REPORT ON SURVEY

FOR DEVELOPMENT OF THE

COASTAL FISHERIES IN CAMBODIA

DECEMBER 1967

OVERSEAS TECHNICAL

COOPERATION AGENCY

GOVERNMENT OF JAPAN

PREFACE

In response to the request of the Royal Government of Cambodia, the Government of Japan entrusted the Overseas Technical Cooperation Agency (OTCA) in May 1967 to conduct a survey for the development of coastal fisheries in Cambodia.

The OTCA, fully realizing the significance of the mission assigned to it, organized a survey team comprizing six experts headed by Mr. Hajimu Tanaka, Vice Chief of the Forestry & Fisheries Dep., Ohita Prefecture Government to Cambodia.

The survey team, which left Japan on June 4, 1967 and stayed about one month in Cambodia, made a survey on the actual condition of the coastal fisheries and collected data and information concerned as well as studied and discussed with the officials of the Royal Government of Cambodia various problems concerning the development of the coastal fisheries.

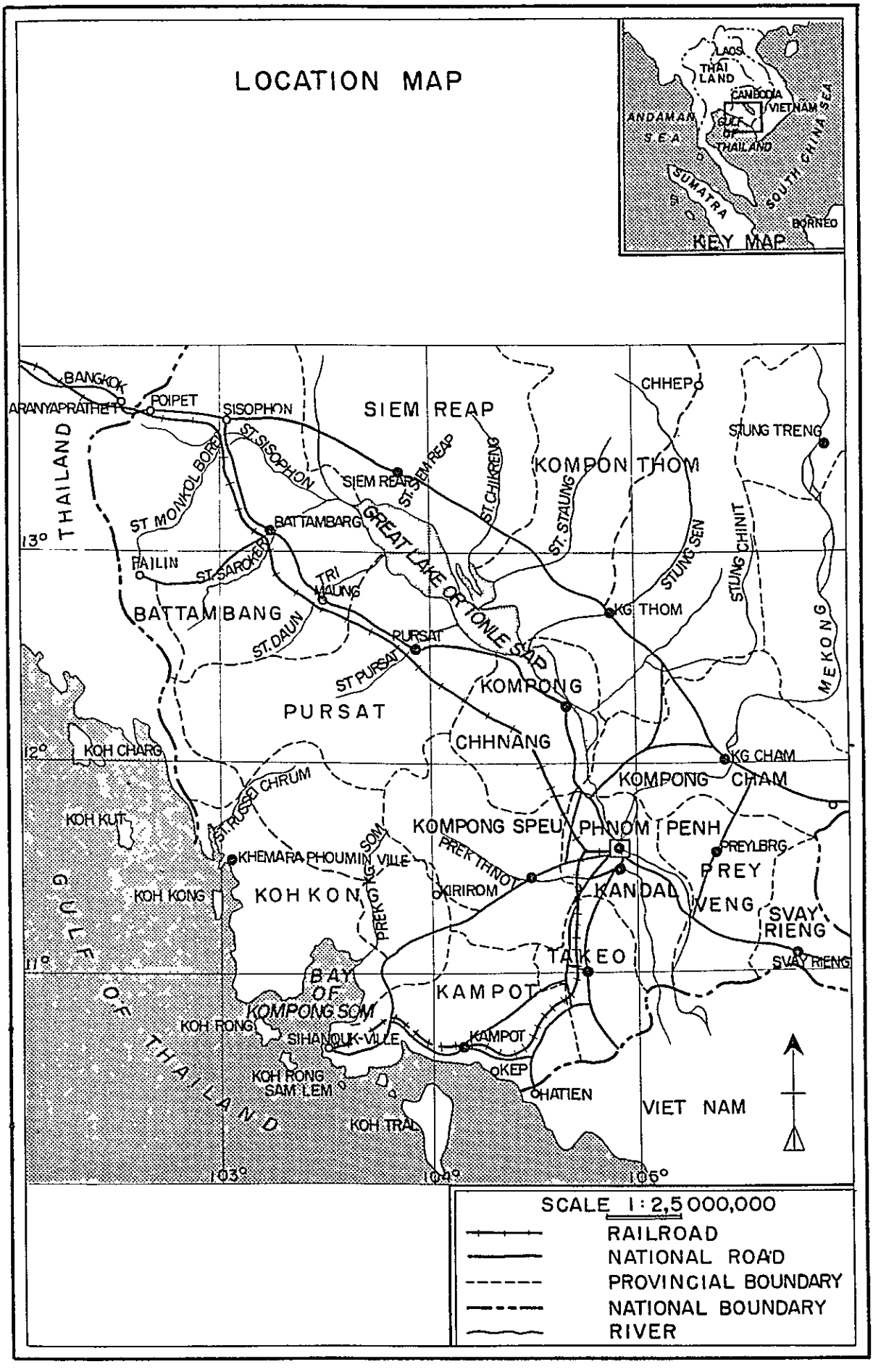
Since its return to Japan, the team has directed its efforts to the compilation of data and the identification of the marine products collected during the field survey, and the results are hereby submitted to the Royal Government of Cambodia as the "Report on Survey for Development of the coastal Fisheries in Cambodia".

It is my sincere hope that this report, which is an outcome of the joint endevours of the peoples of the Kingdom of Cambodia and Japan, will prove to be useful for the future development of Cambodia, particularly for development of its coastal fisheries and will also serve to promote close technical and economic ties as well as friendly relations between both countries.

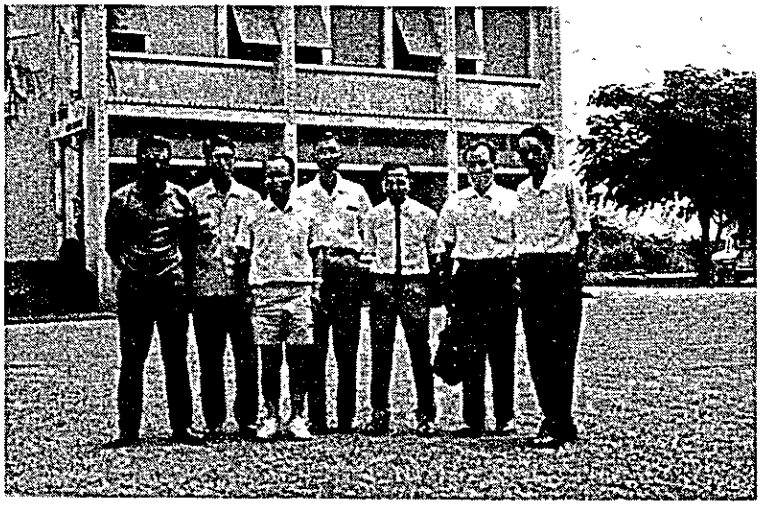
On behalf of the OTCA, I wish to take this opportunity to express my heartiest gratitude to the Royal Government of Cambodia, Embassy of Japan in Cambodia and other competent Authorities for their unlimited cooperation and assistance extended to the team, without which the smooth and efficient execution of the survey would not have been possible.

December 1967

Shinichi Shibusawa
Director General
Overseas Technical Cooperation Agency
Tokyo, Japan


LOCATION MAP
KEY MAP
LAOS
THAI LAND
CAMBODIA
VIETNAM
ANDAMAN S.E.A.
GULF OF THAILAND
SOUTH CHINA SEA
SUMATRA
BORNEO
BANGKOK
ARANYAPRATHET
POIPET
SISOPHON
SIEM REAP
CHHEP
STUNG TRENG
KOMPON THOM
THAILAND
ST SISOPHON
ST SIEM REAP
ST CHIKRENG
ST STAUNG
ST MONKOL BORE
BATTAMBARG
GREAT LAKE OR TONLE SAP
STUNG SEN
STUNG CHINIT
13°
PAILIN
ST SAROKEP
TRI MAUNG
KG THOM
BATTAMBANG
ST DAUN
PURSAT
MEKONG
ST PURSAT
KOMPONG
PURSAT
CHHNANG
12°
KOH CHANG
KG CHAM
KOMPONG CHAM
ST RUSSEI CHRUM
KOH KUT
KOMPONG SPEU
PHNOM PENH
PREYLBRG
KHEMARA PHOUMIN VILLE
PREK THNOT
PREY VENG
SVAY RIENG
KOH KONG
KOH KON
KIRIROM
KANDAL
PREK KG SOM
11°
TAKEO
SVAY RIENG
BAY OF KOMPONG SOM
KAMPOT
GULF OF THAILAND
KOH RONG
SIHANOUK-VILLE
KAMPOT
KEP
KOH RONG SAM LEM
HATIEN
VIET NAM
KOH TRAL
103°
104°
105°
SCALE 1:2,5000,000
RAILROAD
NATIONAL ROAD
PROVINCIAL BOUNDARY
NATIONAL BOUNDARY
RIVER

Discussion with Mr. Sao-Leang, Director of Fishery Services, at his office



In front of Fishery Services, Ministry of Agriculture, Royal Government of Cambodia

From left: Mr. T. Ohtsuki, Mr. M. Kitani, Mr. Y. Ogawa, Mr. H. Tanaka, Mr. S. Saroeung, Mr. A. Sugita and Mr. H. Kimura

CONTENTS

LIST OF FIGURES AND TABLES

I. INTRODUCTION

I. INTRODUCTION

1. OUTLINE OF THE SURVEY

The survey team, which was formed by the Government of Japan in response to the request by the Royal Government of Cambodia, left Tokyo on June 4, 1967 (in advance, two member of the team left on May 28 for the preparation of various matters related to the field survey), and conducted the survey on diverse aspects of the coastal fisheries in Cambodia during their stay of about one month.

The purpose of the survey involved the following:

Recognition of the actual condition of the coastal fisheries and their trend;
Collection of basic information and data related to the coastal fisheries;
Confirmation of the existing various problems; particularly,
Selection of the possible fisheries and fish species to be developed in the future, modernization of the present fisheries and improvement of marine products circulation.

After their arrival in Cambodia, the survey team conducted the following field survey:

(1) Market survey of the marine products and research on the actual condition at Phnom Penh, Kampot, Ream, Sihanoukville, Sre Ambel, Koh Kong and Koh Kapik.

(2) Oceanographic observation, fisheries experimental survey (by trammel net and small size trawl net) and under-water diving for collecting shellfishes at the coastal area between Kampot and Kdat, and around Islands of Koh Rong and Koh Kong.

Particularly, the survey stated in the above (2), aimed chiefly at collecting basic information on the possibilities of oyster culture including pearl culture and of development of crustecea, and further, on the composition of fish species on the coast of Cambodia.

Although the period of survey was in the beginning of the rainy season which was charasteristic in the tropical zone, the survey work was efficiently carried out with the close cooperation of the Cambodian officials of the Royal Government. In the latter part of the survey period, the fisheries experimental survey could not satisfactorily be conducted as originally plan due to the high sea wave caused by the squall and heavy rain during the monsoon season and, accordingly, has left the necessity of further fisheries experimental surveys during the dry season.

However, the team tried to grasp in detail the present state of the coastal fisheries in Cambodia and their trends with an emphasis placed upon the discussion and hearing on the actual conditions in the fishing villages.

It is to be noted herewith that the present report has not regretably been able to incorporate sufficient data and information due to the afore-mentioned reason that the team had to spare much efforts to obtain them by hearing and to overcome difficulties in collecting basic statistics on Cambodian fisheries.

Before leaving Cambodia for Japan on July 4, the team submitted to Mr. Sao-Leang, Director of the Fishery Services, Ministry of Agriculture, the Royal Government of Cambodia, a preliminary report which outlined the results of the survey.

Samples of the fish, shellfish and other marine life collected during the survey, were airborn to Japan and kept at Tokai District Fisheries Research Institute (Arasaki, Nagai-machi, Yokosuka, Kanagawa-pref.) for their identification.

Those samples were identified by:

Dr. Takaharu Abe	Dr. of Science, Technical Official of Tokai District Fisheries Research Institute	Fishes
Dr. Hiroshi Kurata	Dr. of Agriculture Technical Official of Tokai District Fisheries Research Institute	Crustacea
Dr. Takashi Okutani	Dr. of Science Technical Official of Tokai District Fisheries Research Institute	Mollusca
Dr. Takuo Chiba	Dr. of Agriculture Professor of the Fisheries College, Ministry of Agriculture & Forestry	Plankton

The above samples identified are listed in the Appendix.

2. FORMATION OF THE SURVEY TEAM

The formation of the survey team was as follows:

Name & Occupation		Assignment
Mr. Hajimu Tanaka	Vice Chief Forestry & Fisheries Department Oita Prefecture Government	Leader General
Mr. Masukumi Kitani	Chief, Shallow Sea Fishing	Member Coastal Fisheries

	Experimental Laboratory, Oita Prefecture Government	
Mr. Yoshinori Ogawa	Technical Official, Fish Research Sec., Multiplication Div., Tokai District Fisheries Research Laboratory, Fisheries Agency	Member, Coastal Fisheries
Mr. Toshiaki Ohtsuki	Technical Official, Second Ocean Section, Production Div. Fisheries Agency	Member, Fishery Administration & Circulation of Fishery Products
Mr. Akio Sugita	Vice Chief, Guidance Business Sec., Fishery Administrative Policies Div., National Federation of Fishery Co-operative Associations	Member, Fishery Administration & Circulation of Fishery Products
Mr. Hiroshi Kimura	Staff member, Development Survey Div., Overseas Technical Cooperation Agency	Member, Liaison

3. ITINERARY OF THE SURVEY

Immediate commencement of the team's efficient activities after its arrival in Cambodia on June 4, 1967 necessitated the despatch, prior to the departure of the main group, of two members of the team on May 28 for consultation with the officials of the Japanese Embasy in Cambodia, about a preliminary study on the local condition of the coastal area and previous arrangements of accomodation and transportation including vehicles, fishing boats and others.

The itinerary of the survey in Cambodia is described as follows:

Outline of the Itinerary

Date	Stayed at	Description
May 28 (Sun)	Phnom Penh	Departure of the advanced group (Mr. T. Ohtsuki and Mr. H. Kimura) from Japan for preparation of the field survey work in Cambodia.
May 29 (Mon) – May 31 (Wed)	Phnom Penh	Consultation with the official of the Embassy of Japan, Phnom Penh, for the arrangements of vehicles, interpreters, fishing boats, fishermen and related investigation equipment.
Jun. 1	Phnom Penh	Interview with Mr. Sao-Leang, (Director of Fishery

		Services) and Mr. Suon Saroeung (Chief, Institute for Fisheries Research, Cambodia) for the investigation planning.
Jun. 2 (Fri.)	Kep	Preliminary survey (including the arrangements of fishing boats, fishermen and accomodations of the team members) of fishing villages at Kep, Kampot and Sihanoukville.
Jun. 3 (Sat.)	Phnom Penh	Return from Sihanoukville
Jun. 4 (Sun.)	Phnom Penh	Departure of the main group (Mr. H. Tanaka, leader of the team, Mr. M. Kitani, Mr. Y. Ogawa and Mr. A. Sugita) from Japan, and joining the advanced group at Phnom Penh.
Jun. 5 (Mon.)	Phnom Penh	Visit to the Embassy of Japan, Phnom Penh, and in the afternoon, discussion on the results of the pre-limenary survey conducted by the advanced group.
Jun. 6 (Tue.)	Phnom Penh	Visit the Institute for Fisheries Research, Cambodia, and meeting with Mr. Suon Saroeung, Chief of Marine Fishery and Mr. Tin Taing Heng, Chief of the Fresh Water Fishery.
Jun. 7 (Wed.)	Phnom Penh	Interview with Mr. Sao-Leang, Director of Fishery Service for the discussion on the practical way of survey, and visit to Phnom Penh Central Market in the afternoon.
Jun. 8 (Thu.)	Phnom Penh	Inspection and arrangement of the investigation equipments.
Jun. 9 (Fri.)	Phnom Penh	Departure of all members of the team to Sihanoukville, the base for field investigation. (Accompanied by Mr. Suon Saroeung)
Jun.10 (Sat.)	Phnom Penh	Survey of Sihanoukville market in the early morning. Visit to the Division of Kompong Som, Survey of Ream fishing villages, and Discussion with Mr. Suon Saroeung on the field survey to be carried out after June 11.
Jun.11	Phnom Penh	Survey of Sihanoukville market and collection of samples

(Sun.)		in the morning, and their classification in the afternoon.
Jun.12 (Mon.)	Kampot (Sea Group) Kep (Land Group)	Collection of data and information related to the fisheries of Kampot Province at the Division of Kampot (chief: Mr. Prak Tha) and Investigation of Kampot fishing villages. In the afternoon, the team was divided into 2 groups for the following survey: (1) Survey of Kep fishing villages by Land Group (Mr. T. Ohtsuki, Mr. A. Sugita and Mr. H. Kimura) (2) Fisheries experimental survey (by small size trawl net and trammel net) off-shore of Kep by Sea Group. (Mr. H. Tanaka, leader, Mr. M. Kitani and Mr. Y, Ogawa)
Jun.13 (Tue.)	Kampot (Sea Group) Kep (Land Group)	Land Group: Survey of the fishing villages and market at Kep, and sample collection. Sea Group: Fisheries experimental survey at the off-shore of Kampot by small size trawl net and trammel net. (accompanied by Mr. Suon Saroeung)
Jun.14 (Wed.)	Sihanoukville	Land Group: Survey of the fishing villages, market and fish factory (fish-sauce) and classification of samples collected. Sea Group: Fisheries experimental survey at the off-shore of New Kep by small size trawl net and trammel net,, and basic survey including skin diving at the oyster fishing ground in the coastal waters of Kdat. (accompanied by Mr. Suon Saroeung)
Jun. 15 (Thu.)	Sihanoukville	Classification and measurement of various samples collected at the fish markets and by the fisheries experimental surveys. (accompanied by Mr. Suon Saroeung)
Jun.16 (Fri.)	Koh Rong (Sea Group) Sihanoukville (Land Group)	Survey of the fishing villages and fishing grounds around Koh Rong Sam Lem and Koh Rong by 2 fishing boats procured at Sihanoukville. Land Group: Return to Sihanoukville in the evening after the survey of fishing villages at the both Islands.

		Sea Group: Stay at Koh Rong after the fishing experimental survey (small size trawl net and trammel net) off-the coast of Koh Rong.
Jun.17 (Sat.)	Koh Rong (Sea Group) Sihanoukville (Land Group)	Land Group: During June 17 and June 21, survey on the actual state of fishing villages at Ream, Sre Ambel, Kampot and Sihanoukville from the base of survey, Sihanoukville.
		Sea Group: During June 17 and June 21, survey on the fishing villages, the fishing grounds and the fishing experiments around Cham Lang Kour, Koh Smach, Koh Samit, Koh Kong and Koh Kapik, and return to Sihanoukville on June 21 afternoon.
Jun.22 (Thu.)	Sihanoukville	Discussion and study of the results of the survey conducted by the Land Group and the Sea Group on June 17 and June 21.
Jun.23 (Fri.)	Sihanoukville	Discussion on the compilation of an interim report to be submitted to the Royal Government of Cambodia.
Jun.24 (Sat.)	Sihanoukville	Survey of Kampot market, collection of samples and their classification, and Survey of Sihanoukville fishing villages.
Jun.25 (Sun.)	Phnom Penh	Completion of the field survey at Sihanoukville base, and return to Phnom Penh.
Jun.26 (Mon.) Jun.28 (Wed.)	Phnom Penh	Consultation with the official of the Japanese Embassy concerning the outline of the survey results and the interim report to the Royal Government of Cambodia, and the drafting of the interim report.
Jun.29 (Thu.)	Phnom Penh	Inspection of the investigation equipment and arrangement for their shipping and visit to the fishing net factory.
Jun.30 (Fri.)	Phnom Penh	Visit to the fishery Services, Ministry of Agriculture and the submission of the interim report to Mr. Sao Leang, Director of Fishery Services,(accompanied by Mr. Suon Saroeung)

Jul. 1 (Sat.)	Phnom Penh	Visit to the Ministry of Agriculture and submission of the interim report to H.E.Mr. Kol Touch, Minister for the Ministry of Agriculture (accompanied by Mr. Sao Leang, Director and Mr. M. Nakagawa, First Secretary of Japanese Embassy).
Jul. 2 (Sun.)	Phnom Penh	Survey at Phnom Penh Central Market
Jul. 3 (Mon.)	Phnom Penh	Visit to the Fishery Services, Ministry of Agriculture, the Institute for Fisheries Research, Cambodia and the Embassy of Japan for the expression of the team's gratitude.
Jul. 4 (Tue.)	Phnom Penh	Departure of all members of the team to Japan from Phnom Penh.

4. ACKNOWLEDGEMENTS

The team wishes to acknowledge its appreciation of the impressive cooperation and assistance extended by all authorities and people concerned with the fisheries survey.

In the planning of the field survey, the prompt notification of the local authorities and the arrangements regarding transportation and accomodations, the team is particularly indebted to the following officials for their unlimited cooperation:

H.E. Mr. Kol Touch	Minister	Ministry of Agriculture
Mr. Sao Leang	Director of Fishery Services	Ministry of Agriculture
Mr. Suon Saroeung	Chief of Marine Fishery, Institute for Fisheries Research, Cambodia	Ministry of Agriculture
Mr. Tin Taing Heng	Chief of Fresh Water Fishery, Institute for Fisheries Research, Cambodia	Ministry of Agriculture
Mr. Sra Kret	Technical Inspector	Ministry of Agriculture
Mr. Prak Tha	Chief of Kampot Division, Fishery Service	Ministry of Agriculture

Mr. Yim Luon	Chief of Koh Kapik Division, Fishery Services	Ministry of Agriculture
Mr. Chan Pon	Chief of Kandal Division, Fishery Services	Ministry of Agriculture

The team, meanwhile, entends its gratification to the Embassy of Japan in Cambodia and to the Ministry of Foreign Affairs, Ministry of Agriculture & Forestry, Fisheries Agency and other competent Authorities in Japan, and, further, to Dr. T. Abe, Dr. H. Kurata, Dr. T. Okutani and Dr. T. Chiba whose efforts in identifing the fish and shellfish have been indespensable for the preparation of this report.

II. GENERAL DESCRIPTION

II GENERAL DESCRIPTION

1. DEVELOPMENT OF COASTAL FISHERIES IN CAMBODIA

1-1. Summary and Suggestions

For the economic development of Cambodia, there is no need to dwell on the importance of increasing, concurrently with the promotion of secondary industries, the production of agriculture, livestock, forestry and, above all, fishery, which is to be the principal industry in such primary industries.

In the case of food supply, meanwhile, the low cost of animal protein will have to depend mostly on that of marine products. Compared to the livestock which entails the problem of feeding-stuff, the fishing industry utilizes natural productivity principally and will be extremely advantageous and a contribution to the elevation of the national physical standard, and further, a solution to the food problem in Southeast Asia.

The fisheries in Cambodia show considerable development in fresh water fishing but remain for the most part unchanged in the sea fishing industry with the exception of the slight progress made in the motorization of fishing boats. If it remains in the present status, little promotion can be expected in the fishing industries in the future.

Promotion of the sea fishing industry will be attained by such measures as the arrangement of fishing ports, development of fishing grounds and elevation of productivity by the improvement of fishing boat efficiency and fishing techniques.

It is recommended, therefore, that
an increase in the fish catches by enlargement of the fishery enterprises, formation of the cooperative associations, conversion to high productive fisheries, levelling-up of the capital equipment, rationalization in utilization of the fishing grounds, training of the fishermen, etc., be undertaken and,
to promote the increase of demand and the stability of prices by arranging the marine products circulation system and the processing system, and further,
to accelerate the modernization of the management of the fisheries.

II DESCRIPTION GENERALE

1. DEVELOPPEMENT DES PECHES COTIERES AU CAMBODGE

1-1. Résumé et Recommandations

Pour un développment économique du Cambodge, il va sans dire qu'il est nécessaire de faire le mieux afin d'augmenter la production dans l'agriculture, l'élevage et la sylviculture et, en particulier, dans la pêche qui doit être une section principale dans les industries primaires, tout en concurrence avec lés efforts pour un développement des industries secondaires.

Sous l'aspect d'un approvisionnement en provisions par exemple, une fourniture de protéine animale au meilleur marché devrait dépendre pour la plupart de celle des produits maritimes. Contrairement à l'élevage qui s'accompagne inévitablement des problèmes de pâture, la pêche peut utiliser principalement une productibilité naturelle. Par conséquent, la pêche est beaucoup plus avantageuse, et elle peut contribuer au relèvement du niveau de constitution physique des peuples et, en sus de cela, à la solution des problèmes de provisions auxquels fait face actuellement l'Asie du Sud-Est.

Les pêches au Cambodge sont au niveau assez développé dans le domaine de la pêche d'eau douce, cependant dans celui de la pêche maritime ils demeurent encore dans un ancien état de choses, à l'exception d'un progrès léger marqué dans la motorisation des bateaux de pêche. S'ils demeurent encore dans l'état actuel, on ne pourrait compter beaucoup sur leur développement dans l'avenir.

Pour un développement de la pêche maritime, sont nécessaires les dispositions appropriées telles qu' aménagement des ports de pêche, exploitation des pêcheries et relèvement de la productibilité par amélioration des caractéristiques des bateaux de pêche et par mise en progrès des procédés de pêche.

Par conséquent, il est à recommander comme suit:
une augmentation des quantités pêchées doit être réalisée par agrandissement des entreprises de pêche, établissement des associations coopératives, conversion en pêches de haute productibilité, accumulation des capitaux, ainsi que par rationnalisation de l'utilisation de pêcheries et enfin par formation des pêcheurs.
Une évolution de la consommation, une stabilité du prix, ainsi qu' une modernisation de la gestion de pêche doivent être accélérées par mise en ordre des systèmes de circulation des produits maritimes et par modernisation des procédés de traitement de ces derniers.

On the other hand, the development of fisheries in Cambodia is to be preceded by ecological research on marine resources on the coast and off-shore, and, accordingly, will necessitate the consolidation and perfection of a research organization which plays an important role in such fields as the improvement of fishing methods, introduction of modern techniques and rationalization of the management of those fisheries.

D'autre part, le développement des pêches au Cambodge doit être précédé par les recherches écologiques des ressources maritimes tant dans la mer côtière que dans la mer au large. Sont également nécessaires une consolidation et un perfectionnement des instituts et laboratoires qui jouent un rôle important dans une amélioration des procédés de pêche, une introduction des techniques modernes et une rationalisation de la gestion de ces pêches.

1-2 Outline of the Coastal and *Off-shore Fisheries*

1-2 Grandes Lignes de la Pêche Cotière et *de la Pêche sur la Haute Mer*

The coastal and off-shore fisheries in Cambodia are briefly described as follows:

Total length of the coast line	about 435Km
Fishing population	*about 25,000*
Number of fishing boats (including *fishing boats with motors)*	2,157

La pêche côtière et la pêche sur la mer au large du Cambodge sont brièvement décrites comme suit:

Logueur totale de la *ligne littorale*	*environ 435Km*
Population de pêche	environ 25,000
Nombre des bateaux de pêche (y compris des bateaux motorisés)	2,157

Under these conditions, the annual fishery production in Cambodia is estimated to be about 40,000 tons.

Dans ces conditions, la quantité annuelle des *produits maritimes au Cambodge est estimée* à peu près 40,000 tonnes.

The principal fisheries are operated on a small scale by a one-boat purse sein, gill net, small set net, beach seine, long line, shellfish collecting and crab pots.

En général, les pêches sont effectuées sur une petite échelle, et ce principalement aux bourses à un bateau, aux filets "gill", aux petits filets fixes, aux seines, aux lignes longues, ainsi qu' aux pots de crabe et par collection des coquillages

Main products are migratory fish such as mackerel, horse mackerel, anchovy, spanish mackerel, mullet etc., bottom fish such as whip ray, flat fish, sea bream, crouker etc., coral fish and rock fish are also found near the shore. Also, common shrimp, crab, common oysters, hard clams, ark shells etc. are caught. Fin fish occupy more than 90% of the total fishery products. Crastacea is only 2 - 3%, and Mollasca is negligible.

De principaux produits sont les poissons migrateurs tels que maquerau, maquereau bâtard, anchois, maquereau espagnol, mulle, etc. et les poissons du fond tels que raie, sole, dorade, "crouker" etc. Des poissons-corail et des poissons-roche sont également trouvés dans la mer près du rivage. Les langoustes, crabes, huîtres, Cytherea meretrix, Tegillarca modifera, etc. sont aussi pêchés. La quantite pêchée des poissons occupe plus de 90% de la totalité des produits maritimes. Celle des crustacés n'en occupe que de 2 à 3%, et celle des mollusques est presque négligéable.

Those fisheries are carried out in shallow sea along the coast, and only some of purse seine is conducted off-shore.

La plupart de ces pêches sont effectuées sur la mer peu profonde qui longe la littorale, et seulement quelques seines sont conduites dans la mer au large

The coast of Cambodia is shallow for a great distance, and the greater part of it is less than 10m deep, the difference between ebb and high tides is about 2m; many rivers flow into the sea, salinity in the coastal sea is low and the area of low salinity is largely extended. Many islands, large and small, are located in the coastal area, coral reefs develop around these island, luring schools of fish as natural fish reefs.

Les plages cambodgiennes sont bien étendues et peu profondes. Une majeure partie de la mer côtière est de moins de 10m de profondeur, et la différence des niveaux de la mer est d'environ 2m entre la haute marée et la bosse marée. D'ailleurs un nombre de rivières débouchent dans la mer. Pour cela, la salinité de la mer côtière est basse sur une longue distance du rivage. De plus, sur la mer côtière se trouvent beaucoup d'îles, grandes et petites, autour desquelles se développent des bancs de corail qui, en tant que demeures naturelles des poissons, attirent des poissons.

1-3 Development of Resources of the Coastal Water Fisheries

1-3-1 Development of fish resources

The taxonomical report on fish inhabiting the Cambodian coastal waters by Mr. Suon Saroeung (1966) has listed 257 species of fish. During the survey, the team collected 129 species of fish by collection at markets and fishing test at such places as Phnom Penh, Sihanoukville, Ream, Kep, Kampot and Koh Kapik, as shown in the Apprndix.

Among the migratory fish, the following four species are said to be important and great in quantity.

Rastrelliger (Pla thu),
Stromatidae (Trey chap sar),
Engraulidae (Ca com), and
Cybium (Trey beca).

In Cambodia, however, the amount of fish catch by fish species is not exactly confirmed yet. The above-mentioned four species are, due to the off-shore migratory and strong schooling habit, caught by purse seine or gill net.

Important fish for the coastal fisheries are Trygonidae, Clupenidae, Megalopide, Elopidae, Plotosidae Tachysuridae, Heminhamphidae, Sphyraenidae, Mugillidae Serranidae, Carangidae, Lutianidae, Plectorhynchidae etc. Most of these fishes are caught by gill net or beach seine and are mostly large sized ones. This may be because of comparatively rich resources rather than because of meshes of fish net.

If power-driven boats aiming at the schools of off-shore migratory fish are equipped with generators, echo-sounders and fish lamps, the fish catch would further be increased. In the coastal waters, there is a possibility of an increase in the fish catch by making use of beach seines, double net and triple net. Furthermore, it must be added that it is necessary to secure data necessary for resources preservation by conducting thorough fisheries and biological researches on important fish species in parallel with the aforementioned measures.

1-3 Développement de la Pêche Côtière

1-3-1 Pêche des poissons

Le rapport taxonomique de M. Suon SAROEUNG (1966) sur les poissons de la mer côtière cambodgienne a enregistré 257 espèces des poissons. Au cours des présentes recherches notre équipe a collecté 129 espèces des poissons tant par collection sur les marchés que par essai de pêche à Phnom Penh, Sihanoukville, Ream, Kep, Kampot et Koh Kapik. Ces espèces collectées sont montrées dans l'Appendice A.

Parmi des poissons migrateurs, ceux de quatre espèces suivantes sont regardés comme les plus importants, d'ailleurs grands en quantités pêchées:

Rastrelliger (Pla thu)
Stromatidae (Trey chap sar)
Engraulidae (Ca com)
Cybium (Trey beca)

Cependant, au Cambodge les quantités pêchées par espèce de poisson ne sont pas encore exactement confirmées. Ces poissons de quatre espéces sont pêchés aux bourses ou aux filets "gill", en raison de leurs caractéres de migration dans la haute mer et de groupement bien fort.

Les poissons importants dans la pêche côtière sont Trygonidae, Clupenidae, Megalopide, Elopidae, Plotosidae, Tachysuridae, Heminhamphidae, Sphyraenidae, Mugillidae, Serranidae, Carangidae, Lutianidae, Plectorhynchidae, etc. La plupart de ces poissons sont pêchés aux filets "gill" ou aux seines. Ces poissons sont grands en général, ce qui serait plutôt en raison de leurs ressources comparativement riches qu'en raison des mailles des filets utilisés.

Si des bateaux motorisés à la poursuite des groupes des poissons migrateurs dans la haute mer étaient équipés avec générateurs, sondes à écho et lampes de poissons, les quantités par ces bateaux pourraient être augmentées beaucoup. Sur la mer côtière, il est aussi possible d'augmenter la quantité pêchée par l'utilisation des seines, des filets double et des filtes triple. Mais nous ajoutons ici qu'il faudrait chercher à oftenir des renseignements nécessaires à la préservation des ressources maritimes par suite des recherches biologiques complètes sur des poissons d'espèces principales, en parallèle avec application des dispositions sus-mentionnées.

1-3-2 Development of crastacea resources

Shrimp and crab are the most important among Crastacea; these two are distributed all over the Cambodian coast, These are dealt in great amount at fish market, and its consumption is considered to be of a variety of species clarified at the survey conducted by the Mission:

	Species
Shrimp	Penacus monodon
	P. indicus
	P. semisucatas
	Matapenaeus monoceros
Crab	Sylla serrata
	Portunus pologicus

Though the above-mentioned data is not enough to determine which species is the largest resource, it is estimated that, in view of the present fishing method, both Penaeus sp. and Metapenaeus sp. are rich resources.

As for shrimp fishing at present, young shrimp are caught by beach seines or skimming nets in shallow areas of 5 - 7m along the coast, as both P.semisulcatus and P.indicus are to be found in a sea of high salinity considerable far off shore, the fish catch can be increased by the development of off-shore fishing grounds.

From the viewpoint of resources preservation, however, unplanned expansion of production will cause reduction of the resources. Therefore, a fishing promotion plan must be worked out based on detailed survey and research concerning their growth and spawning.

1-3-3 Development of Mollasca resources

Although a detailed survey of Mollasca on the Cambodian coast was impossible, the team tried to survey and sampling as much as possible. Species sampled by diving and at the coast are listed in the Appendix.

Shellfish put on the market were small oysters, ark shells (Tegillarca nodifera) and hard clams (Meretrix meretrix).

1-3-2 Pêche des crustacés

La langouste et le crabe sont les plus importants dans les crustacés; tous ces deux sont distribués presque partout dans la mer côtière cambodgienne. Ils sont vendus en grande quantité sur les marchés, et leur consommation est supposée très grande. Les espèces classées par suite des recherches effectuées par l'équipe sont les suivantes:

	Espèces
Langouste	Penacus monodon
	Penacus indicus
	Penacus semisucateas
	Matapenacus monoceros
Crabe	Sylla serrata
	Portunas pologicus

Quoi que les renseignements sus-mentionés ne soient pas suffisants pour permettre de juger laquelle est la plus riche ressource, il est estimé, compte tenu des procédés de pêche actuelle, que l'espéce penacus et l' espèce matapenacus sont toutes les deux les ressources bien riches.

En ce qui concerne la pêche actuelle des langoustes, les langoustes mineures sont pêchées aux seines ou aux filets "skimming" dans la mer côtière dont la profondeur est de 5 à 7m. Le Penacus semisulcatus et le Penacus indicus pouvant habiter également dans la mer au large d'une haute salinité, leurs quantités pêchées pourraient être encore augmentées par exploitation future des pêcheries sur la haute mer.

Cependant, au point de vue de la preservation des ressoureces, une augmentation de quantité pêchée sans plan bien arrêté causera une réduction des ressources. Par conséquent, un plan de développement de pêche doit être dressé sur la base des études et recherches détaillées relatives à la croissance et à la ponte de ces ressources.

1-3-3 Pêche des Mollusques

Quoi qu' une recherche détaillée des mollusques dans la mer côtière cambodgienne fût impossible, l'équipe a cherché d'en faire des recherches et des collections les plus nombreuses possibles. Leurs espèces collectées tant par plongé dans la mer que sur les rivages sont montrées dans l'Appendice.

Les coquillages vendus sur les marchés ont été petites huîtres, ark shells (Tegillarca nodifera) et hard clams (Cytherca Meretrix meretrix).

The team attentively conducted a survey on the distribution of oysters and pearl oysters at the request of the Fishery Services of Royal Cambodian Government

As mentioned in the Appendix, species of oysters found on the shallow coasts are small and of the Saxostrea genus.

As for pearl oysters, only 2 old pearl oysters of the Pinctada chemnitzii were found off Kdat.

Resources of oysters and pearl oysters are considered to be very small. As for oysters, however, breeding of Crassostraea sp. may be possible.

Future prospects are the improvement of oyster species, a survey on the resources of arc shells and hard clams, and an increase in their catch including Pinna sp. must be taken into consideration.

The resources of Cephalopoda on the coast have not been clarified yet; judging from its higher price in comparison to other fish at the consumer market, there must be some demand for it, and it is imagined that there would be room for development in the future

As for Mollasca resources, the catch itself does not vary and distribution of the species is not clear; thus a detailed survey is required in the future.

In view of the development of resources, and the trend in consumption, Mollasca should be taken into consideration.

L'équipe a mené avec soin des recherches sur la distribution des huîtres et des huîtres perlières, afin de répondre à une demande faite par les Services de Pêche du Gouvernement cambodgienne.

Telles qu'elles sont indiquées dans l'Appendice, des huîtres trouvées sur les plages peu profondes sont petites, et elles appartiennent à l'espèce Saxostrea.

Quant aux huîtres perlières, seulement deux vieillies de l'espèce Pinctada chemnitzii ont été trouvées dans la mer au large de Kdat.

Les ressources des huîtres et des huîtres perlières sont considérées très pauvres. Cependent, quant aux huîtres, une ostréiculture de l'espèce Crassostraea serait possible.

En tant que perspectives futures, une amélioration des espèces d'huître, des recherches sur les ressources de Tegillarca modifera et de Cytherca meretrix, ainsi qu'une augmentation de la quantité pêchée, y compris celle de l'espèce Pinna, doivent être prises en considération.

Les ressources de Cephalopoda qui se trouvent dans la mer côtière ne sont pas encore bien connues. Cependant, le fait que leur prix sur les marchés est plus élevé que ceux des autres poissons suggère qu'il en doit exister quelques besoins, et pour cela il y aura lieu de développer la pêche de ces ressources dans le future.

En ce qui concerne les ressources des mollusques, leur quantite pêchée elle-même étant presque stable, et leur distribution par espèce n'étant pas encore constatée, une recherche détaillée est également nécessaire dans l'avenir.

En vue du développement de la pêche des mollusques, il faudrait tenir compte d'une tendance générale de la consommation de ces ressources.

2. PRACTICAL PLAN FOR DEVELOPMENT OF THE COASTAL FISHERIES

2-1 Development of the Offshore Fisheries by Improvement of Fishing Gears and Methods

Main products of the marine fisheries in Cambodia are Pla Thu, Ca com, Trey chap, Trey beca etc., which are caught with one-boat purse seine or gill-net.

It is necessary to improve the fishing gears, the fishing methods and the structures of fishing boats in order to increase efficiently the catches of the above-mentioned migratory fish both in coastal and offshore waters.

It would cost much if the above measures should be carried out at a time. It may, therefore, be desirable to plan first increasing the fisheries profits gradually, and then, to accumulate capital stock so as to become possible to invest in such improvements.

It is suggested, first of all, that any fishing boat with diesel engine should be equipped with dynamo which will make possible to operate echo sounder and fish lamp on board. Equipped with echo sounder, fish seeking will be easier, topographic conditions of sea bottom clearer and fishing operations more rational. It will be possible to improve the fishing efficiency conspicuously by means of fish lamps luring fish which show phototaxis.

It has been unable for the survey team to investigate closely on the phototaxis of Pla thu, Ca com etc. It is most probable, however, that there will be some particular fish species which show strong phototaxis among such species as Dussmieridae, Engraulidae, Scombridae, Carangidae and so on, which swim in the surface or in the middle layers of the sea waters.

Therefore, it is advisable to research the fish phototaxis and the adaptability of fish lamp in an appropriate manner in the future. If it is possible to lure fish by means of fish lamps, large amount of fish may be caught with purse seine.

For the reference small stick-held dip net, the fish lamps, the small sized seine and the echo sounders employed in Japan are described in some details hereunder.

2-1-1 Stick-held dip net

A. Material and structure of the gear

The stick-held dip net with following parts is shown in Fig. 2-1.

1) Length of floater side : 106m.
2) Floater rope : length 106m.(manila), dia. 13.6mm.
3) Side rope of floater : length 90.9m., dia. 9mm.
4) Looped rope : length 121m., dia. 12mm.
5) Floater : 300pcs. (made of paulownia, 9cm x 15cm)
6) Floater : 3 pcs.(made of vinyl, dia. 3.6cm)

7) Earthenware sinker : 50 - 100pcs., 112gr. per one.
8) Lead sinker : 2 pcs., 3.8kg. per one.
9) Iron loop : 26pcs.

The structures and sketches of net are also shown in Fig. 2-1 and 2-2.

B. Operations

1) A bamboo stick of 7.5m long with the fish lamp on its top is protruded in one side of the boat. The fish lamp is placed in the water to the depth of about 75cm and lit to lure fish. In this case, the lamp is to be set against the direction of tidal current.

2) Then, net will be set in the sea from the other side of the boat. The net should be expanded and held by "Haritake" which is a combined bamboo pole of about 15m long with the fish lamp and floaters on its top as illustrated in Fig. 2-2.

3) After setting the net, the fish lamp is allowed to approach to the boat and then the fish lamp of net side is lit so that the fish school are attracted to the net side.

4) When fish school moves entirely into the net, the loop rope shall be tied up quickly, and then the net hauled in to catch fish.

5) Depending upon the sea conditions, in this operation, there are two cases of using the boat fixed with anchor or floated without anchor.

C. Fishing boat and Echo sounder

The fishing boat is recommendable to be of 5 - 7 gross tons, equiped with about 28 HP diesel engine and operated by 7 - 8 fishermen; small engine room and wide deck is convenient for the operation.

Dynamo of 3 KW is generally used as generating equipment of fishing boat in Japan; The small and low voltage dynamo for car-use (24 - 12V, 1 - 0.2 KW) has been predominantly used in these days because of such a simple operation as to rotate it by means of belt drive.

In order to obtain a necessary voltage from the dynamo, it is to be driven at the rate of 4,000 - 5,000rpm. While, revolutions of a low speed engine are 2,000 - 1,000rpm. at maximum and 700 - 500rpm. at minimum. For good result, therefore, it is necessary to set the diameter of flywheel of the engine in an adequate ratio to that of pulley of the dynamo.

Fish lamp:

Incandescent lamps(500W or more) are used for luring fish as fish lamps to be suspended above the sea surface, while 30 - 100W water-proof lamps or 500 - 1,000W naked lamps are used for the same purpose as fish lamps to be lit in the sea water. All of them should be

Fig. 2-1 Structure of Stick Held Dip Net

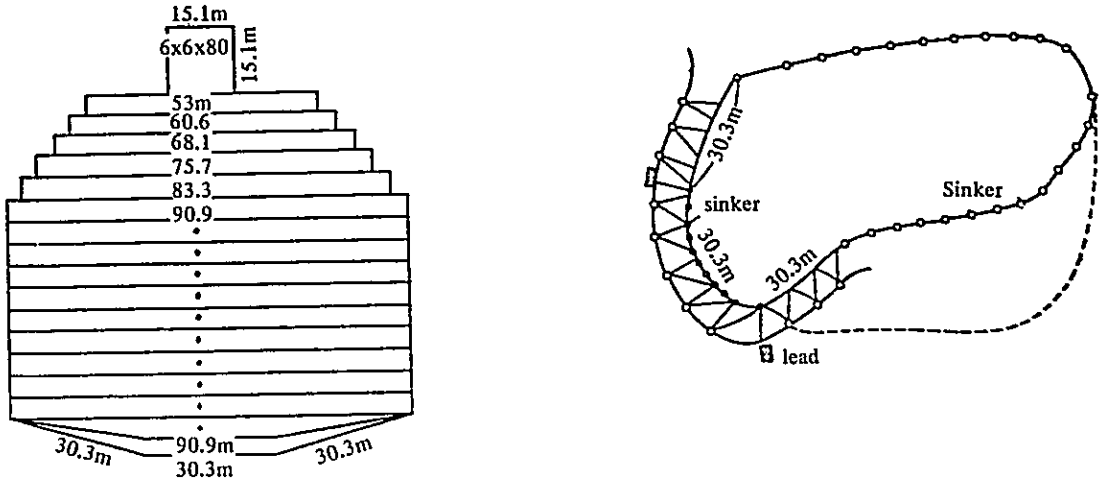
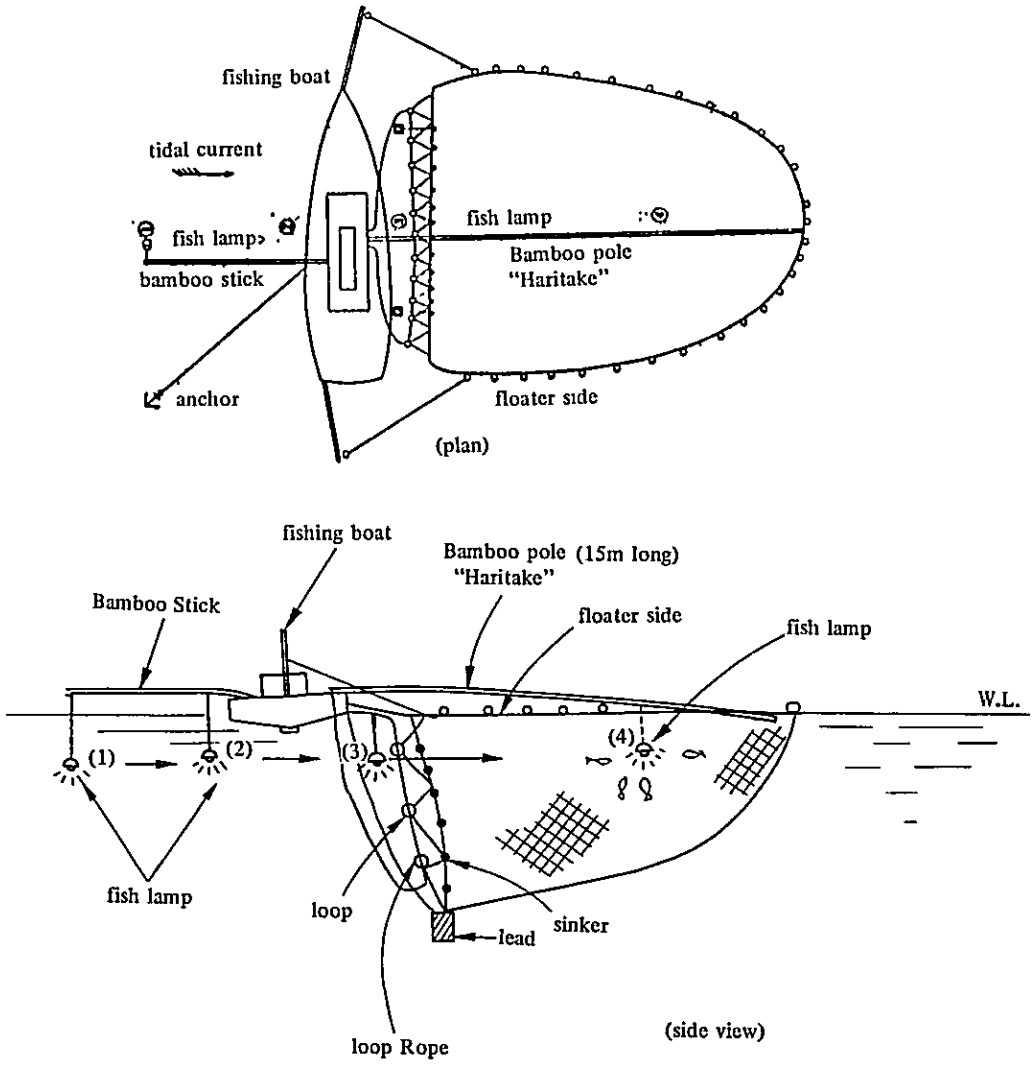


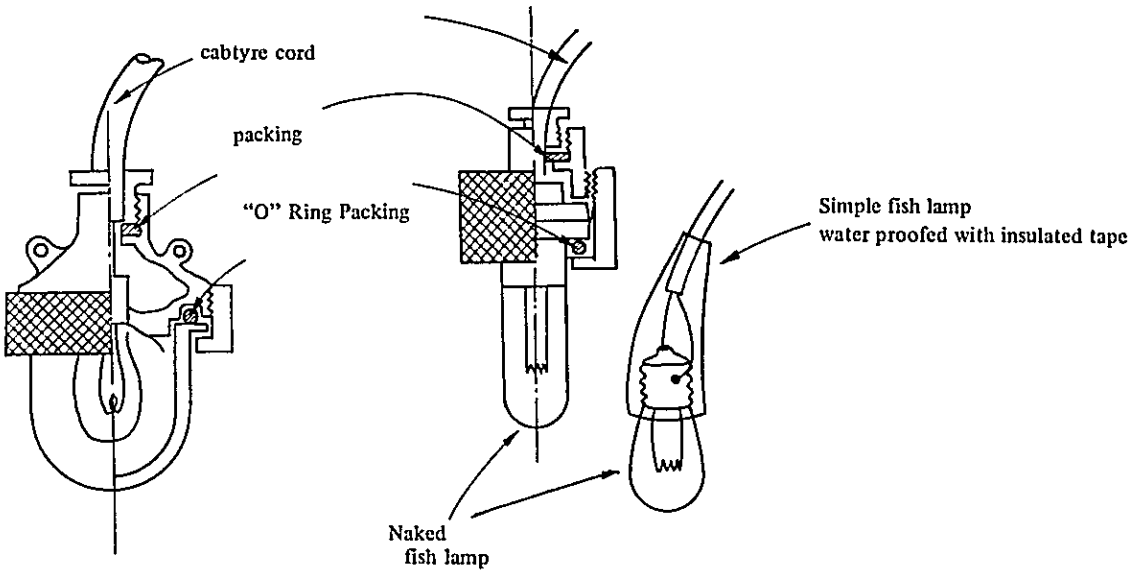
Fig. 2-2 Operation of Stick Held Dip Net



made of strong glass of para-shock and heat-proof. The brightness of fish lamps should also be changed according to the behavior of fish species to be caught.

The fish lamps lit in the sea water are used for the purpose of making fish swim up when they swim in comparatively deep area, while those lit above the sea surface are used for gathering fish dispersed in a wide range. (see fig.2-3)

Fig. 2-3 Fish Lamp



When dynamo is driven directly by the main engine of the boat, meanwhile, voltage fluctuates all the time due to the change of revolutions of the main engine. To eliminate this unfavourable fluctuations of voltage, it is recommended to equip batteries on the boat; fish lamp will be lit with the batteries which are to be charged with by dynamo.

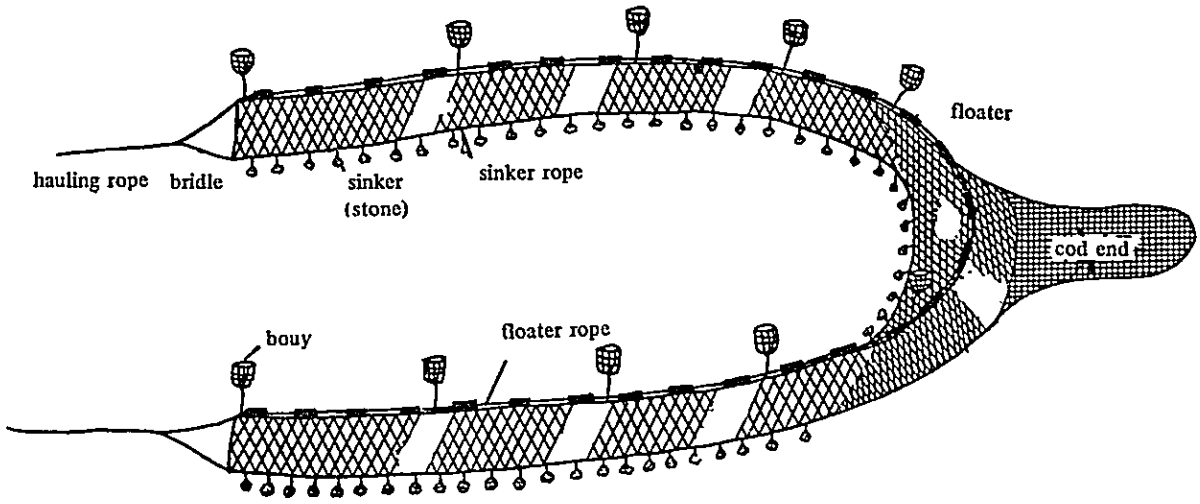
2-1-2 Small boat seine

The small boat seines are used to catch sardines, anchovy, macherels, jackmackerels, sea breams, squids, shrimps and so on in the coastal waters of 20 - 30m deep.

A. Structure of fishing gear

The fishing gear and the sketches of the net including cod-end, both wing-nets and hawling rope are shown in Fig. 2-4

Fig. 2-4 Sardine Boat Seine



B. Operation

The simplest method of operation is as follows:

1) The anckor connected with end of hauling rope is thrown in the sea. The position of ankor is marked by a floating buoy jointed to the hauling rope with a line.

2) The boat moves ahead while stretching the rope.

3) The boat returns to the anckor point after the net was set.

4) Then, the rope is hauled in.

The small boat sein is to be set in the sea in a triangular form, which is shown Fig.2-4 The sinker sides of the boat seine net are placed close the bottom but not so much deeply as those of trawl nets catch the bottom muds and sands. A boat of 3-5 tons manned with 2 - 3 fishermen is recommended for this fishery.

2-1-3 Small trawl net

The small trawl nets are operated by the powered boat (smaller than 15 tons) to catch the demersal fish such as flatfish, sea-bream, crabs, shrips etc.

A. Structure of fishing gear

The trawl nets are used to catch the demersal fish while the boat seines are used for the catch of small size migratory fish.

Therefore, the mouth of the cod end of trawl net has longer width than its height (the width is to be 3 - 4 times as long as the height). For example, the operation of flat fish trawl net is described hereunder and its illustration is shown in Fig. 2-5.

B. Operation

The net setting is as follows:

1) The one end of the hauling rope with buoy is put into the sea.
2) The boat moves slowly while streching the rope.
3) The net is set into the sea.
4) The boat returns to the first buoy point.
5) The rope with buoy is hauled in on boad.

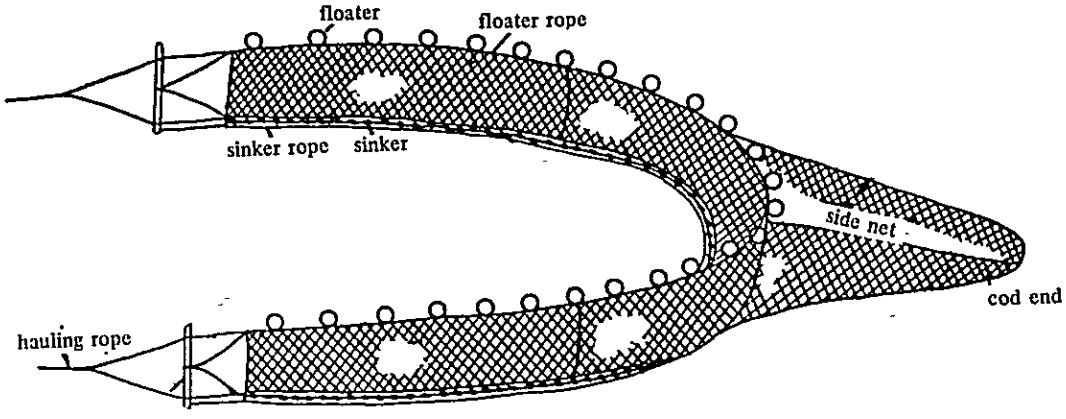
In this case, the boat should also sail in a triangular form, setting the net in the center of the base of right-angled triangle. After the net is set and sunk, it will be hauled slowly by powered boat. A sketch of the net hauling is shown in Fig. 2-5. The length of hauling rope is usually 3 times as long as the depth of the sea. Sometimes a bamboo or wooden pole is set at the mouth of the net to keep the net mouth open as shown in Fig. 2-6 (B). The hauling time is about 60 - 90 minutes.

The hauling method should be changed according to the fish species which should be caught and sea depth. For fishing, for example, it is suggested to make the cod end 8 - 12m long, and to attach a flapper to the square part or fix lead at the tip of hauling rope to prevent it from floating up.

2-1-4 Echo sounder

The small and portable type of echo sounder such as shown in Fig. 2-7 is recommended for the 5 - 10 ton fishing boat. As the echo sounder needs uniform velocity motor for recording, stable source of electricity is essential. Therefore, for small boats are recommended these echo sounders which use unit dry cells (9 - 12V in a line) or 12V small cell. For the recording range of echo sounder, 100m at its maximum may be enough; Rather recommended is such a echo

Fig. 2-5 Flat Fish Small Trawl



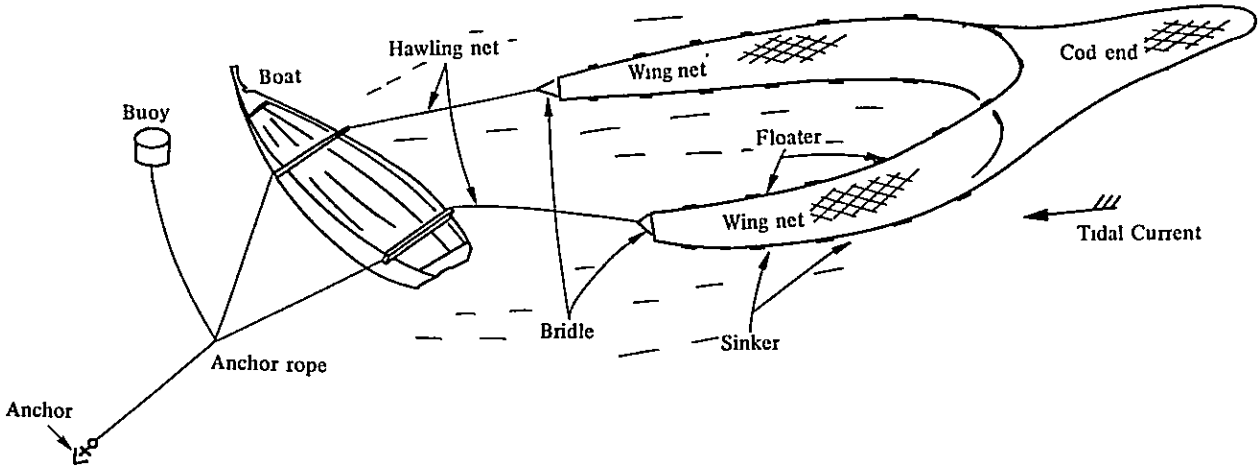


Fig. 2-6 Hauling of Small Trawl Net

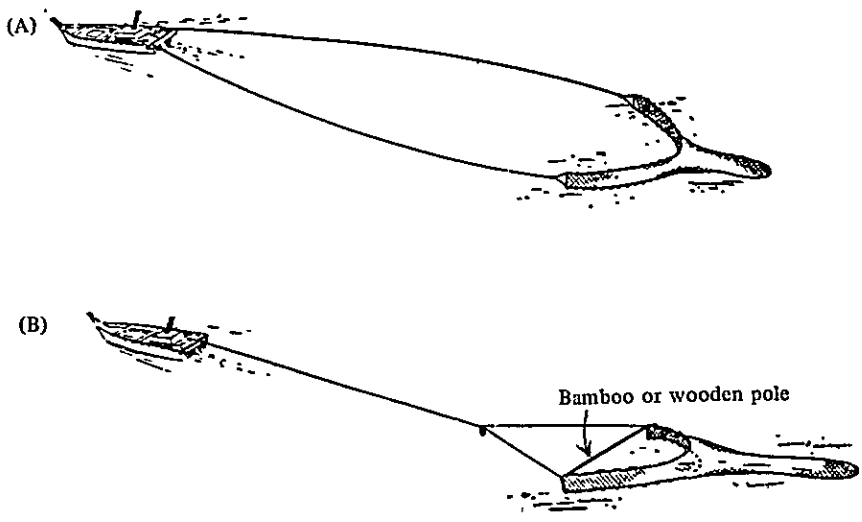
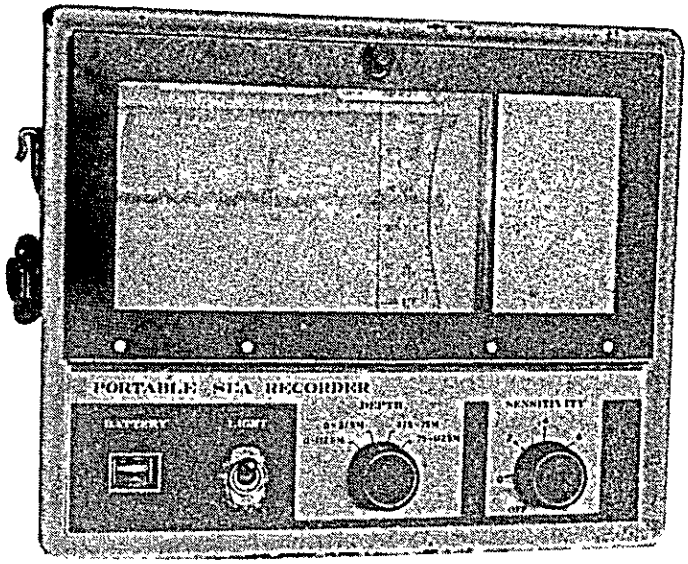
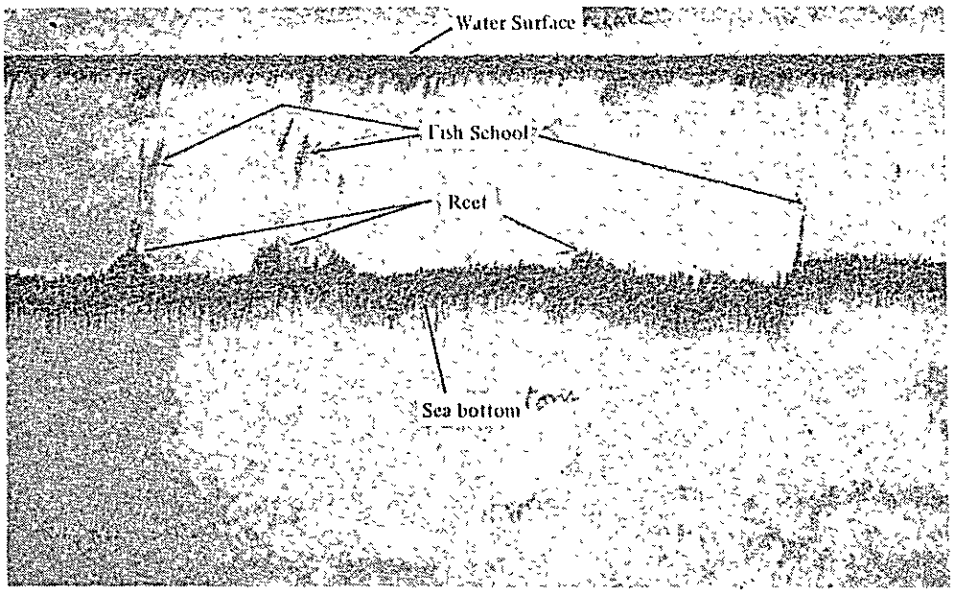


Fig. 2 - 7 Echo Sounder

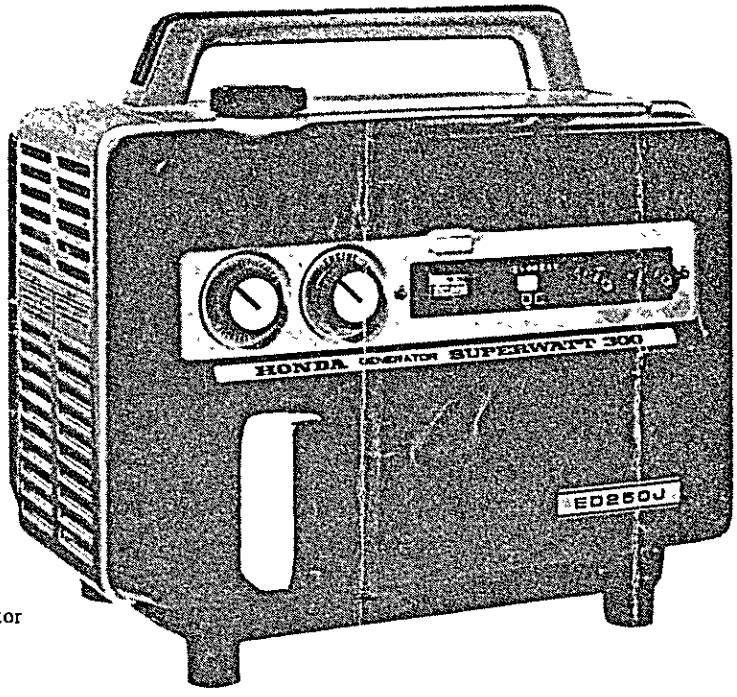


Echo Sounder (Portable type)



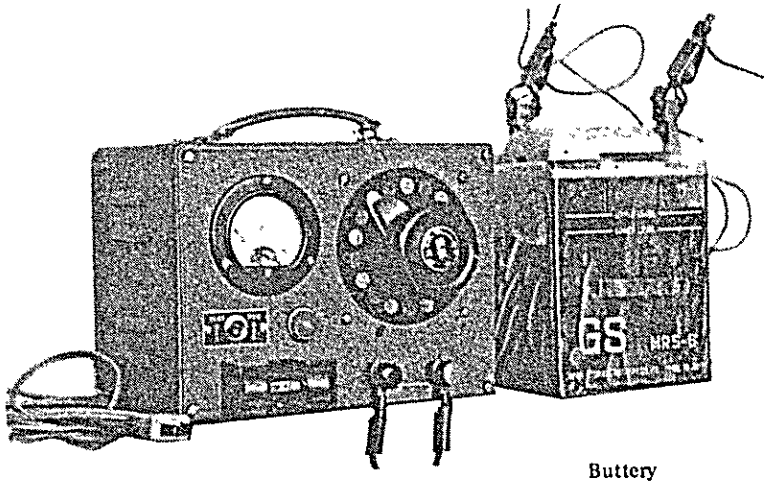
Details of Record

Fig. 2 - 8 Dynamo and Electric Charger



Gasoline Generator

Generator —(Buttery) — Echo Sounder



Buttery

Electric charger

A.C. 100V — Electric charger — Buttery — Echo sounder

sounder as to record clearly fish schools in comparatively shallow layers.

As the sources of electricity for echo sounder, battery or gasoline dynamo are recommended because dry cells cannot be used for a long time.

In selecting the electric source for the echo sounder, it should be ascertained beforehand whether alternative current or direct current is applicable and what the working voltage is. Otherwise, the echo sounder would be damaged.

2-2 Stocking of Fish

Although various projects are to be considered as procedures of developing the Cambodian coastal fisheries, one of the projects which seem to be technically feasible at present would be the stocking of fish.

In this country, the stocking of fish have been conducted on a grand scale in fresh water fisheries. Distribution of the fresh fish has been controlled reasonably by this procedure. In the case of coastal fisheries, however, very little has been conducted about the stocking of fish.

It seems to be evident that demand of sea fish would be increased since the fresh water fishing is prohibited from its operation in the season of monsoon. But productivity of sea fishing also decreases in this season.

Therefore, it is considered as a matter of course that the stocking of fish is profitable for distribution of sea products.

As techniques of the stocking of fish in the fresh water areas in this country has been already established, it is considered not too difficult to apply such techniques to the sea areas.

Fish preservers made of fishing nets are suitable for the stocking of fish, and these areas such as Ream Bay and the inlets of Koh Rong and Koh Rong Sam Lem may be fit for this purpose. The fish preservers would be built by attaching nets to wooden poles set at the sea bottom.

Coastal fish such as sea bass, red snapper, yellow spotted grunt and gray mullet would be suitable for the stocking of fish. In a word, high-class fish migrated in the coastal areas should be preserved in the fish preservers as a general rule.

Regarding the fish preserver, utmost attention should be paid on the in pouring flow of fresh water to this sea area. In this connection, inlet where the open sea water flows in continuously should be selected.

2-3 Cultivation of Useful Creature in the Coastal Area

The investigation in Cambodian coastal areas indicated that useful creatures would be fit for their cultivation. Brief descriptions on the cultivation of some species out of these creatures are given in the following.

2-3-1 Cultivation of oyster

During the investigation, colonies of living oysters were found all over the Cambodian coast and it was identified that they were small sized species which belong to the Jenus Saxostrea. But the survey team has collected several oysters which seemed to belong to Crassostraea in the coastal areas of Kdat and Koh Rong.

It is known generally that the oysters belong to Crassostraea are able to live in low salinity and muddy area. Since the oyster of this genus grows faster and bigger than Saxostrea's one it may be suitable for the culture.

Method of cultivation:

In every country, the cultivation of oyster has been operated by methods met to various natural and artificial conditions of its own. Therefore, it is impossible to decide at present what method should be applied to the Cambodian coastal areas. Accordingly, several methods which have been operated commonly in Japan will be mainly described in the following:

A. Conditions of selecting cultivating ground

Since conditions which the cultivation ground must possess depend on the methods adapted, suitable ground for seed sowing method, spore collecting method and shell hanging method should be selected individually.

In any case, it is basically neccessary that the ground has always calm conditions with fresh water flowing in.

The optimum specific gravity of sea water is approximately 1,020 although the oysters would be able to live in a range from 1,005 to 1,025. Also it is required that planktons which are fed by the oysters propagate themselves in such ground.

Judging from our investigations on the plankton and the natures of sea water in the Cambodian coastal areas, Kdat area would be suitable to the cultivating ground.

B. Method of spat collection

Since Crassostrea gigas begins its spawning in the waters over 23°- 24°C in Japan, the spawning season would occur in the period from May to June in warmer districts. The sea water temperature ranges from 15.8° to 32.0°C in Formosa but it is said that the spats of Crassostrea

gigas attached to something else can be found all the year round.

For security of spats, it is important to decide where the spat collector should be settled in the spat attaching season. For this purpose, the commencement of spawning of oysters and occurrence of their spats should be observed carefully. The spawning and development of Crassostrea gigas are summarized as follows:

(1) Spawning

The commencement and term of spawning season depend upon water temperatures and localities.

In Ariake Bay of Japan, Crassostrea gigas spawns in the period from the beginning of May to the beginning of November, having 4 spawning peaks in that period while Crassostrea rivularis spawns from the end of May to the beginning of September, having 3 spawning peaks in that period.

Besides, Crassostrea gigas spawns during a whole year in Formosa. Galtsoff studied in detail the spawning and sperm discharging of oysters. He described that there was not such a limiting water temparature as to have long been believed, e.g., oyster would never spawn if water temparature should not rise up to the aforementioned limiting water temparature. Also he presented that the egg and sperm discharging may occur comparatively at a short interval of time when water temperature becomes higher abruptly as from 20 to 34° - 35° C. At the time of spawning, he also presented that, the female oyster continue opening and closing movements of their shells to discharge the eggs into the sea water, and sometimes it may take about one hour.

However, the male, different from the female, never make the same movements to discharge their sperms. Galtsoff further presented that the occurence of egg-spawning would require 16.2 minutes (in the mean) if the female oysters were put in 30 litre sea water where 0.03 - 0.02cc of the solution (1 gr. of testis tissues was diluted with 100cc sea water) were added. But, by adding the above-mentioned diluted sperm-solution, some species of oysters may spawn while others may not.

To induce the sperm ejection of oyster, egg-comprising solution of Genus Crassostrea, Pationpecten yessoensis, and star-fish or some chemicals are effective.

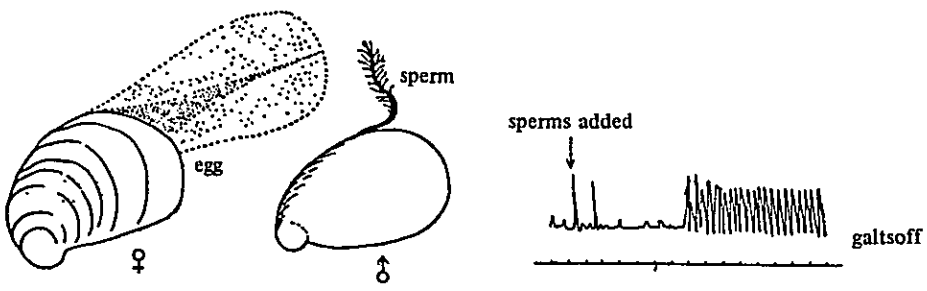


Fig. 2-9 Egg-and Sperm-Discharge of Oysters and the Open-and Close-Movements of Shells at Spawning (Nelson)

By Goltsoff's studies, one female of American oysters spawned about 114.8 million of eggs in 4-118 minutes while Crassostrea gigas did about 55.8 million of eggs in 15-130 minutes.

Ostrea edulis of 1 age spawned 100 thousands of eggs in a time while that of 3 age did 720 thousands of eggs in a time (Danton).

For the induction of spawning, Elsay tried to pour the oyster sperms on Crassostrea gigas placed on the raft floating on the water-surface and make it sink to the bottom as soon as it (Crassostrea gigas) began to exhibit spawning reaction.

This means that the gonads of the sunken oysters may stimulate the spawning of the neighboring oysters on the bottom.

Seki raise the temperature (9°C) of the sea water in which various species of oysters were kept in winter (Feb. - Mar.) up to 30°C and kept them in such circumstances for 17 days, and then lowered the water temperature gradually to 16°C. By those measures, all of Ostrea denselamellosa and Crassostrea gigas of Hiroshima got the ripe gonads whereas some of Crassostrea gigas of Sendai did not get the ripe gonads.

(2) Development and attaching of spats.

(a) Development

The artificial fertilization of Crassostrea gigas is very easy:

1) The ripe eggs from the female are put in a glass schale.
2) The sperms from the male are poured on them.
3) The eggs and sperms are mixed well with pipette.
4) The clean waters (of 1.014 - 1.016 specific gravity) are added, then decanted. This measure should be repeated several times.

Thus the remained sperms are eliminated and the fertilized eggs begin to take cleavage in no time.

The diameter of the eggs and the size of the sperms vary by each species as shown in Table 2-1 and the diameter of the eggs of oviparous species is smaller than that of larviparous species.

Table 2-1 Size of the Eggs and Sperms

Species	egg diameter (μ)	Sperm (head+tail) (μ)
Crassostrea gigas	50	27 (total length)
C. commercialis	50	2 + 42
C. angulata	52	– –
C. spinosa	50	– –
C. virginica	50	1.75 - 2.5 + 3.5 - 50
Ostrea edulis	122	1 - 2 + 20 - 30
O. lurida	105	– –
O. denselamellosa	105	– –

The processes of developments also vary by species or by the water temperature as shown in Table 2-2.

Seo and his colleagues studied on the development of the eggs of Crassostrea gigas. They presented that 90% of hatching rate was obtained with the condition of 23° - 26° C water temperature and that the waters of 1.017 - 1.021 specific gravity are suitable for the growth of the spats.

The morphological changes by the advance of developments are as shown in Fig. 2-10.

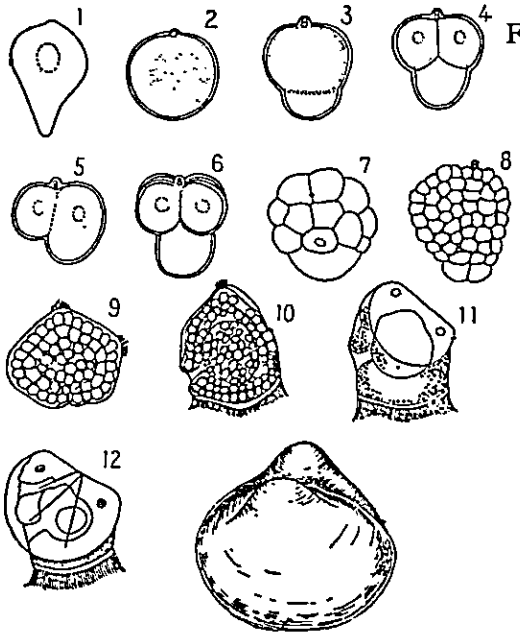


Fig. 2-10 Developments of Crassostrea gigas (Afer Takatsuki)

1. unfertilized egg
2. fertilized egg (the 1st polar body delivered)
3. delivery of the 2nd polar body
4. the 1st cleavage
5. completion of the 1st cleavage
6. the 2nd cleavage
7. completion of the 4th cleavage
8. morula stage
9. gastula stage
10. veliger larvae
11. shell formation
12. D stage larvae
13. larvae just before setting

1) The eggs become spherical as soon as they are fertilized

2) The nuclear disappears.

3) The 1st polar body then the 2nd polar body appear and the 1st cleavage takes place.

4) Trefoil stage (Fig. 2-10-4) can be observed before the completion of the 2nd cleavage but this is the rare phenomenon in case of the developments of shell fish.

5) The cleavages advance to Morula stage then to Blastula stage when the cilia appear on the outer surface and the rotating movements take place.

6) The developments proceed to Gastula stage with Invagination.

7) Through Trochophora stage Vellum on the swimming organ develop well.

8) The origin of the shell appears and comes to Veliger larva stage.

9) The shell develops into D stage larva covering the body.

10) Then the shell develops into uneven in the right and left. The left shell shows protrusive development and comes to Umbo stage. The foot is observed when the shell length develops into 0.2mm in case of Crassostrea gigas.

11) Vellum shrinks concurrently with the appearance of the foot. The foot is used to crawl about. The lime substances are secreted when the suitable object is found.

12) Then the attaching life begins.

Table 2-2 Process of Oyster Development

Phases of development	C. gigas (Amemiya) (25° C)	American oyster (18 - 21.5° C)	Portuguese oyster (20 - 23.5° C)
Appearance of the 1st polar body	50 - 60 min.	40 - 50 min.	40 - 50 min.
Appearance of the 2nd polar body	70 min.	45 - 60 min.	45 - 60 min.
The 1st cleavage	100 min.	75 - 90 min.	70 - 80 min.
The 2nd cleavage	2 hrs.	80 - 120 min.	80 - 90 min.
Blastula stage	6 hrs.	– –	– –
Swimming stage	8 hrs.	8 hrs.	8 hrs.
Appearance of shell	24 hrs.	52 hrs.	24 hrs.
Shell covers body	48 hrs.	– –	– –

(b) Attaching of Spat

The larva begins to take planktonic life several hours after the eggs of oysters are discharged into the sea and fertilized by sperms of the male.

The larva lives planktonic life until it attaches to something else.

It is important, from the view of the culture techniques, to clarify the conditions in which the larvae of attaching stage begin attaching. Because that is directly connected with spat collecting operations.

Of course, the development and growth in every stage may be influenced by both of the oceanographic and food conditions. So, whether successful spat collection is carried out largely depends on the oceanographic conditions.

It is necessary to know the time elapsed and the size of shell at the time when the larvae reach at attaching stage.

The shell size varies with species as shown in Table 2-3.

Table 2-3 Size of Oyster Spats at the Attaching

Species	Shell length (μ)	Remarks	Time elaprsed before attaching
Cryphaea gigas	380	Oviparous	about 20 days
C. virginica	386	Oviparous	14 - 16 days (21 - 23° C)
C. commercialis	330	Oviparous	– –
Ostrea eduils	270	Viviparous	15 - 28 days
O. lurida	255	Viviparous	– –
O. denselamellosa	380	Viviparous	about 28 days

The shell size at the attaching stage of Crassostrea gigas of Japan is about 0.3mm. In practical use, the time when the larvae being near the attaching stage are collected in a mass by plankton net is considered as the suitable period for the settling of spat collector.

In this connection all the Prefectural Marine Experimental Stations of Japan inform the oyster culturists when the larvae nearing the attaching stage are collected in a mass by plankton net with the view of collecting sufficient spats without fail.

Studies carried out so far on the oceanographic conditions of the transfer of the larvae to the attaching life, indicated that 20‰ clorinity was suitable for the attaching of American oysters (Hopkins) or 15 - 25‰ clorinity was suitable (Prytherch).

Furthermore, Prytherch studied how the Cations and Anions in the sea water influenced the attaching of oyster larvae, and found that only the copper ion stimulated the attaching of oyster larvae (0.05 - 0.60mg. per litre of the sea water are suitable and essential for the attaching of oyster larvae).

In the next place, the depth of the attaching is also an important factor for the spat collection; the vertical distribution of larvae or their reaction to the light are related to the depth.

Prytherch put the oyster larvae in a glass bowl of 9 inch deep and observed how the larvae attached to it. He found that 15.3% out of all oyster larvae attached to the bottoms, the attaching became gradually less in number to the upper zone, 72.81% out of all oyster larvae attached to the zone between the bottom and 3 inches high from the bottom, and only 6.87% to the upper zone of 6 - 9 inches high from the bottom.

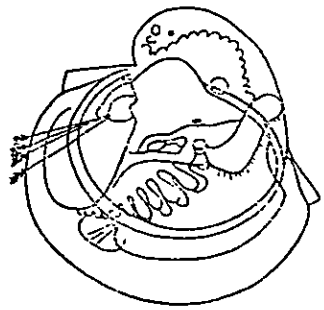


Fig. 2-11 20 Hours after the Attaching of Crassostrea Larva

Besides, the rearing of oysters transfered from Kumamoto, Japan, were carried out in the Shellfish Laboratory, North Bay, Washington, U.S.A. The results are shown in Table 2-4. At the time of its transfer, the shell size of Crassostrea gigas of Kumamoto was 15mm high and that of Crassostrea rivularis was 20mm high. After one year of rearing, Crassostrea gigas of Kumamoto grew up to a little smaller size than that of 3 years' Olympia oyster and became very similar to Olympia oyster in shape. After 3 years of rearing, Crassostrea rivularis grew up to a much larger size than that of 6 - 7 years' Eastern oyster.

Therefore, Crassostrea rivularis became to be famous among the U.S. culturists.

Table 2-4 Comparative Experiments of Various Species (comprising C. gigas in Kumamoto) in the Pacific Coast of U.S.A. (Ota)

Species	Culture period	Number of oyster examined	Shell height	Shell length	Shell width	Shell weight	Shell length / Shell height	Shell width / Shell height
Cr. gigas	1 year	6	38.7mm	28.0mm	11.2mm	5.7g	0.750	0.275
Cr. rivularis	3	2	146.0	71.0	37.0	124.0	0.485	0.255
Olympia oyster O. lurida	3	4	46.3	35.5	9.3	5.4	0.723	0.208
Eastern oyster Cr. virginica	6 - 7	2	70.0	47.5	26.0	42.8	0.695	0.370

Crassostrea echinata (Quoy et Gaimard)

This species is not important commercially.

In the time of spat collection, however, it is important to know what spats belong to the important species. It is necessary, therefore, to elucidate characteristics of Crassostrea echinata.

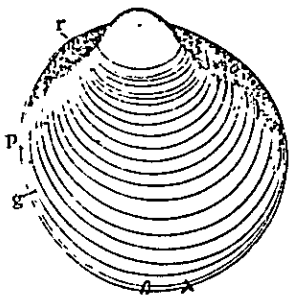


Fig. 2-12 Full Grown Larva of C. echinata

Shell length: 0.335mm
r. : ridge
p. : posterior
g. : growth line

The swollen features of hinge apparatus and umbo of Crassostrea echinata are alike to those of C. gigas, C. rivularis, and American oyster.

There are 2 - 3 rectangular teeth near the slender ligament, of which the posterior teeth are rather degenerated.

The texture of shell surface of C. echinata is not of fine growth rings which are observed from C. gigas and C. rivularis.

Particularly, the shapes of full grown larvae become, as that of Cyamus erraticus, oval and are elongated toward dorsal and ventral sides.

Length of the right shell is larger than its height. Also there is no swelling in the anterior or anterior-ventral parts. There are the hollows on the post-dorsal margin of the larvae of this species which are also observed in the oyster larva belonging to Genus Crassostrea and Genus Ostrea.

C. Attaching apparatus and spat collector

The kinds of the attaching apparatus and spat collector vary with the method applied. In the stick method, poles of bamboo or wood with twigs (mainly bamboo) are used. Two or three bamboo poles of 1 - 2m long are bundled into a stock and sticked into the sea bottom (about 30cm deep).

In the spat collecting method by shell hanging, a wire is passed through the pores of shells (oyster or others) and the shells are folded. The folded shells are set in the sea vertically or horizontally.

In Formosa, the split bamboo of 40cm long with 2 - 3 oyster shells are sticked into the bottom of shallows. Thus the spats attach to them and are left grown in these circumstances.

In France, the tiles which is coated with lime and folded in wooden frame, or other materials including stones, bricks, earthern pipes are used for spat collecting.

In case of the shell hanging method, the spat collecting shelves, from which the shell hanging apparatus is hung, are constructed in the sea. The spats attached to the apparatus grow to the size of seasame seeds in several days, to 5 - 10mm in 2 - 3 months and 30 - 50mm in 4 - 5 months.

D. Culture method

(1) Seed sowing method

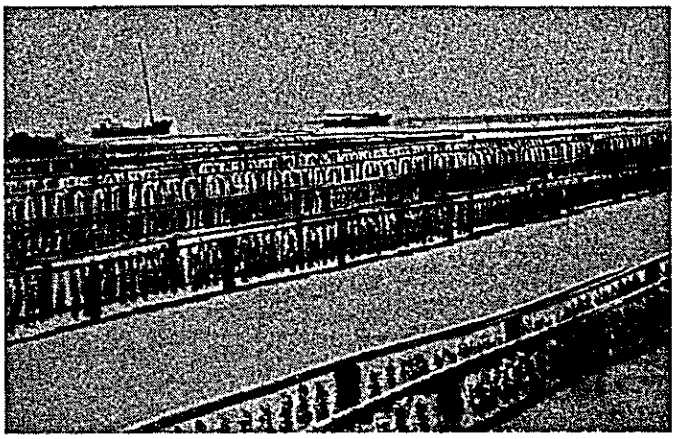
The oyster spats attached to the collector such as those of bamboo, bricks and stones, are sown on the sandy or sandy-gravel sea bottom.

As to the culture grounds, it is necessary to select such sea areas as to appear in the air or to have the depth of 2 - 3m in the low tide level, where the spats are never covered with muds or carried away by waves or tidal currents.

This method is adopted generally all over the world. In Hiroshima, the torn-off-spats from bamboo sticks are cultured by this method. By this method the growth of oysters is comparatively slow and it takes 2 - 3 years until they reach the commercial sized ones.

A lot of oysters are reared up by the seed sowing method in U.S.A. For harvesting shells, they are sucked up together with sea waters on the boat by the centrifugal pumps on the boat. Otherwise, the large dredges are employed to collect grown-up shells.

Fig. 2-13 Spat Collecting



Spat-collecting Shelves

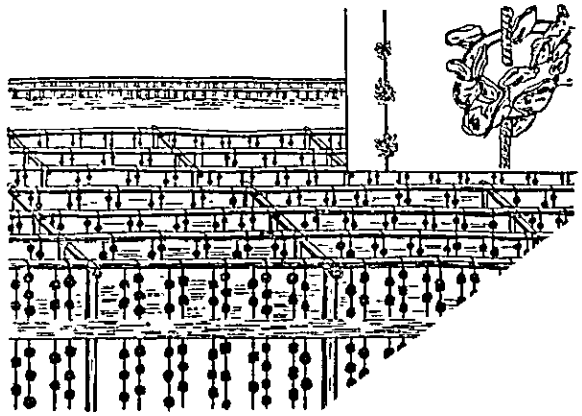
Spat-collector

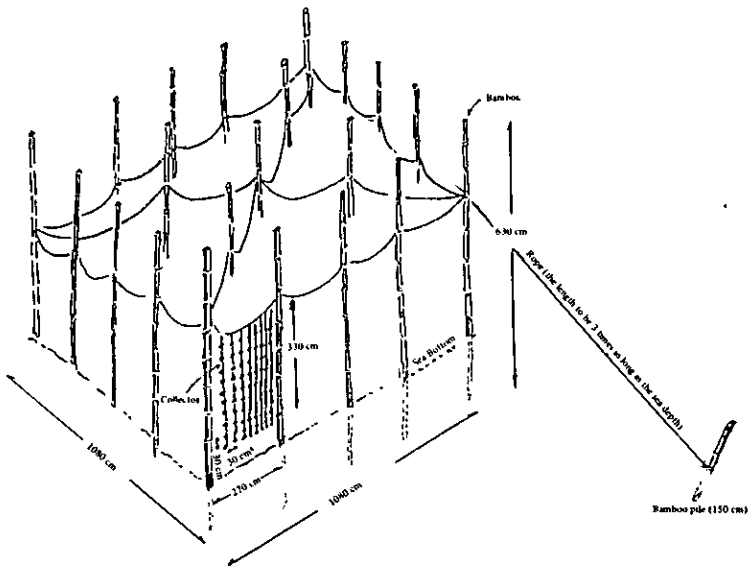
Distant View of Spat-collecting Shelves

Fig. 2 - 14 OYSTER CULTURE Shell Hanging Method (1)

Shell hanging method:

Hanging method of simple type: Oyster seeds attached to shells or pipes are hung about 20 to 25cm apart from the bars made of cedar or pine wood, 2—3m in height, at a depth of 2 to 4m below the low tide level by fastening them with steel wires or tanned straw ropes.



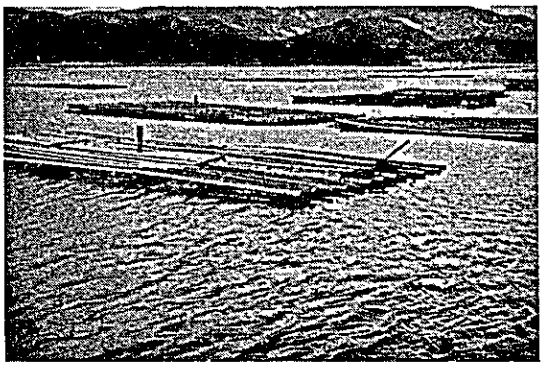


Other simple type

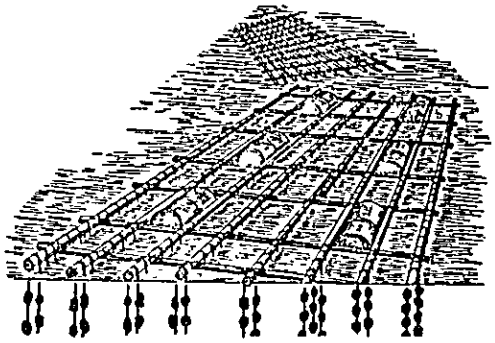
Harvested oysters

Fig. 2 - 15 OYSTER CULTURE Shell Hanging Method (2)

Method of hanging from rafts: This culture method is adopted in waters more than 4 meters deep below the low tide level. About 150 wires or ropes of seed oysters are hung from the raft of about 5m × 10m. Empty drums and anchores are fastened to the raft to stabilize the buoyancy.

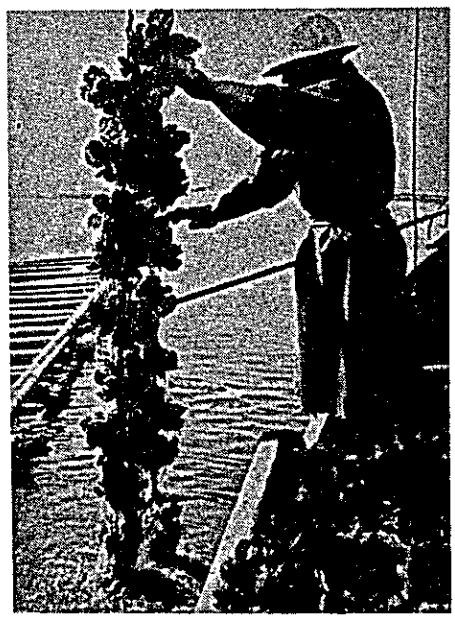


Distant view



Sketch of the method

Harvest of the undergrown oysters



Harvest of the full-grown oysters pulled up by means of crane

(2) Shell hanging method with raft

This method is adopted in the inlets where the sea depths are over 4m at low tide level and influences of winds and waves are little.

The size of raft is usually 5.5 x 9.0m or 4.5 x 9.0m square made of wooden logs under which 6 - 9 of wooden barrels or iron drums are fixed as floaters. The raft is fixed with an anchor. At interval of 30 - 40cm, the hanging shells are suspended from the wooden log. No. 12 wire is pierced into the pores of shells with spats then bamboo tube of about 15cm is connected, and same processes are repeated.

Thus about 20 of shells with spats are tied up with a wire. This bundle is called as one "ren" in Japanese. In these days, the straw threads coated with coal-tar take the place of the wires.

Quantity of the shells in one "ren" and its length vary according to the depth of each culture ground.

Number of "ren" to be hung is also different due to the size of raft.

(3) Hanging method of simple type

This method (pile method in other name) is adopted to the sea waters where the depths are 2-4m in low tide level, and winds and waves have little influence. About 2m long poles are inserted vertically at 1.5m interval into the bottom, on which the horizontal bars are set in the height of about 30cm above low tide level. The hanging shells are suspended from the bars. The lengths of the hanging bars vary with the sea depths.

About 20 "ren" of hanging shells are suitable in the area of $3.3m^2$.

The product per one "ren" (1.5m long and 6 - 7 shells with spats) is 12 - 15kg, being about 1 litre in raw flesh (without shells).

(4) Hanging method with rope

Two rows of straw ropes (or manila ropes) coated with coal-tar are set in parallel on the sea surface in stead of the raft. Wooden barrels connect two ropes and float in between as buoys. The both ends of the two ropes are fixed. From the ropes, the hanging shells are suspended. This method saves much materials and is also free from the influences of winds and waves. But this method is under a patent.

In this hanging methods, the spats of spring grow rapidly and the fat oysters can be gained in winter season of the year (November to March).

(5) Oyster culture methods in Formosa

In Formosa, the oysters spawn and the spats attach throughout the year as the water temperature is high. In winter, the spat collection is carried out with such materials as the split bamboo with shells attached, stones, shells. They are harvested during July - December. As oysters grow up to adults in 5 months, they can be harvested in a year. If the spat collector is set in winter season, the damages by Cyamus erraticus may be little.

E. The growth

At the time of attaching, the size of oysters is about 0.3mm and they grow so much rapidly as Crassostrea gigas is said to grow in 0.47mm every day during the first several days. The attaching spats are abundant in number at the first time but decrease in number with the lapse of time owing to the death of spats. It is said that the survival rate is 20 - 28% in a day and 13 - 14% in two days. With seed sowing method, the growth is so slow as to take 2 - 3 years for sale. While the growth is very rapid with hanging method, of which the main reason may be ascribed to the enough supply of prey-planktons. Consequently, the growth of oysters vary according to their circumstances or their individual variations.

It grows to 7cm in shell height and about 60g in weight in a year, 9 - 10cm in shell height and 90 - 140g in weight in two years, and thereafter it does not grow so much.

Besides, the size of some oysters in Lake Saroma (which seem to be over 30 years of age) is over 5cm in its shell thickness, over 30cm in shell height, and 1.5kg in weight. The growths of Crassostrea nippona and Crassostrea gigas with hanging method are shown in Table 2-5 and 2-6. It is clear that Crassostrea nippona, which seems to be slow in growth, grows rather rapidly with hanging method.

Table 2-5 Growth of Crassostrea gigas
(in Lake Saroma in Hokkaido) (Kinoshita)

Date	6.0	6.26	7.10	7.25	8.14	9.15	10.4	11.14
Shell length (cm)	3.0	3.5	3.7	4.4	5.8	7.0	8.6	9.6

Table 2-6 Growth of Crassostrea nippona
(in the Seto Inland Sea) (Tanaka)

Month	3	6	8	10	11
Shell height (cm)	28	41	55	69	81
Shell weight (g)	39	47	67	81	107

In Lake Saroma, it was reported that, 360 "ren" of hanging shells were hung under one raft (13.5 x 6.0m) and 900kg raw flesh (without shell) were harvested.

Foods and Feeding methods:

To elucidate the food for oysters, many investigators examined contents in the digestive organs and found lots of broken organic matters and planktons, particularly diatoms.

Besides, protozoan, copepods, lamellibranchian larva, and other organic matters are found in the digestive organs of oysters.

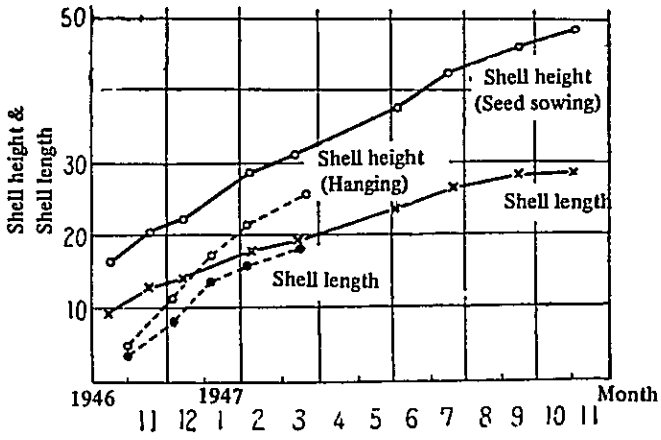


Fig. 2-16 Growth Speed of Oysters in Ariake Bay

(Ikematsu)

As the diatoms are very abundant both in quantities and in the number of species, they may naturally be said to be fed by oysters in a mass.

But in one hand, the shells of diatoms are not digested in oyster digestive tracts. So many remains of diatom shells are found when examined undera microscope. Also, many investigators observed how the oysters fed.

The oysters take in the sea water comprising fine planktons and broken organic matters into their mantle cavity with ciliary movements.

In mantle cavity, those foods are carried to lavial palp, then at last to mouth with the ciliary movements on the surface of gill.

At that time, it is said that the large or heavy foods are rejected to pass the mouth. In this case, the cilia on the surface of gill play the most important role to take in foods. Galtsoff measured the quantity of water passing through the gill of one oyster, and found the quantity unexpectedly large although it depends on the water temparature.

The potency to move the water is most powerful in 18° - 30° C. It is understood that the feeding ability of oysters and their growth in natural culture grounds are variable with the temperature of the circumstances or the quantity of planktons.

There are some physiological studies on the ciliary movements of gill epidermis.

As to the temperature, it is said that Crassostrea gigas has the most vivid ciliary movements at 30°C, and that the movements are stopped at 40°C and are very feeble at 12°C.

Table 2-7 Quantity of Water passing through the Gills of a Oyster (Galtsoff)

Temparature C°	Quantity of water per hour (l)
5.8	0
7.2	0.29
10.4	0.39
15.6	0.41
19.5	0.95
25.5	1.05
29.4	1.22

The above-mentioned facts are considered to be the foundamental knowledges of oyster culture.

If it is planned in Cambodia to culture oysters, it should be, first of all, tried to collect spats of the natural oysters in Cambodia and to culture them experimentally.

Another measure is to culture those spats which attached to the roots of mangroves with hanging method or with seed sowing method.

Also, it is necessary to carry out an experimental spat collection with window-shells. The above-mentioned measures should be taken in Cambodia in order to get the foundamental data about oyster developments and growths as well as to select the suitable grounds for oyster culture and spat collection (including collection of data on the fresh water floods in monsoon season).

Through the above-mentioned measures, Cambodian method of oyster culture techniques may be exploited.

After the natural oysters have been studied, in the next place, the foreign oyster spats of rapid growth and large size should be imported thus the improvements of oyster-races would be considerably promoted.

2-3-2 Propagation of prawn

The Cambodian prawn fishery has been operated mostly in shallow waters at a depth of 5 - 7m, especially beach seines and simple dip nets have caught the prawns in waters of 1m deep at most.

These prawns which have been caught in such waters were mainly Penaeus sp. and Metapenaeus sp.

Above all, the prawns such as P. monodon and M. monoceros would be promising species for the cultivation.

The prawns collected in this survey period were almost immature or young individuals. If they were preserved in the stocking pond and distributed successively after their first spawnings were finished at least, they could be connected not only to their reproduction but also the increased yields due to the weight increase of themselves.

Since the water temperature indicates high degree all the year round in the Cambodian coastal areas, it is highly probable that the prawns make their spawnings almost all the year round except the certain period of intensive spawnings. From the facts that the young prawns of M. monoceros which were caught by the small trawl fishing test conducted in the coastal area from Kampot through New Kep and by local fishermen off Kudat, were composed of two groups made up of large prawns group and small ones group, the survey team came to a recognition that the prawns' spawning season would be a considerable long term.

In Japan, P. japonicus' spawning season takes similarly such a long term as from April to September, and its concentration occurs mostly from June through August when the water temperature rises highly with some regional exceptions. Such intensive spawning season must be also observed in the Cambodian coastal waters. It is necessary, therefore, to establish measures for restriction or prohibition of the prawn fishing in this period concurrently with promotion of the cultivation of prawns.

While the cultivation or propagation of P. japonicus has been operated, there is a plan which contemplates to improve a vast sea area into a large abundant fishing ground of the prawns in Japan. Since 1964, artificial breeding of the prawns has been performed, a large number of the young prawns have been released in the sea area. Results of the above mentioned artificial breeding meet with considerable success. In the future the releasing quantity will be increased more and more and a vast sea area will be turned into a large oceanic farm finally.

Cambodia has broad shallow coastal areas which possess several conditions fit for living of the prawns. The trend of demand for the sea fishery products is going up gradually in this country, and it may be an important subject in establishing a permanent policy for promotion of the Cambodian coastal fishery that such a plan as the above project is to be realized together with development of the cultivation of prawn in the future.

The large sized prawns belong to Metapenaeus and Penaeus have been caught by the beach seines and the simple dip net in Kompong Som Bay as well as in other coastal areas. However, the survey team could not find adult individuals out of the samples collected probablly because they were all harvested in the shallow areas.

As matured individuals with egg were found among other crustacea such as crabs (Portunus pelagicus and Scylla serrata) and fresh water prawns during the survey, it is apparent that the matured prawns belong to Penaeus and Metapenaeus must inhabit areas outside of the existing fishing grounds. From the fact that very many larva were found among the planktons collected during the oceanographic survey, the above mentioned view could be understood easily.

It is undesirable, from the standpoint of preservation of stocks, that the present catch of prawns is mainly composed of the young individuals. Therefore the prawns of full one year old or more which already experienced their first spawning at least should be caught.

From the fact that two groups of young prawn of M. monoceros have been caught by the small trawl and the beach seine off New Kep, Kampot and Kdat, it may be suggested that the large scale spawning would be performed twice during the period from March to May.

It is also presumed that the other prawns belong to Penaeus would take their spawning approximately all the year round and the concentration would occur in the period from April to August. Therefore, it might be necessary to take up measures for the preservation of stocks although further ecological research could crarify these problems in the future.

From the fact that the life span of Peuaeus japonicas sp. caught in Japan is 2 - 3 years and their fishing grounds exist on such deep areas as 40 - 100m below sea level, it is presumed that the fishing grounds of groups of large sized Penaeus sp. and Metapenaeus sp. might exist in a certain sea area which has not been used so far. Above all, it is considered necessary to promote the development of new fishing grounds which would exist in the deep sea area in Cambodia.

2-3-3 Propagation of crab

Portunus pelagicus is also one of the important aquatic resources as well as shrimps in Japan.

Crabs spawn usually the less numbers of eggs in comparison with Penaeus sp. and Metapenaeus sp. The spawned eggs generate and grow while being embraced by their mother crabs, and they leave their mothers as soon as they hatch out, when they begin to look for bait at once.

Portunus pelagicus grows to the adult in 5 months and spawns in a year. While its survival rate during growth is not so good enough.

Its spawning season in Japan is during the period of high water temparature between April and September, with its peak at the period between April and June.

Portunus pelagicus stops to take foods and hibernate during winter season. If it is kept in warm circumstances during winter season, it may be possible to have it spawn and to have the spawned eggs hatch out even in December and January.

Judging from the above-mentioned facts, it is suggested that in the warm waters all round a year, it may grow earlier and spawn in 6 - 8 months, with its spawning season ranging all the year round and its spawning peak taking place during a considerably short period.

During the survey, the team often found the egg-holding individuals or the corpulated ones. Near Kampot, the team observed that the individuals before the 8th moulting stage and

the ones after the 14'th moulting stage (Portunus pelagicus becomes adult and corpulate after the 14'th moulting stage) were mixed in the catch.

Judging from these facts, it is suggested that at least 2 spawnings, the one after April and the other after November, might have taken place in a short period.

The features of Scylla serrata are similar to those of Portunus pelagicus. Scylla serrata may spawn in a suitable but short period, some of them spawning all a year round.

While in the blakish waters, its spawning season may be changed largely due to the conditions of floods in the rainy season.

It has been said by the people of Koh Kapik area that the size of Scylla serrata has become smaller, and its catch has decreased in these days. Those facts indicate clearly that the groups of 2 - 3 years' Scylla serrata have decreased in number.

Generally speaking, the facters at the time of fish and shellfish development (hatch-out and growth) may be changed and their quantities may fluctuate conspicuously depending upon the conditions of the natural circumstances.

Besides, it is clear that the artificial overfishing also deminish their sizes as well as their catches. It may, therefore, be advisable to protect their resources at an early date. Especially, it is easy to carry out any protecting and rearing measure to those fish species as Scylla serrata which live in a mass in the blakish waters. If any protection or rearing were carried out, it may immediately give favourable effects on its catch.

For the protection and propagation of Scylla serrata should be elucidated its life history, most of which have been remained for future studies.

For the time being, it is necessary to prohibit the fishing and sale of the egg-holding adults, to prohibit the fishing during its spawning season, or to prohibit the fishing of the small individuals.

Above all, closed fishing grounds where fishing is entirely prohibited should be settled, in the nearest possible future, in the proper sea areas as one of the suitable measures to protect fish resources.

2-4 Arrangement of Fishing Ports and Related Facilities.

2-4-1 Arrangement of fishing ports

Most of the fishing villages are located inside the mouths of rivers, with only a few directly facing the open sea. This is because outfall areas are considered safer mooring sites for fishing boat; however, it is difficult for large fishing boats of deep draught to frequent such areas.

Though large fishing boats are required for all means of offshore and deep-sea fisheries,

development of fisheries is impossible if fishing boats' going in and out of the fishing ports are influenced by heavy seas or ebb and flow consequently large fishing boats cannot be utilized.

The Cambodian Government is aiming at securing the supply of sea fish meat for the period that fresh-water fishing is prohibitated; however, this period is during the monsoon season, fishing bases (fishing villages) on the continent side are hardly utilized and advanced fishing bases on islands of the Koh Kong district are utilized.

With such fishing bases far from consumer areas, fishing products during the monsoon season cannot be smoothly and immediately transfered to consumer areas; this is the main reason why fishery products cannot be transfered to consumer areas unless they are treated by various types of processing at advanced bases.

Since considerable time and a sizable expenses are required for the completion of such fishing port facilities all over the country, for the present it is advisable to make preferential arrangements for a place near the main fishing ground and also convenient for land transport.

Such a fishing port must be arranged for not only the mooring of fishing boats but also with consideration of various land facilities attached to fishing ports.

2-4-2 Arrangement of land facilities

The fishing port must be equipped with various facilities for unloading and distribution of fishery products, supply of food and water, repairing and replacement of fishing boats and implements, ice manufacture, cold storage, and recreation facilities for fisherman, for the convenience of fishing boats and fishermen. Since many fishing boats will come to the port from all over the country, fishing products of a considerable volume will be unloaded everyday; automobiles for the exclusive use of transport of fresh fish will be required to transfer fishing products to consumer areas in a short period of time.

2-4-3 Intensification of facilities for ice manufacturing and cold storage

In order to transport fishing products to consumer areas under as fresh conditions as possible, ice shall be required in Cambodia where the atmospheric temperature is high all the year.

Ice, of course, must be used from the period of unloading at the fishing port to consumer areas; and also, it must be used from just after the catch, because the body heat of fish caught from the sea at higher temperatures will already be about 30° C. Otherwise, the freshness of the fish will drop before returning to port; and because the freshness of fresh-water fish is high, the price of sea fish will be lower in consumer areas, and consequently the income of fishing families will decrease.

The ice used at present in the fishing industry is edible ice; since a considerable expense is required for securing water for ice manufacturing in Cambodia, if such expensive ice is

used only for the fishing industry, the price of fish will become high and the demand for fish will decrease; therefore, the manufacturing of inexpensive ice is required for use in the fishing industry.

It is clear that the necessity for ice will become higher in the future, when development of offshore and deep-sea fisheries are promoted and fishing products in great quantities are transported from distant fishing grounds.

Furthermore, for fish as raw materials for canned goods and fish meal in the future, it is necessary that freshness is required; it is, therefore, advisable to construct at fishing ports, ice plants for manufacturing ice at a low price for use in great quantities. Since the main items of fresh-water fish are put on market alive at present, it is necessary to maintain the freshness of sea fish to increase the demand for them. Also, the maintenance of the freshness of sea fish shall be necessary, when fishing products in great quantity were unloaded, to keep them in cold storage for the time being and deliver them gradually during the period of no unloading or a poor fish catch caused by stormy weather for the purpose of balancing demand and supply.

2-4-4 Completion of facilities for maintenance of freshness

Trains, automobiles or boats are available for transport of fresh fish; however, in Cambodia where the railway network is not well established yet, the transportation of fresh fish depends on automobiles.

Automobiles are the most suitable for the transport of fresh fish to the hinterland of the country in view of the time required for transport.

In Japan, for short distances of a few hours, fish are transfered by ordinary trucks, packed in ice; while, in transporting for long distance, particularly for the transport of high-class fish for which freshness is required, refrigerators are employed; at fishmongers in cities, fresh fish are displayed in refrigerated show cases, with attention payed to the maintenance of freshness. To supply fresh fish meat to consumers will increase the consumption of fresh fish, and finally it will be concerned with the stabilization of the livelihood of fishermen, the producers of fresh fish.

From such a viewpoint, in order to supply fresh-fish to consumer areas, arrangement and consolidation will be required for such facilities as cold storage in fishing boats for use from just after the catch off shore, quick handling after unloading, maintenance of freshness to consumer markets and also at the consumer markets.

Though many of the fresh water fish are sold in the market as fresh fish in Japan, sea fish are transfered alive to consumer areas; this is a problem to be studied in the future, according to necessity.

2-5 Completion of Fishery Policies

2-5-1 Consolidation of statistic data

At main fishing bases along those coasts, Divisions are located, and under them, there are Triages in various areas, in charge of such instructive administration as compilation of statistical data concerning fisheries and tax collection etc. It is, not only for fisheries but for any industrial development, necessary to grasp thoroughly the present conditions of the industry, and according to the results of the analysis and examination of the conditions, estimate the future vision and work out a development plan of 5 or 10 years.

Particularly, in the field of sea fisheries, it is necessary to arrange data for even the items invisible. It is necessary to collect and compile data on fisheries, fishing vessels and equipments, form of fishery, fishermen, fishery management, circulation system, etc.; and also it is required to investigate fishing grounds and resources, to arrange various resources necessary for fishing and propagation and protection as early as possible.

2-5-2 Establishment of fishery system

The sea is the place for production of marine products and the base for livelihood for fishermen, like the farm and rice fields for farmers.

Efficient utilization of the sea is the problem directly connected with improvement of fishing productivity, stabilization of the economy of fishing families and maintenance and improvement of the people's health.

Therefore, it is required to establish the system for efficient utilization of the sea as early as possible.

It is understood that the existing law on fishery is not in touch with reality, and that the Government of Cambodia is taking its revision into consideration. Such revision should be made according to sufficient data based on a scientific foundation.

Accordingly, such revision shall require a long period of time. However, an increase in the production of marine products is so urgent that complete revision of the law may not be in time concerning certain aspects.

Though preparations for the revision of the law must be steadily carried on, appropriate arrangements must be made occasionally for various matters or problems for the period of preparation; for example, discussions and agreements between competent authorities concerned, independent control such as rules or bylaws within fishery cooperative associations, or such immediate administrative managements as instructions and guidance by governmental organizations.

Scientific research is required as the basis for such administrative management, it is necessary to promote consolidation of research laboratories.

2-5-3 Necessity of establishment of fishery cooperative associations and policy for promotion

A. Policy for promotion of establishment of fishery cooperative associations

The fishery cooperative association is a cooperative organization of fishermen as a group with the objective through the organization's activities; improvement of social and economical status of fishermen and increase in productivity, with function and mission as a promoting organ for the promotion of coastal fishing. Accordingly, as the development of fishery cooperative associations will be directly related to the prosperity of the fishermen and will play an important role as an economic and social nuclear body for the comprehensive promotion of coastal fishery and the prosperity of fishing villages, it is advisable that the Cambodian Fishery Services takes up, as a fundamental policy for promotion of a future coastal fishery promotion plan, the promotion of the establishment of fishery cooperative associations for fishermen in coastal areas as one of the important items of the fishery administration.

Furthermore, it is considered desirable for the Cambodian Fishery Services to promote the following policies for the promotion of the establishment of fishery cooperative associations.

(1) Intensification of guidance and education

It was commented on, that Cambodian fishermen had no full understanding of and were little interested in cooperative association and the establishment of cooperative associations was very difficult; to settle this problem at first will be the most fundamental prerequisite for the promotion of the establishment of fishery cooperative associations in the country.

For this purpose, most important for Cambodian Fishery Services is to deepen the fishermans' understanding and concern with cooperative associations steadily and systematically with its full organizational force and administrative instructive capacity; an effective method of practical guidance and education is to promote active guidance for fishermen through community meetings and regional conferences.

Fishing cooperative associations have the character of human cooperative bodies consisting of fishermen, and it is a profitable union with the objective of developing fishing communities.

To deepen the fisherman's understanding and concern at first and promote their independent intention to promote the establishment of fishing cooperative associations should be the natural form of union activity. It is advisable for the Cambodian Fishery Services to promote, with the above-mentioned aim, its positive educational programs.

(2) Preparation of materials for guidance and education for fishermen.

It is recommended that the Cambodian Fishery Services will, for the purpose of promoting the fisherman's understanding of the establishment of fishing cooperative associations and popularization of the aim of the establishment, compile and distribute educational materials

on the main advantages of fishing cooperative association and the necessity of its establishment, material easily understood by the fishermen, and carry out practical guidance and education, to produce fruitful effects in the future.

(3) Consolidation of the administrative guidance system

For the purpose of promoting the programs mentioned in the above-mentioned Paragraphs (1) and (2), it is desirable to foster official instructors on fishing cooperative associations, and also at the same time it is required to promote the establishment of fishing cooperative associations and consolidate an administrative guidance system for the management of associations.

(4) Establishment of "Bounty Grant System"

It is advisable for the Cambodian Government to examine such a system suitable for reality in the country as a part of the development program for coastal fisheries, because the "bounty grant system" will be effective for the promotion of the establishment of fishing cooperative associations, and for administrative promotion of the establishment of associations.

(5) Training and securing leaders for the fishing communities.

It goes without saying that every one of the fishermen is required to cooperate and understand of the purposes of promoting the establishment of fishing cooperative associations and the development of fishing communities; and also it is desirable to foster persons to play leading roles in fishing communities from among the people and to promote the development of fishing communities and the fishermens' independent intention of establishing fishing cooperative associations centered around those leading persons in the fishing communities.

B. Policy for effective management of fishing cooperative associations and promotion of guidance

The only fishing cooperative association in Cambodia is located at Koh Kapik; and it is very glad that this association is carrying on sales activities centered on Pla thu produced by the association members to bring about a great effect on the stabilization of Pla thu fish prices, and the members are expecting much help from the association and it gains the members' favor.

However, it is considered that, in Cambodia where only one fishing cooperative association will greatly influence the fishermen in areas without such associations. In order that the association will not come to a standstill in its activity, it is desirable that, as a previous countermeasure the Cambodian Government will carry out active guidance, protection and supervision. And, for the sake of further development of the association, it is advisable that the Cambodian Government pay attention to the following points in its guidance and supervision:

1) The competent authorities concerned should pay constant attention to the activity of the association and also positively instruct and supervise both finacially and administratively so that it will not come to a standstill in management.

2) As the development of association management depends upon the members' co-operative set-up, it is required to awaken and promote the association members' understanding of the association's activities, as the basis of administrative guidance, and positively educate the fishermen so that the association will not be spoiled.

3) It is advisable that training programs be positively carried out to make the executive members understand the importance of executives' responsibilities and duties to fulfill, in order to cope with the members' expectation towards the association and also to stabilize and improve the management of the association. A similar program is required for advancement of the office members of the association.

4) For the sake of the prosperity of association, it is desirable to raise financial powers enough to follow the economic trend in general and to aim at enriching the capital with repletion of the economic foundation.

2-6 Arrangement and Completion of Fishing Research Institutes

For the fishery development, priority should be given to survey on oceanic conditions of the Cambodian coast and offshore and also the ecology of fishery resources such as fish, shrimps, crabs etc.

Improvement or newly introduced techniques in fishing gears or fishing methods shall be applicable for practical fishing only after experiments by experimental institutes so as to arrange them to meet various requirements in Cambodia.

Only research institutes shall be able to prepare fundamental data necessary for reasonable management of fisheries (including the business management and control of fishing-grounds). Therefore, the arrangement and consolidation of research institutes should precede.

The sequence of experiments and research work shall be as follows:

The first step is to study the conditions of the sea where fishing or breeding is carried out. Next, investigation must be conducted on the marine life.

When, the conditions of the sea and marine life there are understood, research work must be conducted on techniques of fishing or breeding of the marine life.

Then, it is necessary to conduct research on utilization and processing of the marine life which were caught or bred.

It is necessary to educate the technical staff for the execution of the above-mentioned works. Such a technical staff shall be educated in developed countries as early as possible, to start such research works by Cambodia herself.

Fishing training institutes also should be established to train fishing technicians; and

the arrangement of machinery and equipment for survey and research is necessary for effective surveys and research works.

In Cambodia, a national fishery research institute is now under construction at Sihanoukville; and details must be consolidated as early as possible. Following are the items necessary for the research institute:

1. Papers and documents of various categories.
2. Biological and chemical experimental equipment.
3. Observation equipment for oceanic and meteorological observation.
4. Fishing tools for sampling use.
5. Survey boat (one ------ 4 - 5 ton,
   one boat with an outboard engine)
6. Automobiles for research work.
7. Diving sets.

III. RESEARCH ON FISHING GROUNDS OF CAMBODIAN COASTAL WATERS

III RESEARCH ON FISHING GROUNDS OF CAMBODIAN COASTAL WATERS

1 GENERAL DESCRIPTION OF SEA CONDITION

Oceanographic observations were conducted at 10 points in the area from the estuary of Kampot River to Kdat offing during June 13 - June 14 '67, 21 points in the North-eastern waters of Koh Rong and 5 points in the area from Koh Samit to Koh Kapik during June 18 - June 19. At each above point, water temperature, specific gravity, PH and transparency were observed and plankton was collected.

Upon the whole, the water temperature (approximately 29° C - 30° C) was high and the specific gravity (15.0 - 20.0) was low. The PH ranged from 8.0 to 8.5 and the transparency was about 10 - 11m.

Kampot - Kdat offing:

This sea area has the large Island Koh Tron in its south side and many rivers flow into this area from the continent. Accordingly, the specific gravities of the estuary's water were very low (15.0 - 16.5) and in other areas these ranged 18.0 - 19.5. The surface temperatures ranged 27.8° - 30.3°C and 29.0° - 30.6°C at the bottom. (cf. Table 3-1)

Vicinity of Koh Rong:

Results of the observations which commenced from Kampong Som Bay of Koh Rong are shown table 3-2 and the specific gravities were generally high in the inlet of Koh Rong Sam Lem. This may indicate that the water of open sea flow into this area. The water temperature at the surface ranged from 29.5° - 32.1° C and 29.6° - 30.9° C at the bottom.

Koh Samit - Koh Kapik offing:

In the coastal area faced on Siam Bay, the water temperatures at the surface ranged from 29.5° to 31.0° C and 29.5° -32.0° C at the bottom. The specific gravities in the Koh Kong Bay were extremely low and in other areas influenced directly by the open sea water these ranged from 20.0 to 21.0 (cf. Table 3- 3)

2. PLANKTON

When the oceanographic observations were conducted on each point, the planktons were also collected by hauling the plankton net horizontally at the sea surface areas for 3 minutes. The planktons collected in these areas were 152 species and were composed of plant planktons of 63 species and zoo-planktons of 89 species. But, at the standpoint of quantity, the plant planktons were predominant in comparison with the zoo planktons. (cf.Appendix)

Composition and distribution:

Composition of the plant planktons were considerably complex, 12 species of genus Chaetoceros, 11 species of Rhizosolenia, 5 species of Coscinodiscus, 3 species of Ditylium, 2 species of Biddulphia, 2 species of Thalassionema, 2 species of Tholassiosira and 2 species of Hemiaulus were found. On the zoo planktons, Ceratium and Corycaeus were 10 species respectively, Acartia and Labidocera 6 species respectively, 5 species of Centropages and 3 species of Oithona.

In case of the plant planktons, dominant species in these areas were Coscinodiscus astcromphalus, Chaetoceros decipiens, Rhizosolenia alata, Rhi. calaca-avis, Rhi. imbricata, Thalassionema nitzschioides, Thal. frauenfeldii and Biddulphia sinensis. In case of the zoo planktons, Brochyuran and Macruvan larve were dominant in the whole area and Turtanus porcipitotus, Ceratium massiliens and Noctiluca scintillans were dominant locally.

Both of numbers of species and quantities of planktons were maximum among Station 1 - Station 10, but minimum was found among Station 11 - Station 16.

In general, neritic planktons were found in large quantities and also observed oceanic planktons intermingled with the former in considerable quantities.

This may suggest that the water masses of the river systems were mixed enough with the oceanic water masses.

It is also noted that fish eggs, fish, fish larva, Brachyuran and Mecruran were collected in the most parts of areas investigated. However, oyster larva could not be found entirely. Balanus which has almost same life environment as that of oyster were found in every area.

The quantity of plankton is shown by the following signs in the Appendix.

C C	very "common"
C	"common"
+ +	between "common" and "present"
+	"present"
R	"rare"
RR	very "rare"

3. RESULT OF FISHING TEST

3-1 Research by Gill Net

1) In the southern sea area of the Peahed Island off Kep, fishing operations by gill nets (2 pannels for shrimps and 3 pannels for fish) were carried out.

Date and time: June 12, 14:30 - 18:00
Net setting: 16:00
Net put-in: 17:00
Catches were 8, consisting of Portunus pelagicus, Leiognathus rivulatus and others.

2) In the sea area off New Kep, fishing operations by gill nets (2 pannels for shrimps and 3 pannels for fish) were as follows:

Date and time: June 14, 06:00 - 12:30
Net setting: 08:00
Net put-in: 10:00
Catches were one of Scyliorhinidae, 10 of Dasyatus akajei, 2 of small Nematognathi, several of Platycephalidae, Bothidae, Aluteridae etc.

3) In the sea area off Koh Rong, gill nets (5 pannels for shrimps and 5 pannels for fish) were operated at night (net-setting : 20:00) on June 16, but no catch was obtained.

3-2 Research by Small Trawl Nets

4) In the sea area off New Kep, the small trawl nets were operated.

Date and time: June 14, 06:00 - 12:30
The first haul: depth 3m, 60 minutes' hauling
Catch were 486, belonging to 27 fish species. The main catches were the small individuals of Siganus Oramin and Pomadasys maculatus.

As the commercial species were caught Narke diplerygia, Tachysurus caelotus, Lutjanus fulviflamma, Sillago sihama, Otolithus argenteus and Thysanophrys indicus, while their catches were few in number.

The second haul: depth 1.5m, 30 minutes' hauling
Catches were 21, belonging to 20 species. The species were almost same as in the first haul.

5) In the sea area off Koh Rong, the small trawl nets were operated.

Date and time: June 17, 15:00 - 15:45
The haul: depth 7 - 10m, 45 minutes' hauling

As the hauling speed was decreased because of the boat being held in the current rip, the catches were only a few of Upeneus tragula.

6) In the sea area off Koh Kapik

Date and time: June 19, 08:40 - 13:00
The first hauling: depth 7 - 9m, 60 minutes' hauling

As the net form in the sea was not adequate, no catch was obtained.

The second haul: depth 2 - 5m, 40 minutes' hauling

The catches were only a few of small fish belonging to Andontostoma chacunda, Anchovielia commersonii, Leiognathus sp., Nemiptenus sp. etc.

As described above, the fishing tests were carried out to a very limited extent and their fishing results were accordingly not sufficient. Therefore, it is considered necessary to conduct further detailed fishing test in a large scale.

The experimental fishing operations for shrimps and crabs contemplated at first were entirely impossible because of the rough weather prevailing almost every day during the latter half of the investigation.

4. DIVING RESEARCH AND DISTRIBUTION OF SHELL-FISH

Viet Nam Border ---- off Kdat

The coast of this region chiefly consist of coral sand, having partly the mangrove zone. The sand banks develop in the estuaries of rivers, especially in the area from the estuary of the Kampot River to off New Kep. In the channel of the estuary of the Kampot River, many of Meretrix meretrix lived and were fished.

Off New Kep, sea-weeds belonging to Zosterales flourished in the shallower zones than 1.5m deep, forming the fishing grounds of shrimps.

Off Kdat, the reefs developed around the sea area of the depth of 3 - 35m where Corallium, Oysters and Sea-urchins lived. Sea-cucumbers, Atrina sp. and Ephippium were observed in the coral sand of the sea bottom. One of Pinctada chemnitzii was collected in the reef.

As to Oysters, the individuals of the small type of Crassostrea sp. which are of little economic importance were abundantly found. (See Table 3-1)

The Islands around Koh Rong

The sea depth around the islands are 10 - 18m in the sea area facing to Kampong Som Bay. The beaches of the inlets of the islands consist of sand. In the reefs, Crassostraea sp. were observed to be attached to them in the ebb-tide line, where Chama sp. was also found abundantly.

In the sandy-muds of the bottom, Ephippium, Pinna sp., Atrina sp., Sea-cucumbers, and Sea-stars were found. Sea-weeds were hardly observed. (See Table 3-2)

Koh Samit ---- Koh Kapik

In the northern area of Samit Islands, the sea depths are shallower than 20m in the

sea area from the beach to 5,000 - 6,000m off the land.

In the reef zone of the southern inlet of Koh Kong Island, Oysters attached to the reef were observed, but the team could not collect them owing to the rough weather.

Delta zone of mangrove develops around Koh Kapik. On the roots of mangroves were observed small oysters, most of which were dead. The cause of their death may be ascribed to the excessive fresh waters flowing in their living area in the monsoon season.

The good fishing grounds for Portunus sp., have been formed in the canals of mangrove zone.

Besides, the whole coastal zones of Cambodia, particularly those of Kompong Som Bay, are considered to be the good fishing grounds for shrimps as Penaeus monodon, P. indicus, P. semisuricatus and Metapenaeus sp. were found abundantly. (See Table 3-3)

5. EVALUATION OF FISHING GROUNDS BASED ON OCEANOGRAPHIC OBSERVATION

From results of the observations, it could be said generally that the low salinities and the high temperatures were extended widely in the Cambodian coastal waters. The waters between Koh Kapik and Koh Samit were the oceanic, the neritic water masses were mixed with the oceanic water masses in the insides of inlets of Koh Rong, and the shallow waters between Kdat and Kampot were the neritic.

In this survey, the investigations of the inside of Kompong Som Bay could not be conducted but it seems that this area would have probably the low salinities and the neritic one.

From the trend of the planktons collected, it may be able to point out that these low salinities and the neritic waters would be suitable breeding areas for fish, prawns and crabs.

Table 3-1 Results of Ocenographic Observations (Kampot - Kdat) (June 13 - 14 '67)

		1	2	3	4	5	6	7	8	9	10
Water temperature	Surface	30.3	28 8	29.2	29 2	29.1	29 6	27.8	29.4	29.4	29.3
	Bottom	30.6	29.4	29.2	29.3	29 0	29 1	29.0	29.2	29 2	29.0
Specific gravity	Surface	15.0	18 0	19.5	18.2	18.0	18 0	---	18.0	18.0	18.0
	Bottom	16.5	18.0	19.5	19.0	18 0	18 0	---	18 0	18 0	18 0

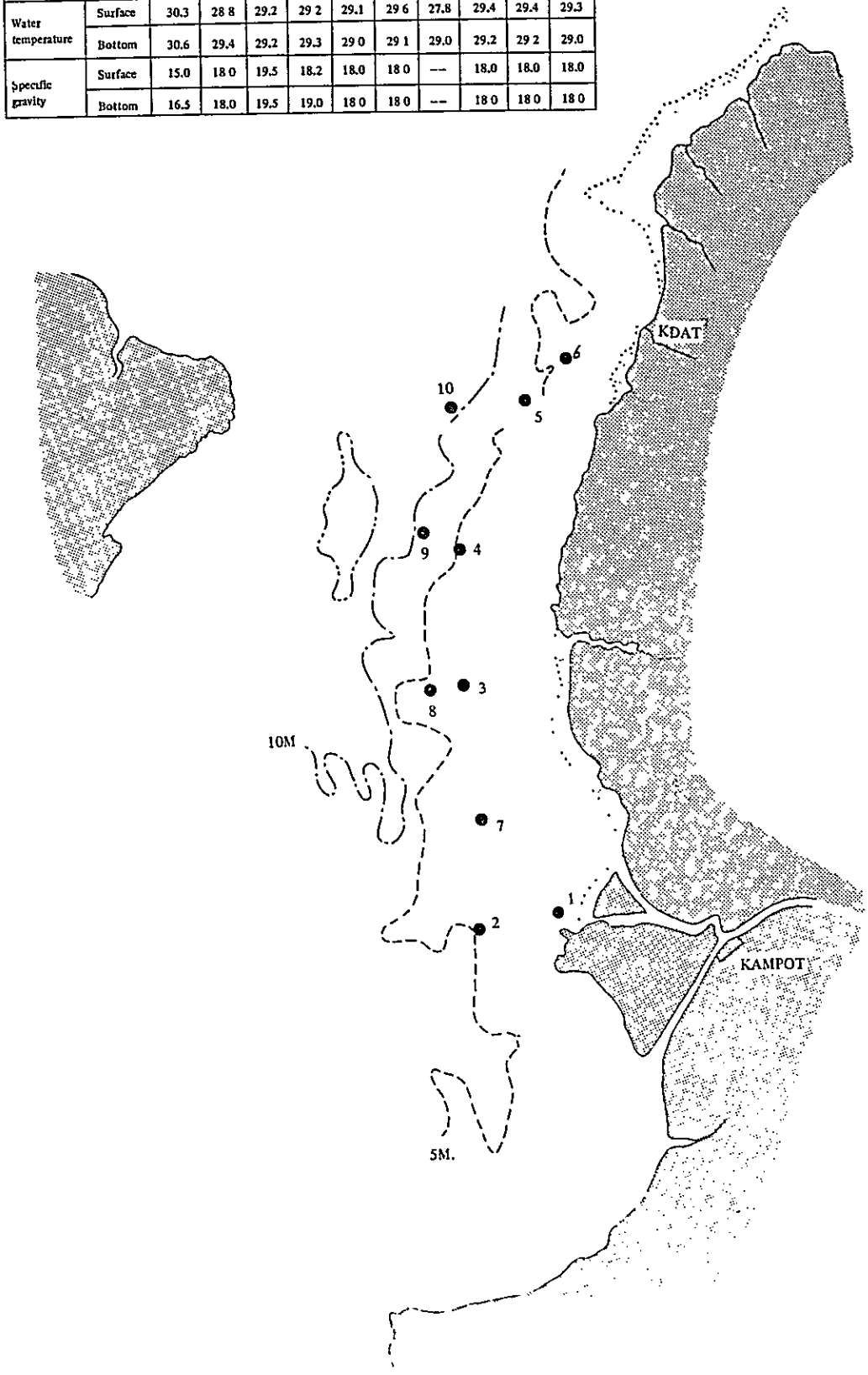


Table 3-2 Results of Oceanographic Observations (around Koh Rong) (June 16 '67)

		11	12	13	14	15	16	17	18	S-1	S-2	S-3
Water temperature	surface	29.5	30.1	30.5	31.5	32.1	31.5	30.5	30 4	30.7	30.8	30.9
	Bottom	29.8	29.8	30.3	30.9	29 9	30.1	29.6	29.7	--	--	--
Specific gravity	Surface	20.05	20 05	19.0	18.5	18.5	18.5	16 0	16.5	--	--	19.0
	Bottom	20.05	19.05	20 05	18.5	20.0	19.5	19 0	19.5	--	--	--

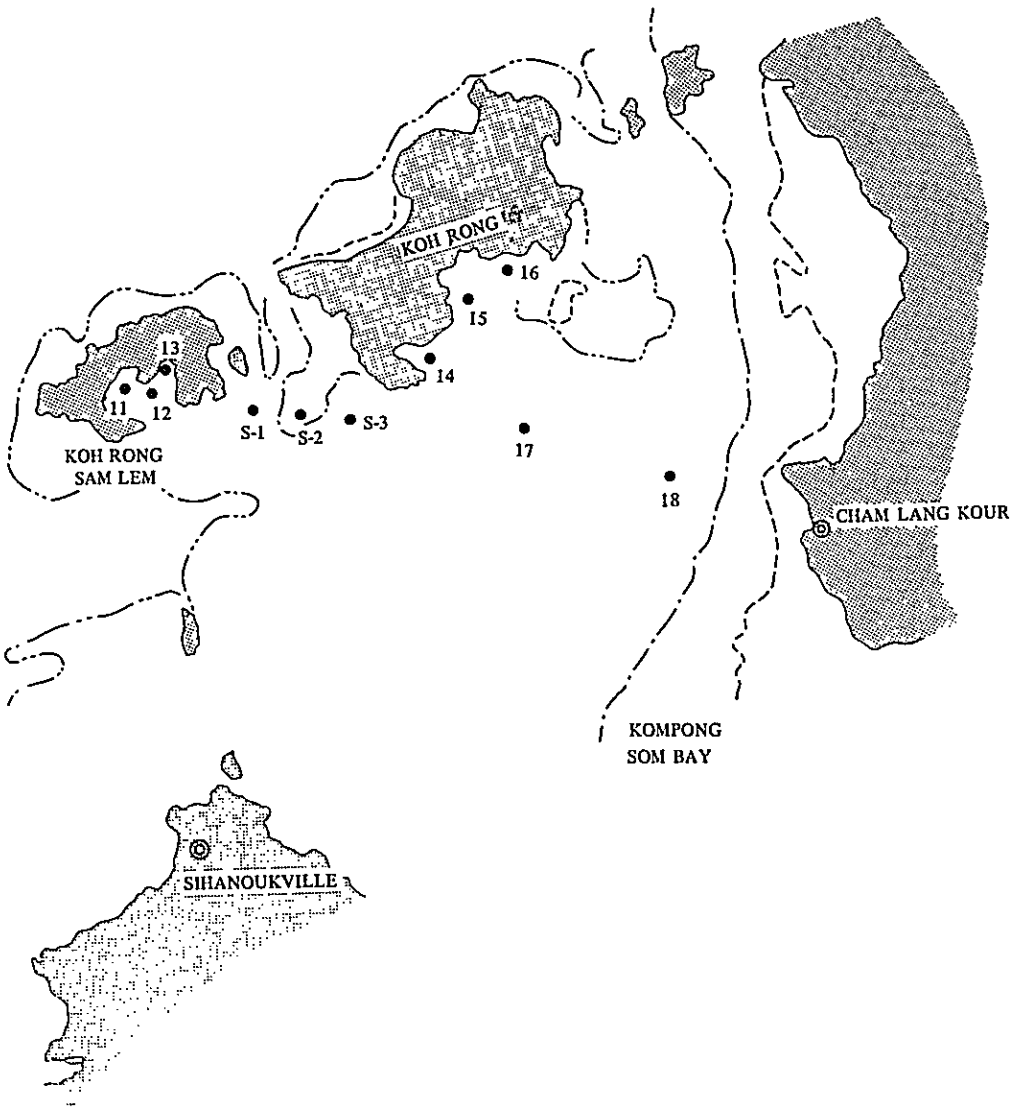
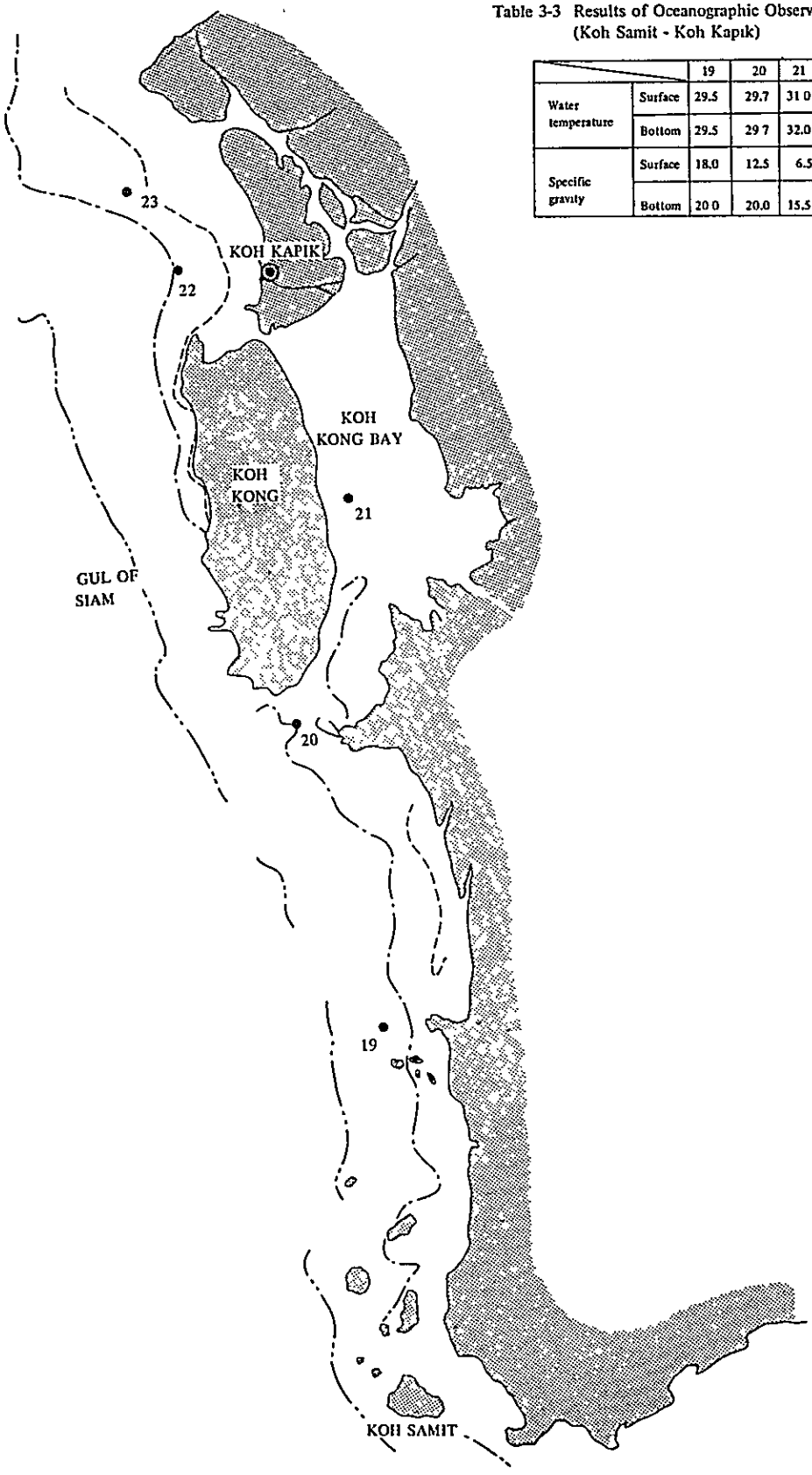


Table 3-3 Results of Oceanographic Observations
(Koh Samit - Koh Kapik) (June 18 - 19 '67)

		19	20	21	22	23
Water temperature	Surface	29.5	29.7	31 0	29.7	30.5
	Bottom	29.5	29 7	32.0	30.5	30.5
Specific gravity	Surface	18.0	12.5	6.55	14.5	15 5
	Bottom	20 0	20.0	15.5	21 0	20.0



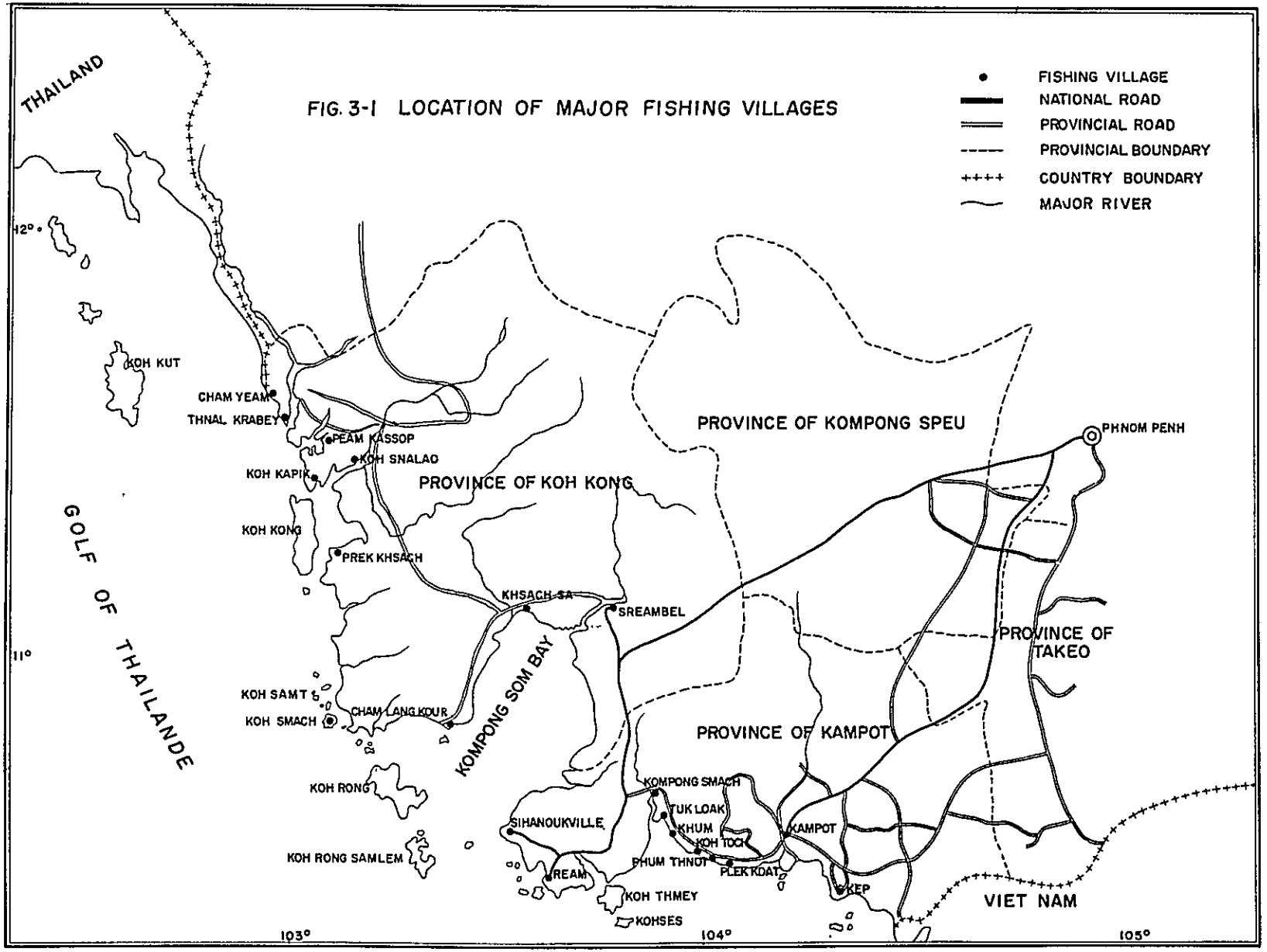


FIG. 3-1 LOCATION OF MAJOR FISHING VILLAGES
FISHING VILLAGE
NATIONAL ROAD
PROVINCIAL ROAD
PROVINCIAL BOUNDARY
COUNTRY BOUNDARY
MAJOR RIVER
THAILAND
12°
11°
103°
104°
105°
KOH KUT
CHAM YEAM
THNAL KRABEY
PEAM KASSOP
KOH SNALAO
KOH KAPIK
KOH KONG
PREK KHSACH
KHSACH SA
SREAMBEL
KOH SAMT
KOH SMACH
CHAM LANG KOUR
KOH RONG
KOH RONG SAMLEM
SIHANOUKVILLE
REAM
KOH THMEY
KOHSES
KOMPONG SMACH
TUK LOAK
KHUM
KOH TOCH
PHUM THNOT
PLEK KDAT
KEP
KAMPOT
PHNOM PENH
PROVINCE OF KOMPONG SPEU
PROVINCE OF KOH KONG
PROVINCE OF TAKEO
PROVINCE OF KAMPOT
VIET NAM
GOLF OF THAILANDE
KOMPONG SOM BAY

APPENDIX

A. List of Fishes, Crustacea, Mollusca and Plankton collected in the coastal water of Cambodia

A-1. List of Fishes

A-1-1. Composition of Fishes by type of the experimental fishing and by the location of markets

A-2. List of Crustacea

A-2-1. (a) Composition of Shrimp collected by the trawling
(b) Composition of Shrimp collected at the markets.

A-3. List of Mollusca

A-4. List of Plankton

B. Figures of Fishes, Shellfishes, Crustacea and Mollusca collected in the coastal water of Cambodia

C. Coastal Chart of Cambodia

C-1. Prek Kdat, Kampot and Kep

C-2. Ream

C-3. Kompong Som Bay, Koh Rong and Koh Rong Sam Lem

C-4. Koh Kapik, Koh Kong and Koh Samit

D. Illustrations of Japanese Fishing Boat and Fishing Gear

D-1. Crab Gill Net Fishing Boat

D-2. Pacific Saury Stick-held Dip Net Boat

D-3. Coastal Fishing Boat

D-4. Small Trawl

D-5. Sardine Drag Net

D-6. Hand-operated Trawl by Boat

D-7. Beach Seine

D-8. Two Boat Purse Seine

D-9. One Boat Surrounding Net

D-10. Stick-held Dip Net

A. List of Fish, Crustacea, Mollusca and Plankton collected in the coastal water of Cambodia

A-1. List of Fishes

Species

Orectolobidae
1. Chiloscyllium indicum (Gemelin)
Scyliorhinidae
2. Atelomycterus marmoratus (Bennett)
Carcharhinidae
3. Scoliodon sorrakowah (Cuvier)
Trygonidae
4. Cymnura micrura (Bloch and Schneider)
5. Taeniura meyeni Muller and Henle
6. Pastinachus sephen (Forskol)
7. Amphotistius imbricatus (B. and S.)
Torpedinidae
8. Narke dipterygia (B. and S.)
Clupeidae
9. Kowaia coval (Cuvier)
Dussumieridae
10. Dussumieria acuta Valengiennes
Dorosomidae
11. Andontostoma chacunda (Hamilton-Buchanan)
Engraulidae
12. Anchovielia commersonil (Lacépéde)
13. Thrissocies malabarica (Bloch)
14. Setipinna tany (Valencinciennes)
15, Thrissa mystax (B. and S.)
16. Thrissa setirosteris (Broussonet)
Megalopidae
17. Megalops cyprinoides Broussonet
Elopidae
18. Elops machnata (Forskal)
Chirocentridae
19. Chirocentrus nudus Swainson
Plofosidae
20. Plotosus canius Hamilton-Buchanan
21. P. anguillaris (Bloch)
Tachysuridae
22. Tachysurus caelatus (Valenciennes)
Muraenesocidae
23. Muraenesox cinereus (Forskol)
Belonidae
24. Ablennes hians (Cuvier-Valenciennes)
25. Tylosurus strongylurus (Van Hasselt)
Hemiramphidae
26. Hyporhamphus gaimardi (Valenciennes)
27. Hemirhamphus georgii (Valenciennes)
Syngnathidae
28. Syngnathoides blaculeatus (Bloch)
Sphyraenidae

Species

29. Sphyraena langsar Bleeker
30. S. acutipinnis Day

Mugilidae

31. Liza parsia (Hamilton-Buchanan)
32. L. strongylocephalus (Richardson)
33. L. oligolepis (Bleeker)

Atherinidae

34. Allanetta forskali (Ruppel)

Polynemidae

35. Polynemus plebeius (Broussonet)

Serranidae

36. Promicrops lanceolatus (Bloch)

Epinephelinae

37. Epinephelus undulosus (Quoy and Gaimard)
38. E. malabaricus (Schneider)

Latinae

39. Lates calcarifer (Bloch)

Theraponidae

40. Pelates quadrilineatus (Bloch)
41. Therapon jarbua (Forskal)

Apogonidae

42. Archamia lineolatas (Cuvier)
43. Apogon thermalis Cuvier
44. Apogon sp.
45. A. quadrifasciatus Cuvier

Sillaginidae

46. Sillago sihama (Forskal)

Lactaridae

47. Lactarius lactarius (Schneider)

Trichiuridae

48. Trichiurus savala Cuvier

Scombridae

49. Rastrelliger canagurta (Cuvier)

Thunnidae

50. Katsuwonus pelamis (Linnaeus)

Scomberomoridae

51. Scomberomorus commersoni (Lacépédé)
52. S. lineolatus (Cuvier)
53. S. guttatum (Bloch and Schneider)

Carangidae

54. Megalaspis cordyla (Linnaeus)
55. Alectis indica (Ruppell)
56. Selaroides leptolepis (Cuvier)
57. Gnathanodon speciosus (Forskal)
58. Selar mate (Cuvier)
59. Carangoides praeustus (Bennett)
60. Caranx melampygus Cuvier
61. C. carangus (Bloch)
62. Chorinemus laysan (Forskal)
63. C. tala Cuvier
64. Trachinotus blochi (Lacépédé)

Lutjanidae

Species

65. Lutjanus johni (Bloch)
66. L argentimaculatus (Forskal)
67. L. fulviflamma (Forskal)
68. L. vaigiensis (Quoy and Gaimard)
69. L. sebae (Cuvier and Valenciennes)

Nemipteridae

70, Nemipterus personii (Cuvier and Valenciennes)
71. N. sp.

Lobotidae

72. Lobotes surinamensis (Bloch)

Gerridae

73. Pentaprion longimanus (Cantor)
74. Gerreamorpha setifer (Hamilton-Buchanan)
75. Gerres abbreviatus (Bleeker)
76. Gerres oyena (Forskal)
77. G. sp.

Leiognathidae

78. Secutor ruconius (Hamilton-Buchannan)
79. Leiognathus equulus (Forskal)
80. L. daura (Cuvier)
81. L. sp.
82. Gazza achlamys Jordan and Starks

Pomadasydae

Pomadasyinae

83. Pomadasys maculatus (Bloch)
84. P. hasta (Bloch)

Scolopinae

85. Scolopsis phaeops (Bennett)

Plectorhynchinae

86. Spilotichthys pictus (Thunberg)
87. Gaterin cinctus (Schlegel)

Sciaenidae

88. Sciaena russelli (Cuvier)
89. Johnius soldado (Lacépédé)
90. Otolithus argenteus Cuvier

Lethrinidae

91. Lethrinus rhodopterus Bleeker
92. L. reticulatus Valenciennes

Sparidae

93. Acanthopagrus berda (Forskal)

Mullidae

94. Upeneus tragula Richardson

Monodactylidae

95. Monodactylus agrenteus (Linne)

Drepanidae

96. Drepane punctata (Linnaeus)

Chaetodontidae

97. Parachaetodon ocellatus (Cuvier)

Sxiaenidae

98. Johnius sina (Cuvier)

Scatophagidae

99. Scatophagus argus (Linnaeus)

Species

Pomacentridae
100. Abudefduf biocellatus (Quoy and Gaimard)
Labridae
101. Platyglossus notopsis (Valenciennes)
102. Halighoeres hyrtlie (Bleeker)
Blenniidae
103. Dasson sp.
Congrogadidae
104. Congrogadus subducens (Richardson)
Siganidae
105. Siganus oramin (Bloch and Schneider)
106. S. vermiculatus (Valenciennes)
107. S. stellatus (Forskal)
Stromateidae
108. Pampus argenteus (EUPHRASEN)
Gobiidae
109. Gobius sp.
110. Glossogobius fiocedlatus (Cuvier-Valenci)
Eleotridae
111. Ophiocara porocephala (Valenciennes)
Scorpaenidae
112. Gymnapis tes niger (Cuvier)
Aploactidae
113. Aniculerosa taprobanesis Whitley
Platycephalidae
114. Thysanophrys indicus (Linnaeus)
115. T. crocodilus (Tilesius)
Callionymidae
116. Callionymus sp.
Bothidae
117. Pseudorhombus arsius (Hamilton)
118. P. japanicus (Bleeker)
Psettodidae
119. Psettodes erumei (Bloch and Schneider)
Soleidae
120. Brachirus orientalis (Bloch)
Cynoglossidae
121. Cynoglossus macrolepidotus (Bleeker)
122. C. bilineatus (Lacépédé)
123. C. brachycephalus Bleeker
124. C. lida (Bleeker)
Aluteridae
125. Pervagor tomentosus (Linne)
Anacanthidae
126. Anacanthus barbatus (Gray)
Lagocephalicae
127. Amblyrhynchotes hypselogenion (Bleeker)
128. Lagocephalus inermis (Schiegel)
Batrachoididae
129. Batrachus grunniens (Linnaeus)

A-1-1. Composition of Fishies by type of the experimental fishing and by the location of markets

(1) Offshore Kep (by Beach seine) (June 13, '67)

Species	Specimens	Size (T.L.mm)
Cymnura micrura	1	174
Amphotistius imbricatus	1	265
Narke dipterygia	2	97 - 111
Anchovielia commersonii	3	89 - 142
Setipinna tany	1	82
Thrissa setirosteris	1	80
Elops machnata	2	141 - 330
Hemirhamphus georgii	2	130 - 167
Sphyraena acutipinnis	2	170 - 164
Liza parsia	2	122 - 190
Archama lineolatas	1	75
Sillago sihama	3	92 - 101
Trichiurus savala	1	190
Caranx carangus	2	150
Lutjanus argentimaculatus	1	194
Gerres oyena	3	91 - 110
Leiognathus equulus	3	110 - 120
Sciaena russelli	4	84 - 117
Siganus oramin	2	82 - 95
Gobius sp.	2	69 - 76
Glossogobius fiocedlatus	1	85
Pseudorhombus arsius	1	130
Thysanophrys crocodilus	3	83 - 102
Callionymus sp.	1	81
Brachirus orientalis	1	103
Pervagor tomentosus	2	92 - 130
Lagocephalus inermis	1	73

(2) Offshore New Kep (by Trawling) (June 14, '67)

	Species	Specimens	Size(T.L.mm)
1)			
	Narke dipterygia	2	110 - 125
	Plotosus canius	2	592
	Tachysurus caelotus	1	289
	Syngnathoides blaculeatus	15	214 - 251
	Apogon thermlis	2	79 - 95
	Apogon quadrifasciatus	10	
	Lutjanus fulviflamma	6	73 - 115
	Sillago sihama	1	172
	Leiognathus equulus	39	26 - 60
	Gaxxa achlamys	3	87 - 93
	Pomadasys maculatus	70	
	Otolithus argenteus	1	140
	Lethrinus rhodopteus	2	50 - 75
	Siganus oramin	150	
	Glossogobius fiocedlatus	1	82
	Gymnapistes niger	2	86 - 125
	Johnius soldado	1	176
	Halighoeres hyrtli	1	100
	Dasson sp.	1	86
	Thysanophrys indicus	3	132 - 178
	Congrogadus subducens	1	145
	Pseudorhombus arsius	5	140 - 211
	Brachirus orientalis	5	120 - 185
	Cynoglossus macrolepidotus	1	126
	Pervagor tomentosus	38	50 - 153
	Anacanthus barbatus	1	147
	Amblyrhynchotes hypselogenion	4	43 - 60
2)			
	Atelomycterus marmoratus	1	370
	Amphotistius imbricatus	1	169
	Narke dipterygia	1	110
	Syngnathoides blaculeatus	1	138
	Pelates quadrilineatus	1	72
	Apogon sp.	1	58
	Apogon quadrifasciatus	1	82
	Sillago sihama	1	187
	Leiognathus equulus	1	170
	Gaxxa achlamys	2	110 - 115
	Lethrinus reticulatus	1	172
	Upeneus tragula	1	85
	Parachaetodon ocellatus	1	38
	Siganus oramin	1	76
	Pseudorhombus arsius	1	160
	Thysanophrys crocodilus	1	281
	Brachirus orientalis	1	191
	Cynoglossus lida	1	112
	Perragor tomentosus	1	100
	Amblyrhynchotes hypselogenion	1	50

1) by small size trawling (60 minutes)
2) by small size trawling (30 minutes)

(3) Offshore New Kep (by Gill net) (June 14, '67)

Species	Specimens	Size(T.L.mm)
Atelomycterus marmoratus	1	414
Taeniura meyeni	1	386
Amphotistius imbricatus	9	200 - 430
Tachysurus caelotus	2	125 - 172
Thysanophrys indicus		
Pseudorhombus arsius	1	140
Pervagor tomentosus	2	126 - 178

(4) Offshore Koh Kapik (by trawling) (June 19, '67)

Species	Specimens	Size(T.L.mm)
Andontostoma chacunda	44	
Anchovielia commersonii	6	
Nemipterus sp:	2	90 - 95
Leiognathus sp.	10	
Monodactylus agrenteus	1	100
Pseudorhombus arsius	1	162
Cynoglossus brachycephalus	1	70

(5) Ream (from purse seine boat) (June 17, '67)

Species	Specimens	Size(T.L.mm)
Rastrelliger canagurta	2	189 - 190
Katsuwonus pelamis	3	275 - 310

(6) Sihanoukville (by sruf fishing) (June 22, '67)

Species	Specimens	Size(T.L.mm)
Therapon jarbua	12	90 - 113
Lethrinus rhodopteus	1	111
Platyglossus notopsis	3	68 - 115

Re.: by Mr. H. Kimura, member of the Team

(7) Sihanoukville Market

Species	Specimens	Size(T.L.mm)
(June 7, '67)		
Lactarius lactarius	2	170 - 186
Alectis indica	2	245 - 295
Gnathanodon speciosus	1	205
Lobotes surinamensis	2	215 - 220
Pomadasys maculatus	1	175
Acanthopagrus berda	2	180 - 300
Pampus argenteus	2	156 - 168
Cynoglossus bilineatus	1	234
(June 10, '67)		
Scoliodon sorrakawah	1	430
Pastinachus sephen	1	344
Kowaia coval	2	116 - 220
Chirocentrus nudus	2	360 - 370
Tachysurus caelotus	3	240 - 273
Tylosurus strongylurus	1	285
Liza parsia	1	151
Liza oligolepis	1	235
Therapon jarbua	2	185
Sillago sihama		250
Rastrelliger canagurta	7	142 - 221
Scomberomorus guttatum	1	220
Scomberomorus lineolatus	1	268
Megalaspis cordyla	2	176 - 192
Selar mate	1	154
Caranx melampygus	2	210 - 320
Caranx carangus	1	165
Chorinemus laysan	1	208
Chorinemus tala	1	146
Lutjanus fulviflamma	1	223
Lutjanus sebae	1	450
Nemipterus sp.	1	364
Lobotes surinamensis	1	278
Gerres abbreviatus	2	131 - 146
Leiognathus equulus	1	200
Gazza achlamys	1	159
Pomadasys maculatus	1	184
Spilotichthys pectus	2	360 - 416
Sciaena russelli	1	206
Otolithus argenteus	2	220 - 225
Acanthopogrus berda	2	257 - 264
Drepane punctata	1	200
Siganus stellatus	1	275
Pampus argenteus	3	175 - 265
Thysanophrys indicus	1	237

(8) Kampot Market

Species	Specimens	Size(T.L.mm)
(June 17, '67)		
Sphyraena langsar	1	554
Caranx melampygus	2	240 - 246
Trachinotus blochi	1	564
(June 23, '67)		
Andontostoma chacunda	4	125 - 200
Hemirhamphus georgii	1	216
Sphyroena acutipinnis	1	320
Rastrelliger canagurta	8	135 - 166
Katsuwonus pelamis	2	140 - 141
Scomberomorus commersoni	5	252 - 382
Caranx sp.	1	104
Upeneus trogula	2	106 - 123
Platyglossus natopsis	2	180 - 193
Megalops cyprinoides	1	530
Caranx melampygus	1	362
Lutjanus vaigiensis	1	448

(9) Koh Kapik Market (June 18, '67)

Species	Specimens	Size(T.L.mm)
Amphotistius imbricatus	1	300
Kowaia coval	1	121
Anchovielia commersonii	3	180 - 194
Polynemus plebeius	3	270 - 296
Lactarius lactarius	1	207
Otolithus argenteus	1	231
Gobius sp.	3	160

A - 2 List of Crustacea

	Locality	Species	Specimens
1.	Kep market (June 13, '67)		
		Penaeus monodon	4
		P. indicus	6
		P. semisuricatus	1
2.	Kep market		
		P. semisuricatus	9
3.	New Kep (trawling 30 minutes)		
		P. semisuricatus	8
4.	Kampot market		
		P. semisuricatus	4
5.	Kampot market		
		P. monodon	4
		P. indicus	2
6.	Offshore Kdat (trawling) (June 13, '67)		
		P. monodon	2
		P. indicus	70
		P. semisuricatus	16
		Netapenaeus sp.	30
		M. sp.	21

A - 2 - 1 (a) Composition of Shrimp collected by trawling

Species	Sex	Length of Carpace	Weight	Locality
P. semisulcatus	♀	1.80mm	5.5g	Kdat
P. monodon	♂	4.20	34.5	Kdat
"	"	4.39	47.5	"
?	♂	2.90	19.5	Kep
"	"	3.25	21.5	"
"	"	2.93	17.0	"
"	"	31.6	22.5	"
"	"	28.9	16.2	"
"	"	31.3	19.8	"
"	"	30.0	19.7	"
"	♀	32.5	23.0	"
"	"	26.4	12.5	"
P. indicus	♂	2.75	13.5	Kdat offshore
"	"	2.55	11.0	"
"	"	2.40	10.5	"
"	"	2.60	10.5	"
"	"	2.72	12.5	"
"	"	2.60	10.5	"
"	"	2.65	12.0	"
"	"	2.81	8.5	"
"	"	3.84	9.0	"
"	"	2.45	8.5	"
"	"	2.22	8.5	"
"	"	2.83	12.5	"
"	"	2.16	9.0	"
"	"	2.62	12.5	"
"	"	2.36	9.5	"
"	"	2.45	11.0	"
"	"	1.95	5.8	"
"	"	2.05	4.0	"
"	"	2.12	8.3	"
"	"	1.92	6.3	"
"	"	2.15	7.5	"
"	"	1.48	9.5	"
"	"	1.55	11.8	"
"	"	1.90	6.0	"
"	"	2.16	7.8	"
"	"	2.35	13.0	"
"	"	2.59	12.5	"
"	"	2.501	12.5	"
"	"	2.52	12.5	"
"	"	2.05	7.2	"
"	"	2.86	18.0	"
"	"	1.94	7.8	"
"	"	2.85	15.0	"
"	"	2.63	15.0	"

P. indicus	♂	2.80	14.8	Kdat offshore
"	"	1.70	5.8	"
"	"	2.66	7.8	"
"	"	2.33	10.0	"
"	"	2.20	9.8	"
"	"	2.43	12.5	"
"	"	2.26	8.0	"
"	♀	3.98	17.5	"
"	"	2.64	12.5	"
"	"	3.11	18.5	"
"	"	3.84	7.0	"
"	"	2.78	11.5	"
"	"	2.58	13.0	"
"	"	2.70	13:5	"
"	"	2.85	15.0	"
"	"	2.50	11.0	"
"	"	2.20	7.2	"
"	"	1.80	9.0	"
"	"	2.85	16.2	"
"	"	2.64	13.0	"
"	"	2.76	16.5	"
"	"	2.48	12.0	"
"	"	2.37	10.8	"
"	"	2.63	14.0	"
"	"	2.22	8.5	"
"	"	2.44	11.8	"
"	"	2.70	14.5	"
"	"	2.55	12.5	"
"	"	2.55	10.8	"
"	"	2.33	9.0	"
"	"	2.76	9.8	"
"	"	3.03	19.0	"
"	"	2.70	13.7	"
"	"	2.37	11.8	"
"	"	2.75	13.5	"
"	"	1.93	4.5	"
P. semislcatus	♂	25.7	12.2	New Kep
"	"	21.5	5.0	"
"	"	16.6	2.8	"
"	"	15.5	3.0	"
"	"	2.05	6.8	Kdat
"	"	1.90	6.8	"
"	"	1.65	3.0	"
"	"	2.13	7.0	"
"	"	2.23	8.2	"
"	"	2.35	11.5	"
"	♀	22.0	6.0	New Kep
"	"	22.9	6.5	"
"	"	28.0	15.8	"
"	"	35.0	23.0	"
"	"	2.0	6.3	Kdat
"	"	1.72	4.8	"
"	"	2.20	9.0	"
"	"	1.87	6.0	"
"	"	2.0	7.5	"
"	"	1.99	6.5	"
"	"	1.83	6.0	"
"	"	2.38	10.5	"
"	"	1.82	5.0	"

Metapenaeus	♂	1.74	5.0	Kdat offshore
"	"	1.66	3.5	"
"	"	1.80	5.0	"
"	"	1.78	3.8	"
"	"	2.0	5.0	"
"	"	2.0	6.2	"
"	"	2.02	6.0	"
"	"	1.9	4.0	"
"	"	1.8	5.0	"
"	"	1.56	3.0	"
"	"	1.78	4.0	"
"	♀	2.40	9.0	"
"	"	1.89	5.0	"
"	"	1.71	4.2	"
"	"	1.93	5.8	"
"	"	2.24	7.0	"
"	"	1.79	4.2	"
"	"	2.47	8.0	"
"	"	1.95	6.0	"
"	"	1.86	5.0	"
"	"	1.58	3.0	"
"	"	5.45	93.0	"
"	"	5.55	89.0	"
"	"	3.85	33.5	"
"	"	3.45	22.0	"
"	"	3.29	22.0	"
"	"	3.25	18.0	"
"	"	4.56	57.0	"
"	"	3.86	35.0	"
"	?	1.25		"
"		1.36		"
"		1.40		"
"		1.21		"
"		1.05		"
"		1.27		"
"		1.22	17.2	"
"		1.22		"
"		1.14		"
"		1.50		"
"		1.50		"
"		1.30		"
"		1.36		"
"		1.25		"
"		1.48		"
"		1.12	19.0	"
"		1.20		"
"		1.23		"
"		1.15		"
"		1.21		"
"		1.60		"
"		1.20		"
"		1.54		"
"		1.69		"
"		1.35		"
"		1.17	23.0	"
"		1.44		"
"		1.10		"
"		1.38		"
"		1.20		"

A - 2 - 1 (b) Composition of Shrimp collected at the markets

Species	Sex	Length of Carpace	Weight	Locality
P. monodon	♂	4.6mm	45g	?
"	"	4.9	60	"
"	"	4.9	60	"
"	"	2.86	3.8	"
"	"	1.82	3.0	"
"	"	1.62	1.5	"
"	♀	5.3	80	"
"	"	2.10	5.0	"
P. semi	♂	1.55	3.0	Kampot Market
"	♀	1.80	3.6	" "
"	"	1.70	2.3	" "
"	"	2.90	10	Kep Market
"	"	1.65	2.0	Kampot Market
P. indicus	♂	2.80	18	Kep Market
"	"	3.05	20	" "
"	"	3.0	20	" "
"	"	2.5	8.0	
"	♀	3.15	20	Kep Market
"	"	2.60	15	" "
"	"	3.45	25	" "
"	"	2.95	13	

A - 3. List of Mollusca

I. Bivalvia and Gastropoda

Locality		Species	Specimens
(a)	Kdat (Underwater sampling)		
	1.	Tegillarca nodifera (v. Martens)	3
	2.	Pinctada chemnitzii (Philippi)	1
	3.	Pteria sp.	2 (1 is juv.)
	4.	Isognomon isognomon (L.)	1
	5.	Pinna bicolor Gmelin	2
	6.	Plicatula australis Lamarck	1
	7.	Ephippium ephippium (Retzius)	1+1/2
	8.	Crassostraea sp. (probably rivularis Gould)	ca. 20
	9.	Saxostrea sp.	4+
	10.	Regozara flava (L.)	1
	11.	Periglypta puerpera (L.)	1/2
	12.	Paphia textile (Gmelin)	1
	13.	Meretrix meretrix (L.)	8
	14.	Circe stutzeri (Dononvan)	1
	15.	Telebralia palustris (L.)	1
	16.	Canarium isabellum (Lamarck)	8
(b)	Kdat (Beach collection):		
	17.	Scapharca cornea (Reeve)	1 1/2 x 3
	18.	Melina ephippium (L.)	9 1/2 x 2
	19.	=7	
	20.	Crassostrea belcheri (Sowerby)	1/2 x 10 +
	20a.	20. (reworked fossil)	
	21.	Saxostrea mytuloides (Lamarck) + S. mordax (Gould)	over 40
	22.	Saxostrea sp. (? = 9)	1/2 specimen
	23.	Plicatula horrida Dunker	2
	24.	=13.	
	25.	Katelysia sp.	1/2
	26.	Volegalea cochlidia (L.)	1
	27.	Volutocorona nobilis (Solander)	1
(c)	Sre Ambel:		
	28.	Chloromytilus viridis (L.)	2
	29.	Modiolus philippinarum (Hanley)	1/2
	30.	Chama reflexa Reeve (attached on 29)	1
	31.	Phacosoma aspera (Reeve)	1
(d)	Koh Rong:		
	32.	=28	1
	33.	=5	1

Locality		Species	Specimens
	34.	Atrina vexillum (Born)	1
	35.	=7	2
	36.	=8	7
	37.	Chama iostoma (Conrad) (attached on 35)	1
	38.	Chama sp. (probably pacifica (Broderip)	6
(e) New Kemp:			
	39.	=17	1/2
	40.	Scapharca sp. aff. subcrenata Lischke	1/2
	41.	=21.	20 +
	42.	Trapezium japonicum Pilsbry	3
	43.	Katelysis hiantina (Lamarck)	1
	44.	Gafrarium tumidum Röding	1/2 x 2
	45.	Anomalodiscus squamosus. (L.)	1/2
	46.	Psammotaea elongata (Lamarck)	1
	47.	=26.	1

II. Cephalopoda

(a) Kep		
	Octopus sp. (probably macropus Robson)	2
	Sepia aculeata Férussac	1
(b) Kep		
	Octopus sp. (probably macropus Robson)	1
	Loligo sp. (juv.)	1
(c) Kep		
	Loligo sp. (probably duvaucelli d'Orbigny)	1
(d) Kep		
	Octopus ocellatus Gray	1
	Sepioteuthis lessoniana (Lesson)	1
	Sepia sp. (juv.)	2
(e) Kampot		
	Octopus ocellatus Gray	1
	Sepioteuthis lessoniana (Lesson)	1
	Loligo sp. (probably duvaucelli d'Orbigny)	1

A - 4 List of Plankton

Phytoplankton	Station	6/13													6/16						6/17		6/18	6/18	6/18	Koh Kong
		1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	1
Coscinodiscus	asteromphalus	C	C		R	C	R	C	C	C	+	C	C	++		RR	+	+			R	R	R		C	+	R
Cos.	excentricus										+																
Cos.	lineatus										+																
Cos.	granii	R				R		+										R						R	R		
Cos.	gigas										C	C	C		C												
Guinardia	flaccida					R		RR			R		R					R									
Hemiaulus	Hauckii						+						+														
Hem.	indicus										R																
Hem.	sinensis	R		C					+	C	+				+												
Hemidiscus	cuneiformis	+				+	R	+			R	+	+	R	+			R						+			
Lauderia	sp.	R		R		R	R	R	R		R				R			+									
Stephanopyxis	palmeriana	R						RR	R	RR	R		R		R												
Cerataulina	Bergonii	+		R				R	+	+	R	R	+		+									R			
Cerat.	compacta	R																									
Chaetoceros	decipiens					R	+	C	R	+	C		+	+	C		R	+						R			
Chaet.	brevis							+			+																
Chaet.	curvisetus					+	+	R	R	R	+		·		+												
Chaet.	coarctatus						+	R	+																		
Chaet.	laevis													RR	R												
Chaet.	laciniosus							+																			
Chaet.	peruvianus				R		R	+			+		R	R											R		
Chaet.	denticulatum							+	+	+					R												
Chaet.	affinis														R												
Chaet. atlantica var.	neapolitanum									R																	
Chaet.	pendulus														+												
Chaet.	Lorenzianus														R												
Rhizosolenia	alata	C				+		+	+	C	+	+	+	R			R	C						+	R		
Rh.	robusta	+			R	+	+	C	++	++	+	++	+.		+		R										
Rh.	calca-avis	+		+			+	+		++	+	C	C		C			+						C			

		1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	1
Rhizosolenia	styliformis	+										+		R	+												
Rh. styliformis var.	latissima											+															
Rh. alata f.	indica							+		C																	
Rh.	imbricata	C		+	RR	+	+	+	+	+	C	+	R	+	+	+		R	+	RR			RR	+	+		
Rh.	stoltherfothii					+	+	+	R	R					+	R	+	+									
Rh.	acuminata									C																	
Rh.	delticatula														R												
Rh.	setigera														R												
Thalassionema	nitzschioides	+		+		+		+	+	C	C	C	C	R	+		C	+						C	+	+	
Thalassiothrix	Frauenfeldii			+		+	+	+		C	+	C	C	R	+		+	+						C	+		R
Thal.	delicatula			R		R	+	+	+		R	R	RR	+	+							R		R			
Thalassiosira	decipiens												RR														
Tha.	condentata												RR														
Asteromphalus	flabellatus														RR												
Eucampia	zoodiacus	R		R				+		+	+				R		RR					RR					
Nitzschia	seriata	R		R			R				+	+	R	R										R			
Climacodium	Frauenfeldianum	R																									
Bacteriastrum	varians	+		+		+	+	C	R		+	+	+	+	+		+							+			
Bact. varians var.	hispida														R		R	+									
Bact.	delicatulum					R												+									
Bact.	hyalinum						R											+									
Biddulphia	granulata																										
Bid.	sinensis	C	C	+		+	+	C	+	C	C	+	+	+	R							+	R	R			
Dityloum	sol	R						R						R													
Dity.	undulatum													R													
Dity.	Brightwelli							R		++		RR															
Triceratium	favus							R				RR	RR											RR			
Pleurosigma	Normanni											RR															
Pleuro.	rectum																	+									
Pleuro.	pelagicum											RR															
Pleuro.	sp.												+											R			
Diatoma	sp.																								RR		

		1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	1
Navicula	sp.										R				R												
Melosira	sp.																							RR			
Amphiprora gigantea var. sulcata														RR													

Zooplankton	Station	1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	1
Globigerina	bulloides						R					RR															
Acanthometron	pellucidum												R											R			
Codonellopsis	parva			R														RR									
Tintinnopsis	platensis								R	RR			R		R									RR			
Tint.	bütchlii											R						RR						RR	R		
Ceratium	massiliense			C	R		+	R	R	R			R	R	R		+	RR				R		RR	+		
Cer. massiliense	var. protuperans						+																				
Cer.	fusus		R				R			R	R	R	R	R	R		R					R		RR	+		
Cer.	fluca																R										
Cer.	tripos																R										
Cer.	macroceros							R						R			R										
Cer.	kofoidi												R		R		R							R			
Cer.	stricutum							R																			
Cer.	gibberum							R					R									+		RR			
Cer.	azoricum																					R					
Peridinium	divergens					R		R	R	RR	R																
Pyrocystis	lunula														RR												
Pyro.	noctiluca																RR										
Pyro.	fusiformis																+								R		
Noctiluca	scintillans												C											C	+		
Clausocalanus	arcuicornis											R	R									RR			R		
Cl.	pergens											R	+														
Eucalanus	subcrassus											R	+														

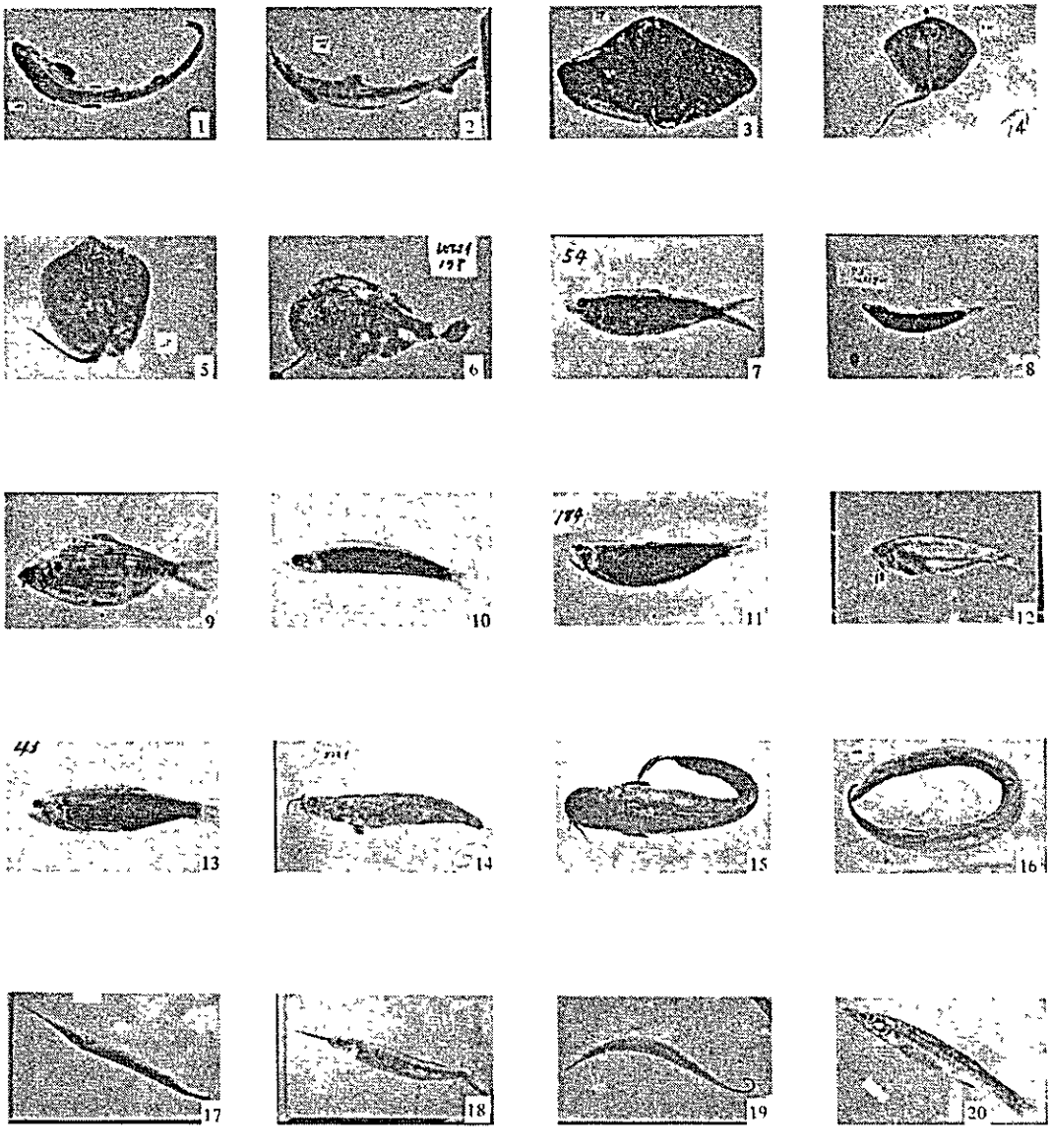
		1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	1
Paracalanus	parvus					+		+	+	+	+											R					
Para.	aculeatus							+														R					
Acrocalanus	monachus							+			R											R					
Acro.	gibber																					R					
Centropages	bradyi							RR	R		R											+	R				
Centr.	elongatus																						R				
Centr.	violaceus																						R				
Centr.	fulcatus									R			R										R	R	+		
Centr.	calanınus									R												+					
Labidocera	Krŏyeri							RR																	R		
Lab.	detruncata									R												R					
Lab.	bipinnata							R	R	R	R											R	R				
Lab.	euchaeta						R																				
Lab.	pavo									RR	R																
Lab.	spinicauda																						RR				
Aetideus	armatus					R										RR											
Tortanus	forcipitatus		+			+		+	C	+												R					
Candacia	catula																					R	R				
Acartia	erythraea		R			+	R	+	+		R											R	+				
Aca.	spinicauda																					+					
Aca.	danae																					C	R				
Aca.	clausi		R		R																	R					
Aca.	longiremis							R																			
Aca.	pacifica										R																
Calanopia	elliptica				R						R																
Gaetanus	armiger				R																						
Pontella	spinicauda							RR																			
Pontellina	plumata										R																
Lucicutia	ovalis				R																						
Pontellopsis	sp.										R																
Temora	turbinata							+			R																

		1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	1
Euterpe	acutifrons								R			R															
Scolecithricella	sp.														R												
Oithona	rigida							R	R																		
Oit.	robusta									R																	
Oit.	sp.									R																	
Corycaeus	speciosus		R				RR				RR										R			R			
Cory.	concinnus							R																			
Cory.	limbatus			R		R																					
Cory.	gibbulus							R																			
Cory.	agilis							R																			
Cory.	dahli													R													
Cory	catus					R		R	+									R						R			R
Cory.	lautus										R													R			
Cory.	robustus												R				R					R					
Cory.	vitreus										R													R			
Evadno	tergestina						R					R									+	+		+	R	+	
Balanus	naupli	R	R	R			R	+	+	R		+							+					+	+		
Copepoda	nauplii	R	R	+			R	+	+	R		+							+					+	+		
Fish	eggs		+	+		+	R	+	R	R		R	R						R	R		R		R			
Fish	larvae										R					R										R	
Brachyuran	larvae	+	+		+	C	R		C		+	+					+		+		R.	C			+	+	
Macruran	larvae	+	+		+	+	+	C	C	+	+		R			R	+		+		R			+	+		
Stomatopod	larvae					+	+	C	C	C					+		+									+	
Polychaeta	larva																									+	
Sagitta	spp.								R	R			R	R													
Megalocercus	huxleyi																							R			
Muggiaga	atlantica																					R					
Fritillaria	formica																					R					
Oikopleura	sp.																							R			
Sabellaria	sp.						RR																				
Paraphronima	sp.						RR																				

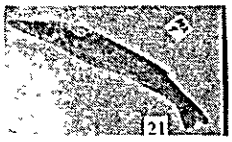
	1	2	3	4	5	6	7	7'	8	8'	9	9'	10	10'	1	2	3	4	5	6	7	8	9	10	11	I
Grammatophora sp.																							R			
Cyphonautes larva																						R				
Veliger.																						R				
Ostracoda																							R			

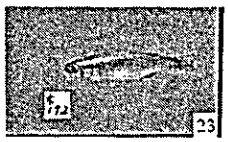
B. Figures of Fishes, Shellfishes, Crustacea and Mollusca collected in the coastal water of Cambodia

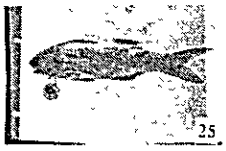
B-1 Fishes (1 - 92)

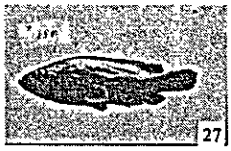


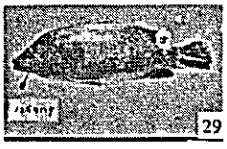
1. Atelomycterus marmoratus
2. Scoliodon sorrakowah
3. Cymnura micrura
4. Pastinachus sephen
5. Amphotistius imbricatus
6. Narke dipterygia
7. Kowaia coval
8. Dussumieria acuta
9. Andontostoma chacunda
10. Anchovielia commersonii
11. Thrissocles malabrica
12. Setipinna taty
13. Thrissa mystax
14. Plotosus canius
15. Tachysurus caelotus
16. Muraenesox cinereus
17. Tylosurus strongylunis
18. Homirhamphus geogii
19. Syngnathoides blaculeatus
20. Sphyraena langsar

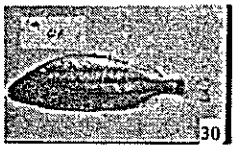


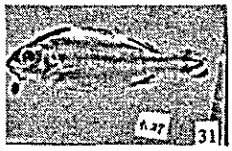


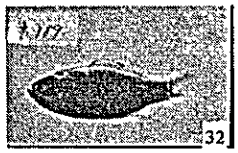


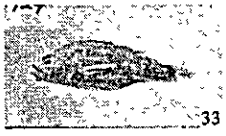


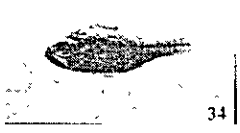


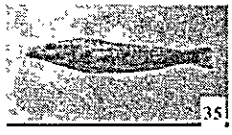


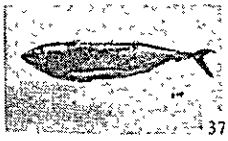


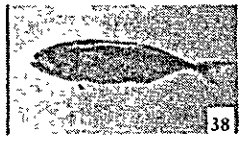




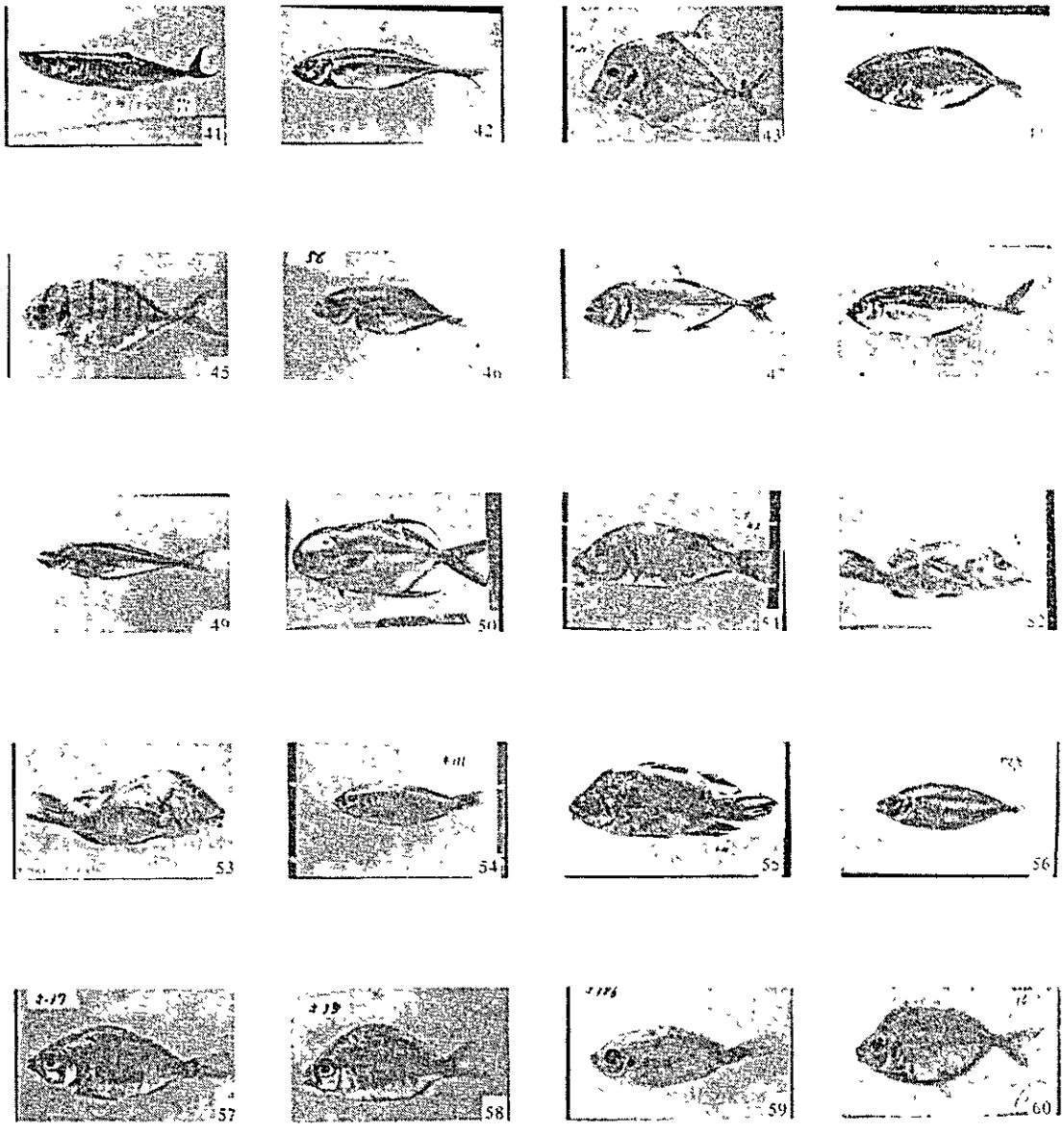




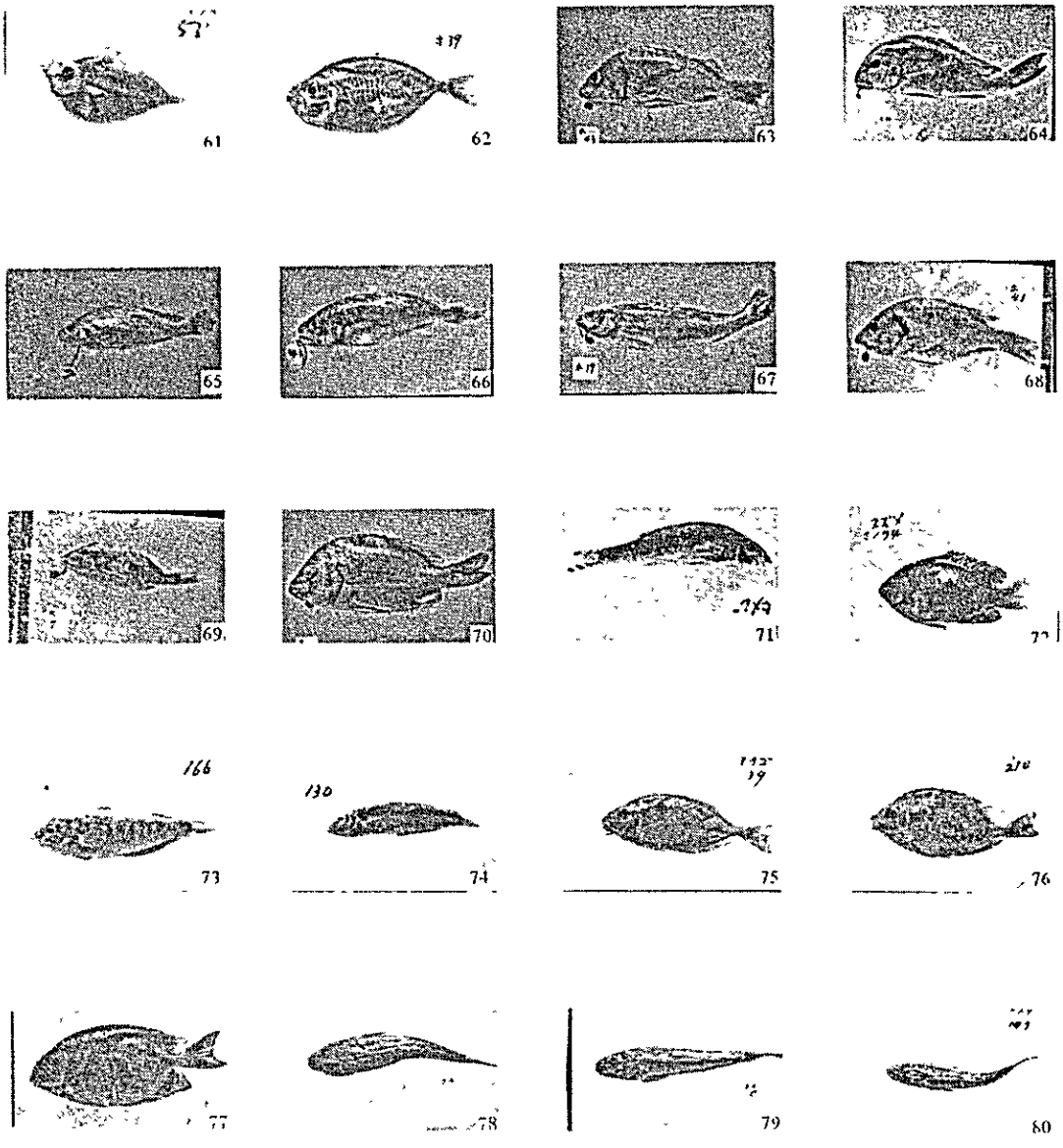




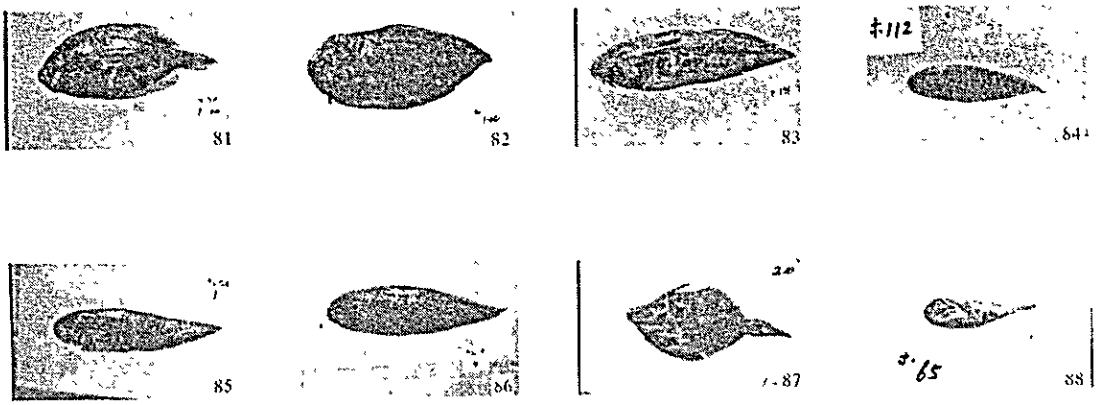
21. Sphyraena acutipinnis
22. Liza parsia
23. Liza strongylocephalus
24. Liza oligolepis
25. Polynemus plebeius
26. Promicrops lanceolatus
27. Epinephelus undulosus
28. Epinephelus malabaricus
29. Lates calcarifer
30. Pelates quadrilineatus
31. Therapon jarbua
32. Archamia lineolatas
33. Apogon thermalis
34. Apogon quadrifaciatus
35. Sillago sihama
36. Trichiurus savala
37. Katsuwonus pelamis
38. Rastrelliger canagurta
39. Scomberomorus commersoni
40. Scomberomorus lineolatus



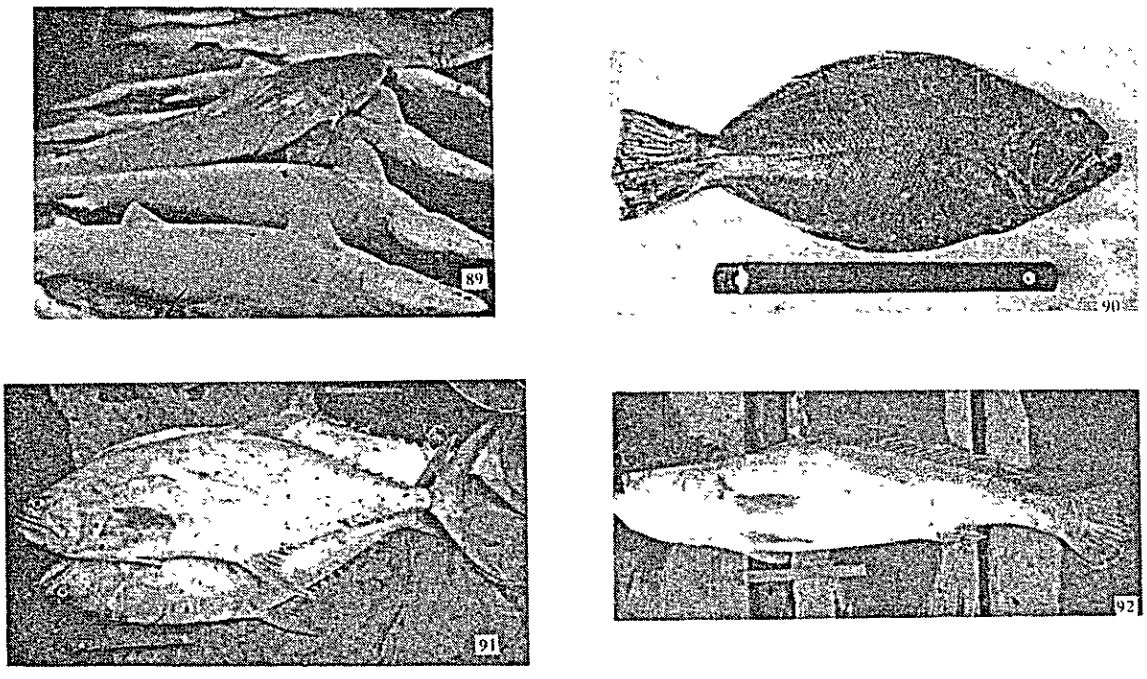
41. Scomberomorus guttatum
42. Megalaspis cordyla
43. Alectis indica
44. Selaroides leptolepis
45. Gnathanodon speciosus
46. Carangoides praeustus
47. Caranx melampygus
48. Caranx carangus
49. Chorinemus tala
50. Trachinotus blochi
51. Lutjanus johni
52. Lutjanus fulviflamma
53. Lutjanus sebae
54. Nemipterns personii
55. Lobotes surinamensis
56. Pentaprion longimanus
57. Gerreomorpha setifer
58. Gerres abbreviatus
59. Secutor ruconius
60. Leiognathus equulus



61. Leiognathus daura
62. Gazza achlamys
63. Pomadasys hasta
64. Spilotichthys pictus
65. Sciaena russelli
66. Johnius soldado
67. Otolithus argenteus
68. Lethrinus rhodopteus
69. Lethrinus reticulatus
70. Acanthopagrus berda
71. Upeneus tragula
72. Abudefduf biocellatus
73. Platyglossus notopsis
74. Halichoeres hyrtli
75. Siganus oramin
76. S. vermiculatus
77. S. stellatus
78. Thysanophrys indicus
79. Thysanophrys crocodilus
80. Callionymus sp.

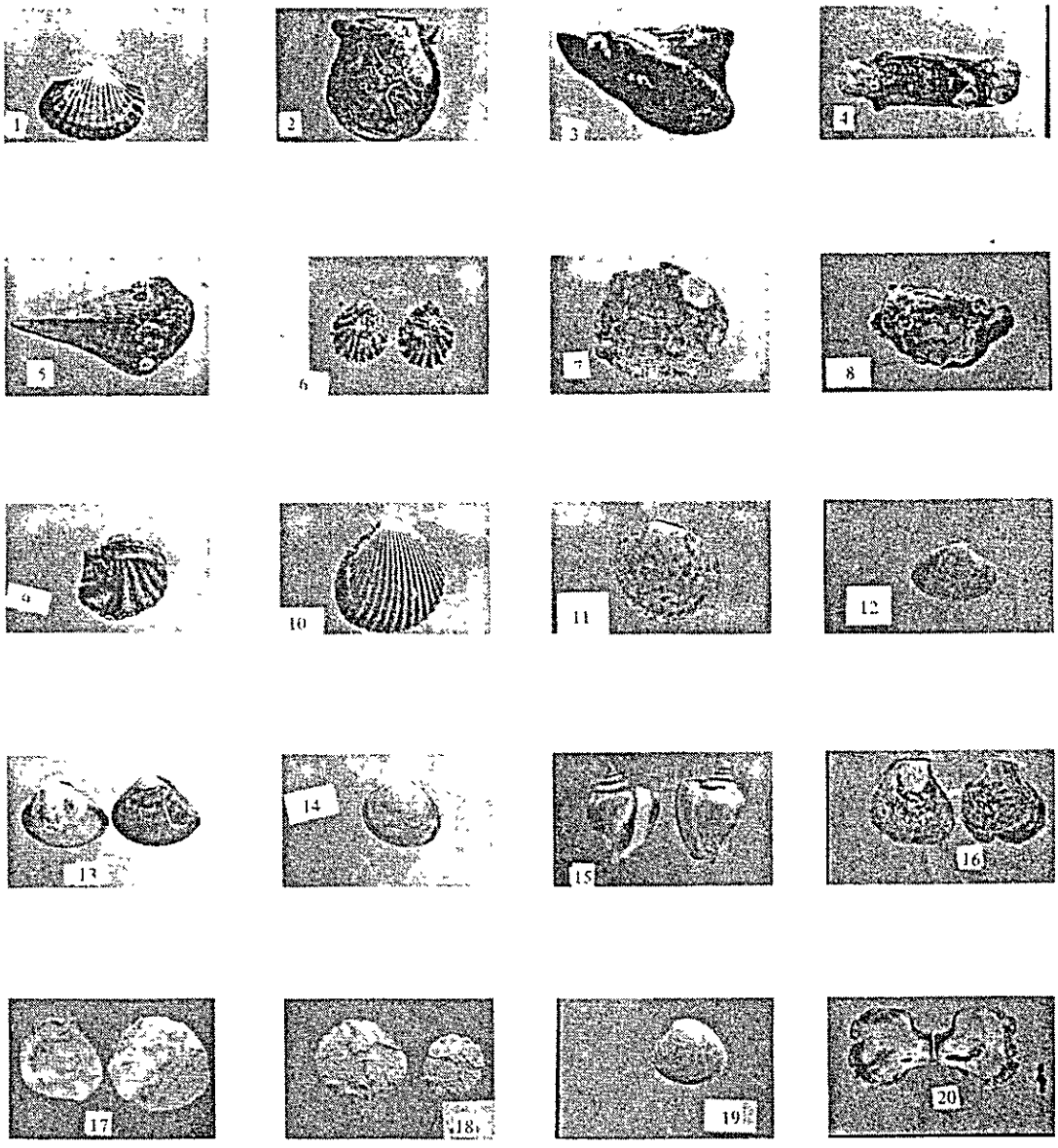


81. Pseudorhombus arsius
82. Brachirus orientalis
83. Cynoglossus macrolepidotus
84. C. brachycephalus
85. Cynoglossus lida
86. C. bilineatus
87. Pervagor tomentosus
88. Amblyrhynchotes hypselogenion

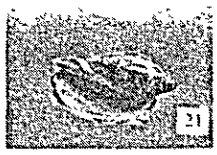


89. Chiloscyllium indicum
90. Psendorhombus japonica
91. Chorinemus laysan
92. Otolithus argenteus

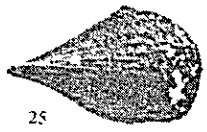
B-2 Shellfishes (1 - 37)



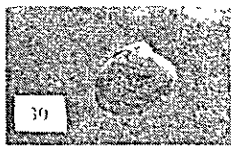
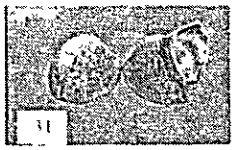
1. Tegillarca nodifera
2. Pinctada chemnitzii
3. Pteria sp.
4. Isognomon isognomon
5. Pinna bicolor
6. Plicatula australis
7. Ephippium ephippium
8. Crassostraea rivularis
9. Saxostrea sp.
10. Regozara flava
11. Periglypta puerpera
12. Paphia textile
13. Meretrix meretrix
14. Circe stutzeri
15. Canarium isabellum
16. Melina ephippium
17. Crassostrea belcheri
18. Plicatula horrida
19. Katelysia sp.
20. Melina ephippium

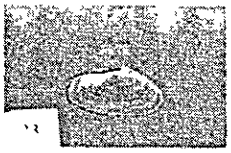


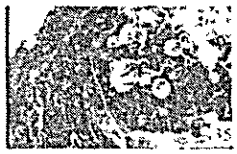


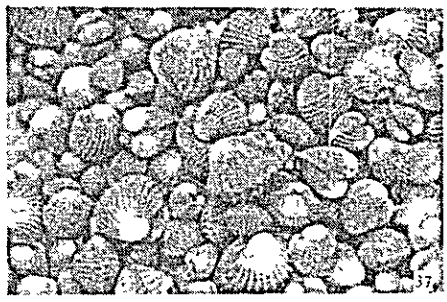




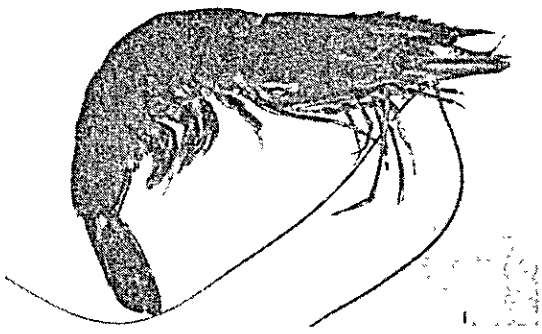




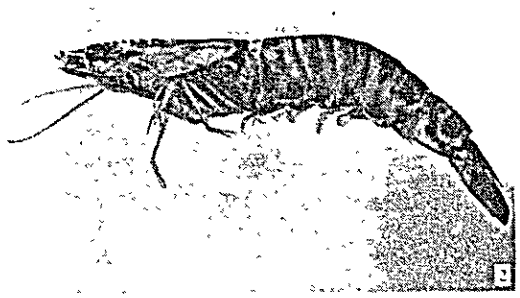


21. Volutocorona nobilis
22. Chloromytilus viridis
23. Modiolus philippinarum
24. Phacosoma aspera
25. Atrina vexillum
26. Crassostraea rivularis
27. Chama pacifica
28. Scapharca suberenata
29. Trapezium japonicum
30. Katelysis hiantina
31. Gafrarium tumidum
32. Anomalodiscus squamosus
33. Psammotaea elongata
34. Volegalea cochlidia
35. Larva oyster
36. Meretrix meretrix
37. Scapharca cornea

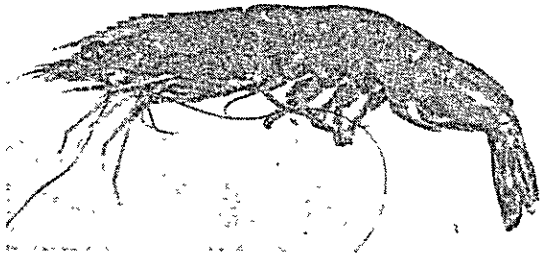
B-3 Crustacea (1 - 10)



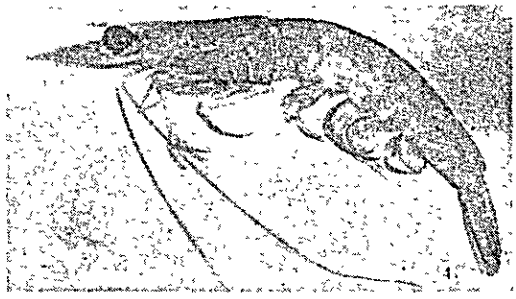
1. Penaeus monodon



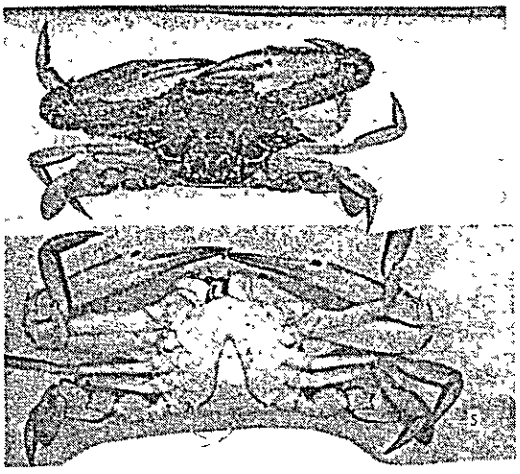
2. Penaeus semisuricatus

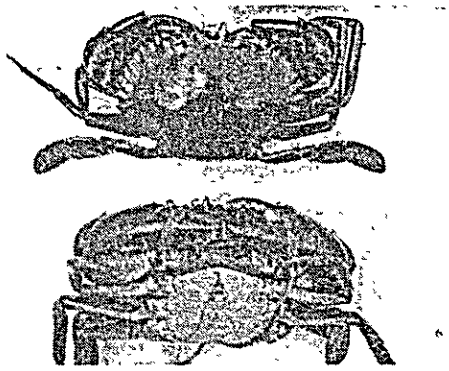


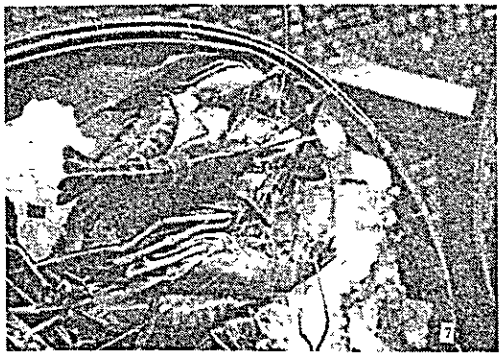
3. Penaeus indicus

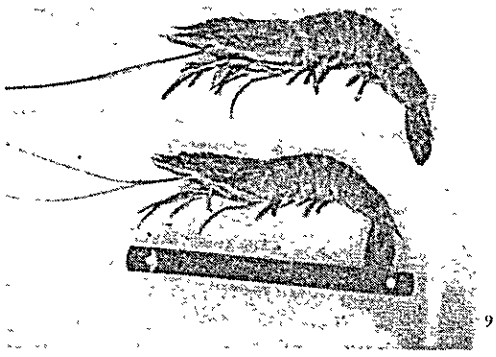


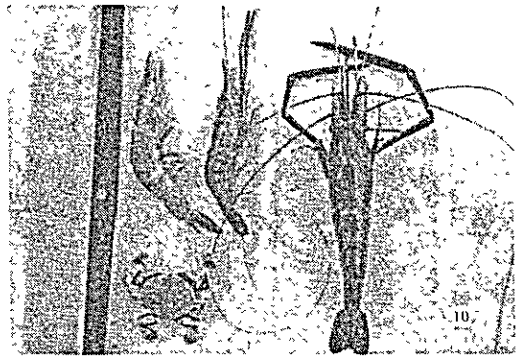
4. Metapendeus sp.





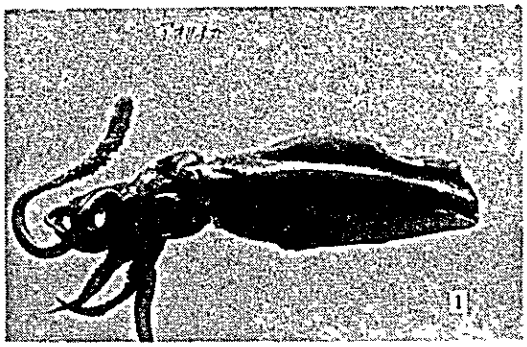


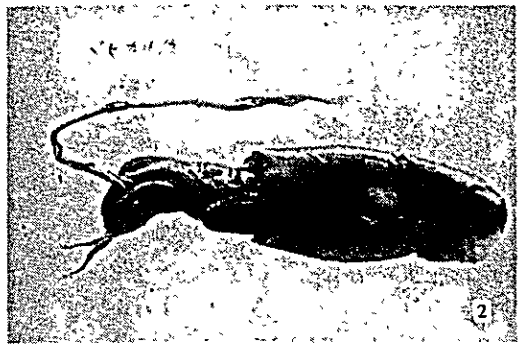


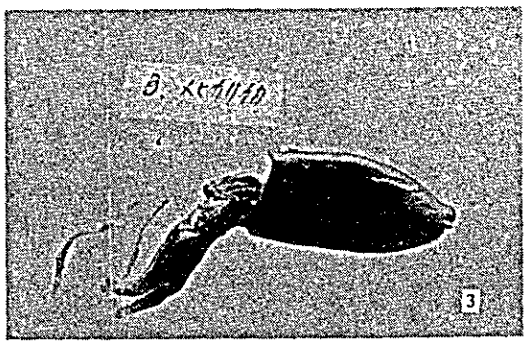


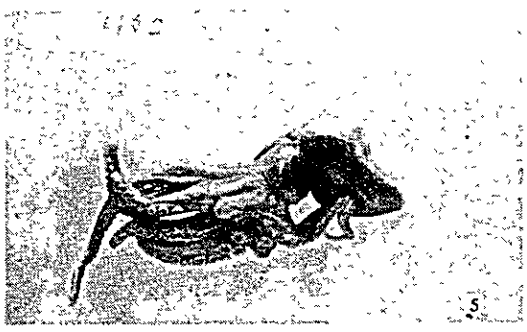
5. Portunus pelagicus
6. Scylla serrata
7. Macrobrachium rosenbregii
8. Penaeus sp.
9. Penaeus semisuricatus
10. Macrobrachium sp.

B-4 Mollusca (1 - 6)





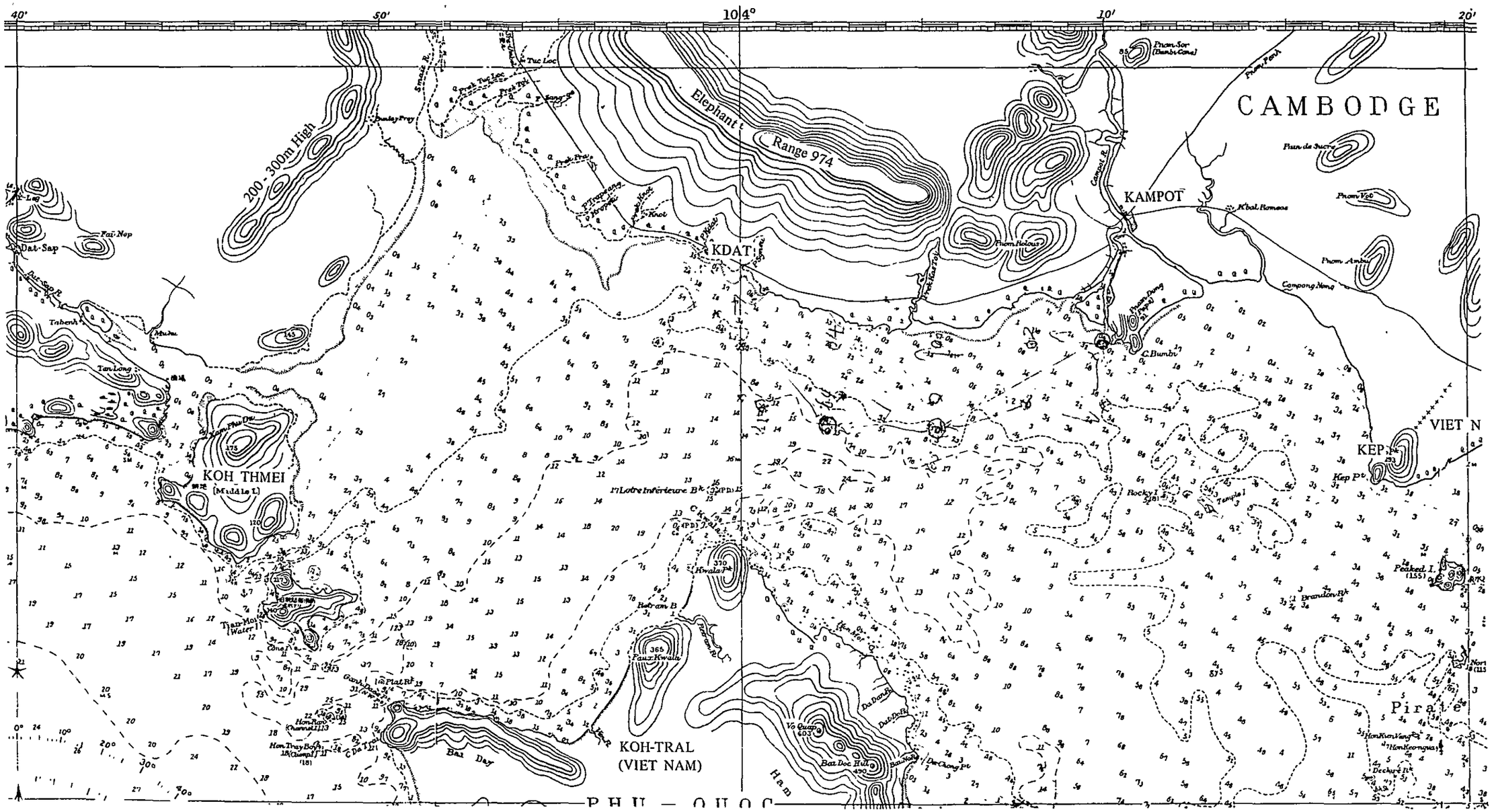




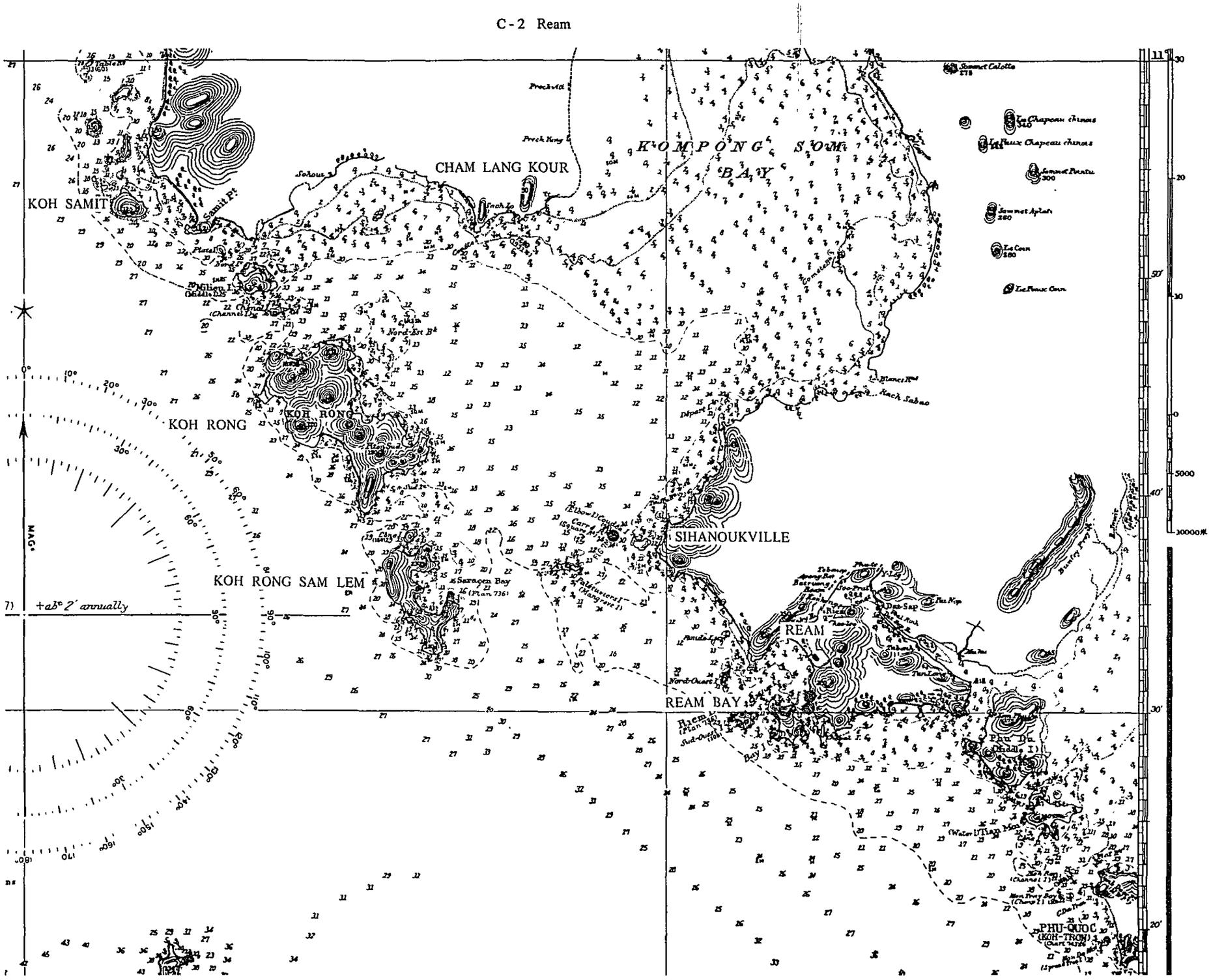
1. Sepioteuthis lessoniana
2. Loligo duvauselli
3. Loligo sp. (juv.)
4. Sepia aculeata
5. Octopus ocellatus
6. Octopus macropus

C. Coastal Chart of Cambodia

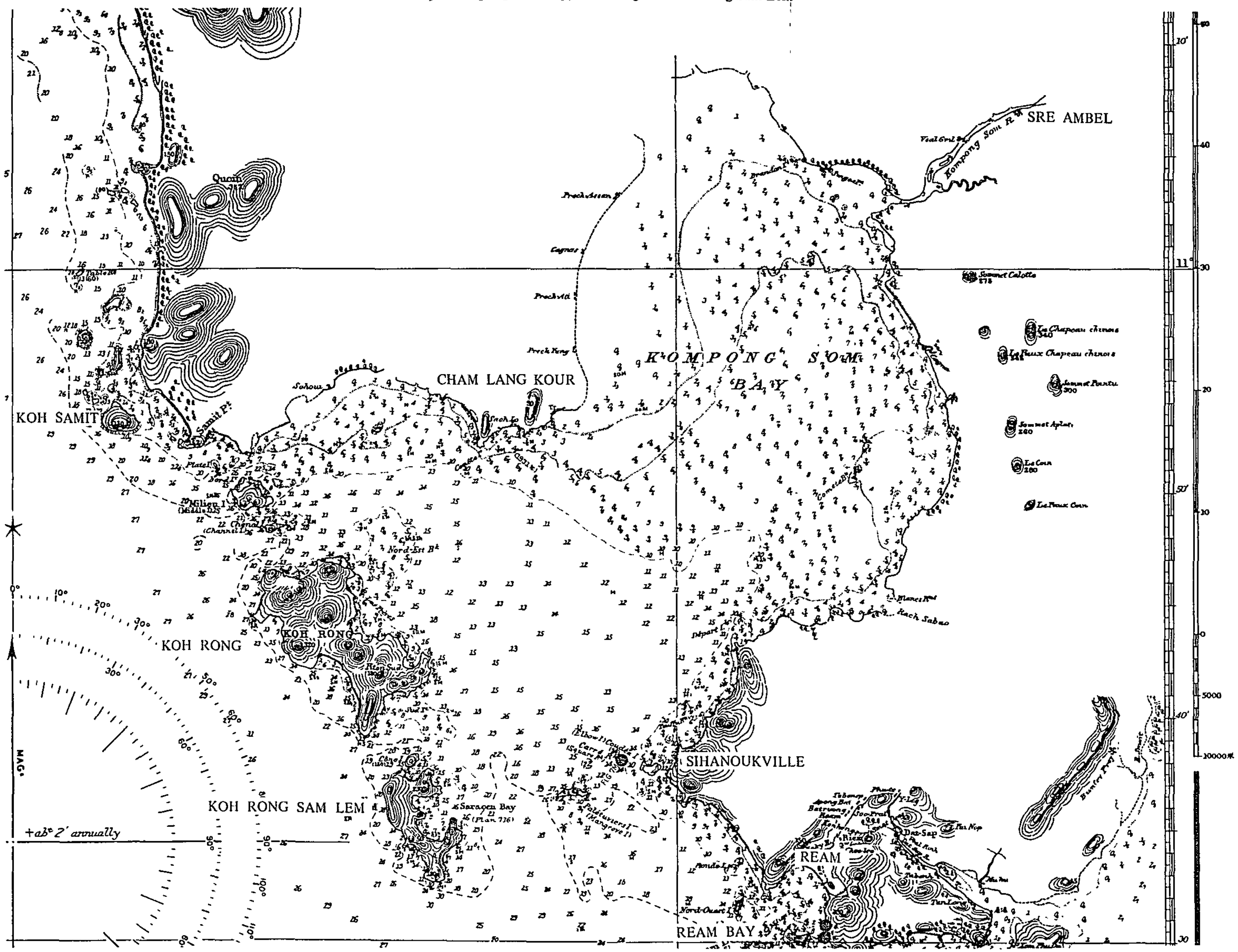
C - 1 Prek Kdat, Kampot and Kep



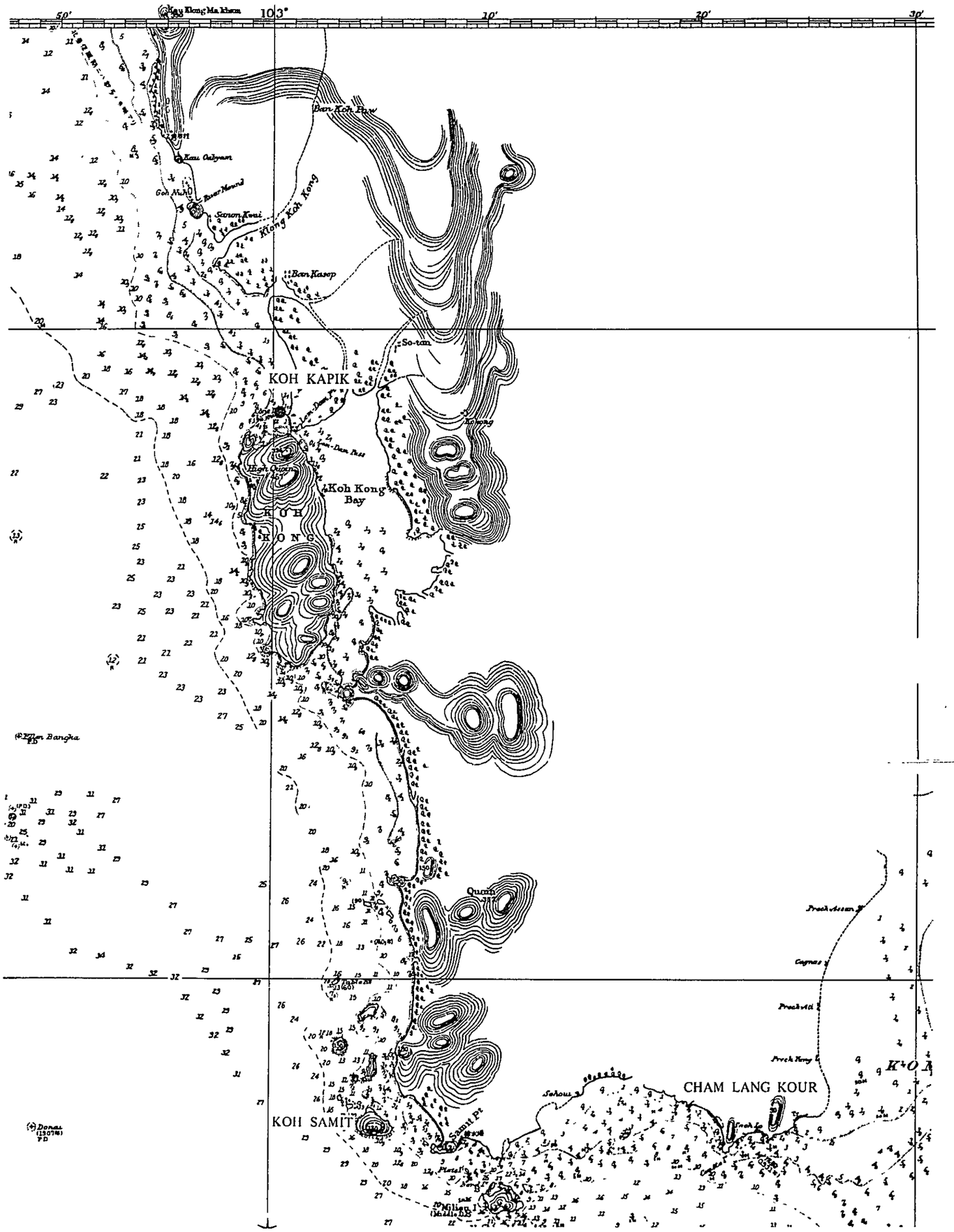
C-2 Ream


KOH SAMIT
CHAM LANG KOUR
KOMPONG SOM BAY
KOH RONG
KOH RONG SAM LEM
SIHANOUKVILLE
REAM
REAM BAY
PHU-QUOC
(KOH-TROM)
+ab° 2' annually

C-3 Kompong Som Bay, Koh Rong and Koh Rong Sam Lem

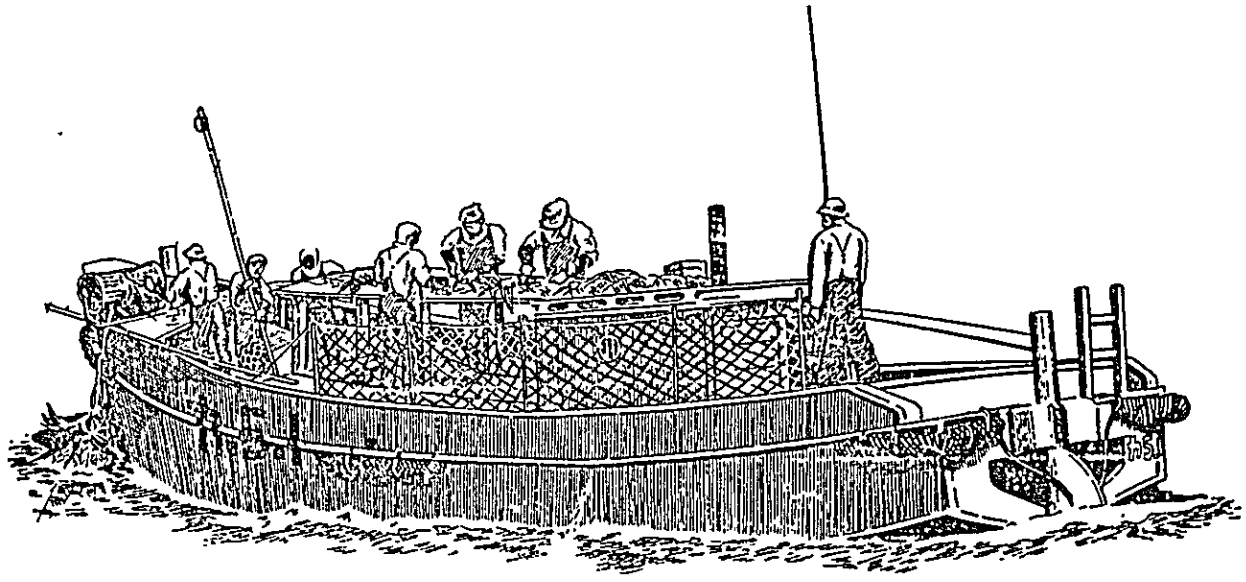


C - 4 Koh Kapik, Koh Kong and Koh Samit



D Illustrations of Japanese Fishing Boat and Fishing Gear

D - 1 Crab Gill Net Fishing Boat



Construction: Generally wooden boats of some 15 tons, though some lately constructed are of aluminum alloy.

They are taken on the factory ships to the fishing grounds, where they are employed for hauling up the nets.

They are of Japanese form, even in the case of the light alloy boats. Provided with aft-engine and have holds before the engine room.

To enhance stability and buoyancy, the boats are furnished with water-tight air space, some 40 cm wide, between the holds and the shell of the boats.

The nets are hauled in by means of the net-hauler, and the crabs are taken out on the work platform made on the holds.

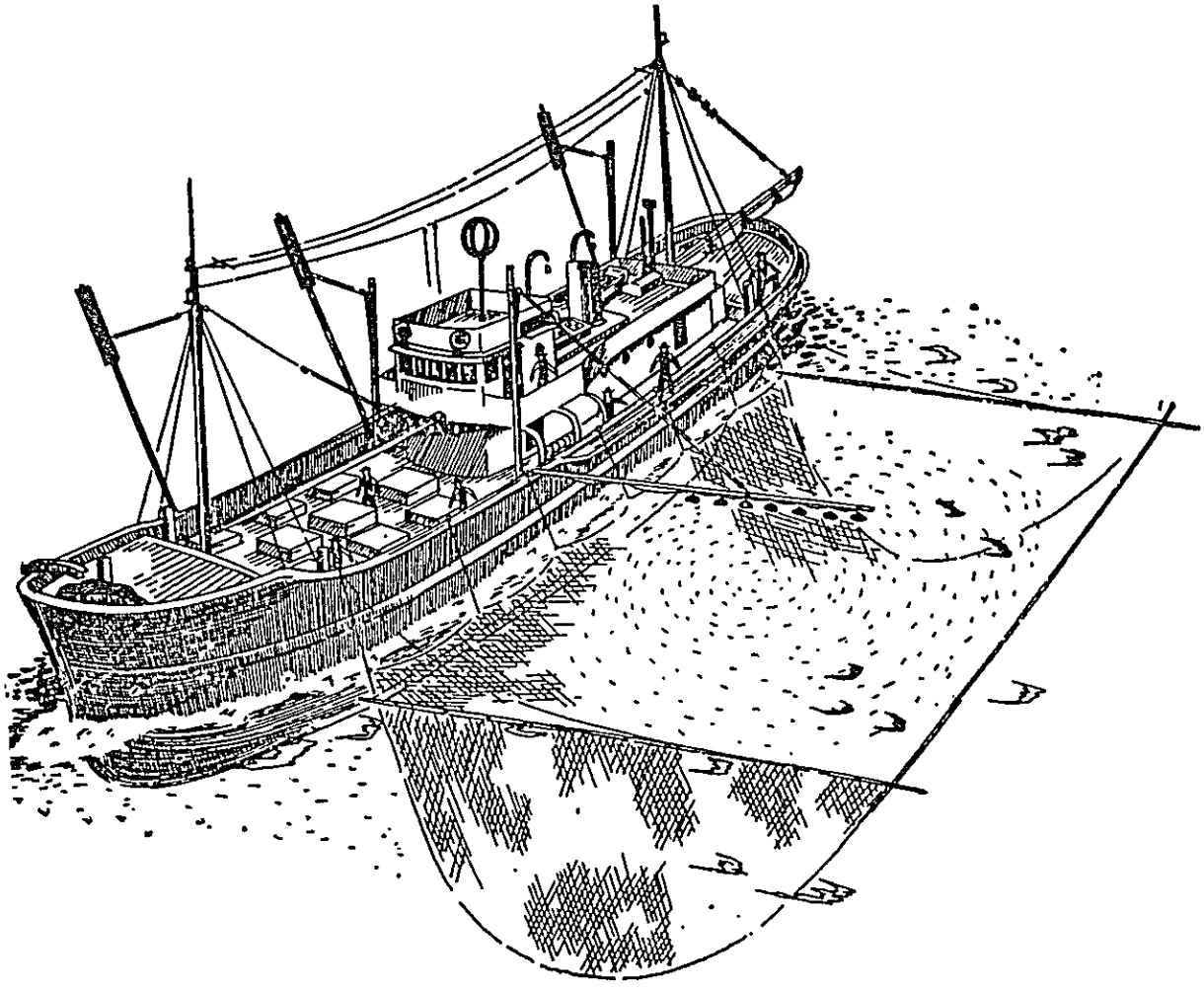
Equipments: Powered by high speed Diesel, electric ignition engine, or others. Equipped with micro-wave telephone, net-hauler or other necessary instruments.

Characteristics: Cruising speed is some 7 knots, with short cruise duration. Manned by 8—9 men.

They are carried on board the factory ships.

Note: They resemble ordinary Japanese style boats in the fundamental form, but are made stouter.

D - 2 Pacific Saury Stick-held Dip Net Boat



Construction: The title is a collective name for boats engaged in this fishery, which are multifarious in the type of boat and also in size. Usually, they are used for one or other seasonal fisheries, such as skipjack and tuna fisheries, drift net or trawling. The hold is partitioned into small rooms for carrying catches in bulk.

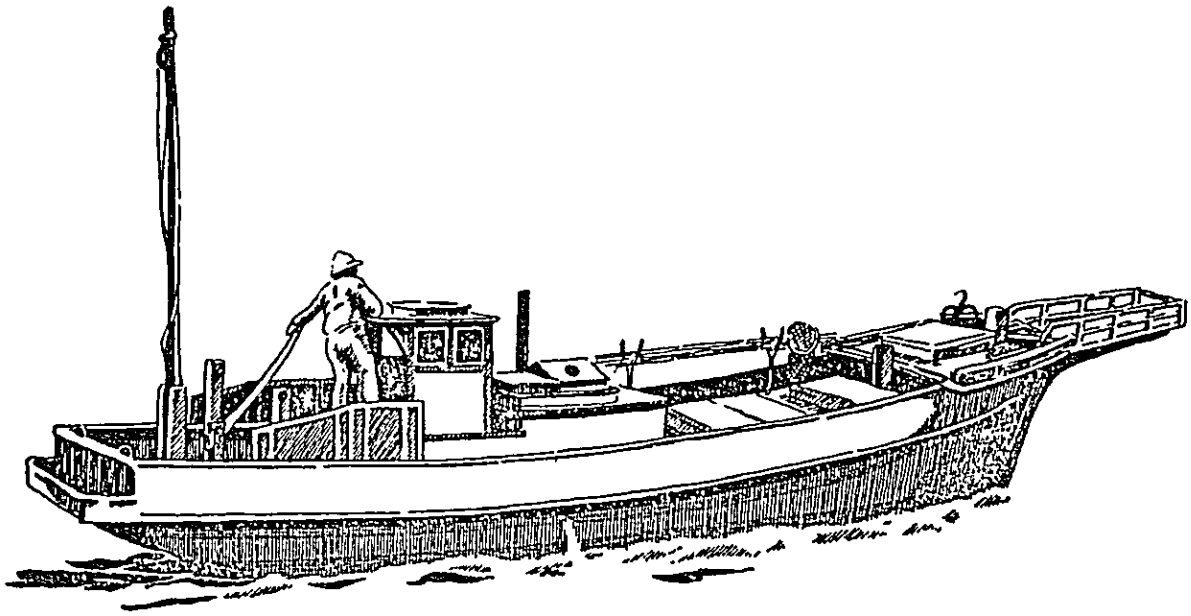
Equipments: Usually Diesel powered. Equipped with wireless telegraph, fish and direction finders, and some 30 K. W. generator for fish luring lamps or other demands. The lamps are fixed, with one set on the net side and three or four sets on the opposite side. Beside these, search light of 500 W—1 K. W. is often set on the bridge.

Characteristics: Cruise duration varies individually with a speed ranging from 7 to 10 knots. Manned by a relatively large number of men, as of 30 men in 50 ton boats and 40 in 100 tons.

Bases: Scattered all around Japan. Fishing grounds are extended along the Pacific coasts of northern Japan, from Hokkaido down to the Kanto district.

Note: There are similar types of boats, such as skipjack and tuna boats, drift netters, and trawlers.

D - 3 Coastal Fishing Boat



Construction: Wooden boats of less than 20 gross tons, which form the main strength of the Japanese coastal fishing fleet. Their shape is of Japanese style, but their construction almost of western style.

They are provided with aft-engine and fore-fish holds. No crew space is particularly found in small boats.

Their forms vary locally, and they are used for miscellaneous fisheries.

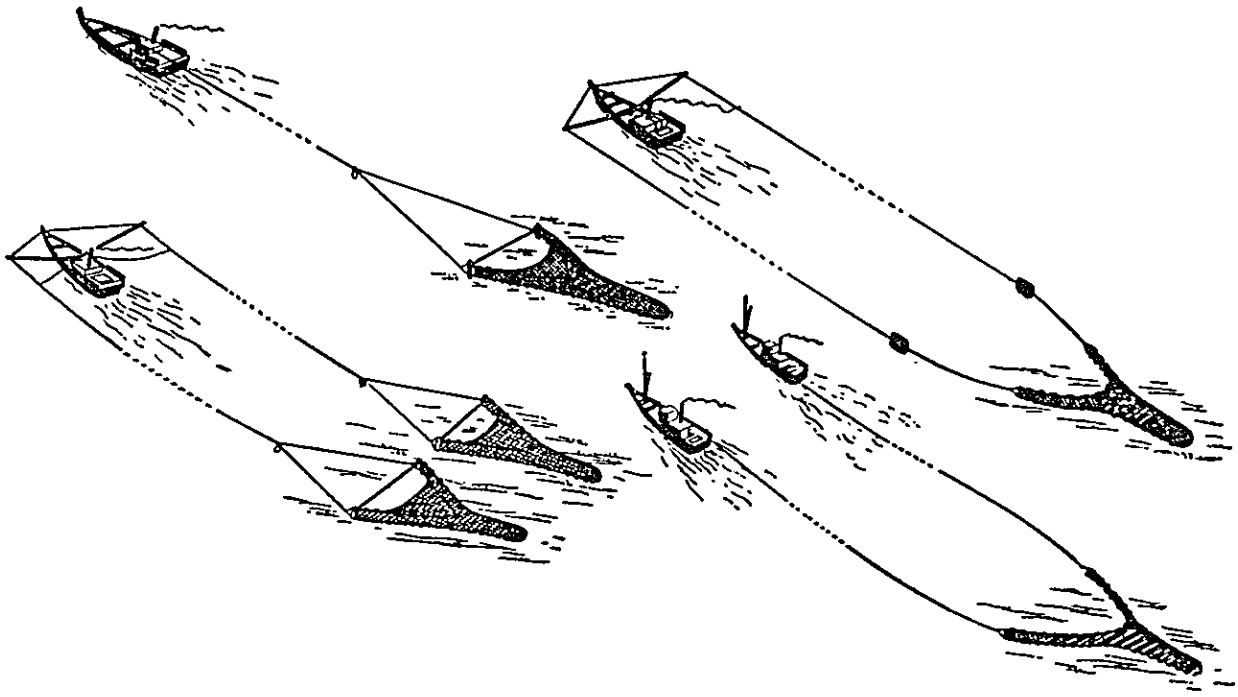
Euipments: Powered by electric ignition, hot-bulb, or Diesel engine. Usually equipped with sails, and some with fish finders.

Characteristics: Cruising speed ranges from 4 to 8 knots. Fishing trip usually covers one day or a few days at most. Manned by 3—8 men.

Bases: Scattered all along the Japanese coasts.

Note: This type of boats is a compromise among various types of fishing boat.

D - 4 Small Trawl



Construction: The gear consists of cod end or pocket net, wing net and ceiling net. The mouth of the net is kept open by means of beam. The total length of the net is about 15—20m. 'Kogi ami', locally called 'Hiki-ami' (drag net) or 'Teguri-ami' (hand purse seine), is a kind of drag net of small type.

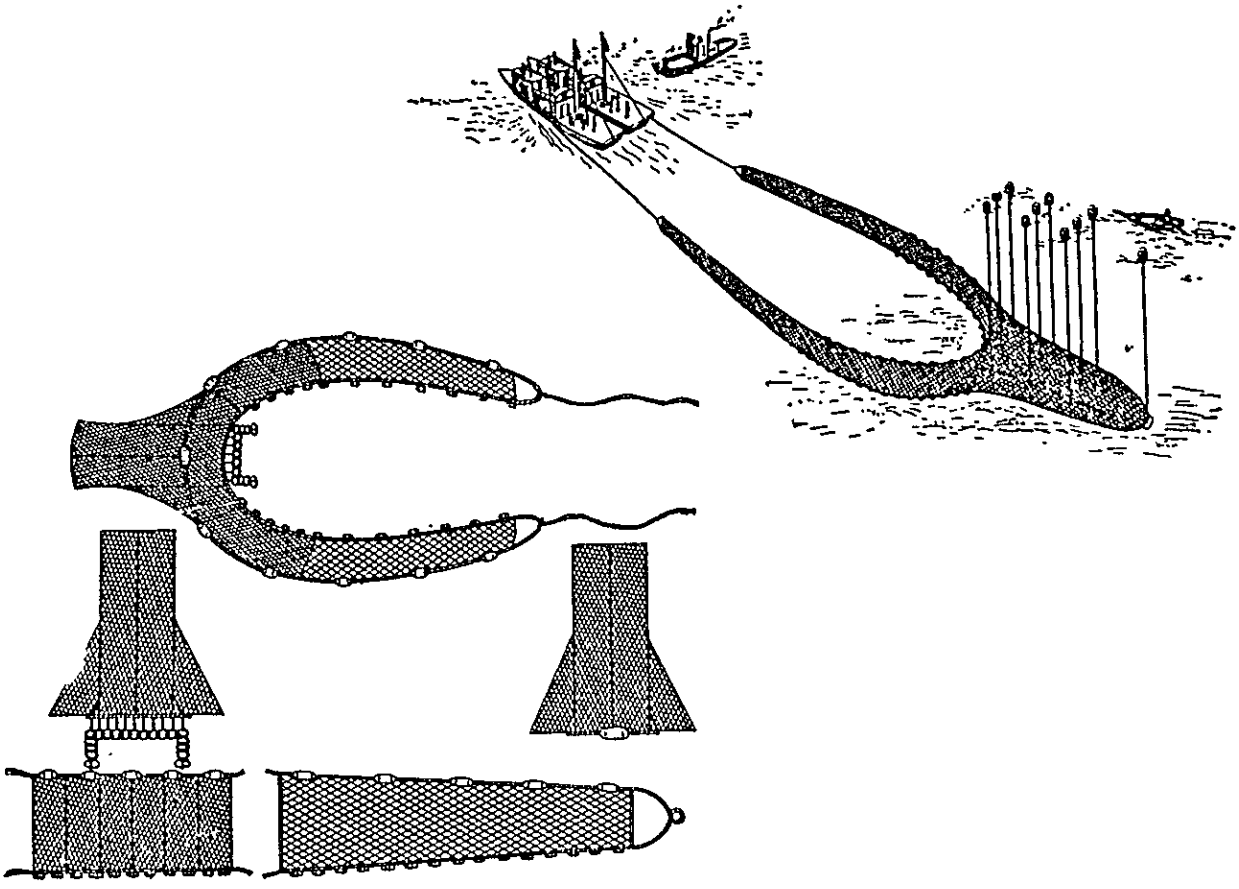
Operation: Fishing boats of 2—5 tons and 10—15 HP are used. The net is trawled on the sea bottom, and is hauled up by a winch. The fishing operation is usually conducted at night.

Fishing season: All the year round, especially from May to October.

Species: Chiefly shrimp; conger eel, flatfish, flathead, octopus and crab are also caught.

Fishing grounds: The Seto Inland Sea, Ariake Bay and other coastal waters.

D - 5 Sardine Drag Net



Construction: The construction of gear varies with the locality where it is used, but it is almost similar to that of beach or boat seine. The total length of the net is about 250m. The pocket net or minnow net is about 50m; the wing net is about 70m; the large-meshed wing is about 130m, and the rope is about 160 m long. An iron anchor of around 120kg is used for holding up the boats while the net is being trawled.

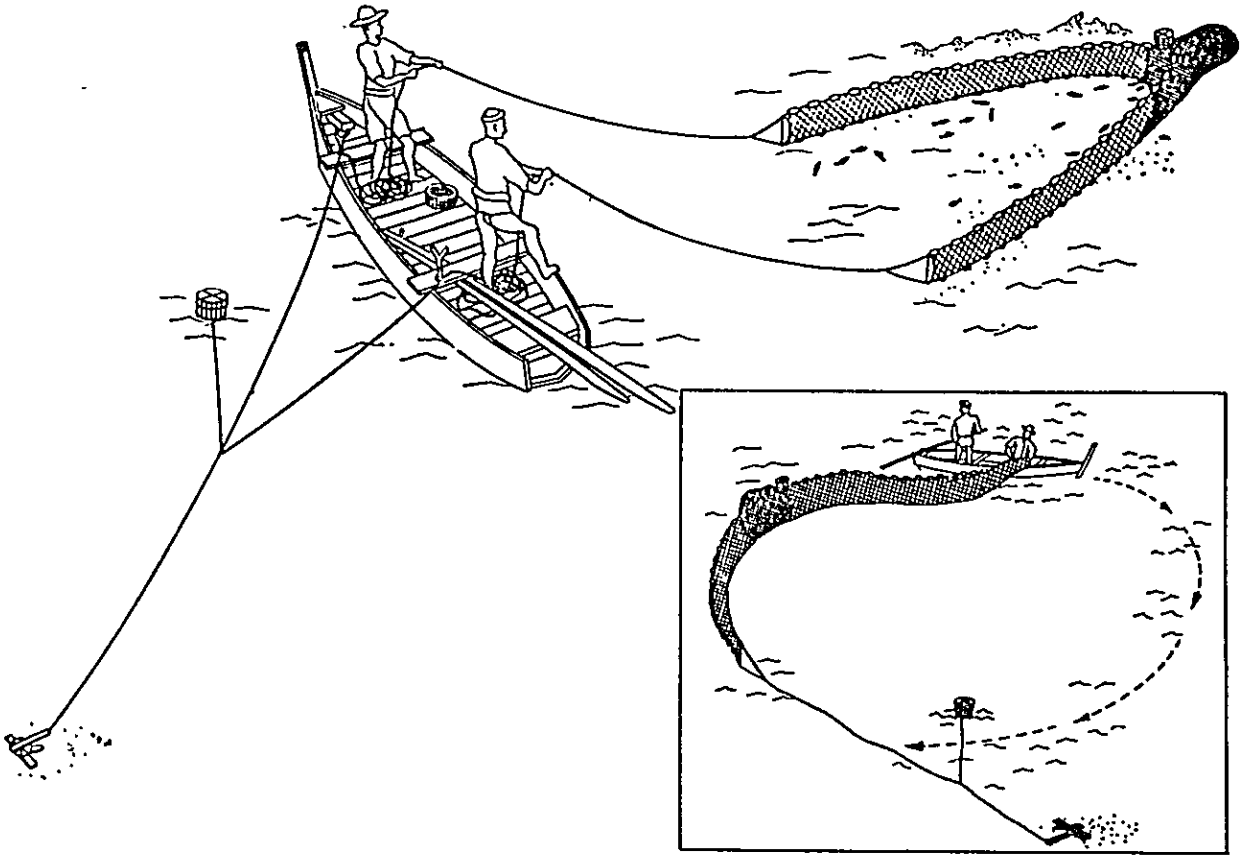
Operation: Two fishing boats (15—18Ts and 40—70 HP each), a small boat and a carrier form a unit of operation, and 20—50 men are needed for this fishery. The two fishing boats, surround fish school holding each end of the hauling rope. When both boats come side by side, they hold up or keep on sailing together, and haul up the net by a winch. The catches are carried home by the carrier.

Fishing season: All the year round.

Species: Chiefly sardine; cuttlefish, horse mackerel, mackerel and sand lance are also caught.

Fishing grounds: Coastal waters of Aichi and Mie Prefectures and the Seto Inland Sea.

D - 6 Hand-Operated Trawl by Boat



Construction: The gear is a smaller type of beach seine. It consists of pocket net, wing net, rope and buoy. A flapper is attached to the pocket net to prevent the esape of once entrapped fish.

Operation: One or two fishing boats manned by 5—6 men each and a handy boat manned by 2—3 men form a unit of operation. One end of the rope is held by an anchor whose position is marked by the buoy. Then holding the other end of the rope the fishing boat surrounds fish school and the men on board trawl the net and ropes, and haul up the catch.

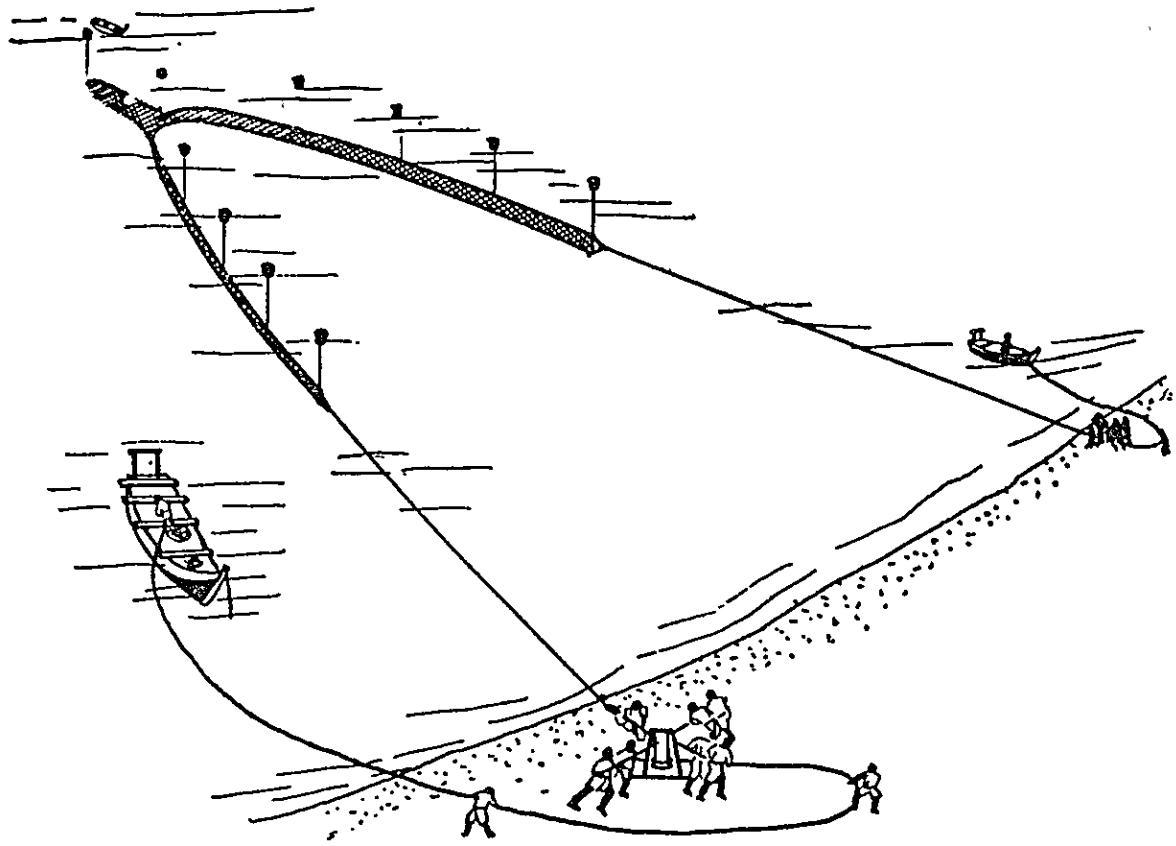
Fishing season: June-September.

Species: (a) Sardine and barracuda [1]
(b) Sea bream, flatfish and shrimp [2]

Note: [1] These species are caught by the so-called 'sardine hand operated trawl' which is operated by two fishing boats in pair in the coastal waters of 10—15 m deep.

[2] These species are fished by a single boat in bays up to 50m in depth.

D - 7 Beach Seine



Construction: The gear consists of pocket net or cod end, wing net, rope, sinker and buoy. The wing net is 150—200m long. The rope is usually of Manila rope, sometimes of rice straw, and is about 3,000m in length.

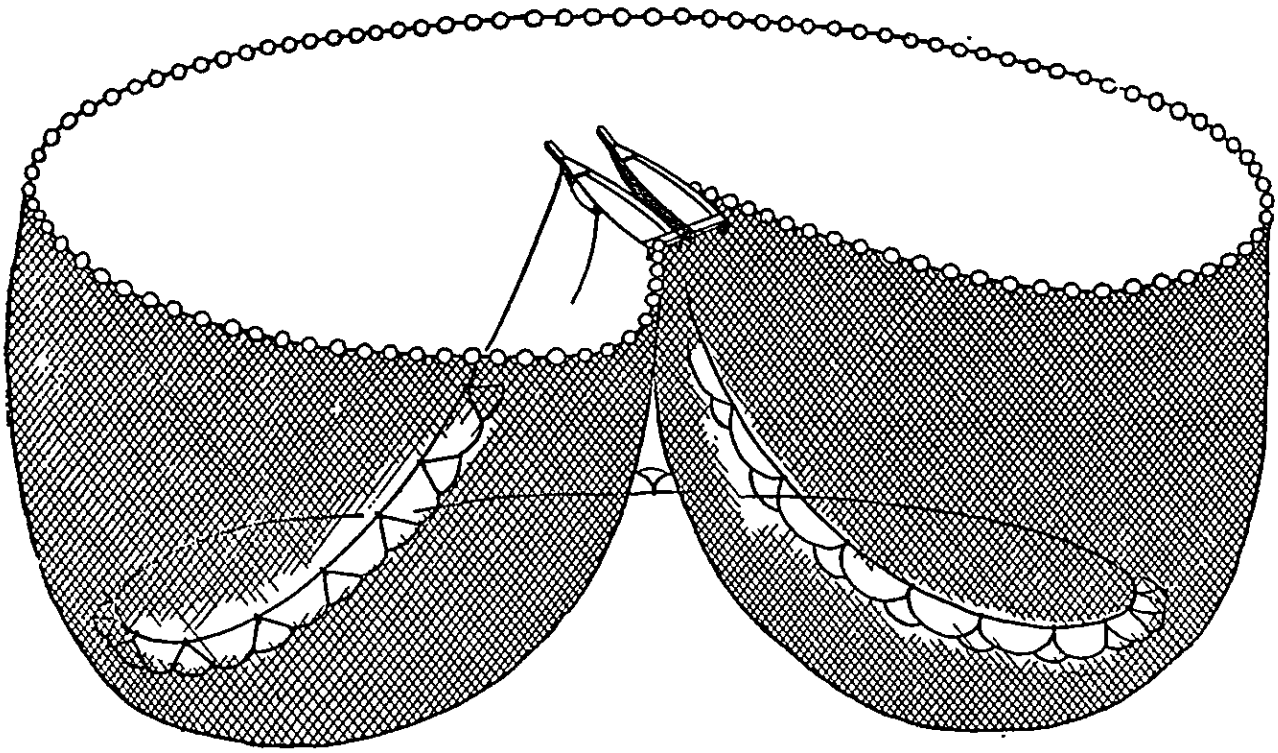
Operation: To surround fish school, a single boat or two boats are used. After the net has surrounded the fish school, fishermen on beach regularly drag the wings of the net. As the net approaches the beach, the fish are driven into the pocket and are hauled up on shore.

Fishing season: Spring and summer.

Species: Sardine, mackerel, Spanish mackerel, hard tail, seabream, flatfish, etc.

Fishing grounds: Coastal waters near sandy beaches facing the open sea and with no rapid current running.

D - 8 Two Boat Purse Seine



Construction: The gear consists of net, warp, float and sinker. The net is long and broad, the ratio of the length and breadth being 6—10 : 1, namely 250—500m : 40—70m. The upper part of the net is kept afloat by means of floats and the lower part is kept submerged by means of sinkers. The purse lines or wire ropes which are designed to close the bottom of net are attached to the sinkers. The wire ropes are connected together by a shackle at the bunt. The warps are fastened to the ends of net.

Operation: Two fishing boats are used in the operation. The net is carried to the fishing ground by the two boats sailing side by side. In the fishing ground, they quickly separate from each other lowering the net in the water as they sail, so as to surround fish school. Then the bottom of net being closed, the fish are entrapped in the net.

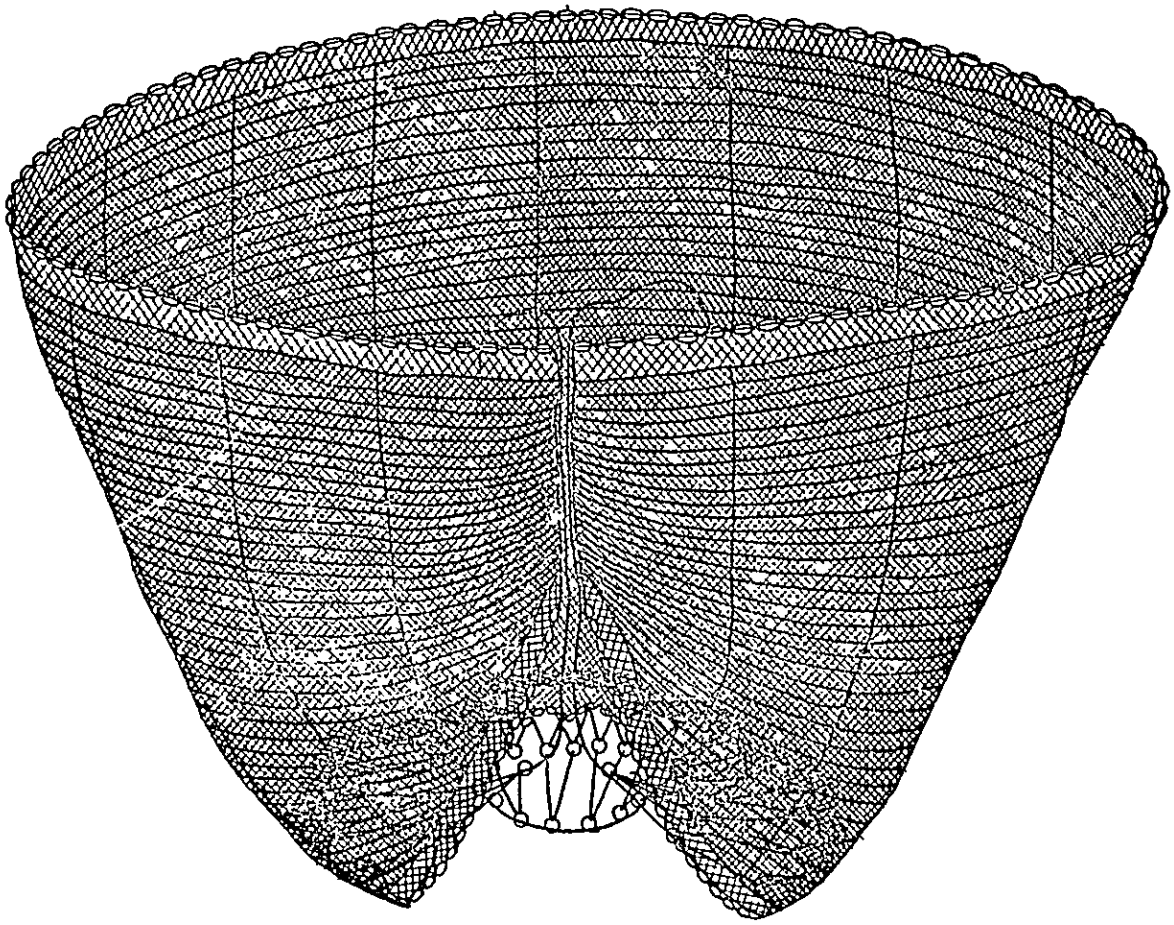
Fishing season: All the year round.

Species: Sardine, mackerel, horse mackerel and other pelagic fishes.

Fishing grounds: Coastal and off-shore waters throughout the country.

Note: 'Takiyose ami', a variation of this gear, is operated at night by aid of luring lights. In the Tokoku district, skipjack fishery is also operated by two-boat purse seine.

D - 9 One-Boat Surrounding Net



Construction : Similar to that of the two-boat surrounding net. It is the recent trend that the nettings are made of synthetic fibers.

Operation : The gear is operated in a similar way to that of the two-boat type. Particularly, the relative position of the boat and the form of the net in the water, after the surrounding is through, are kept entirely in the same manner as in the case of the latter.

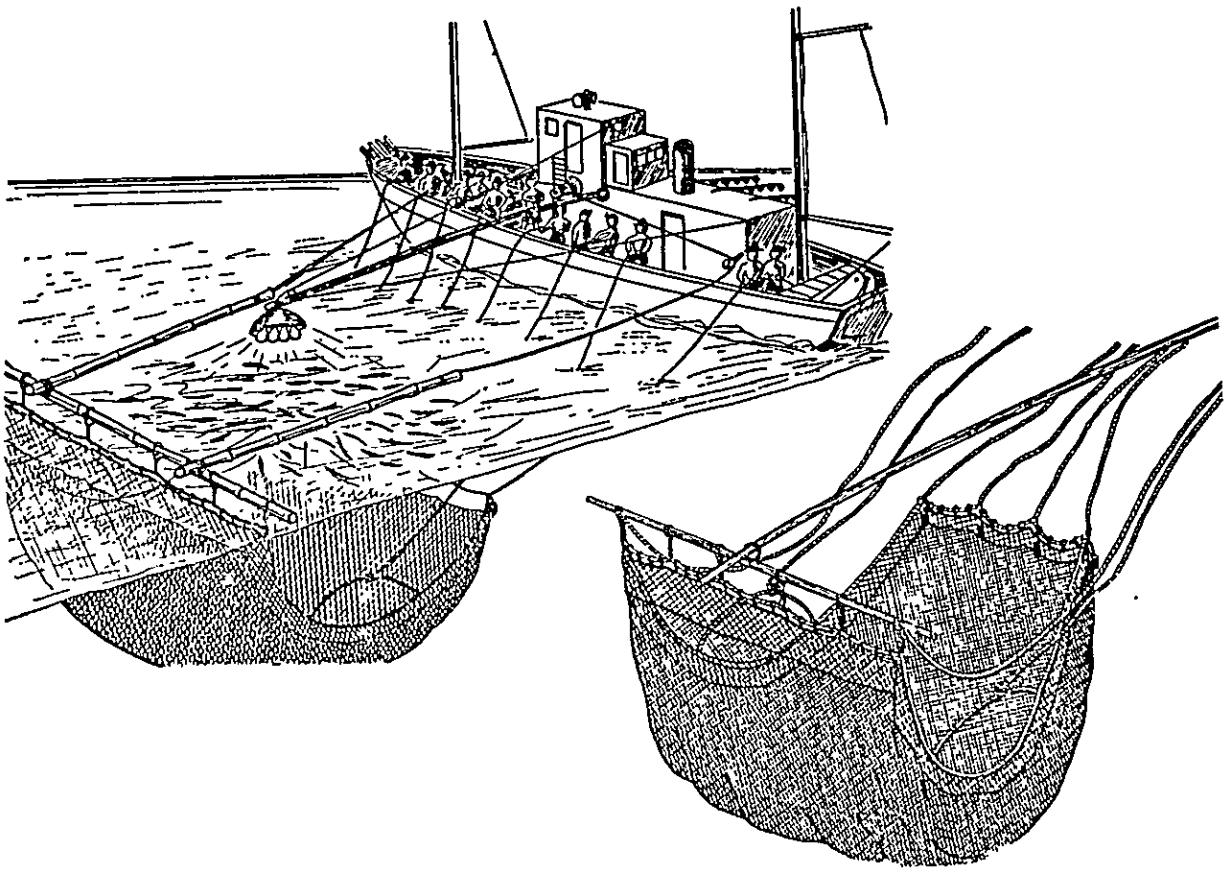
The netting boat, holding one end of the net, surrounds fish school at full speed and in such a way as to block the fish passage, during which a skiff standing still holds the other net end. After that, the netting boat, receiving the purse line and bridle from the skiff, brails the bottom of the net.

The net is, then, hauled up from one end to capture the fish thus enclosed.

Distribution and Season : Same as the two-boat surrounding net.

Species : Sardines, mackerel, horse mackerel, skipjack, etc.

D - 10 Stick-Held Dip Net



Construction: The gear consists of net, stick or pole, and rope. The net is a sort of square lift net, and is made of cotton twine or synthetic fiber thread. The size of gear varies according to that of fishing boats used for the fishery. In case of small type, its upper part is held by a bamboo stick or pole and in case of the net of large type, by a float, and its lower part is weighed down by weights.

Operation: The net is set by a fishing boat in the fishing ground. Fish are lured into the net by lights or by dropped baits, and then they are scooped up. Pacific saury fishing is a typical stick-held dip net fishery operated with aid of luring lights at night. The fish school are attracted by lights at one side of the fishing boat first, then lured by change-over switch operation the fish turn in group to the other side of the boat where the net has been set, and are entrapped therein.

Fisning season and grounds: Pacific saury——September-December, Pacific coast area.
Horse mackerel——from autumn to spring, around Izu Islands.

Species: Pacific saury, horse mackerel, sarding, etc.

Note: This fishery was initiated in Chiba Prefecture to catch small mackerel and horse mackerel.