent unrecorded exits.

/3 This includes 50,000 MT from the Great Lake; about 28,000 from the Tonle Sap and about 69,000 MT from all the other rivers and bangs.

/4 Transported to Thailand.

In more recent years statistics have become even less reliable than in the past. Indirect evidence from the fiscal yield of fisheries suggests a total catch of about 150,000 MT in 1957 while customs records and the process of prorating production according to the historical disposition of the catch lead to an estimate of 96,000 MT. The latter, however, does not take into account a possible increase in the per capita consumption, nor the extensive clandestine trade.

Unofficial informants such as fishing concessionaires who are familiar with recording practices indicate a total catch of 165,000 MT. Of this 110,000 MT are supposed to be consumed fresh, with an uncertain proportion going clandestinely across the border; 45,000 MT are supposed to be turned into 15,000 MT of dried fish for export and about 10,000 MT are used for the manufacture of smoked fish, prahoc, fish oil and dried fish for home consumption.

We believe that the 1957 catch was below these estimates: 130,000 MT only, including 95,000 MT for local consumption and processing into home consumed fish products; 15,000 MT clandestinely exported to Vietnam and 20,000 MT transformed into about 7,000 MT of dried fish, 5,500 MT of which was legally exported in 1957 and the rest smuggled out of the country.

Recommendation 10

That reliable methods be devised to assess accurately, with a breakdown to principal species, in-country fish consumption and fish exports.

Before 1940 Cambodian exports of dried freshwater and marine fish were considerable. The main customer was the Dutch East Indies. The Indochinese protectorate outside Cambodia also drew heavily on the Cambodian fish supply.

Cambodian fish exports are negligible now, those reported officially did not exceed 5,500 MT for 1957.

This drop is only in a small part due to a possible reduction in natural production, the true extent of which is yet to be ascertained. Economic and political reasons are far more important determinants of the volume of the Cambodian fish export trade than is natural production, with a fish yield as abundant as it still seems to be.

1) Exports at the artificially low rate (35₮ = 1$) at which proceeds have to be repatriated do not interest exporters.

2) Indonesia, the former principal customer has no foreign exchange to pay for the fish. Such trade as it exists is still in the hands of a group of Chinese merchants in Phnom Penh, Saigon, Singapore and Djakarta. They are not willing to buy on speculation the quantities they could formerly move when the Dutch guilder was used for payment.

3) Trade with South Vietnam and Thailand is clearly frought with many difficulties because of the intermittently strained relations between Cambodia and her neighbors. Fresh and dried fish are exported clandestinely however. Cambodia's marine fisheries represent a special case where an annual export volume of about 10,000 MT of fresh fish at a value of 50,000,000₮ leaves the country paid for by black market currency. This trade supports the coastal population but adds nothing to the Cambodian economy. Large scale economic and administrative changes would be required to change this situation. These involve other administrative units besides the Fishery Service and they are clearly beyond the present individual scope of action of all government services concerned.

Recommendation 11

The settlement of fish export difficulties for freshwater and marine fishes being beyond the scope of the Fishery Service it is suggested that an inter-ministerial committee be instituted to deal with this question, consisting of representatives from the Ministries of National Economy and Agriculture, Foreign Affairs, Finances and Trade, and Industry.

THE UTILIZATION OF THE CAMBODIAN FISH CATCH

The problem of preserving fish caught during the short season, for consumption all year around and for export to comparatively distant markets has been solved traditionally by use of reservoirs for fresh fish and more importantly by drying or transferring the fish into paste or prahoc. The latter method includes a great amount of waste. With a reduced amount of catch that might be commercially available in the future, interest in the development of more economic fish byproducts should be fostered; before and during the war, fish oil and more recently tuk-trey and fish meal. Refrigeration and canning do not exist in Cambodia on an industrial scale and do not appear likely to be introduced, in view of the considerable cost involved and the fact that they have no obvious advantages over the traditional processing methods.

We shall review each of these methods succinctly. For more details see Chevey and Le Poulain.

1. Fresh Fish. Fresh fish is preserved and transported from the fishing grounds to the market (Phnom Penh, Saigon) in floating bamboo enclosures (about 20x6x6 meters) or in junks with live chambers (three to eight tons).

2. Dried Fish. Drying is accomplished in the sun after cleaning and light salting according to traditional methods. Fish drying results in the waste of nearly 1/5 of the weight of fish (head and internal organs). This protein material could be recovered (see below, Fish Meal). For human consumption only large fish (10 cm. and more) can be processed by drying.

3. Smoked Fish. A family industry without extensive commercial importance.

4. Fish Oil. Fish oil is produced by boiling of small fish or fish waste. In 1927, 4,000 MT of fish oil was exported mainly to France. During World War II fish oil was extensively used as a substitute for petroleum products in Indochina. For instance the Phnom Penh electric plant worked on fish oil for many years. Since the war, production of fish oil for export is not economical any more and oil is produced in limited quantity for internal consumption (light and fuel). Preparation of fish oil leaves a residue out of which fish meal can be processed.

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5. Prahoc. This is the traditional method of preserving fish in Cambodia. The paste is produced by fermentation of a fish homogenate, the preparation of which requires elimination - and waste - of the heads and scales. The fabrication of prahoc - strictly a family industry - utilizes fish of all sizes with a preference for larger (over 15 cm.) specimens.

It should be noted at this point that all the traditional methods above result in waste or leave residues. What was permissible when Cambodia's fish catch and consumption was more favorable cannot be tolerated now and new methods of fish processing are being developed in order to use (a) the small fish which were previously neglected and (b) the dried fish residue.

6. Tuk-trey /1. The production of tuk-trey by autolysis of whole fish, whatever the size, can utilize the very large quantities of small fish which are largely wasted at present. It is estimated that about 2 million liters of tuk-trey are produced annually in Cambodia. There is a good demand for this commodity all over Southeast Asia and it is estimated that 20 million liters of good tuk-trey, comparable with the Vietnamese nuoc mam in quality could be produced in Cambodia annually. At present the production of tuk-trey is the only semi-industrialized form of fish processing existing in Cambodia on a comparatively large scale. The main problem is to convince the manufacturers to keep up the quality of their product (20 gr. of nitrogen per liter).

7. Fish Meal. The Fisheries Research Institute at Phnom Penh, under the direction of R. Lafont, is developing methods for the production and the utilization of fish meal in poultry and small livestock raising. This research has already yielded interesting results but not on a scale sufficient to make a great change in the fisheries economy of Cambodia. Problems encountered in the production of fish meal result from (a) the dispersion of fisheries, (b) the short duration of the fishing season, (c) the absence of a businesslike approach on the part of fishermen and (d) the low value of fish oil which must be extracted from the fish before fish meal is produced.

Production of fish meal consists in extracting oil by boiling, pressing and drying the residue, then crushing it into a flour which can be mixed with animal fodder. R. Lafont's idea was to first make presses available to

/1 See Lafont in Section II of Proceedings of Indo-Pacific Fisheries Council. 1954.

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fisherman and to let them accomplish the first three phases of the processing. Because of dispersion of the fisheries and the short fishing season, the fishermen do not find sufficient interest in the operation to go through the labor consuming steps of boiling, pressing and drying especially in view of the fact that at present prices the oil produced is wasted. The dried fish residue delivered to the station was found to contain a large amount of earth and sand.

M. Lafont is now experimenting with another system of production. This time the end-user - the cattle or poultry raiser himself - would be the processor. Being directly interested in the quality of the product, he should be ready to devote the necessary time to the production and he should also be above the temptation to tamper with it.

Fish meal production is one of the more hopeful developments in the Cambodian fisheries economy. It should make possible the recovery of some 10,000 tons of fish waste and lead to a better integration of the Cambodian subsistence economy by using in poultry and livestock raising the unpalatable surplus of another food industry namely, fisheries. Unfortunately no Cambodian Fisheries officials were assigned to Mr. Lafont. Thus he could not perform the very important function of on-the-job training and his know-how and experience may well leave Cambodia without a trace when he departs.

Recommendation 12

After the establishment of a well functioning and well staffed Fisheries Extension Service set forth in another recommendation it is suggested that the following improvements in fish rendering practices be considered:

1. Fish Meal
   a. Pictorial instruction for processing, cooking and drying the fish at the capturing site.
   b. Make available on a "deduction-from-sale" rental basis the necessary presses and cooking utensils.
   c. Establishment of grades and prices for raw material supplied for grinding, cleaning and bagging plants either privately or government operated.

2. Tuk-Trey
   a. Government or cooperative credit to establish small tuk-trey factories.
   b. Cheap salt supply to operators to be insured.
   c. Government inspection for sanitary operation and minimum nitrogen content - important if export of produce is to be attempted.
3. Fish Oils and Fats
   a. Standardize practices of cooking time, heat, etc. to insure a unit quality product which can be sold competitively.
   b. Improvement of cleaning practices with drying of wastes on bamboo or straw mats; resulting material to be used as fertilizer. (attempts along this line are being made at present but the product is of unequal quality and contains too much dirt to make the salvage of oil wastes an even near profitable undertaking).

FISHERIES ADMINISTRATION

Cambodian fishing waters belong to the Public Domain which is administered by the National Fisheries Service, a branch of the Service of Waters, Forests, Hunting and Fishing under the Division of Agriculture.

From a legal and economic point of view, fishing activities are divided into three categories: family or subsistence fishing, "pêche artisanale" (small scale commercial fishing) and fishing concessions (industrial fisheries). The distinction between these three categories is not clear-cut because under the present conditions of non-observance of regulations a portion of the family catch is sold. Family fishing is permitted all year round in the "protected fishing domain" or that portion of the fishing area not used as reserve nor subject to concession (classified domain) and, out-of-season (July-October) only, in the area of concessions. "Pêche artisanale" can take place only during the fishing season (see above) and only in the "protected domain". Non-subsistence fishing is subject to the payment of a tax on fishing gear. Industrial fisheries or concessions (affermage) are adjudicated to the highest bidder for a period of 2 years. They are restricted to the "classified domain" and are subject also to the payment of taxes on gear and sub-leasing. Concession fishing can take place only during the open season.

Traditionally it has been the function of the government service in charge (in the past it was the Ministry of Finance) to maximize government revenue which can be obtained from the system of leases, sub-leases and taxes described above. Such activities require administrative rather than technical status for their personnel. Factfinding and research has until 1950 been in the hands of French technicians of the Institute Oceanographique of Indochina at Nhatrang or its branches. One French Fishery Produce technician was supplied to RKG by the French economic mission. The support he received from his host government can at best be described as token.

It is logical to place Fisheries under Agriculture, it is even logical to insure close collaboration with the Forestry administration, in view of the conservation problems of inundated forests but it is, in my opinion, not efficient to have placed Fisheries under Forestry if not in intent so at least

in practice. The construction of a separate Fisheries Headquarters Building in Phnom Penh is, it is hoped, to be considered as a step in the right direction.

In view of the fact that the fiscal revenue from fisheries, 50 million riels, exceeds the fiscal revenue from forests and also in view of the fact that the value of fishery produce to the first producer is over 300 million riels a year against an estimated 170 million riels from forests at present, fisheries deserves to be administratively and financially, if not independent, at least on par with forests. It should be added that the fiscal revenue from fisheries exceeds the budget of the now combined Fish and Forest Service.

APPROXIMATE FIGURES COMPARING CAMBODIA'S FOREST & FISHERY RESOURCES, FY 1958

DIRECT FISCAL REVENUE
RKG MINISTRY OF FINANCE

FORESTS		FISHERIES
35,000,000₰		50,000,000₰
	INTO COUNTRY ECONOMY	
200,000 m^3 at 800₰ am^3		
160,000,000₰		
ca. 10,000,000	Other forest resources Fuel wood Charcoal	120,000 MT @ 2-3₰ kg.
170,000,000₰		240-360,000,000₰
[226,000,000₰ if taken at GNP or Market Value (1957)		990,000,000₰]

Budget of the Service des Eaux et des Foréts = 47,000,000₰ of which 29,000,000₰ is for salaries.

Fisheries portion of Service budget = ca. 10,000,000₰.

When it was decided in 1947 to create a National Fisheries Service no specially trained personnel was available; it was therefore most natural that this service should finally have been incorporated into the Forestry Administration, the only other government agency in existence which dealt

with resource exploitation. In addition, French Inland Fisheries are under Eaux et Foréts in France; their economic importance to France however does not begin to approximate that of Cambodian Inland Fisheries to Cambodia.

The situation is also reflected in the training of Fisheries personnel. The three year Forestry and Fisheries curriculum of the National School (College) of Agriculture deals largely with Forestry practices and administration; 10% of the subject matter taught in a 3-year curriculum deals directly with fisheries.

It is proposed in the reorganization plans of this college to upgrade fisheries training with the final aim at establishing a special fisheries curriculum.

Until there are graduates of this institution whose training is specifically directed to administer the waters of the Kingdom and their resources and until the Fisheries administration is budgetarily independent from and administratively at least on par with forestry, efforts at fishery conservation work can progress but slowly.

It will be essential that officials are permanently assigned to their chosen fields and not shifted from Fisheries to Forestry and vice versa or called upon to administer both resources at the same time as is now still the case in some provinces.

Under an administrative setup such as discussed above it will be possible to emphasize research and to execute it with Cambodian personnel instead of having to rely on foreign experts, a practice clearly undesirable from the point of continuity of work and the implementation of recommendations based on research findings.

Foreign aid will make it possible for Cambodian Fisheries officials to receive special training in addition to their core curriculum in America, Europe or other countries. It is essential that such individual training mission be aimed at the acquisition of one specific skill or a group of closely related skills if it is to last less than one year; those which extend over a year or more will probably lead to an additional, possibly advanced degree for the trainee. The Fisheries Conservation PPA for FY 1959 contains a list of training subjects desirable for Cambodian Fisheries Service officials.

The subject of fish culture is fairly prominent on this list. The Fisheries Service has attempted some efforts at fish culture, unfortunately without much success. Fish culture has been discussed in more detail in a previous chapter. The discussion here will restrict itself to the role of the administration in fish raising.

In a country where natural waters produce over 2,000 kg/ha. (the yield of Samra fishing in the Great Lake), a quantity not always attained even in good fish ponds elsewhere, it is difficult to realize for the potential raisers of fish in ponds that fish culture, like any branch of animal husbandry requires continuous tending of ponds and their inmates. This requires further that a trained person or persons without other duties are assigned to supervise and manage the fish cultural operation. Even then it usually takes several seasons before manager, fish, pond and nature come to "cooperate" in the attainment of maximal production.

It follows further that fish culture ponds ought, at first, to be restricted to one or maximally two locations in Cambodia.

After success has been attained at these experimental sites an extension effort can carry methods to the people in order to supplement regional protein supplies.

It is likely that there will be successful private fish farmers long before the Fisheries Service can succeed in fish raising. It is hoped that close collaboration will come to exist between these agriculturists and Fisheries Service fishpond technicians.

Law enforcement in the fisheries domain is difficult even in technologically advanced countries, it is very difficult in Cambodia. It appears that central Government Service officials like those of the Forest and Fisheries Service do not receive full collaboration from provincial authorities, that the lawlessness which came to prevail during the period of insecurity has given way to a state of affairs where attempts at law enforcement are considered by some portion of the population as infringements on hard-won independence. The present high governmental concern for "le petit peuple" unless accompanied by a vigorous extension and education campaign is not conducive to facilitate the jobs of conscientious natural resource administrators who want to see to it that reckless exploitation ceases for the good of all.

Recommendation 13

To aim at establishing a Fisheries Service which is de facto on par with the Forestry Service. If it is necessary to establish a separate service parallel to the Forest Service to attain this goal this possibility should not be too lightly discarded.

To attain this goal, whether with the existing service organization or in a revised one it will be necessary:

i. To intensify training in the National College of Agriculture and aid towards a semi-autonomous or autonomous fisheries curriculum.

ii. To create a specialized extension service or furnish trained fisheries extension workers to a ministry-wide extension service.

iii. To assign technicians once trained in specific phases of work, e.g. fish culture or research, to their respective jobs on a permanent basis.

SUMMARY

(Including a list of Conservation and Other Recommendations)

Fish and fish products contribute 8.8% to the gross National Product of Cambodia. They are second only to Rice in the area of agriculture and natural resources. It follows therefore that fish is by far the most important protein complement in the Cambodian diet.

About 130,000 MT of fresh and dried fish came from Cambodian fresh waters in 1957, 35,000 MT of this amount were exported through official and clandestine channels as dried and fresh fish. The rest was consumed in Cambodia at an average per capita annual intake of 21.6 kg., expressed as fresh fish.

Compared to earlier - pre World War II - catch and export figures, the above estimates represent a small decline in total catch and a serious decline in export. Reasons for these declines are discussed; lack of conservation measures, habitat destruction and inability to enforce laws due to lack of personnel are the primary ones.

The hydrologic and edaphic basis of Cambodian fisheries is discussed; the river network, water level changes and inundated areas are described.

A large and varied fish fauna evolved in response to the special conditions prevailing in Cambodia's lakes and rivers. The composition of the fauna and descriptions of the most common families are included under "The Cambodian Fish Fauna".

Fishing methods are described succinctly mainly to provide a background for mentioning the lack of certain conservation measures having to do with the escapement of young of the year fish to insure perpetuation of several threatened species. This leads into a listing of extant fragmentary information on spawning locations and migrations again treated with a view towards necessary conservation measures.

The food of Cambodian freshwater fishes is tabulated before a description of the raising of native and introduced species.

The official fishery statistics of Cambodia are not exact, only a best guess of production and the disposition of the catch could be made. There

are several possibilities of less wasteful utilization; suggestions for attaining such procedures are given in the chapter on the Utilization of the Cambodian Fish Catch and, since such measures are dependent on a well functioning Extension Service, they are treated from a different aspect under "Fishery Administration". This last section of the report also deals with education and training of Fisheries officials, pointing to some remediable deficiencies in this field. Coping with them will indeed have to be the first and one of the more important steps in creating a strong fisheries service.

Recommendation 1, (page 14) - Concerns the mesh sizes of fishing nets.

Recommendation 2, (page 17) - Suggests study of the regulation of set distances between the staves in bamboo barrages.

Recommendation 3, (page 19) - Deals with the structural changes in the Day and recommends abolition of Day fishing.

Recommendation 4, (page 21) - Suggests the gradual abolition of Samra fishing in the Great Lake.

Recommendation 5, (page 25) - Research on spawning locations and habits is recommended.

Recommendation 6, (page 27) - Advocates an escapement quota for Trey Proul (Cirrhinus auratus) after some research on spawning locations and habits of this species.

Recommendation 7, (page 28) - Strongly recommends coordination of efforts at preservation of inundated forests and severe action against defrauders.

Recommendation 8, (page 30) - Deals with fish culture and suggests that special government attention be given to this form of supplementing proteins for human consumption.

Recommendation 9, (page 31) - Deals with the law forbidding the raising of catfishes and suggests re-examination of the facts on which this law is based.

Recommendation 10, (page 35) - Suggests attention to and better methods of obtaining reliable fishery statistics.

Recommendation 11, (page 36) - Inasmuch as Fish Export concerns several government departments, coordination of their efforts is recommended to settle this problem of importance for the national economy.

Recommendation 12, (page 39) - Deals with improvements in fish rendering practices and the conservation of fish wastes.

Recommendation 13, (page 45) - Has to do with fishery administration and the training of fisheries personnel.

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ACKNOWLEDGEMENTS

It is a pleasure to extend my sincere thanks to the many individuals who have generously cooperated in diverse ways to enable me to write this report.

To Mr. Khieu-Vann, Director of the Service of Waters, Forests, Hunting and Fishing and his staff, especially Messrs. Sao Leang and You Kim Chhon, for material help and information. To M. R. Lafont and M. J. Huet for sharing with me what they accumulated through long experience in Cambodia.

To M. R. Serène for permission to ascertain unedited materials and to Messrs. Chevey, Blache, Goossens and H. Smith for having in the past written much about the fishes and fisheries of South East Asia in general and Cambodia in particular. Their written works are indeed the basis of this report; I am sure they would not object or would not have objected to have them used in this manner.

I also want to thank my colleagues in USOM (especially Mr. Waldo Sands) for letting me pick their brains occasionally.

This report was put on stencil by Dom Elefano, USOM/Cambodia.

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(Use of the larger, FAO compiled area fisheries bibliography is gratefully acknowledged)

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