FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

INDO-PACIFIC FISHERIES COUNCIL

PROCEEDINGS

4TH MEETING
QUEZON CITY
REPUBLIC OF THE PHILIPPINES
23rd October-7th November, 1952

SECTION II

IPFC Secretariat, FAO Regional Office
for Asia and the Far East,
Bangkok
1953

The full PROCEEDINGS of this meeting consists of two sections of which t[illegible]
nd, *Technical Papers*, is contained in this issue. Section I comprised the *Report* [illegible]
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ERRATA

Page 148, below Table I, line 5, *for* Burek *read* Burck.

,, 152, below (a) *Belat*, line 7, *for* bedd *read* Bedd.

,, 156, below (i) *Pukat Britus*, line 5, *for* 3″ × 8″ *read* 3/8 inch.

,, 163, 1st col. line 6, for *faute de mixux* read *faute de mieux*.

,, ,, 2nd col. line 1, *for* such the new *read* such new.

,, 167, 2nd col. last but two lines under Summary, for *Dcytela* read *Dyctela*.

,, 170, Table 5 *for* in Table 3 *read* in Table 4.

,, 195, Table 1, col. 2, item 3, *for* 60-75 *read* 65-75.

,, 196, Original map reduced from $8\frac{7}{10}$″ to 6″.

,, 207, 2nd col. line 3 under Reference, *for* Aperqu *read* Apercu.

,, ,, ,, last but 3 lines under Reference, *for* Zeotwater *read* Zoetwater.

,, 264, 1st col. line 6, *for* effects *read* effets.

,, ,, 2nd col. line 3, *for* Grands-Lace *read* Grands-Lacs.

,, 266, ,, ,, ,, 2, *for* qu'oa *read* qu'on.

,, ,, ,, ,, last line *for* fig. 6 *read* figure.

,, 268, ,, ,, line 1 : for *Belodon tichthys* read *Belodontichthys*.

,, 269, 1st ,, lines 6 and 7 : for *Clupeoïdes, bornesus* read *Clupeoides borneensis*.

,, ,, ,, ,, para 2 lines 24 and 25, for *Belodon tichthys* read *Belodontichthys*.

,, ,, ,, ,, ,, ,, 30 and 31, for *Clupeoid bornesus* read *Clupeoides borneensis*.

,, ,, ,, ,, last para lines 8 and 9, for *Belodon tichthys* read *Belodontichthys*.

,, ,, 2nd ,, lines 5 and 6, for *Pangasius nodon sutchi* read *Pangasius sutchi*.

,, 270, 1st col. last para lines 7 and 8, for *Clupeoide bornesus* read *Clupeoides borneensis*.

,, ,, 2nd ,, lines 8 and 9, for *Clupecidē bornesus* read *Clupeoides borneensis*.

,, ,, ,, ,, para 3 line 5, *for* Grands-Lacs le *read* Grands-Lacs vers le.

,, 274, ,, ,, ,, 2 line 4, *for* avec lu *read* avec lui.

Section II

TECHNICAL PAPERS

1

A STUDY OF DRIFT IN THE MALACCA AND SINGAPORE STRAITS FROM SALINITY DETERMINATIONS

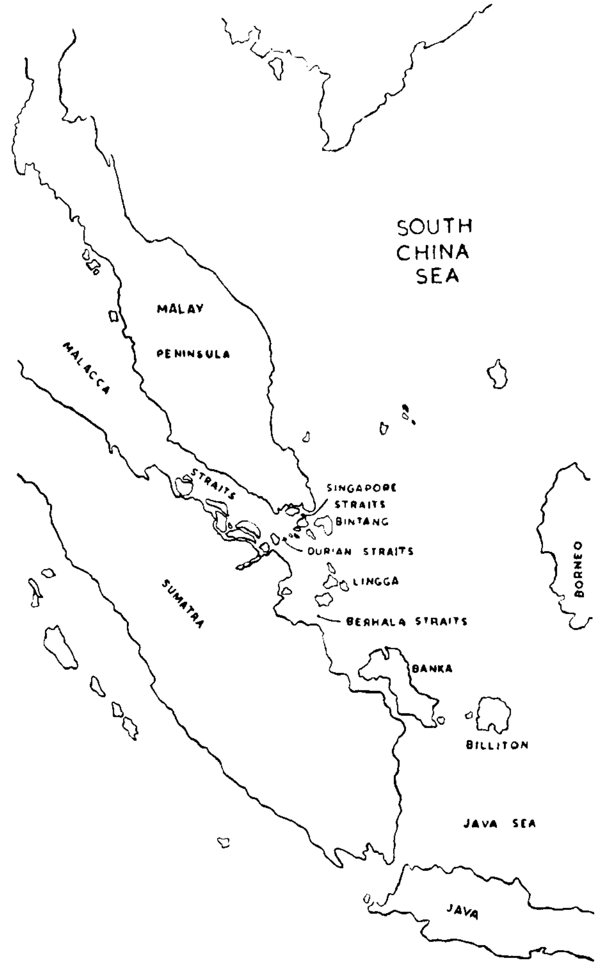
by

R. A. Robinson[1], H. Tong[2] and Tham Ah Kow[3]

As sea water constitutes the medium in which all marine organisms live, it is clear that a study of the constituents of sea water is a very necessary preliminary to any scientific study of fisheries. Sodium chloride is a major component of sea water and its quantitative variation in the sea plays an important part in determining the types of organisms which may be found in it. Whilst certain types of fish such as the Salmon and the Eel spend a part of their life successively in marine and fresh water environments, there are others such as the lajang (*Decapterus* sp.) of the Java Sea which, according to Hardenberg (1937), do not prefer a salinity of less than $32^{\circ}/_{\circ\circ}$. There is evidence also that the Malayan mackerel (*Rastrelliger kanagurta*) which is so abundant in South East Asia does not prefer a salinity of less than $30^{\circ}/_{\circ\circ}$. It may be expected therefore that a study of the salinity variations in the fishery areas of the Straits of Malacca and of Singapore Straits should contribute to a clearer understanding of the fluctuations in the various fisheries in the area.

Some work on the salinity of the seas adjacent to Malaya has already been done by various workers. Oceanographic research carried out by Sewell (1928, 1929) covered, in addition to other seas, the Bay of Bengal and the Andaman Sea. Weel (1923) carried out a survey of the Java Sea and its entrances, whilst Chevey & Serene (1948) reported on the conditions off Nhatrang in French Indo-China. A report on the surface salinities in the Indonesian Archipelago and adjacent waters by P. Ch. Veen (1951) came to the notice of the writers at the time when this paper was being prepared for publication.

A preliminary study of the seasonal variation in salinity at one fixed point in Singapore Straits has already been undertaken by one of us (Tham, 1950) for the years 1948 and 1949. The present study which extended from April, 1949 to April, 1951 was designed to extend the preliminary study to other parts of Singapore Straits and the Straits of Malacca and at the same time to test the validity of the tentative conclusions in respect of the water movements in Singapore Straits and the southern portion of Malacca Straits arrived at in a paper by one of us (Tham, 1953).



Map 1 showing the Straits of Malacca and of Singapore.

MATERIALS AND METHODS

Samples of sea water were collected just below sea level every day at each of five lighthouses

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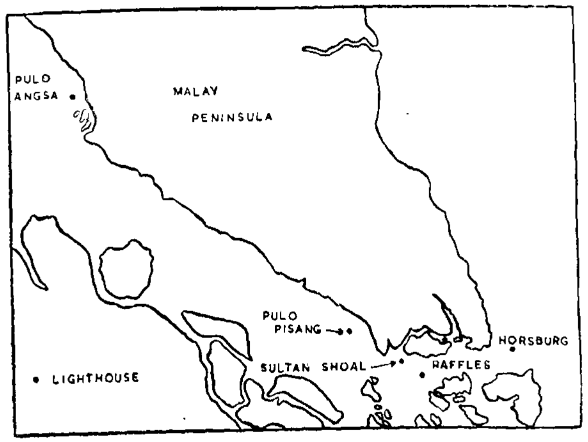
in Singapore Straits and the Straits of Malacca, viz.—Horsburg, Raffles, Sultan Shoal, Pulo Pisang and Pulo Angsa (see sketch maps), during the period April, 1949 to April, 1951. The chlorinities



Map 2 showing the five sampling centres.

of these samples were determined by Knudsen's method as described by Mathews (1923). The standard sea water used was supplied by the Conseil Permanent International pour l'Exploration de la Mer and the salinities were calculated from Knudsen's Hydrographical Tables (1901).

SALINITY VARIATIONS IN SINGAPORE STRAITS

The salinity variations between January, 1948 and December, 1949 at a fixed point in the middle of Singapore Straits approximately ten miles east off Raffles Lighthouse have been determined by one of us (Tham, 1953). The results are reproduced in Fig. 1 as monthly average variations over the period April, 1948 to April, 1949 together with, for comparison, the monthly average variations at Raffles lighthouse between April, 1949 and April 1950 and between April, 1950 and April, 1951 as determined from the present work. This work is more extensive and includes three stations in the Singapore Straits, viz.—Horsburg lighthouse at the eastern entrance, Raffles lighthouse in the centre and Sultan Shoal near the western entrance. The daily figures at these stations are averaged for each month and the results are graphed in Figs. 2 and 3, together with the data for the station at Pulo Pisang which are of interest as this station in the Malacca Straits is not far distant from the three in Singapore Straits. The seasonal variation indices for each of those four stations and those for the station at Pulo Angsa, further north in the Straits of Malacca, have been calculated using the monthly averages and the method given by Croxton and Cowden (1940). These seasonal variation indices are given in Fig 4. They are based on monthly averages of daily figures representing a continuous period of

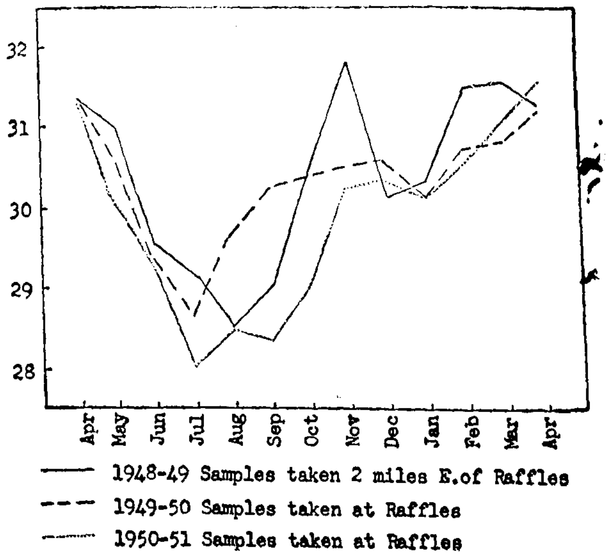


FIG. 1. Monthly average salinities at centre of Singapore Straits.

twenty-five months and should give a close approximation to the true seasonal variations at each of the stations.

Tham (1953) found that the salinity patterns for the two years 1948 & 1949 were essentially the same excepting that in 1949 the mid-year salinity minimum and the autumn salinity maximum occurred one month earlier than in 1948. Fig. 1 shows that the data for Raffles lighthouse confirm the tentative conclusion of Tham that the salinity pattern for Singapore Straits appears to consist of two maxima, one during March-April and the other during November and two minima, one during December-January and the other July-August.

There is no doubt that the salinity minimum during December-January is due to the heavy north-east monsoon rainfall, and if the effects of this rainfall were eliminated the resulting salinity curve would have only one maximum centred around December-January and one minimum centred around July-August. This pattern would then be the result of currents of high salinity from the South China Sea during the north-east monsoon (November-April) and currents of low salinity from (1) the Java Sea filtering through the islands south of Singapore during the south-west monsoon (May to October) and perhaps also from (2) the Straits of Malacca during part of the south-west monsoon (May-August).

Figures 2 and 3 show that the correspondence in the rise and fall in salinity between four stations,

Horsburg, Raffles, Sultan Shoal and Pulo Pisang, is extremely close. The correlation coefficients between the monthly averages for (1) Horsburg

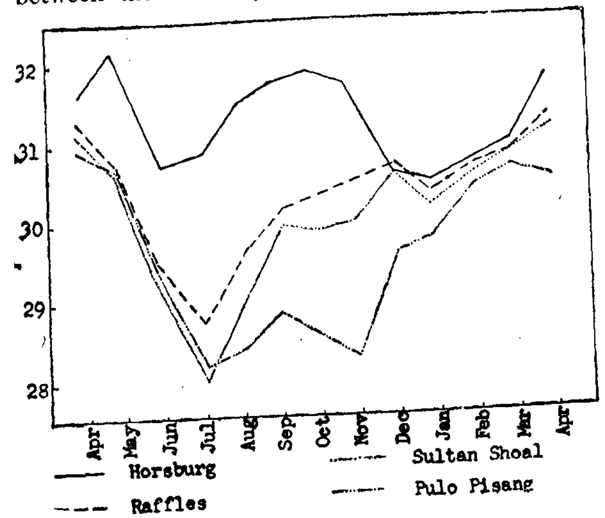


FIG. 2. Monthly average salinities in or near Singapore Straits 1949-50.

and Raffles, (2) Raffles and Sultan Shoal and (3) Sultan Shoal and Pulo Pisang have been calculated

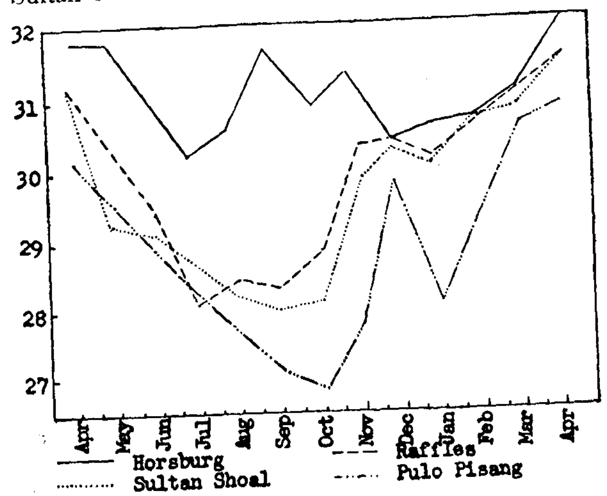


FIG. 3. Monthly average salinities in or near Singapore Straits 1950-51.

and are given in the following table together with the corresponding values 't' and 'P' (n=23).

Correlation between	r	t	P
Horsburg and Raffles	0.4733	2.57	0.02 to 0.01
Raffles & Sultan Shoal	0.9794	23.23	less than 0.01
Sultan Shoal & P. Pisang	0.8501	14.70	,, ,, ,,

MONTHLY AVERAGES OF DAILY SALINITY READINGS

Month.		Lighthouses.				
		P. Angsa	P. Pisang	Sultan Shoal	Raffles	Horsburg
1949	April	31.04	30.98	31.15	31.33	31.61
	May	31.36	30.45	30.45	30.59	32.11
	June	31.45	29.25	29.04	29.35	30.62
	July	31.41	28.14	27.99	28.62	30.74
	August	31.25	28.41	28.97	29.70	31.52
	September	28.66	28.91	29.87	30.25	31.82
	October	28.95	28.60	29.84	30.42	31.93
	November	28.76	28.28	29.97	30.51	31.70
	December	27.38	29.51	30.50	30.58	30.46
1950	January	27.80	29.56	30.00	30.11	30.20
	February	29.08	30.34	30.57	30.72	30.75
	March	29.81	30.58	30.83	30.84	30.93
	April	29.90	30.26	31.15	31.22	31.89
	May	30.12	29.33	29.22	30.10	31.87
	June	30.81	28.72	29.05	29.31	31.10
	July	31.03	28.15	28.52	28.03	30.24
	August	31.18	27.64	28.14	28.47	30.69
	September	30.73	27.07	27.97	28.39	30.56
	October	30.79	26.73	28.06	29.00	31.09
	November	29.40	27.61	29.69	30.25	31.39
	December	29.19	29.75	30.22	30.31	30.34
1951	January	28.35	28.07	30.05	30.12	30.55
	Februray	29.22	29.25	30.60	30.57	30.66
	March	29.91	30.68	30.91	31.10	31.23
	April	30.11	30.89	31.59	31.60	32.22

These correlation coefficients are given to show in statistical terms the correspondence in the rise and fall in salinity between these stations.

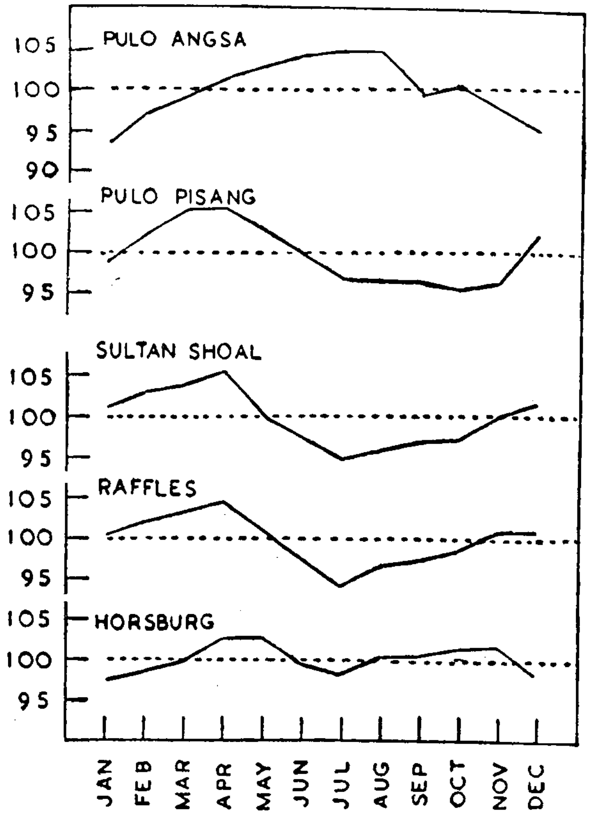


FIG. 4 SEASONAL INDICES AT FIVE STATIONS

Fig. 4 gives the seasonal variation indices for all the five stations. It is at once clear from the graphs in Figure 4 that the seasonal variations in four of the stations, viz., Horsburg, Raffles, Sultan Shoal and Pulo Pisang, are very similar. This, together with the close correspondence between stations in the rise and fall in salinity, indicates that the water circulation at all these four stations is the same at any particular point of time.

Salinity Variations in the Southern Half of Malacca Straits

Figure 5 shows the monthly averages at the two stations in Malacca Straits, viz.—P. Pisang and P. Angsa. Looking at the curves superficially it is clear that from December to April the variations at both stations are in the same direction. After April the curves diverge. The P. Angsa curve rises slowly to a maximum whilst the P. Pisang curve drops to a minimum. The P. Angsa maximum occurs one or two months before the P. Pisang minimum. After this both curves converge again.

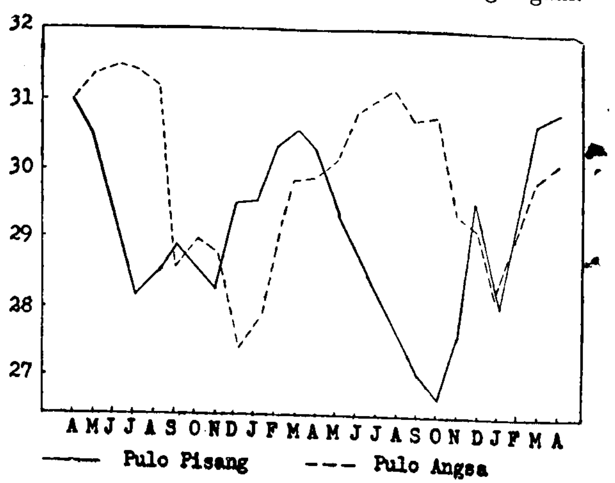


FIG. 5. Monthly average salinities at two stations in the Malacca Straits, 1949–51.

The graphs for the seasonal variation indices for these two stations in Fig. 4 show the same phenomena, i.e. between December and the following April the trend in seasonal variation is the same and after April they diverge until their divergence is greatest in August after which they converge again towards the end of the year.

Direction of Drifts in Singapore Straits and the Southern Portion of Malacca Straits.

Weel (*l.c*) who studied the salinity at different depths from surface to bottom stated that during the months covered by his investigations (i.e. February, May, August and November) there was no compensatory current in the deeper layers of the Straits of Malacca between One Fathom Bank, which is very near P. Angsa, and the Straits of Singapore. This statement is fully supported by his data, so that it was not considered necessary in the present investigation to take samples below the surface.

Tham (1953) has discussed the present state of knowledge on the direction of drifts in Singapore Straits. From the information available so far it would appear that during the north-east monsoon (November-April) the general direction of the drift is south-west in the South China Sea. At the eastern entrance to Singapore Straits the stream bifurcates, one branch passing into Singapore Straits and the other going south between Borneo on the one hand and the islands of Bintang, Lingga, Banka and Billiton on the other. The water which passes into Singapore Straits runs straight through the Straits,—some of it presumably filtering south between the channels formed by the islands of the Rhio Archipelago. At the western entrance to Singapore Straits one branch goes north-west along Malacca Straits and another presumably goes south through Durian Straits and Berhala Straits to Banka Island. The close correspondence between the curves for the period of the north-east monsoon in both Figs. 2 and 3 as well as the close correspondence between the curves for P. Pisang and P. Angsa for this same period as shown in Fig. 5 supports this tentative conclusion.

Tham, after full consideration of his own data as well as the data of Weel (*l.c.*) and Sewell (1929), came to the following tentative conclusion for the period of the south-west monsoon. With the onset of the south-west monsoon in May, there exists a southerly drift in the southern portion of the Straits of Malacca, which combines with the northerly drift from Berhala Straits at the western entrance to Singapore Straits. The combined drifts then flow through Singapore Straits from west to east. This would explain satisfactorily the very sharp drop in salinity in Singapore Straits from May to July-August. During August the southerly drift is reversed and the northerly drift from Berhala Straits flows through Durian Straits straight into the Straits of Malacca. The water in Singapore Straits from August to October is displaced by more saline water from the area of sea immediately east of a line joining the western fringes of the Rhio and Lingga Archipelago and is then pushed into the Straits of Malacca.

Since (1) the data of Weel (*l.c.*) indicates that there is no compensatory current in the deeper layers of the Straits of Malacca between P. Angsa and P. Pisang and (2) Tham's observations during June and July, 1949, indicate that during those two months there was a progressive increase in salinity from P. Pisang to P. Angsa, the continued divergence in salinity at these two points during the period April to July-August during both years under observation, i.e. 1949, & 1950, is not consistent with a drift from P. Pisang to P. Angsa. But this divergence could have arisen with a drift from P. Angsa to P. Pisang, i.e. in the reverse direction.

The slow rise in salinity at P. Angsa from April to July-August indicates that the drift at P. Angsa must be in the direction of P. Pisang. Fig. 5 shows that there is a downward trend in the salinity variations at P. Pisang during this period. This could only be explained by the existence of a rather slow drift from P. Angsa to P. Pisang which would result in a greater dilution of the water by land drainage. It could also be that the rain-bearing south-west monsoon had brought its full force to bear on Sumatra during this period and the land drainage from Sumatra would then be heavy. The drop in salinity at P. Angsa and the rise in salinity at P. Pisang after July-August indicates a reversal in the drift. There is a short period of small fluctuations around October which is the period of change from south-west to north-east monsoon. The further drop in salinity after this indicates that the north-east monsoon has started in Malaya and its full effect is seen in the drop in salinity at all five stations in December-January. From February to April the salinity curves at all five stations are closely correlated and this indicates that the drift then goes along the stations in the following order:—Horsburg, Raffles, Sultan Shoal, P. Pisang and P. Angsa.

The evidence produced by this investigation substantiates the tentative conclusion of Tham with respect to the direction of drift in Singapore Straits and the southern portion of the Straits of Malacca at different times of the year.

A study of the charts in the paper by P. Ch. Veen on the surface salinities in the Indonesian Archipelago and adjacent waters (which came to our notice towards the end of 1951, i.e. after the conclusion of this investigation) shows that Veen's data also substantiates our present conclusion.

SUMMARY

A study of the daily changes in salinity at five points in Malacca and Singapore Straits, viz.—Pulo Angsa, Pulo Pisang, Sultan Shoal, Raffles and Horsburg, was carried out for twenty-five months.

2. Tentative seasonal variation indices have been calculated for each month of the year for each of the five stations.

3. The drift of currents in Singapore Straits and the southern portion of Malacca Straits throughout the year has been traced.

Acknowledgment

The authors wish to express their indebtedness to the Master Attendant, Singapore, and the Marine Superintendent, Federation of Malaya, who kindly made arrangements for the collection of water samples at the five lighthouses.

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2

THE PLANKTON CALENDAR OF SINGAPORE STRAITS WITH SUGGESTIONS FOR A SIMPLIFIED METHODOLOGY

by

Tham Ah Kow*

THE PLANKTON CALENDAR OF SINGAPORE STRAITS

Plankton investigations carried out in different parts of the world during the past half century have shown that (1) the crops change, both in quantity and in specific composition, throughout the year, (2) that they form a pattern which is peculiar for each geographic location and (3) that these changes are rhythmic in nature and are recapitulated every year. There may be differences in the magnitude of the maximum from year to year; it may occur earlier or later in one year than in another; but the basic characteristics of this periodicity are unmistakable. After some years of study of this cycle of changes in abundance with the seasons of the year and of the succession of one genus or species after another, it is possible to formulate what has been called a Plankton Calendar.

Plankton Calendars are available for Japanese waters, the Pacific and Atlantic coasts of North America, the European Coasts from Norway to the Mediterranean and the Adriatic Seas, the Australian coast and certain parts of the coasts of India. Work was carried out in Singapore Straits in 1935, 1948 and 1949 by the writer (Tham, 1950 and 1953) and continued in 1950 and 1951. As a result of this work it is now possible to formulate the following Plankton Calendar for Singapore Straits:—

PLANKTON CALENDAR

January

Weather: Strong north-east winds, rough sea, heavy monsoon rain, less sunshine than usual.

Sea Water: Salinity and temperature at minimum, high turbidity and high phosphate content.

Phytoplankton: *Coscinodiscus* abundant. *Biddulphia sinensis, Ditylum sol* and *Thalassiothrix* may be common. *Chaetoceras, Bacteriastrum* and *Rhizosolenia* rare.

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Small zooplankton: Copepods and Tintinnids present. Ceratium, Polychaete larvae and Lamellibranch larvae rare.

Larger zooplankton: Siphonophores very common. Medusae and Brachyuran larvae common. Other Decapod larvae present. Ctenophores, Polychaetes Amphipods and Chaetognaths rare. *Oikopleura* very rare.

February

Weather: Drop in total wind speed and rainfall. Sea still rough and turbid.

Sea Water: Temperature rising. Salinity high. Slight drop in phosphate.

Phytoplankton: *Coscinodiscus* abundant. *Chaetoceras* may be very common. *Thalassiothrix* and *Rhizosolenia* common.

Bacteriastrum and *Biddulphia* may be common. *Ditylum* and *Guinardia* may be present. *Hemidiscus* and *Planktoniella* very rare.

Small zooplankton: *Noctiluca* may be abundant. *Ceratium* very common. Copepods may be very common. Polychaete larvae may be present. Cirripede larvae very rare.

Larger zooplankton: Siphonophores and Chaetognaths common.

Medusae, Polychaetes, Ostracods, Amphipods, Mysids, *Lucifer*, Decapod larvae very rare.

March

Weather: Wind and rainfall as in February.

Sea Water: Temperature rising. Salinity at maximum 31.50°/₀₀.

Phytoplankton: *Coscinodiscus* abundant. *Biddulphia, Chaetoceras, Thalassiothrix* and *Rhizosolenia* may be common. *Ditylum, Bacteriastrum* and *Leptocylindricus* may be present.

Hemidiscus and *Hemiaulus* very rare.

Small zooplankton: Copepods may be very common. Lamellibranch larvae present. *Ceratium* rare. Tintinnids, Peridinians, Cirripede larvae, *Noctiluca*, Gastropod larvae and Polychaete larvae very rare.

Larger zooplankton: Siphonophores, Decapod larvae and Chaetognaths very common. Medusae and Brachyuran larvae present. Ctenophores rare. Stomatopod larvae very rare.

April

Weather: Changeable wind. Change-over from north-east monsoon to south-west monsoon take place during latter part of this month. S(periodically calm. Total wind speed at minimun

Sea Water: Temperature and salinity at max mum.

Phytoplankton: Diatoms may increase sudden] in numbers sometime during this month. *Cha toceras* abundant. *Coscinodiscus* very commoi *Biddulphia* and *Ditylum* may be common. *Thala: siothrix* and *Rhizosolenia* may be present. *Ba teriastrum, Leptocylindricus* and *Pleurosigma* may l rare.

Small zooplankton: Copepods abundan Lamellibranch larvae may be common. *Cer tium*, Gastropod larvae and Polychaete larvae ma be present.

Larger zooplankton: Siphonophores very con mon. Chaetognaths and fish eggs may be ver common. Brachyuran and other Decapod larva may be common.

May

Weather: This is the change-over period fro north-east monsoon to south-east monsoon. Weather generally calm and windforce at minimum.

Sea Water: Temperature at maximum—30°C. Salinity begins to drop. Phosphate at minimum.

Phytoplankton: Diatom maximum. *Chaetoceras* abundant.

Biddulphia and *Coscinodiscus* may also be abundant.

Ditylum and *Bacteriastrum* common. *Rhizosolenia* may be common.

Small zooplankton: Copepods very common or abundant.

Lamellibranch larvae may be common.

Larger zooplankton: *Oikopleura* may be abundant. Siphonophores common. Chaetognaths may be common. Brachyuran and Decapod larvae present.

June

Weather: South-west monsoon begins. Windforce increasing.

Sea Water: Temperature and salinity decreasing.

Phytoplankton: *Coscinodiscus* very common. *Biddulphia, Ditylum* and *Chaetoceras* may be common.

Small zooplankton: Copepods very common and may be abundant. Tintinnids and lamellibranch larvae may be common.

Larger zooplankton: Siphonophores and decapod larvae common. Chaetognaths may be common.

July

Weather: South-west monsoon in full swing. Total windforce may be at a maximum.

Sea Water: Temperature still decreasing. Salinity low and may be at minimum. 28°/₀₀-29°/₀₀.

Phytoplankton: *Trichodesmium* may be abundant. *Coscinodiscus* and *Biddulphia* very common and may be abundant. *Ditylum* and *Chaetoceras* may also be abundant. *Bacteriastrum*, *Thalassiothrix*, *Guinardia* and *Lauderia* may be common.

Small zooplankton: Copepods very common.

Larger zooplankton: Chaetognaths and decapod larvae very common. Siphonophores may be common. Fish eggs may be common.

August

Weather: S.W. Monsoon in full swing. Total windforce high.

Sea Water: Temperature 29°C. Salinity at minimum.

Phytoplankton: *Coscinodiscus* very common or abundant.

Trichodesmium may be abundant. *Biddulphia* and *Ditylum* may be common.

Small zooplankton: Copepods very common.

Larger zooplankton: Decapod larvae very common. Chaetognaths common.

September

Weather: Total windforce decreasing.

Sea Water: Temperature about same as August. Salinity rising.

Phytoplankton: *Coscinodiscus*, *Biddulphia and Ditylum* common.

Small zooplankton: Copepods very common.

Larger zooplankton: Siphonophores *and Oikopleura* may be common.

October

Weather: Total windforce decreasing. Change-over from S.W. to N.E. monsoon may take place during latter part of this month.

Sea Water: Temperature about same as Sept. Salinity rising.

Phytoplankton: *Coscinodiscus* very common. *Biddulphia*, *Ditylum*, *Chaetoceras* and *Rhizosolenia* common.

Small zooplankton: Copepods common or abundant. Lamellibranch larvae may be common.

Larger zooplankton: Siphonophores very common. Decapod larvae common. Chaetognaths and *Oikopleura* may be common.

November

Weather: Total windforce low. Change of Monsoon usually takes place during this month.

Sea Water: Temperature decreasing. Salinity at peak.

Phytoplankton: Peak in diatom numbers. *Coscinodiscus* and *Rhizosolenia* abundant. *Thalassiothrix*, *Biddulphia*, *Chaetoceras*, *Ditylum* and *Bacteriastrum* may be common.

Small zooplankton: Copepods abundant. Tintinnids and lamellibranch larvae may be common.

Larger zooplankton: Chaetognaths very common. Siphonophores and decapod larvae common and may be abundant. Medusae and *Oikopleura* may be common.

December

Weather: Windforce rising. N.E. monsoon getting under way. Rainfall high.

Sea Water: Temperature and salinity decreasing.

Phytoplankton: *Coscinodiscus* very common. *Chaetoceras* common. *Biddulphia*, *Ditylum*, *Thalassiothrix* and *Bacteriastrum* may be common.

Small zooplankton: Copepods very common. Tintinnids may be very common.

Larger zooplankton: Decapod larvae, Chaetognaths and *Lucifer* may be common.

Methodology

During the 3rd meeting of the Indo-Pacific Fisheries Council at Madras in 1951 one of the recommendations of the Planktology sub-committee was that each member country might be requested to draw up regular plankton calendars with particular emphasis on those groups of probable importance to Fisheries. At the same time it was known that whilst plankton programmes were quite advanced in certain member countries, no such work had been initiated in others. It was felt by members of the Planktology sub-committee that the elaborate modern techniques which were in use in

countries which had adequate scientific staff available could not be adopted in other countries, which were less fortunate in this respect, for a long time to come. Yet, as Dr. Thompson (1950) has pointed out, it is obvious that for purposes of comparison and integration of results some general agreement should be reached as to what gear and methods are to be used. The Planktology sub-committee was not in a position to recommend any methodology which would be sufficiently simple for immediate use in all countries of the Indo-Pacific Fisheries Council and at the same time would give a picture of the quantitative variations of plankton which was sufficiently accurate to recommend its use.

When the writer started work on the plankton of Singapore Straits in 1948, he was well aware of these problems. The work carried out in Singapore Straits in 1935 consisted of drawing a tow net along the surface between two fixed points. The investigations carried out during 1948 and 1949 were more strictly quantitative. Fixed volumes of sea water were pumped up at different levels and filtered through a net of fine silk with a mesh equivalent to that of No. 20 bolting silk, when wet. The filtered sample was then preserved in formalin and later on examined in the laboratory. The sample was allowed to settle in a graduated sediment glass for half an hour after which the volume was read and recorded. An aliquot part of the sample was then taken and the number of different plankton organisms was counted. Another aliquot portion of the sample was taken and the concentration of pigment was determined by Harvey's (1934) method. For full details of the above procedure, the reader is referred to the paper by Tham (1953).

By August 1948 the writer felt that the correspondence between the variation in plankton volumes of samples in the same month in 1935 and 1948 by the different methods was sufficiently close to warrant a closer investigation. Accordingly from September 1948 to December 1949, a plankton net (mouth 40 cm in diameter and length 120 cm) of the same material and mesh as the filter used above was towed between two fixed points in the same area every day where possible. The plankton catch was preserved in formalin. The next day it was shaken up and allowed to settle in a graduated sediment glass for half an hour and the volume then read and recorded.

For the period from September 1948 to December 1949, 32 samples were taken by the first (more strictly quantitative) method. The volumes of these samples are given with the volumes of samples taken by the second method on corresponding days in Table 1. The volumes given by the first method

TABLE 1

Date	First Method. Volume. cc/m³.	Second Method. Volume of Total Catch. cc.
3/ 9/48	4	5
17/ 9/48	4	7
1/10/48	6	19
15/10/48	4	21
30/10/48	6	18
12/11/48	10	14
3/12/48	6	68
17/12/48	4	15
30/12/48	4	6
17/ 1/49	6	10
2/ 2/49	6	13
15/ 2/49	3	5
4/ 3/49	3	6
18/ 3/49	8	12
31/ 3/49	8	10
13/ 4/49	4	4
29/ 4/49	35	50
12/ 5/49	90	45
30/ 5/49	11	14
13/ 6/49	3	5
29/ 6/49	2	4
11/ 7/49	2	4
28/ 7/49	32	16
11/ 8/49	10	11
28/ 8/49	9	4
8/ 9/49	9	13
23/ 9/49	20	21
7/10/49	8	5
21/10/49	12	16
4/11/49	8	7
20/11/49	10	6
6/12/49	9	12

First Method: Pump and Filter method.

Second Method: Towing plankton net between two fixed points.

are recorded in cubic centimetres per cubic metre of sea water filtered. The volumes by the second method represent volumes of the whole catch and are given in cubic centimetres. The volumes given by the two methods are not comparable but the variations in volume by the two methods are comparable. The correlation coefficient between these two sets of data is found to be 0.5269 ($t = 3.395$; $n = 30$; $P =$ less than 0.01). It is definitely statistically significant. It is clear that for the plankton of Singapore Straits, the second method of simply towing a plankton net between two fixed points can give as accurate a picture of the variations in the volume of the plankton as the first method which is more elaborate and time-consuming.

It has already been pointed out by the writer (1953) that because of the differences in size and form of different plankton organisms, the total settled volume cannot be considered a reliable indication of the magnitude of the standing crop. But in spite of the objections raised the writer found that the phytoplankton peaks corresponded with those in the plankton volume graphs (Tham, 1953). This was due to the fact that organisms such as salps and coelenterates were not numerous in the plankton of Singapore Straits.

Harvey (1934) extracted the pigment content from his samples by using acetone and then matched the intensity of the colour of the extract against arbitrary standards which are expressed as Harvey units. This method was used by Harvey, Cooper, Lebour and Russell (1935) who found good correspondence between pigment content and phytoplankton numbers after weighting those diatoms occurring in large numbers. The writer (1953) found that for the plankton of Singapore Straits, even without weighting, there was a good correspondence between total diatom count and pigment content expressed in Harvey units. A detailed discussion of this procedure as applied to the Plankton of Singapore Straits is given by Tham (1953). Suffice to say that the correlation coefficient between total pigment content and phytoplankton count is 0.4650 ($t = 2.4636$; $P = 0.02 - 0.05$; $n = 22$) which may be considered as statistically significant.

For the assessment of the zooplankton there appears to be no more simple method than microscopic examination and enumeration.

The sub-committee for Planktology at the 3rd meeting of the Indo-Pacific Fisheries Council at Madras endorsed the remarks made by the Secretary of the Council about the disappointing status of programmes in this field. In order that a start might be made immediately in those countries where no programmes are envisaged in the immediate future because of lack of gear and/or specialised staff, the following simple methods are recommended to the Planktology sub-committee for consideration :—

(1) Collection of plankton samples by towing a net of constant dimensions (a standard net might perhaps be recommended by the Planktology sub-committee) between two fixed points and the settled plankton volume determined. This should give a representative picture of the variations of plankton volume with time. The preserved samples could be examined later by experts to determine the Plankton Calendar.

(2) Determination of pigment content in Harvey units of an aliquot portion of the above sample. This should give a representative picture of the variations of the standing crop of phytoplankton with time.

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3

STUDIES ON THE REVIVAL OF THE INDIAN OIL SARDINE FISHERY[1]

By

R. Velappan Nair[2]

The oil sardine, *Sardinella longiceps* Cuv. & Val., ranks as one of the best known commercially important fish of India, and is extensively used as food in the fresh and cured conditions. Its bye-products are of great value: the oil is widely used in the jute, leather, soap and other industries, and also for painting the canoes as it has a deterrent effect on ship-worms and other timber boring organisms ; the guano is an important fertilizer of the tobacco, coffee, tea and other crops. The annual fluctuation of the oil sardine fishery is very well known, and Day (1889) wrote about the species as follows :—" Abundant in some years, they occasionally forsake their haunts for several consecutive seasons, returning again in enormous quantities ". A pioneer attempt to determine the food, spawning habits and migration of the oil sardine was made by Hornell (1910) who also showed the necessity for a sound knowledge of the factors controlling and influencing the seasonal migrations and of those causing the extreme annual fluctuations, besides stressing the need for the proper development of the fishery. In 1923, Hornell and Nayudu published a contribution to the life-history of the oil sardine with notes on the plankton of the Malabar coast, in which they arrived at certain conclusions of which the important ones are :—

" The absence of local races among the oil sardines of the Malabar and South Kanara coasts ; the stability of the main outward characters shows this species to be little liable to individual variation. Oil sardines attain sexual maturity and almost full adult size at the age of one year, when they measure on the average 15 cm. They leave the inshore waters just prior to spawning which takes place from June to August inclusive—once only in the year. The young migrate to the shallow inshore waters in August and September, their size on their first appearance being from 4.5 to 7.5 cm to the end of scales. After spawning, mortality is high, particularly among the females. Of those that survive to spawn a second time very few indeed are met with thereafter. Growth during the second year is extremely slow and amounts to only 1 cm in length on the average. The oldest sardines examined were approximately 2½ years old, and this appears to be the ordinary limit of life in this species. The reason for the shoreward migration is to feed upon the immense quantities of unicellular plants (protophyta) and animals (protozoa) which develop and concentrate in the sheltered coastal waters towards the close of the south-west monsoon and thereafter till the end of the year. The season of chief abundance, from September to December inclusive, is one of rapid growth ; succeeding this is a long period extending till the end of April, when growth virtually ceases, due to a great decrease in the supply of food organisms in the inshore waters from January to April inclusive. During this period the fat reserve accumulated in the tissues from September to December is gradually used up in supplementing deficiency in the food supply. The period of arrested growth coincides with the appearance of what in the temperate zone would be termed a ' winter ring ' upon the scales. In the scales of very few individuals can a second of these rings be seen ; such belong entirely to the large sardines that survive in small numbers to an age of two years and upwards. The fat content of oil sardines from September to December is dependent primarily upon the abundance or scarcity of the oil-secreting organisms present in the inshore plankton during these months, whereof dinoflagellates and certain flagellate infusorians are the most important. The abundance of these minute organisms is in turn dependent on the favourable combination of several physical factors ; the more important are the presence of much nitrogenous material in solution in the inshore water, brought from the land by the monsoon floods, and an adequate amount of bright sunshine ".

In 1943, Devanesan published the results of an investigation into the causes of the fluctuation of the annual fishery of the oil sardine, the determination of its age and the discovery of its eggs and spawning grounds. His conclusions are as follows :—

" *Sardinella longiceps* depends mainly on pelagic organisms for its food and is, therefore, a surface feeder, occasionally resorting to bottom-feeding. There is no such thing as ' unrecognizable debris ' in the stomach contents. The inedible *Noctiluca* when predominant in the plankton may cause disturbance in the food-chain of the oil sardine and cause local scarcity. The free eggs of the oil sardine have been isolated from the marine plankton off Quilandy. The eggs are pelagic unlike those of the herring which are demersal. A scale of ovarian stages has been drawn up on the model of Hjort's scale for the herring. This will be useful in following the maturing stages and seizing eventually opportunities to determine the season of spawning and to conduct embryological research. The question of migration has been examined at some length and the evidence at our disposal at present does not lend support to the theory

[1] Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

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of migration of the oil sardine. More than two rings are found in the scale of *Sardinella longiceps*. The primordial ring and vestigial rings have been discovered for the first time in the scales of the oil sardine and an interpretation of them is beset with difficulties owing to want of collateral researches like marking experiments."

He also made certain recommendations about the future plan of work on the oil sardine.

In view of the disagreement about the span of life of the oil sardine between these authors based on their studies of the scales, Nair (1949) made a detailed study of the otoliths of the oil sardine and detected two and in exceptional cases three growth rings. He also came to the conclusion that the average span of life of the oil sardine is about three to four years. Chidambaram (1951) studied the length frequencies, size and age groups of the oil sardine and his findings lend support to Nair's conclusions. He also indicated that the availability of food and the surface temperature and salinity influence the movements of the oil sardines and also the spawning and survival of the young ones. Recently Nair and Chidambaram (1951) while reviewing the oil sardine fishery showed the irregular fluctuation encountered in the fishery at intervals ranging between two and six years and also indicated that small-sized immature oil sardines have contributed largely to the success of the fishery during the years of abundance. These authors have also pointed out the inverse relationship between the oil sardine and the mackerel fisheries supported by data relating to their landings extending over 25 years. The subject has recently been discussed by Panikkar (1952).

Even though investigations were commenced some three decades ago to study the biology and fishery of the oil sardine, precise information relating to the food and feeding habits, spawning habits and breeding grounds, development, races, migration, etc., of the oil sardine is still lacking. A knowledge of these and other kindred aspects of the biology of the fish and of its fishery is highly necessary for the proper exploitation of this valuable fishery. The results of the detailed biological investigations on the oil sardine and its fishery carried out at Kozhikode during the recent revival of the fishery after the disastrous failure of over a decade, are briefly presented in this paper.

I take this opportunity to express my grateful thanks to Dr N. Kesava Panikkar for the valuable suggestions received during the course of this investigation and to Mr. George K. Kurian, Assistant Director of Fisheries (Marine Biology), Kozhikode, for making available the data relating to the oil sardine landings presented in this paper.

MATERIAL AND METHODS

The material for this study was mainly taken from the commercial catches of oil sardines landed at Kozhikode and also from the biweekly departmental catches made from the same locality. Samples of oil sardines were also periodically examined from the other fishing zones mainly with a view to verifying the results of the investigations carried out at Kozhikode. It may be mentioned here that the oil sardines were mainly caught with two types of nets—the boat seine "Mathikolli vala" (Photograph 1) and the gill net "Mathichala

PHOTO 1. The oil sardines being transferred from the bag of the boat seine, "Mathikolli vala" to the 'hold' of the large canoe.

vala" along the Malabar coast and the shore seine "Rampani" along the South Kanara coast.[1] The

[1] *Mathikolli vala* is a boat seine made of cotton and is used exclusively for the capture of the oil sardine. The dimensions of the net are :—length 60′, breadth 18′ and mesh size 5/8″. It consists of a wide-mouthed bag, a platform and two wings and is operated by two dugout canoes. Half of the net is carried in each canoe and when the shoal is sighted the canoes separate paying out the net. The encircled shoal is driven into the net by the loud noise produced from auxiliary canoes.

former two nets constitute efficient gear for the capture of this pelagic shoaling species out in the sea, while the "Rampani" is used only when the shoals enter the shallow inshore waters. The boat seine, "Paithu vala" is also used in the oil sardine fishery along the Malabar coast, but with limited efficiency because of its structural variations. For obtaining a correct picture of the size composition of the oil sardine population in the region under investigation, the samples have been analysed irrespective of the gear employed for their capture. The toal length was measured from the tip of the snout to the end of the dorsal caudal fluke when it was held parallel to the long axis of the fish and the measurements were grouped within ten millimetre intervals (example: 10 cm size group includes oil sardines measuring from 10.0 to 10.9 cm in total length). The data relating to the estimated landings of oil sardines were compiled by the Fish Curing Yards of the South Kanara and Malabar coasts. The hydrological data presented in the paper relate to the eight fathom surface waters off West Hill, Kozhikode, and were collected at the Sub-Station. The rainfall figures have been compiled from the daily weather reports issued by the Regional Meteorological Centre, Madras.

THE FISHERY OF THE OIL SARDINE

The estimated landings of the oil sardine along the South Kanara and Malabar coasts from the 1925-26 season onwards presented in Table I show clearly the general trend of fluctuation including the recent failure extending over a number of years and the later improvement and the revival of the oil sardine fishery. The maximum catches recorded during the period was in 1933-34 with a total landing of 1.9 million maunds[1] of oil sardines. The total catch exceeded a million maunds during the 1925-26 season as well. Even though the annual catches of oil sardines varied considerably during the earlier years, the fishery proved to be a disastrous failure after the 1941-42 season and the lowest catch of 237 maunds was reached in the 1946-47 season. In the succeeding years the fishery showed steady improvement and revived considerably during the 1951-52 season. A perusal of the table of estimated landings of oil sardines shows the striking feature that the catches are, as a general rule, far greater along the Malabar coast than those of the South Kanara coast. Exceptions to this have been observed only during the 1925-26, 1929-30, 1938-39, 1944-45, 1947-48 and 1948-49 seasons.

The estimated landings of oil sardines at the different fishing villages along the South Kanara and Malabar coasts during the 1948-49 to 1951-52 seasons, have also been tabulated for the purpose of this study.

1948-49 OIL SARDINE FISHERY OF THE WEST COAST

During the 1948-49 season the catches of oil sardine along the South Kanara coast were heavy and accounted for 6,645 maunds out of the total of 7,789 maunds landed along the coast. The shoals first appeared during the season in September, 1948, at two widely separate fishing centres, namely, Polippu in South Kanara and Pudiappa in Malabar. In the next month, the oil sardine shoals occurred only at Malpe. November and December, 1948, were the best months during the season and the total landings for the two districts were 2,471 and 2,848 maunds of oil sardines valued at 0.1 and 0.2 lakhs of rupees respectively. The fishery came to a close by January, 1949, in South Kanara while small shoals continued to appear erratically along the Malabar coast until April, 1949. It is interesting to mention here that the oil sardine fishery of the 1948-49 season was more or less confined to two small zones, the first one extending from Hungarcutta to Kaup in South Kanara and the second from Quilandy to Kadalundy in Malabar. The heaviest catches of the season were recorded from the former zone which includes Malpe, the most important fishing centre of South Kanara. The landings of oil sardine at Malpe were particularly heavy during the season and accounted for approximately half the total quantity landed during the season throughout the coast.

Mathichala vala is a gill net made of cotton and is used only for catching oil sardine. The net is operated by two canoes. The dimensions of the net are :—length 36-90′, breadth 12-18′ and mesh size 3/8-5/8″. Each canoe carries 4 to 8 such pieces of net laced together and when the shoal is sighted the net is paid out quickly from both the canoes in a semicircular manner across the direction of the movement of the shoal which gets encircled by the net. The terrific noise produced by the fishermen makes the oil sardines panicky and in their attempts to escape from the net they get themselves firmly gilled.

Rampani is a very large shore seine used for catching shoals of oil sardine and mackerel. The net is made of hemp and consists of about 100 pieces linked together. The dimensions of each piece are:—length 36′, breadth 20′ and mesh size 3/4-1″. One end of the net is held by a party of 40 men in the shore and the net is carried in a large boat and is paid out in a semicircular way encircling the shoal. The other end of the net is brought ashore and is handed over to another party. The two ends of the net containing the shoal are slowly dragged by the two parties of men. Large quantities of these fishes, sometimes weighing several tons, are landed in one haul of the net.

[1] 1 Ton=27.22 Maunds.

1949-50 OIL SARDINE FISHERY OF THE WEST COAST

The oil sardine fishery of the 1949-50 season was noticed to be better than the previous season and this was more apparent along the Malabar coast, where 74,444 maunds were landed out of the total of 90,827 maunds of oil sardines caught during the season. The oil sardine fishery commenced early along the Malabar coast and the shoals first appeared in September, 1949, at Quilandy. The fishery gradually extended to the other fishing villages and was observed to be uniformly good till the end of the season in June, 1950. The appearance of the shoals along the South Kanara coast, on the other hand, was delayed considerably and the fishery started abruptly and simultaneously in the different fishing villages in December, 1949. In the subsequent months, the landings of oil sardines decreased and the fishery of South Kanara came to a close in April, 1950. The peak of the fishery of the 1949-50 season was reached in December 1949. The landings in South Kanara and Malabar for the month were 11,676 and 23,017 maunds of oil sardines respectively valued at 3.7 lakhs of rupees. These catches constituted more than a third of the total quantity landed during the entire season. The fishery of the 1949-50 season was also confined to two zones of the West coast extending from Marwanthi to Baikampadi in South Kanara and from Madapalli to Blangad in Malabar. The catches were particularly heavy at Kozhikode and the landings at this place were nearly a third of the total quantity landed during 1949-50.

1950-51 OIL SARDINE FISHERY OF THE WEST COAST

The 1950-51 oil sardine season also maintained the steady improvement in the fishery noted during the preceding years. The fishery was very good along the Malabar coast with a landing of 139,762 maunds out of the total of 180,884 maunds of oil sardine for the entire season. The season commenced in Malabar in July, 1950 more or less in continuation of the 1949-50 season. The oil sardine shoals first appeared at Palacode and Madai and at Vadanapalli and Karimpuram situated at the northern and southern extremities respectively of the Malabar coast. The fishery extended to most of the other fishing villages of the Malabar coast during the subsequent months and terminated by April, 1951. Along the South Kanara coast the fishery commenced later, in August, 1950, and terminated also earlier, in February, 1951. The noteworthy feature of the 1950-51 season was the uniformly good condition of the fishery throughout the West coast, particularly along Malabar. The zonal occurrence of the oil sardine shoals conspicuously seen in the previous two seasons was also noted during the present season, especially along the South Kanara coast where the region of concentration of the shoals extended from Malpe to Baikampadi. The peak of the 1950-51 season was also in December, 1950, and the quantities of oil sardine landed in South Kanara and Malabar during the month were 27,219 and 74,311 maunds respectively valued at 4.14 lakhs of rupees. The landings for the month constitute more than half the total quantity landed during the entire season. Madai and Kozhikode were the two best oil sardine centres during the 1950-51 season. The oil sardine landings were heavy and exceeded 10,000 maunds at Malpe and Udayavar in South Kanara and at Cannanore and Kootayi in Malabar.

1951-52 OIL SARDINE FISHERY OF THE WEST COAST

The 1951-52 season, which was comparable to the earlier years of plenitude, marks the complete revival of the fishery after its protracted failure extending over a decade. The fishery was exceptionally good along the Malabar coast and the heavy landings amounted to 273,374 maunds during the season. In South Kanara, on the other hand, the fishery was not so good as in Malabar, and the total landings were only 19,500 maunds, less than half the quantity caught during the 1950-51 season. The 1951-52 season, like the previous one, commenced first along the Malabar coast. Shoals appeared simultaneously at its northern (Madai, Mattool and Thalayi) and southern (Nattika) extremities in July, 1951. During the next three months, the fishery spread rapidly throughout the coast. The fishery commenced in South Kanara only in August, 1951, and it was mainly confined to the southern portion. The " Malpe zone " which consistently recorded good landings of oil sardines during the last three seasons was completely forsaken by the shoals during this season. The " Hosdrug zone " which was not represented during the 1948-49 and 1949-50 seasons and indications of which were noticed during the 1950-51 season came to prominence during the 1951-52 season mainly owing to the complete absence of the oil sardine fishery at the " Malpe zone ". The peak of the fishery was reached in Malabar in October, 1951, and in South Kanara in September, 1951. The landings were 158,444 and 11,595 maunds of oil sardine valued at 9.7 and 0.7 lakhs of rupees respectively. The fishery of the oil sardine in South Kanara was also fairly good during October,

1951, with a landing of 6,475 maunds valued at 0.4 lakhs of rupees. The fishery took a sudden turn in November, 1951, when the shoals abruptly disappeared from the coastal water throughout and the catches for the month dwindled to 1,010 maunds in Malabar and to practically zero in South Kanara. The shoals reappeared in December, 1951, but in small numbers only. The fishery of the 1951-52 season terminated in January, 1952, in South Kanara and in April, 1952, in Malabar. Even though a shifting of the region of maximum occurrence of the oil sardine shoals from the " Malpe zone " to the " Hosdrug zone " was seen in South Kanara during the 1951-52 season, no such change in the regional distribution was noticed along the Malabar coast, and the " Kozhikode zone " continued to yield the maximum catches. It may also be mentioned that Kozhikode landed the record

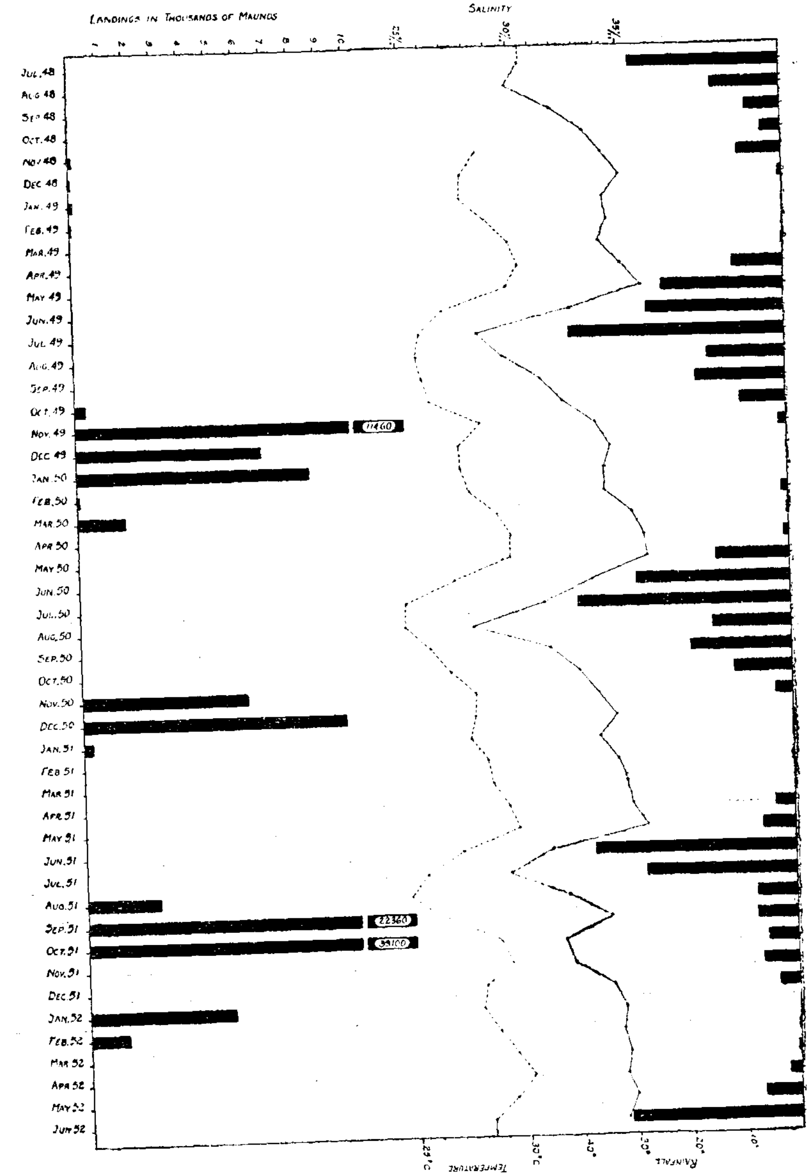

FIG. 1. Histogram showing the estimated monthly landings of oil sardine together with the total monthly rainfall and the average monthly temperature and salinity at Kozhikode from July, 1948, to June, 1952.

quantity of 61,800 maunds during the season. Pudiappa was the second best centre during the year with a total catch of 26,250 maunds of oil sardine. The landings at Hosdrug in South Kanara and at Quilandy, Parapanangadi, Tanur, Ponnani, Mannalamkunnu, Puthenkadapuram and Blangad in Malabar exceeded 10,000 maunds during the 1951-52 season.

THE OIL SARDINE FISHERY AT KOZHIKODE

From the general picture of the oil sardine fishery of the West coast presented above, it is apparent that there is a zonal distribution in the intensity of occurrence of the shoals and that the " Malpe zone " and the " Kozhikode zone " are the two principal regions where the shoals occur in great abundance during the season. " Kozhikode zone " in particular, appears to be the best region for the fishery. During the last four seasons, Kozhikode has landed the record average catch of 26,000 maunds of oil sardine and it is presumed that the result of this critical study of the biology of the oil sardine and of its fishery conducted at this place during these years of revival of the fishery would reflect the condition of the oil sardine fishery existing in the " Kozhikode zone " of the Malabar coast.

The estimated monthly landings of oil sardines at Kozhikode from the 1948-49 to 1951-52 seasons are given in Table II and they are shown in the form of a histogram in Figure I along with data relating to the rainfall and hydrological conditions at Kozhikode.

1948-49 OIL SARDINE FISHERY AT KOZHIKODE

The fishery, in its initial stages in July, 1948, was composed of mature oil sardines with a dominant size of 19 cm shoals of which entered the inshore fishing grounds in relatively small numbers. Later, in August, 1948, spawners belonging to the same size group contributed to the fishery in large numbers. The ovaries of these spawners were soft and translucent and completely filled with transparent eggs which were ready for extrusion. The mature ovarian eggs of the active spawners were found to have an average diameter of 1 mm with the yolk perfectly transparent and showing the vacuolated condition characteristic of clupeoid eggs. The majority of the eggs were provided with a single golden yellow oil globule measuring about 0.1 mm in diameter. These spawners in stage VI[1] and males with active motile sperms in the testes which were cream-white in colour, continued to occur in smaller numbers during September, 1948 also, but disappeared by the end of the month from the inshore waters. Pelagic oil sardine eggs were noticed in the plankton collections made off Kozhikode during these months.[2] A sudden change in the composition of the oil sardine fishery was noticed in November, 1948, when oil sardines with a modal size of 14 cm entered the fishery in enormous numbers and formed the bulk of the catches made during the month. The oil sardines belonging to the same size group continued to occur in fairly large numbers in the commercial catches made during December, 1948, also along with those of the 15 cm size group. In the subsequent months, however, the latter size group dominated in the fishery till the end of the 1948-49 season at Kozhikode. Detailed examination showed that the oil sardines belonging to these size groups were immature and in most cases the gonads were in the course of formation. It was also observed that these juvenile oil sardines formed the mainstay of the commercial catches landed at Kozhikode.

Qualitative and quantitative studies on the stomach contents of the oil sardine samples examined during the season showed that the active spawners invariably had empty stomachs indicating the cessation of feeding activity at the time of spawning. The mature adults, on the other hand, showed frequent changes in the composition of the stomach contents and the main constituents noted in large numbers were *Coscinodiscus concinnus*, *Dinophysis caudata*, *Ornithocercus magnificus*, *Peridinium depressum*, *Biddulphia mobiliensis*, *Evadne tergestina*, copepods, etc. The analysis of the stomach contents of the immature juvenile oil sardines showed remarkable similarity in the composition of the food taken by them during the few months they dominated in the fishery. *Fragilaria oceanica* was observed to constitute the important food of these sardines. *Asterionella japonica* was another diatom noticed to contribute to the food of the juveniles in large numbers. *Prorocentrum micans*, *Biddulphia mobiliensis*, *Pleurosigma angulatum* var. *strigosa*, *Nitzschia sigma* var. *indica*, *Planktoniella sol*, *Coscinodiscus* spp. and a few other forms occasionally dominated in the food of the juvenile sardines.

[1] The stages mentioned in this paper are after the maturity scales adopted by the International Council for the Exploration of the sea.

[2] The embryonic and larval development of the oil sardine have been worked out in detail and an account of its life-history is being published elsewhere.

1949-50 OIL SARDINE FISHERY AT KOZHIKODE

During the earlier part of the 1949-50 season, the oil sardine fishery was very irregular partly on account of the intensity of the South West monsoon and the periodic appearance of swarms of *Noctiluca miliaris* constituting the red water phenomenon characteristic of the West coast. However, on days when conditions were favourable for fishing operations, particularly by the middle of August, 1949, large shoals of very small sardines with a modal size of 7 cm were encountered in the 10-15 fathom waters off Kozhikode and they were extensively caught by the commercial fishermen with large boat seines along with large numbers of *Rastrelliger kanagurta*, *Decapterus russelli* and *Anchoviella commersonii*. These small-sized juveniles disappeared altogether after a few days. Unlike the immature adults and spawners which feed mostly on phytoplankton, the food of these very young sardines was found to be composed mainly of copepods like *Euterpina acutifrons*, *Oithona brevicornis*, *Acartia erythraea*, *Paracalanus parvus*, copepodites and the cladoceran *Evadne tergestina* in large numbers. Mature sardines with a modal size of 18 cm entered the fishery by September, 1949, and the ovaries of almost all the females were well developed reaching stage V. The composition of the stomach contents of these sardines frequently showed sharp changes which were mainly caused by the fluctuations in the abundance of planktonic diatoms and other forms during the monsoon months. The oil sardines examined on the 31st August, 1949, were observed to have fed on large swarms of *Chaetoceros lorenzianus* while those caught the next day showed swarms of *Fragilaria oceanica*, *Coscinodiscus concinnus*, *Thalassiothrix frauenfeldii*, *Biddulphia mobiliensis*, *Pleurosigma* spp., *Nitzschia seriata*, *N. sigma* var. *indica*, *Ceratium massiliense*, *C. fusus*, *Peridinium depressum* and *Dinophysis caudata* were the other organisms found in large numbers in the stomach contents of these adult oil sardines.

In the subsequent months the oil sardine fishery showed remarkably steady improvement and the peak of the fishery was reached at Kozhikode in November, 1949, when the sardines practically dominated the commercial catches. The landings at Kozhikode for the month were 11,460 maunds. These were mainly caught with the boat seine, " Mathikolli vala " from waters at a distance of 8-10 miles from the shore. Gill nets were also used during this month, but only when the shoals entered the shallower inshore waters. The boat seine catches were observed to be composed exclusively of oil sardines while *Rastrelliger kanagurta* and *Sardinella fimbriata* were also caught along with the oil sardines in the gill net. Frequent changes in the population of the oil sardine in the fishing grounds were also observed with the improvement of the fishery in October, 1949. The spawners observed in the fishery during September, 1949, disappeared from the foreshore waters and the month of October, 1949, saw the entry of a different size group having a modal size of 13 cm in the commercial catches. Adult oil sardines with a modal size of 17 cm again appeared in the fishery in November, 1949, but these completely disappeared by the middle of December, 1949, when small-sized immature juveniles with the majority sizes ranging from 10-12 cm appeared in enormous numbers along the entire coast and dominated the fishery till the end of February, 1950. It is apparent that this year class of immature oil sardines which contributed in no small measure to the improvement of the fishery of the 1949-50 season, is a new stock probably the result of the successful spawning observed during the last season. The fishery rapidly declined during the succeeding months and this tendency was seen early in March, 1950, when the shoals occurred rather erratically in the inshore waters. These shoals were also observed to be composed of spent oil sardines.

The food of the spawners during the first week of September, 1949, consisted mainly of huge swarms of *Fragilaria oceanica* and this was replaced by *Nitzschia seriata* by the end of the month. During October and November, 1949, though the volume of food in the gut was relatively low, less than 1 cc in most cases, *Coscinodiscus concinnus* formed the major food. *Fragilaria oceanica*, *Pleurosigma* spp., and *Dinophysis caudata* also contributed to the food of the mature oil sardines. Active spawners in stage VI were again noticed to have empty stomachs confirming the observation made earlier that there is very little feeding activity at the time of spawning. The stomachs of these spawners were always observed to be very much distended probably owing to intense pre-spawning feeding activity.

The juvenile oil sardines were observed to have fed on *Evadne tergestina* and *Penilia avirostris* by the middle of October, 1949, but a week later their food was mainly composed of *Peridinium depressum* swarms. The cladocerans again formed the important food of the young sardines in November, 1949. *Prorocentrum micans*, *Dinophysis miles* and *Coscinodiscus* spp. were also present in large numbers and formed a major portion of the food of the juvenile sardines. Early in December, 1949, the food of the young oil sardines was found to be composed mainly of *Trichodesmium erythraeum* along with *Coscinodiscus* spp. and *Evadne tergestina* in small numbers. A change in the composition of the food was noticed by the middle of the month when *Fragilaria oceanica* dominated among the constituents of the stomach contents. During this period *Trichodesmium erythraeum*, *Coscinodiscus* spp. and *Pleurosigma* spp. also formed major elements of the food of the oil sardine. By the middle of January, 1950, another change was noticed when the tintinnids formed the important food along with *Biddulphia mobiliensis*, *Fragilaria oceanica*, *Ceratium massiliense*, *Trichodesmium erythraeum*, etc., in fair numbers. In March, 1950, the food was mainly composed of *Nitzschia seriata*. *Trichodesmium erythraeum* was again noticed to contribute to the food of the oil sardine in large numbers during April, 1950. It is interesting to mention here that the polychaete, *Prionospio pinnata*, was noticed for the first time in large numbers in the stomach contents of the juvenile oil sardines caught on the 16th February, 1950, which was a new moon day. The volume of food in the gut of these sardines rose to the high figure of 3.5 cc mainly owing to the presence of large numbers of this polychaete worm.

Oil sardine eggs were noticed in small numbers in some of the townet collections made from the sea off West Hill during the latter half of November, 1949.

1950-51 OIL SARDINE FISHERY AT KOZHIKODE

The noteworthy feature of the oil sardine fishery of the 1950-51 season was the early appearance of the active spawners in July, 1950, and the commencement of the spawning season much earlier than in the previous two seasons. It was also observed that the spawning period was somewhat protracted during the year judging from the gonadial condition of the spawners which appeared erratically along the coast. The first shoal of active spawners appeared on the 8th July, 1950, off Kozhikode even though the sea at that time was very rough owing to the intensification of the South West monsoon along the coast which resulted in the formation of mud banks in the foreshore regions extending to about the four fathom limit. The shoals of oil sardines composed exclusively of spawners appeared irregularly on the subsequent days also and they were mostly captured from the eight fathom regions where the water was very clear. The spawners had the characteristic bulging belly caused by the fully-developed and enlarged ovaries in stage VI containing transparent eggs which were ready for extrusion. The mature eggs oozed out in most of the specimens at the slightest pressure and milt was also observed to come out when the belly of the males was gently pressed. The spawners continued to occur till the end of November, 1950. During the next month exceptionally large shoals of immature oil sardines with a modal size of 9 cm and spent oil sardines dominated in the fishery. The immature oil sardines were particularly abundant during this month which constituted the peak period of the oil sardine fishery of the 1950-51 season and large shoals frequently entered the very shallow inshore waters where heavy catches were made with the boat seine and the cast net. The immature oil sardines continued to appear irregularly and in smaller numbers in January, 1951, and the fishery came to a close by the end of the month.

The stomach content examination of the different samples from the catches made during the year showed again that there is active pre-spawning feeding activity as shown by the large volume of food present in the stomachs of females in stage V. The stomachs of the spawners were also observed to be greatly distended. On the contrary, the stomachs of the active spawners were always found to be empty indicating the cessation of feeding activity at the time of spawning. Active feeding was again noticed in the spent individuals. *Thallassiothrix frauenfeldii* in huge swarms formed the important food of the adult oil sardines in June, 1950. *Fragilaria oceanica* in swarm condition dominated in the constituents of the stomach contents in July, 1950, and the first half of August, 1950. The cladoceran, *Evadne tergestina*, in exceptional numbers, was seen dominating in the stomach contents of the mature oil sardines caught during the latter half of August, 1950. *Fragilaria oceanica* again formed the chief food of the mature ones in September, 1950. Other planktonic forms like *Nitzschia seriata*, *Coscinodiscus lineatus*, *Asterionella japonica*, *Bacteriastrum varians*, *Rhizosolenia robusta*, *Biddulphia seriata*, *Peridinium depressum* and *Dinophysis caudata* also formed the important food of the grown-up oil sardines during the season. The spent oil sardines have been observed to have fed on swarms of *Peridinium conicum*, *Nitzschia sigma* var. *indica*, *Dinophysis caudata*, etc. in November, 1950. *Prorocentrum micans* and *Nitzschia seriata* formed the chief food of the juveniles during October and November, 1950. *Fragilaria oceanica*, *Coscinodiscus* spp., *Thallassiothrix frauenfeldii*, *Nitzschia seriata* also contributed to the food of the juveniles during the season.

Detailed examination of the plankton collections made from the commercial fishing grounds where the active spawners of the oil sardines occurred in large shoals, revealed the presence of oil sardine eggs in large numbers in August, 1950, and in relatively smaller numbers in September, 1950, and the average number of eggs present in a haul of 15 minutes duration was about 50 in the former month. The unusually abundant occurrence of the oil sardine eggs in the plankton off Kozhikode showed the success of spawning during the 1950-51 season and based on this and other factors a tentative forecast of the improvement of the oil sardine fishery of the 1951-52 season was made possible by the end of December, 1950.

1951-52 OIL SARDINE FISHERY AT KOZHIKODE

The 1951-52 oil sardine fishery at Kozhikode commenced early in August, 1951, immediately after the cessation of the South West monsoon. As usual the oil sardine fishery commenced with the appearance of spawners which had a modal size of 18 cm during the first half of August, 1951. The second half of the month witnessed a sudden change in the composition of the oil sardine population of the fishing region. The indeterminate juveniles with a dominant size of 12 cm entered the fishery during the latter half of the month in enormous shoals and exceptionally heavy catches were made reminiscent of the former years of abundance. During the next two months the oil sardine fishery showed remarkable improvement with a record catch of 22,360 and 33,100 maunds during September and October, 1950, respectively. The catches of oil sardine during this glut period was also used for the manufacture of oil and guano in newly erected oil and guano factories. It may be mentioned that the success of the fishery during this period was mainly due to immature oil sardines with a dominant size of 15 cm. The shoals abruptly disappeared from the inshore waters during the next two months and no catches were made by the commercial fishermen. The juveniles, the disappearance of which was responsible for the temporary setback in the fishery seen during this period, reappeared in large shoals from the second week of January, 1952. They continued to occur in February, 1952, also along with spent oil sardines with a modal size of 19 cm. The oil sardine fishery of the 1951-52 season came to a close by the end of February, 1952, at Kozhikode. It is interesting to mention here that in spite of the remarkable improvement of the fishery of the 1951-52 season, active spawners in stage VI and planktonic oil sardine eggs were not encountered during the year and it is likely that their absence may adversely affect the oil sardine fishery of the 1952-53 season.

The detailed qualitative and quantitative study of the food of the oil sardine conducted during the season has shown that *Fragilaria oceanica* which occurred in enormous swarms in the coastal waters during the post-monsoon months formed the chief food of the juvenile oil sardines. The juveniles which reappeared in the fishery in January, 1952, after the temporary setback in the fishery showed again large quantities of *Fragilaria oceanica* though the species was not present in such abundance in the coastal plankton. It is possible that *Fragilaria oceanica* occurred in patches in the offshore waters and that the oil sardines had fed on these patches. However, the study of the food and feeding habits clearly show that the availability of *Fragilaria oceanica*, the favourite food of the oil sardine, partly controls the movements of the oil sardine shoals, especially of the juveniles which form the mainstay of the oil sardine fishery during the years of abundance. *Thallassiothrix longissima*, *Peridinium conicum*, *P. depressum* and *Pyrophacus horologicum* formed the main food of the mature adults observed in the fishery in August, 1951, while swarms of *Ornithocercus magnificus*, *Dinophysis caudata* and *Prorocentrum micans* constituted the chief food of the spent oil sardines noted in the fishery at the end of the 1951-52 season.

STUDIES ON THE LENGTH FREQUENCY

During the four years of study, 7,316 oil sardines were measured for total length and the size group analyses for the different seasons were made, the number of individuals in each size group being expressed as percentage of the total number examined during the different months and years with a view to facilitate comparison. The length frequency histograms from the seasons 1948-49 to 1951-52 and the average length frequency histogram for the entire period of investigation are given in Figure 2. A study of the length frequency tables, histograms and polygons made shows clearly the presence of distinct size groups denoting age classes comprising the fishery every season and also their passage through the fishery in the succeeding months.

In the fishery of the 1948-49 season two distinct modes were observed to be present represented by group A at 19 cm and group B at 15 cm (Fig. 2). The latter group was constituted by immature juveniles which entered the fishery in November, 1948, and formed the mainstay of the fishery of the season. This group predominated in the commercial catches and formed more than 43% of the landings. Group A was composed mainly of adult oil sardines including the active spawners which contributed to the fishery from July to September, 1948 (Fig. 5).

During the 1949-50 season, three distinct modes were represented in the fishery, viz., group B at 17 cm, group C at 13 cm and group D at 10 cm

(Fig. 2). The group D composed of juveniles with undeveloped gonads dominated in the fishery during December, 1949, and represented more than 25% of the catch. This group belonged to a new stock recruited during the previous season. Group C which was insignificant in comparison with the other two groups of the season, was also composed of immature oil sardines with the gonads in the earlier stages of development. On the other hand group B, which was also present in the previous season and had increased in length by 2 cm was found to be composed of mature adults including the active spawners. This group appeared in the fishery during November and December, 1949. Group A of the previous season was not represented in the fishery of the 1949-50 season.

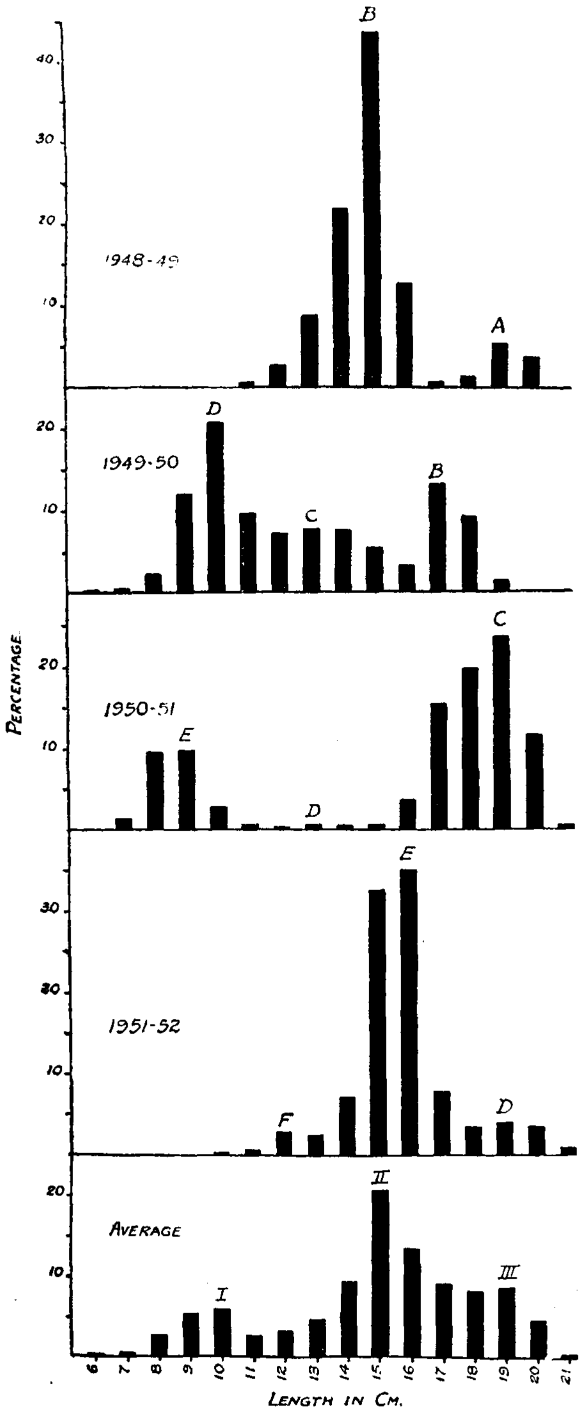

FIG. 2. Length frequency histograms of the oil sardine for the seasons 1948-49 to 1951-52 and the average length frequency histogram for the entire period of investigation.

In the 1950-51 oil sardine fishery, three modes dominated and these were group C at 19 cm, group D at 13 cm and group E at 9 cm (Fig. 2). Group E was a new stock composed of indeterminate juveniles, the result of the spawning of the 1949-50 season. Group D which had registered an increase of 3 cm in total length was poorly represented in the fishery and was composed mostly of oil sardines with gonads in the course of development. Group C was composed of adult oil sardines and active spawners. It may be recalled that the spawning season of the 1950-51 oil sardine season was unusually longer than that of the previous season and the adult and the spawning oil sardines formed the bulk of the catches from July to December, 1950. This group was present in the fishery of the previous season and showed a growth of 6 cm. Group B of the 1949-50 season had disappeared from the fishery of the 1950-51 season.

Three distinct modes represented by groups D, E and F at 19, 16 and 12 cm respectively were noticed in the fishery of the 1951-52 season (Fig. 2). It is clear that group F composed of indeterminates encountered in the fishery in August, 1951, was the product of the intensive spawning observed during the previous season. Group E which entered the fishery during the last season practically dominated in the fishery during January, 1952. Group D which was observed first in the 1949-50 fishery constituted the mature adults of the 1951-52 season.

The different age groups of the oil sardines seen in the fishery of the four seasons showed variations in their rate of growth. Groups D, E and F recorded a growth of 10, 9 and 12 cm respectively at the end of the first year. Similarly, groups B, C, D and E also showed different growth increments at the end of the second year when they measured 15, 13, 13, and 16 cm respectively. There is some uniformity in the size reached at the end of the third year as shown by groups A, B, C and D which measured 19, 17, 19 and 19 cm respectively. Accurate determination of the growth rate of the oil sardine based on modal progression during the successive months is rendered difficult owing to the tendency of uniformly sized oil sardines to form the shoals which move in and out of the zone of study. Apart from the sampling error likely to be caused by the shoaling and migratory habits of the oil sardine, it is probable that such variations in the growth rate of the different year classes are caused by the slight shifting of the time of recruitment during the spawning season and also by the fluctuations in the availability of the favourite food of the larval and juvenile oil sardines.

The length frequency histogram based on the averages of percentages for the four seasons under investigation shows the presence of three distinct modes represented by the 10, 15 and 19 cm groups in the population of the oil sardine at Kozhikode (Fig. 2). It is obvious that these three groups represent year classes and that the life span of the oil sardine is three to four years. The new stock recruited during the short spawning season extending from August to November grows to a size of 10 cm and enters the fishery of the succeeding year in a very immature condition. At the end of the second year, when the gonads are in the early stages of development, the oil sardines measure 15 cm and again contribute the bulk of the fishery. They attain the adult spawning size of 19 cm at the end of the third year. A small percentage of the oil sardine population alone reaches the maximum size of 21 cm and even though this group was not represented as a distinct mode in any of the seasons under investigation, it is possible that this size is reached during the fourth year of existence.

THE OIL SARDINE FISHERY IN RELATION TO HYDROLOGICAL CONDITIONS AND THE PHYTOPLANKTON

The South West monsoon with its heavy downpour during June and July is an important factor regulating the annual biological cycle of the West coast. The heavy rains prevailing at the height of the monsoon affect both the fauna and flora of the coastal waters. The influx of rain water brought down by the rivers Beypore, Kallayi and Korapuzha alters considerably the hydrological conditions of the sea off Kozhikode and the lowest temperature and salinity are reached during these months as evident from Table III and Figure 1 which show the monthly average surface temperature and salinity of Kozhikode waters and the total monthly rainfall at Kozhikode. The change in the hydrological conditions brings about marked alterations in the composition of the plankton of the coastal waters as well. The sudden outburst of phytoplankton bloom is the characteristic feature of the monsoon months and the diatom dominance in the plankton extends usually from July to September. It is during this period that the oil sardine fishery usually commences along the West coast. The active spawners appear in the fishery first and the detailed studies have shown that they do not show any feeding activity. It can, therefore, be reasonably assumed that the spawners enter the coastal waters only for spawning and the stimulus for breeding activity is given by the outbreak of the monsoon which alters the hydrological conditions considerably. Panikkar and Aiyar (1939) and Nair (1952) have arrived at the same conclusion in regard to the breeding of marine fishes of the East coast. With the return of higher values of temperature and salinity during the post-monsoon months, the spawners forsake the coastal waters and the composition of the fishery also changes during this time. The immature and juvenile oil sardines gradually enter the fishery when the temperature and salinity are on the increase and they practically dominate the fishery from November to January which represent the peak period of the fishery at Kozhikode. The salinity at this time is usually high and varies from 34 to 35‰. The temperature, on the other hand, after showing a progressive increase to 28-29°C in November declines again and this fall is partly caused by the occasional rains of the North East monsoon. The temperature generally varies from 27-28°C during the peak period of the fishery. The second minor peak in the production of phytoplankton extending usually from December to January coincides with the peak period of the oil sardine fishery. The immature and juvenile oil sardines apparently enter the inshore waters during this period when the temperature and salinity are higher than those of the monsoon months, mainly to feed on the phytoplankton at its secondary maximum period. The juvenile oil sardines disappear from the coastal waters by February or March when stray shoals of spent oil sardines alone appear in the fishery. The oil sardine fishery generally terminates by March or April which are poor months for the occurrence of phytoplankton.

The food and feeding habits of the oil sardines as observed during the last four seasons have also shown that phytoplankton forms the chief food of the juvenile and adult oil sardines, and among the different diatoms, *Fragilaria oceanica* is the most important constituent of the food of the fish. A significant correlation has been found to exist between the occurrence of this diatom and the oil sardine in the waters off Kozhikode. The major peak in the occurrence of the diatom is during June and July, representing the monsoon months. A minor peak is reached during September-October, more or less coinciding with the peak period of the oil sardine fishery. The relationship which became apparent during the earlier seasons was seen markedly during the 1951-52 season which was a very good year both for the diatom and the oil sardine. During this season, the maximum occurrence of *Fragilaria oceanica* was observed during the monsoon months June and July, 1951. In the next month, however, a sudden decline in their production was seen and it registered a low position in the phytoplankton composition of the month. A steady increase in their numerical abundance was observed in the two subsequent months and the secondary maximum in its occurrence was reached in October, 1951. The diatom was practically absent during November and December, 1951, in the inshore waters. It again reappeared in the plankton in January, 1952, though in smaller numbers.[1] The data relating to the commercial catches of oil sardines at Kozhikode show a direct correlation with the fluctuation in the abundance of *Fragilaria oceanica* in the coastal waters. Large-scale commercial exploitation of the oil sardine fishery commenced only in August, 1951. The fishery also showed steady improvement in the subsequent months and the peak of the fishery was also reached in October, 1951. The fishery suffered a setback during the next two months caused mainly by the disappearance of *Fragilaria oceanica*, the favourite food of the juvenile oil sardines from the inshore waters. The fishery recovered in January, 1952, with the reappearance of the diatom in the sea off Kozhikode. The availability of *Fragilaria oceanica* is probably one of the main factors responsible for the seasonal fluctuations of the oil sardine fishery.

OIL SARDINE FISHERY IN RELATION TO OTHER FISHERIES

The oil sardine and the mackerel are the two principal fishes which contribute to the marine fish production of the West coast. The fluctuation characteristic of the fishery of the oil sardine does not normally affect that of the mackerel. An inverse relationship in the annual yields of these two fisheries has been indicated in an earlier paper (Nair and Chidambaram, 1951). The fluctuations in the oil sardine fishery seen within the season do not in any way influence the course of the mackerel fishery. The estimated monthly landings of the oil sardine and the mackerel at Kozhikode for the 1951-52 season are given in Table III. It is seen that the landings of these fishes have been uniformly good during the different months. The oil sardine fishery was poor during November and December, 1951, and a similar decline in the landings of mackerel was also observed during these months.

On the other hand the success or failure of the oil sardine fishery has been observed to exert a profound influence on the other sardine fisheries of the West coast, namely, of *Sardinella fimbriata*, *Sardinella brachysoma*, and *Kowala coval*. The oil sardine being a more highly priced and esteemed fish than even the mackerel, its fishery is intensively exploited neglecting the other fisheries of the West coast. This relationship existing between these fisheries is clearly seen from the monthly landings presented in Table II. It may be mentioned that the 1951-52 season also showed prospects of a very good fishery of the other sardines and enormous shoals of these fishes frequently entered the very shallow inshore waters, but their fisheries were neglected by the commercial fishermen owing to the unusual improvement of the more lucrative oil sardine and mackerel fisheries at that time. Commercial exploitation of these fisheries was observed only on those days when the oil sardine and mackerel were scarce in the fishing grounds.

DISCUSSION

This study brings out clearly the regular cyclical changes in the composition of the oil sardine stocks encountered in the fishery during the 1948-49 to 1951-52 seasons. The oil sardine fishery always commences during the South West monsoon with the appearance of the spawners along the coast. The post-monsoon months show the disappearance of the spawners and the entry of the juvenile oil sardines which practically form the bulk of the commercial catches during the peak period of the fishery. The spent oil sardines generally appear in the closing stages of the fishery.

Detailed biological investigations conducted during the four seasons of progressive improvement of the fishery, have shown that the oil sardines reach the average size of 10, 15 and 19 cm at the end of the first, second and third year respectively and that the one-year old oil sardines are indeterminates, the two-year old oil sardines are immature with developing gonads and the three-year old oil sardines are mature adults and active spawners. This is in agreement with the earlier findings based on the studies on the otoliths of the oil sardine (Nair, 1949). The presence of the first growth ring followed by a narrow growth zone in the indeterminate oil sardines of the 12 cm size group, one growth ring and a wide growth zone in the immature oil sardines of the 15 cm size group and two growth rings followed by a wide growth zone in mature sardines belonging to the 19 cm size group was shown in this paper. Judging from the size of the fish, the number of rings and the width of the last growth zone, it can be assumed that these size groups represent one-, two- and three-year old oil sardines. In the majority of the preparations two rings alone were detected and in exceptional cases indications of the third ring were also seen.

The present study has established that the oil sardines show a definite preference for phytoplankton food. Phytoplankton production commences along the coast with the onset of the South West monsoon and paucity of phytoplankton is generally observed during the summer months extending from March to May. It is probable that the growth checks detected on the otoliths of the oil sardine, especially the first two ones, are formed during the summer months when there is scarcity of phytoplanktonic food. The third ring encountered in some oil sardines is either caused by the same factor or by the cessation of feeding at the time of spawning.

Chidambaram (1950) has also arrived at the same conclusion in regard to the span of life and rate of growth of the oil sardine. Based on length frequency studies he has shown very similar growth rate, namely 10.0, 14.5, 18.3 and 20.5 cm during the first, second, third and fourth year of life of the oil sardine. It may be mentioned that the growth rate of the oil sardine arrived at by these studies on the otoliths and length frequencies is in general agreement with that of the sardines of other countries, particularly the Australian pilchard, *Sardinops neopilchardus* (Blackburn, 1949).

Contradicting views were, however, expressed by earlier workers about the life span of the oil sardine. Hornell and Nayudu have suggested on the basis of their studies on the scales, that the oil sardine attains sexual maturity and almost full adult size at the age of one year when it reaches 15 cm. According to them growth during the second year is very slow and amounts to only 1 cm. Their estimation of the span of life of the oil sardine is about two and a half years only. Devanesan, from his studies on the scales of the oil sardine, suggested that the oil sardine of 6.5 cm belonged to the second year class, 8.7 cm to the sixth year class, etc., and 21 cm to the fourteenth year class. It is clear from the photographs illustrating his paper that he had counted the false rings also along with the true ones for determining the age of the oil sardine.

Another point which has emerged as a result of this investigation is about the size and age of the oil sardine at the time of the first maturation and spawning. Hornell and Nayudu state that the oil sardine attains sexual maturity when it reaches 15 cm even though none was ever found by them in the actual spawning or oozing condition. Devanesan collected spawners of oil sardines from Quilandy in the oozing condition. He does not record the measurements of these active spawners but indicates only the size range of the random sample which contained the spawners. The earlier authors appear to have made no distinction between the conditions found in the gonads reaching maturation and those ready for spawning for they appear to have assumed that spawning takes place immediately after the gonads attain the normal size, which according to these authors takes place when the fish reaches a size of 15 cm in length. The present study has shown that the one-year old oil sardines are always indeterminate with undeveloped gonads while the two-year old oil sardines are immature with the gonads usually in the earlier stages of development. Active spawners and spent oil sardines in stages V to VII have always been encountered in the three-year old sardines only. This investigation also shows the possibility that the oil sardines spawn only once in their lifetime as shown by the simultaneous maturation and extrusion of almost all the ovarian eggs and the absence of recovering specimens among the spent oil sardines.

Based on Walford's (1946) positive correlation of the summer salinity with the fluctuations in the abundance of the year classes of the Pacific sardine, *Sardinops caerulea*, Chidambaram has also attempted to explain the migrations of the oil sardine in relation to temperature and specific gravity. He suggests that the oil sardine shoals appear in inshore waters when the temperature is low and disappear from these waters because of higher temperature. It is true, no doubt, that the spawners enter the inshore waters when the temperature and salinity are at their lowest during the monsoon, but for the appearance of the juveniles which form the mainstay of the oil sardine fishery every year, higher temperature and salinity, especially the latter, appear to be necessary. Immense shoals of juveniles have been encountered in the fishery during the peak period from November to December alone when the temperature and salinity vary from 27 to 28°C and 34 to 35‰ respectively. Perhaps, these are the optimal hydrological conditions for the appearance of the juveniles in the coastal waters. The abundance of phytoplankton, particularly of *Fragilaria oceanica*, appears to be another causative factor which influences the movements of the juvenile shoals, on the availability of which depends

[1] I am thankful to Dr R. Subrahmanyam for the information relating to the occurrence of *Fragilaria oceanica* during the 1951-52 season.

the success and failure of the oil sardine fishery every year.

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EXPLANATION OF FIGURES AND PHOTOGRAPH

Fig. 1.—Histogram showing the estimated monthly landings of oil sardine together with the total monthly rainfall and the average monthly temperature and salinity at Kozhikode from July, 1948, to June, 1952.

Fig. 2.—Length frequency histograms of the oil sardine for the seasons 1948-49 to 1951-52 and the average length frequency histogram for the entire period of investigation.

Photo 1.—The oil sardines being transferred from the bag of the boat seine, " Mathikolli vala " to the ' hold ' of the large canoe.

TABLES

Table I.—Estimated landings of oil sardine in South Kanara and Malabar from the 1925-26 to 1951-52 seasons.

Table II.—Estimated landings of oil sardine and other sardines at Kozhikode from July, 1948, to June, 1952.

Table III.—Estimated monthly landings of oil sardine and mackerel at Kozhikode during the 1951-52 season.

TABLE I

Estimated Landings of Oil Sardine in South Kanara and Malabar

Seasons	Landings of oil sardine in maunds		
	South Kanara	Malabar	Total
1925-26 ..	650,707	541,742	1,192,449
1926-27 ..	74,021	322,626	396,647
1927-28 ..	63,673	129,339	193,012
1928-29 ..	8,465	39,968	48,433
1929-30 ..	42,122	31,656	73,778
1930-31 ..	4,824	111,048	115,872
1931-32 ..	17,175	41,378	58,553
1932-33 ..	212	29,901	30,113
1933-34 ..	796,805	1,126,788	1,923,593
1934-35 ..	10,796	547,414	558,210
1935-36 ..	961	39,188	40,149
1936-37 ..	122,365	605,361	727,726
1937-38 ..	76,445	379,592	456,037
1938-39 ..	66,873	24,576	91,449
1939-40 ..	78,240	111,724	189,964
1940-41 ..	290,603	386,406	677,009
1941-42 ..	13,442	105,789	119,231
1942-43 ..	690	23,948	24,638
1943-44 ..	5,867	5,991	11,858
1944-45 ..	17,472	123	17,595
1945-46 ..	195	281	476
1946-47 ..	30	207	237
1947-48 ..	25,494	6,419	31,913
1948-49 ..	6,645	1,144	7,789
1949-50 ..	16,083	74,744	90,827
1950-51 ..	41,122	139,762	180,884
1951-52 ..	19,500	273,374	292,874

TABLE II

Estimated Landings of Oil Sardine and Other Sardines at Kozhikode from July, 1948, to June, 1952

Months	Oil Sardine	Other Sardines
Jul., 1948 ..	..	..
Aug., 1948 ..	..	535
Sep., 1948 ..	..	1,810
Oct., 1948 ..	42	2,895
Nov., 1948 ..	23	7,250
Dec., 1948 ..	44	3,070
Jan., 1949 ..	23	..
Feb., 1949 ..	..	..
Mar., 1949 ..	..	..
Apr., 1949 ..	..	..
May, 1949 ..	..	..
Jun., 1949 ..	..	..
Jul., 1949 ..	..	1,050
Aug., 1949 ..	..	..
Sep., 1949 ..	405	..
Oct., 1949 ..	11,460	..
Nov., 1949 ..	6,775	..
Dec., 1949 ..	8,500	..
Jan., 1950 ..	30	..
Feb., 1950 ..	1,730	..
Mar., 1950 ..	..	..
Apr., 1950 ..	..	..
May, 1950 ..	..	..
Jun., 1950 ..	..	..
Jul., 1950 ..	..	..
Aug., 1950 ..	..	6,050
Sep., 1950 ..	..	5,850
Oct., 1950 ..	6,025	70
Nov., 1950 ..	9,645	..
Dec., 1950 ..	308	..
Jan., 1951 ..	..	3,570
Feb., 1951 ..	..	175
Mar,. 1951 ..	..	20
Apr., 1951 ..	..	..
May, 1951 ..	..	..
Jun., 1951 ..	..	..
Jul., 1951 ..	2,640	..
Aug., 1951 ..	22,360	7,540
Sep., 1951 ..	33,100	820
Oct., 1951 ..	..	..
Nov., 1951 ..	..	150
Dec., 1951 ..	5,300	250
Jan., 1952 ..	1,400	..
Feb., 1952 ..	..	..
Mar., 1952 ..	..	..
Apr., 1952 ..	..	..
May, 1952 ..	..	..
Jun., 1952 ..		

TABLE III

Estimated Monthly Landings of Oil Sardine and Mackerel at Kozhikode during the 1951-52 Season

Months	Oil Sardine	Mackerel
Jul., 1951 ..	2,640	5,070
Aug., 1951 ..	22,360	41,100
Sep., 1951 ..	33,100	34,640
Oct., 1951 ..	..	17,100
Nov., 1951 ..	..	31,400
Dec., 1951 ..	5,300	23,050
Jan., 1952 ..	1,400	10,050
Feb., 1952 ..	..	7,250
Mar., 1952 ..	..	..
Apr., 1952 ..	..	910
May, 1952 ..	..	..
Jun., 1952 ..		

4

PRELIMINARY REPORT ON A COMPARISON OF THE STOCKS OF YELLOWFIN TUNA

by

W. F. Royce*

With so many people in the world looking toward tuna as a source of food and with the increased competition for the tuna fisheries by the fleets of many nations, there arises the question of the inter-relationships of the tuna in widely separated parts of the oceans. Do the schools of each species migrate over thousands of miles as do some of our migratory birds, or are they relatively localized, hatching, growing, and dying within a few hundred miles ? There is also the related problem of whether or not the major species which are world-wide in distribution are composed of discrete units, each of which should be defined as a separate species.

Interest in these questions has been expressed at previous meetings of the Indo-Pacific Fisheries Council and the collection of data on the matter has been a major concern of the Tuna Sub-committee. In 1950 at the second meeting of the Council, the Tuna Sub-committee agreed that "the most urgent and fundamental problem with the tunas and one of distinctly international bearing was to determine whether the population of each important tuna species is continuous and homogeneous throughout its range, or whether it is composed of a number of independent or semi-independent units, and if so, the limits of each."

An approach to this problem through comparison of morphometric measurements had been commenced in various parts of the world and at the second meeting, the Tuna Sub-committee consisting of representatives of the United States, Indonesia, and Australia agreed that it was desirable to take the measurements according to the method of Godsil (1944) as further defined by Marr and Schaefer (1949) and that publication should include the original measurements of the individual fish.

In 1951, at the third meeting, it was reported by the Tuna Sub-committee that sets of morphometric measurements had been obtained on 2,783 specimens of 12 tuna species from 10 different parts of the Indo-Pacific region. Since this time, additional data have been collected, much of which has been made available to the Pacific Oceanic Fishery Investigations, where we have undertaken the analysis of data and the comparison of tunas from many parts of the world. It is the purpose of this report to present the first results of our analysis of the yellowfin tuna data. This species was chosen because it is one of the most important in the Indo-Pacific area, and a large amount of morphometric data is available.

Our comparisons have been greatly facilitated by the data which have been collected in several parts of the world by other workers. First and most assiduous of these was Godsil, who reported in 1948 on the measurements of 1,911 yellowfin from the Pacific coast of Central America. He followed this with a comparison of yellowfin from other parts of the Pacific in collaboration with Greenhood in 1951. Schaefer (1948) published information on the morphometric characteristics and relative growth in yellowfin tuna from Central America and followed this with a comparison of the Central American and Hawaiian yellowfin in a manuscript which is scheduled to appear soon as a Fishery Bulletin of the U.S. Fish and Wildlife Service. Schaefer and Walford (1950) made a comparison between the yellowfin tuna of Angola, Africa, and the Pacific coast of Central America.

These data have been supplemented by others from many regions of the Pacific through the efforts of members of the Indo-Pacific Fisheries Council. The data, both published and unpublished, which were used by me for the preparation of this report, are listed in table 1 and the localities are indicated in figure 1. In addition to the measurements enumerated, a few more have been recently added (too late for use in the following analysis) through the efforts of the Pacific Oceanic Fishery Investigations staff, and others from areas in the Philippine Islands were furnished by Dr. Villadolid.

In view of the Council's resolutions regarding papers, this one will be made as brief as possible. Neither a full discussion of the statistical techniques nor the detailed measurements of individual specimens will be presented here, these matters being left for future publication in a report of the U.S. Fish and Wildlife Service.

I gratefully acknowledge the assistance of Miss Dorothy I. Y. Dung, who has carefully and assiduously performed the large number of calculations necessary for the handling of these data.

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METHODS

Techniques of Measurement

All of these data have been collected according to the techniques described by Marr and Schaefer (1949). Because their paper may not be widely available in this area, it is desirable to repeat here the techniques for measuring characters which in our experience are the most useful for distinguishing the stocks of tunas. The measurements are all made in millimeters with calipers or dividers, depending upon the size of the fish and the distance to be measured. All distances are straight line. The tip of the fixed arm of the calipers (or one point of the dividers) is applied to the first point mentioned and the tip of the sliding arm of the calipers (or the other point of the dividers) is applied to the second point mentioned. Where a choice of sides is involved, all measurements and counts are made on the left side of the fish. Fin insertions are to be determined while holding the fin approximately perpendicular to the contour of the fish. The measurements are defined as follows :

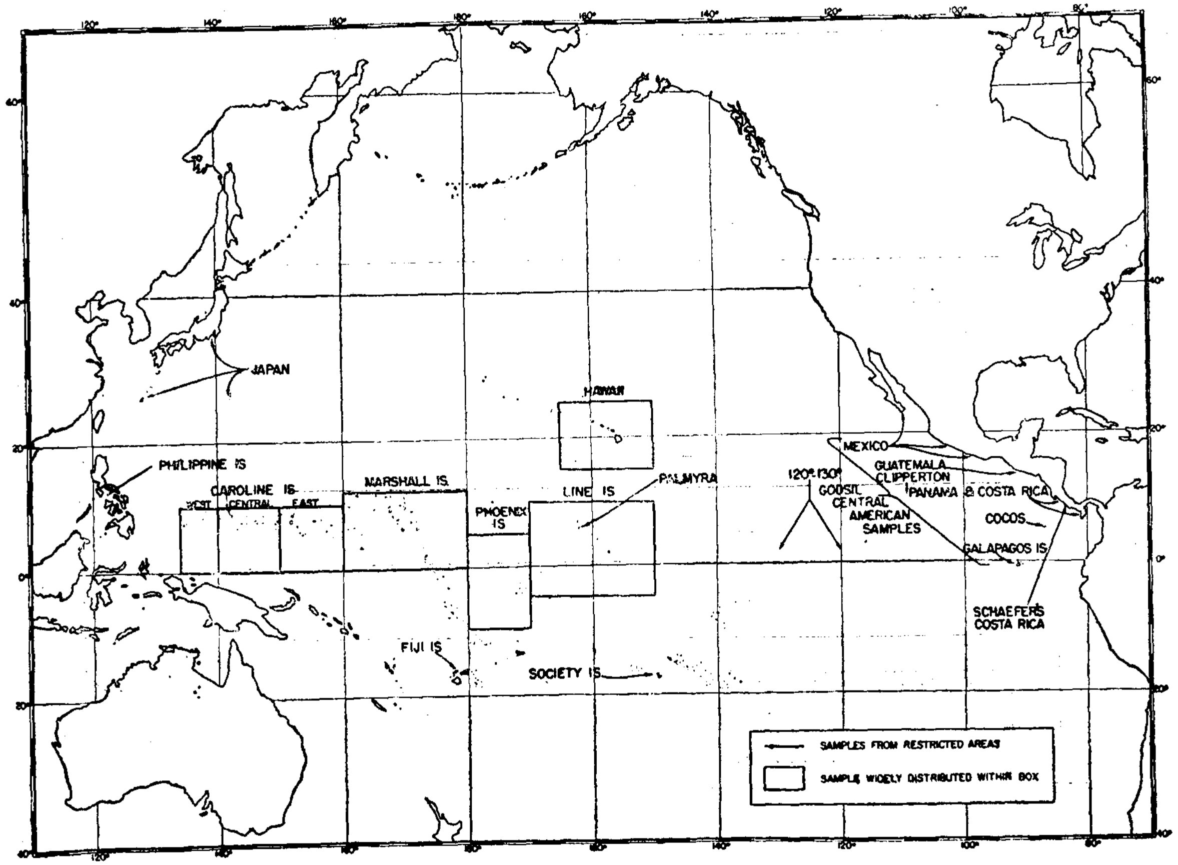

FIG. I LOCALE OF MORPHOMETRIC DATA ON YELLOWFIN TUNA

Fork length (" total length " of Marr, Schaefer, and Godsil). The distance from the tip of the snout (most anterior point on upper jaw), with jaws closed to the cartilaginous median part of the caudal fork (seating the sliding arm of the caliper firmly and thus depressing the small fleshy flap extending posteriorly).

Head length. The distance from the tip of the snout to the most posterior point on the margin of

Table 1. Locale and size of yellowfin tuna measured

Fork length cm	Locality: Angola, Africa[1]	Pacific coast of Central America[2]	Society	Hawaii[3]	Fiji[4]	Japan	Off Luzon, Philippine Is.[5]	Ceylon[6]	Equatorial Pacific (Between 10°N and 10°S latitude): Costa Rica[7]	120°-130° West	Line Is.	Palmyra[4] (One of Line Is.)	Phoenix Is.	Marshall Is.[8]	Eastern Caroline Is.	Central Caroline Is.	Western Caroline Is.
20— 29.9																	
30— 39.9						1											
40— 49.9	1	7	2	16		11	1				1				1	1	
50— 59.9		336	15	15	1	6	59		2		2	1	4	21	8	6	
60— 69.9		551	3	3	2	6	122	1	7		9	10	18	6	23	11	2
70— 79.9	11	597	2	2		8	62	1	3		25	24	14	4	18	19	1
80— 89.9	11	194	8	4	3	8	47	1	6		30	18	16	5	19	21	1
90— 99.9	1	84	1	9	1	6	19		11	1	31	27	19	4	16	21	3
100—109.9		46		15	6	1	9		6		31	10	10	3	6	33	
110—119.9	9	50		6			6		6		21	2	24	1	14	27	2
120—129.9	8	24		17			15		2	3	17	1	13		12	33	7
130—139.9	9	13		29			11			5	19		8		21	24	1
140—149.9	6	5	2	22			5		2	17	24	1	3		9	13	
150—159.9	2	4		15			2		1	13	39				11	2	
160—169.9	2			32						4	6		1		1		
170—179.9				18													
180—189.9																	
Total ..	60	1,911	33	203	13	47	358	3	46	43	255	94	130	44	159	211	17

Sources: [1] Schaefer and Walford (1950).
[2] Godsil (1948).
[3] Schaefer (MS).
[4] Godsil and Greenhood (1951).
[5] Measurements supplied by Dr. D. V. Villadolid.
[6] Measurements by Mr. E. R. A. de Zylva.
[7] Schaefer (1948).
[8] Measurements supplied by Mr. J. C. Marr, Fish and Wildlife Service, Stanford, California. Partly collected near Bikini Atoll, which is at 12°N. latitude.

All other data collected by staff of Pacific Oceanic Fishery Investigations.

the subopercle (depressing the fleshy flap extending posteriorly).

Snout to insertion first dorsal. The distance from the tip of the snout to the insertion of the first dorsal. The insertion of the first dorsal is the intersection of the anterior margin of the first dorsal spine, when the fin is held erect, with the contour of the back. This point is identical with the most anterior point of the first dorsal fin slot.

Snout to insertion second dorsal. The distance from the tip of the snout to the insertion of the second dorsal. The insertion of the second dorsal is not so clearly defined as the insertion of the first dorsal, particularly on larger fish, but is the intersection of the anterior margin of the second dorsal, when the fin is held erect, with the contour of the back. When the second dorsal is raised, the determined point should be marked with thumb nail or scalpel.

Snout to insertion anal. The distance from the tip of the snout to the insertion of the anal. The insertion of the anal is determined in the same manner as the insertion of the second dorsal.

Snout to insertion ventral. The distance from the tip of the snout to the insertion of the ventral. The insertion of the ventral is the intersection of the anterior margin of the ventral, when the fin is extended, with the contour of the body.

Insertion ventrals to anterior edge of vent. The mid-line distance from the insertion of the ventrals to the anterior edge of the vent.

Greatest depth. The greatest distance between the dorsal and ventral contours perpendicular to the axis of the fish. The measurement is taken from the dorsal body contour to the ventral body contour, with the first dorsal fin depressed in its slot. It is oriented by reference to the dorsal spine, the insertion of which is at or nearest the upper end of the vertical. Dorsal spines are counted posteriorly, the most anterior spine being the first.

Length of pectoral. The distance from the anterior end of the fin slot to the most posterior point, taken with the pectoral fin extended posteriorly and opposed to the side.

Height (length) of second dorsal. The distance from the insertion of the second dorsal to its distal end, with the fin in a normal position. Note that this fin is often extended in a long filament, especially in large *Neothunnus*, and care should be taken to notice if this extension is frayed.

Height (length) of anal. The distance from the insertion of the anal fin to its distal end, with the fin in a normal position. Remarks under "height second dorsal" apply here.

Diameter of iris. The greatest diameter measured to the margin of the yellow iris and the adjoining black tissue. This is generally not on a line parallel to the median line of the body.

Number of gill rakers. The number of anterior rakers on the most anterior gill arch on the left side of the fish (some species also have posterior rakers on this same arch). The counts of the rakers on the two arms of the arch are kept separate. For example, 10+20=30 gill rakers with 10 on the upper arm and 20 on the lower. The counts include all rakers that project above the surrounding epithelium. We have encountered no difficulty in assigning rakers near the angle of the arch to one arm or the other.

Sex. Determined by inspection. Very immature males and females may be difficult to distinguish. Ovaries, which are tubular, may often roll between the fingers, while testes, which are solid, will turn over. The testes of ripening or ripe males are enlarged, solid, white bodies, not round in cross section. The ovaries of ripening or ripe females are enlarged, turgid, pink or yellow-orange bodies, round in cross section. Ova may often be distinguishable with the naked eye. The testes of spawned-out males are less turgid, tougher, and pinker than those not spawned, and are difficult or impossible to distinguish from maturing testes in early stages. The ovaries of spawned-out females are hollow, more or less flabby, sac-like tubes.

Weight. This has been determined in pounds on spring balances or steelyards. Metric units would be more desirable, and experience has shown that a counterpoise style of balance, such as Chatillon No. 160, is more satisfactory, since the calibration of a spring balance is subject to change due to corrosion.

Analysis of Data

There are numerous practical and statistical difficulties involved in the analysis of morphometric data. Since most of the dimensions do not maintain a constant ratio to the length of the fish, it becomes possible to compare specimens from different areas only by taking account of variations in length. This has been done by computing a mean square regression[1] for each dimension on the fork length or the length of the head. Unfortunately the best fitting regression line is not in all cases a straight line. This difficulty was resolved by Godsil (1948) and Godsil and Greenhood (1951) by using in all cases a regression of the general type :

$$Y = a + bx + \frac{c}{x}$$

Schaefer (1948), Schaefer and Walford (1950), and Schaefer (MS.) chose to simplify the computations by fitting a straight line with a formula of the type,

$$Y = a + bx,$$

but transformed the original data in order to approximate a straight line relationship. This was done by converting either one or both of the measurements to logarithms.

We have followed Schaefer's simpler formula, but even so there remains a great amount of labor. After making the computations for the determination of a regression line for each character on several hundred fish using a standard desk calculator, we found the labor was excessive and approached the International Business Machines Corporation, who worked out a method of doing most of the calculations on their business machines. We provided them with the raw data sheets and, at a cost of about 35 cents per tuna, we received a completely detailed tabulation of the sums, sums of squares, and sums of products of 12 measurements on each of nearly 2,000 tuna. This reduced the time required for handling the basic computations from approximately 10 man-months to 2 man-months.

Throughout our analysis we maintained a very close watch for errors. All computations were duplicated and an overall check of the computations was made for each character from each sample from each area by plotting the individual points and the regression line as computed from the data. Such plotting serves to reveal any divergent observations, any curvilinearity, and any but the most trivial error in the computation. We used the plots to search for divergent observations and omitted from our analysis any which differed more than three standard errors of estimate from the regression line on the assumption that such large discrepancies are errors of observation. The regression line was then recomputed with the aberrant data omitted. If curvilinearity was noticeable and could not be removed by transformation we dropped the measurements at the ends of the curve and used only fish between 70 and 129.9 cm in length for computing the regression lines and the analysis of covariance. If curvilinearity remained in this central part of the curve, we did not further consider the character.

COMPARISON AND EVALUATION OF DATA

Differences Among Samples

The technique used by all of the authors listed in table 1 has been covariance analysis as described by Snedecor (1946)[2] or in any of several other recent books on statistics. This method uses the basic data as developed through the fitting of the regression lines and it provides a precise answer to the question of whether two samples differ more than would be expected from chance variation. If such a difference exists, it is good proof that the samples were not drawn from a homogeneous population. Schaefer and Walford (1950) and Schaefer (MS.) have shown that the Central American, Angolan (Africa), and Hawaiian populations of yellowfin tuna could not be considered a homogeneous population.

Godsil (1948), using the same technique of covariance analysis, found statistically significant differences among most of his samples from the Central American Region and even between samples taken from the same locality. This suggested to him a fundamental difference in the concepts of statistical and biological homogeneity. Therefore he developed a measure of divergence which compared the maximum deviation from the average local regression line of a local sample with a deviation of a foreign sample. He summed the deviations for the five characters which he used and arrived at figures showing that the foreign samples (from Japan, Peru, and Hawaii) differed from the local samples much more than the local samples differed among themselves.

Similar statistical studies on other species of fish have shown that there may be statistically significant differences between two populations which are mingling to a considerable extent. Tester (1949) studying the British Columbia herring and Roedel (1952) working with the Pacific mackerel had the opportunity to compare their racial studies with tagging results. Both found statistically significant differences among their samples from areas where the tagging showed considerable intermigration of fish. Therefore, we must conclude that the existence of a statistically significant difference means merely that the populations of fish are not homogeneous, i.e., they are not completely mixing ; they may be partially mixing.

When we compare the yellowfin samples from different areas in all possible ways by means of covariance analysis, we find immediately that statistically highly significant differences result from most comparisons.[1] Using the head length of yellowfin tuna from the 15 areas (table 2) we find that 76 of the 105 possible comparisons result in a variance ratio (F) which is statistically highly significant.[2] Of the remaining 29 comparisons, 13 variance ratios are significant and 16 are not significant. Thus using only a single character we find a majority of comparisons yielding highly significant differences among samples.

Turning to a second character, the distance from the snout to the insertion of the second dorsal, and considering only the samples in which the comparison of head length failed to yield a highly significant difference (table 3), we find that this second character shows a highly significant difference in 14 of the 29 comparisons. Using yet a third character, the distance from the snout to the insertion of the first dorsal, in instances where a highly significant difference was not found with the first two characters considered, we find 3 of the remaining 15 comparisons showing highly significant differences.

We now note that 10 of the remaining 12 comparisons involve areas from which we have our smallest samples: Fiji (13 specimens), Society Is. (33), and Western Caroline Is. (17). With such small samples only relatively large differences can be found to be significant, and even if they are so found the agreement between the sample and the tuna stock in its locality is questionable. However, most comparisons involving these small samples show the same tendency toward significant differences. Eight of the ten comparisons show significant (but not highly significant) differences for one or more of the three characters already considered.

The two comparisons of areas involving larger samples may be extended by considering additional characters. For the Line Island-Palmyra comparison the variance ratio (F) for the distance from the snout to the insertion of the anal is not significant (2.49), but the distance from the snout to the insertion of the ventral shows a highly significant (13.05) value. This is the only highly significant difference found among the five characters considered for these two samples, which are so close geographically.

The other comparison, Eastern *vs.* Central Carolines, yields non-significant F values for the height of the anal (1.22), the height of the second dorsal (1.58), and the greatest body depth (0.09), significant values for the length of the pectoral (3.94), the distance from the insertion of the ventrals to the anterior edge of the vent (4.30), and a highly significant difference in the distance from the snout to the insertion of the ventrals (6.91).

Thus even with samples from the most closely allied stocks, it seems very probable that highly significant statistical differences can be found by increasing the size of the samples, by considering enough characters, or by applying the more critical discriminant function proposed by Fisher (1936). Indeed, our criterion of a highly significant difference is one which would occur from chance variation once in 100 times and in several hundred comparisons we expect to find some such differences due to chance alone. Therefore, we turn from a consideration of the differences among samples to the matter of the relationships among samples.

Relationships Among Samples

It is possible to use the variance ratio (F) to indicate which groups of tuna are most closely related. This requires the assumption that the relationship between the populations is closer when the probability of the observed differences being due to chance increases. Such a comparison is difficult, however, because first the significance of the (F) depends upon the number of observations in the samples, and second the value of (F) is not linearly related to the difference between the samples ; it

[1] These computations follow techniques described by Snedecor (1946).
[2] Our use of statistical terms in this paper follows Snedecor (1946) unless otherwise stated.

[1] In our analysis of covariance we follow the technique of Kendall, 1948, vol. 2, p. 239, and subtract the deviations from linear regressions within classes from the total deviation from linear regression. This difference is assigned two degrees of freedom and represents a sum of the differences among regressions and the deviations between classes from the mean linear regression.
[2] We shall speak of ratios expected from chance variation less than once in 100 times as highly significant and those expected one to five times per 100 times as significant.

Table 2. Comparison of head length of yellowfin tuna by means of variance ratios (F)

—	N	Costa Rica	120°-130°W. Long.	Line Is.	Palmyra (One of Line Is.)	Phoenix Is.	Marshall Is.	Eastern Caroline Is.	Central Caroline Is.	Western Caroline Is.	Society Is.	Hawaii	Fiji	Japan	Philippine Is.	Angola, Africa
		Equatorial Pacific														
	N	46	43	253	94	120	44	157	208	17	26	203	13	46	353	60
Equatorial Pacific:																
Costa Rica	46		14.2	15.0	33.1	22.5	28.6	160.9	116.7	75.6	26.5	9 .2	16.5	31.4	18.2	4.4
Equator at 120°-130°N	43			(0.1)	3.3	(1.2)	(1.6)	26.0	18.5	7.2	(0.7)	18.8	0.3	3.5	3.3	6.0
Line Is.	253				3.2	5.6	34.3	98.1	38.6	23.6	20.8	106.3	5.2	52.5	24.0	10.2
Palmyra Is.	94					(2.3)	48.1	89.4	69.4	23.3	36.2	68.9	9.1	63.7	13.0	18.1
Phoenix Is.	120						15.3	43.9	42.7	13.6	8.8	46.9	(1.9)	2 .7	7.8	16.4
Marshall Is.	44							9.0	6.0	12.3	(0.6)	7.5	(0.1)	(2.5)	16.4	26.6
Eastern Caroline Is.	157								(0.8)	4.3	3.9	4.3	5.9	18.8	89.9	137.5
Central Caroline Is.	208									3.1	(2.5)	4.1	7.8	11.4	92.3	112.4
Western Caroline Is.	17										7.0	(1.1)	7.2	13.4	32.8	45.0
Society Is.	26											4.5	(0.2)	4.3	8.6	21.0
Hawaii	203												4.6	7.4	97.3	93.7
Fiji	13													(0.7)	2.2	10.2
Japan	46														34.6	34.0
Philippine Is.	353															12.7

( ) Value expected more than 5 per cent of the time by chance.
—— Value expected between 1 and 5 per cent of the time by chance.
All others are expected less than 1 per cent of the time by chance.

Table 3. Comparison of the distance from snout to insertion of the second dorsal of yellowfin tuna by means of variance ratios. Comparisons are made only in cases showing differences less than highly significant when comparing head length (table 2).

—	N	Costa Rica	120°-130°W. Long.	Line Is.	Palmyra (One of Line Is.)	Phoenix Is.	Marshall Is.	Eastern Caroline Is.	Central Caroline Is.	Western Caroline Is.	Society Is.	Hawaii	Fiji	Japan	Philippine Is.	Angola, Africa
		Equatorial Pacific														
	N	46	41	254	93	120	44	158	206	17	31	202	13	46	354	60
Equatorial Pacific:																
Costa Rica	46															3.3
Equator at 120°-130°W.	41			10.7	13.6	51.0	15.9				12.5		7.0	20.8	18.4	
Line Is.	254				(0.5)											
Palmyra Is.	93					4.3										
Phoenix Is.	120												(2.2)			
Marshall Is.	44										4.6		7.2	6.5		
Eastern Caroline Is.	158								(.04)	(0.3)	3.3	19.5				
Central Caroline Is.	206									(0.1)	(2.8)	19.0				
Western Caroline Is.	17											(2.1)				
Society Is.	31											(1.1)	3.3	11.7		
Hawaii	202												(2.1)			
Fiji	13													4.9	10.0	
Japan	46															
Philippine Is.	354															
Angola, Africa	60															

( ) Value expected more than 5 per cent of the time by chance.
—— Value expected between 1 and 5 per cent of the time by chance.
All others are expected less than 1 per cent of the time by chance.

Table 4. Comparison of the distance from snout to insertion of first dorsal of yellowfin tuna by means of variance ratios. Comparisons are made only in cases showing differences less than highly significant when comparing head length (table 2) or snout to insertion of second dorsal (table 3).

	N	Equatorial Pacific: Costa Rica 46	120°-130°W. Long. 43	Line Is. 252	Palmyra (One of Line Is.) 94	Phoenix Is. 118	Marshall Is. 44	Eastern Caroline Is. 159	Central Caroline Is. 208	Western Caroline Is. 17	Society Is. 31	Hawaii 201	Fiji 13	Japan 47	Philippine Is. 353	Angola, Africa 60
Equatorial Pacific:																
Costa Rica	46															8.8
Equator at 120°-130°W. Long.	43															
Line Is.	252				(2.9)											
Palmyra Is.	94					7.3										
Phoenix Is.	118												3.5			
Marshall Is.	44										7.0					
Eastern Caroline Is.	159								(0.3)	(2.0)	(0.1)					
Central Caroline Is.	208									(1.3)	(0.1)					
Western Caroline Is.	17											(2.0)				
Society Is.	31											(0.6)	3.0			
Hawaii	201												(1.9)			
Fiji	13													(0.8)		
Japan	47															
Philippine Is.	353															
Angola, Africa	60															

( ) Value expected more than 5 per cent of the time by chance.
—— Value expected between 1 and 5 per cent of the time by chance.
All others are expected less than 1 per cent of the time by chance.

increases much more rapidly than the difference between sample means.

A more satisfactory study of relationships among areas may be made by comparing the dimensions of tuna of a given length. Using the regression formulae which were computed for each character, we have estimated the dimensions of tuna of 100 cm fork length. This length was chosen because it is a round figure and very close to the grand mean of all the yellowfin tuna in our data. Thus it is affected little by fluctuations in the slope of the regression lines.

The estimated values (table 5) on close examination show many significant features. Noteworthy is the tendency for certain samples to show close agreement among all characters. Such is the case between the samples from the Eastern and the Central Caroline Island areas. The greatest difference between areas for any of the nine characters is only 0.5 cm. Almost as close is the agreement between our Line Island sample and Godsil's sample from Palmyra (which is one of the Line Islands). In this case the maximum difference between areas for any of the five characters is 0.7 cm. Much better is the comparison of Schaefer's Costa Rican sample with Godsil's from Panama and Costa Rica. Only four characters may be compared, but the maximum difference is only 0.2 cm. Such figures indicate how close agreement can be, even in the latter two cases where the samples were measured by different people in different years.

A second and most interesting feature of these data is the tendency for the samples collected along the Equator in the Pacific to form clines or gradients. It will be noted that for the characters head length, snout to insertion of first dorsal, snout to insertion of second dorsal, snout to insertion of anal, and greatest body depth, the measurement is greatest in the Eastern Pacific and least in the Caroline Island area. A cline in the other direction is indicated for the size of the fins, fish in the Western Pacific having the largest pectoral, second dorsal, and anal fins.

The regularity of these clines can better be appreciated by plotting them against longitude. This has been done for head length (figure 2), snout to insertion of second dorsal (figure 3), and length of pectoral (figure 4). It can be seen for each of these characters (and for several others which space does not permit us to plot here) that the samples from the Equatorial Region do in fact form a cline and that many of the samples from the other regions differ quite markedly from the cline. The correlations between the estimated dimensions for the

Table 5. Estimated proportions of yellowfin tuna, 100 cm fork length.

	Head Length	Insertion first dorsal	Insertion second dorsal	Insertion anal	Insertion ventral	Greatest depth	Length pectoral	Height second dorsal	Height anal
Angola, Africa	27.2	30.9	52.9	58.2	30.2		28.0		
Pacific Coast of Cent. Am. Panama									
& Costa Rica	27.5	29.7	52.5	58.7	30.6				
Cocos Island	27.3	29.8	52.5	58.5	30.6				
Galapagos Is.	27.7	30.5	53.0	58.8	30.6				
Clipperton Is.	27.3	30.0	52.7	58.5	30.6				
Gautemala	28.1	30.7	54.1	59.9	31.6				
Mexico	27.8	30.4	53.0	59.2	31.0				
Society	26.4	28.6	51.4				30.2		
Hawaii	25.8	28.8	51.4	56.9	29.2	25.3	29.2	18.4	19.6
Fiji	26.4	29.2	51.9	57.2	29.7				
Japan	26.6	29.5	52.2	57.4	29.7	24.7	28.1	18.2	19.1
Luzon, P.I.	26.7	29.8	53.4	58.9					
Equatorial Pacific 10°S-10°N Lat.									
Costa Rica	27.3	29.5	52.6	58.9		25.5	27.0	15.8	17.1
120°-130° W. L.	26.7	29.7	53.3	58.7	29.3		26.7		
Line Is.	26.9	28.9	51.4	56.9	30.1	24.3	28.7	18.8	20.3
Palmyra Is.	26.6	29.2	51.6	56.8	29.4				
Phoenix Is.	26.6	29.2	51.3	56.8	29.8	24.6	29.4	19.8	22.6
Marshall Is.	26.5	28.8	51.6	56.7	29.5	24.4	28.9	19.7	21.1
Caroline Is.									
Eastern	26.0	28.6	51.0	56.1	29.0	24.1	29.9	21.9	24.3
Central	26.0	28.7	51.0	56.5	29.3	24.0	30.2	21.5	23.8
Western	25.7	28.8	51.1	56.9	29.1	23.4	29.9	20.7	23.7

Note.—Samples obtained as indicated in Table 1.

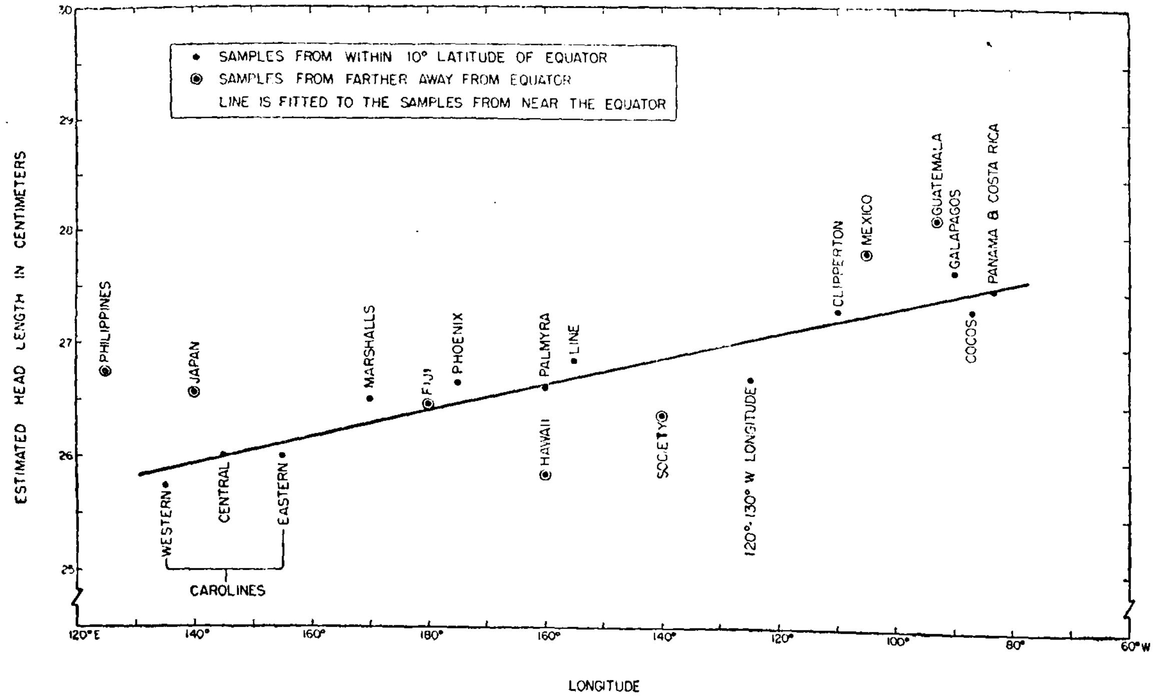

FIG. 2 ESTIMATED MEAN HEAD LENGTH OF YELLOWFIN TUNA 100 CM IN FORK LENGTH

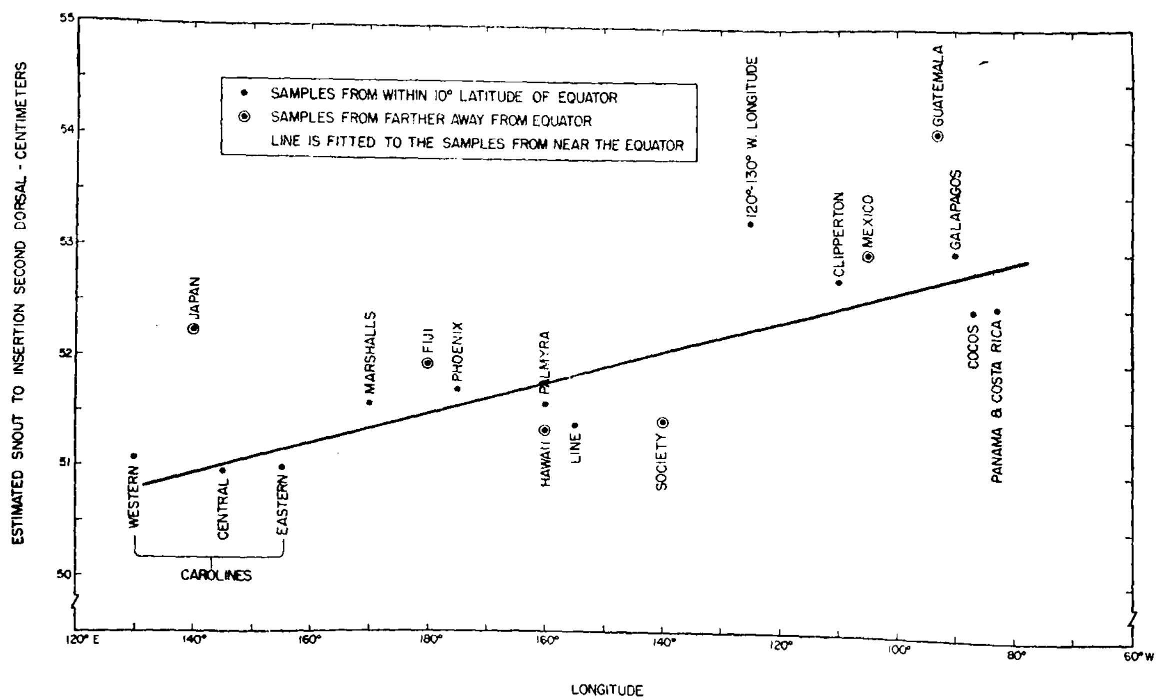

FIG. 3 ESTIMATED MEAN DISTANCE FROM THE SNOUT TO THE INSERTION OF THE SECOND DORSAL OF YELLOWFIN TUNA 100 CM IN FORK LENGTH

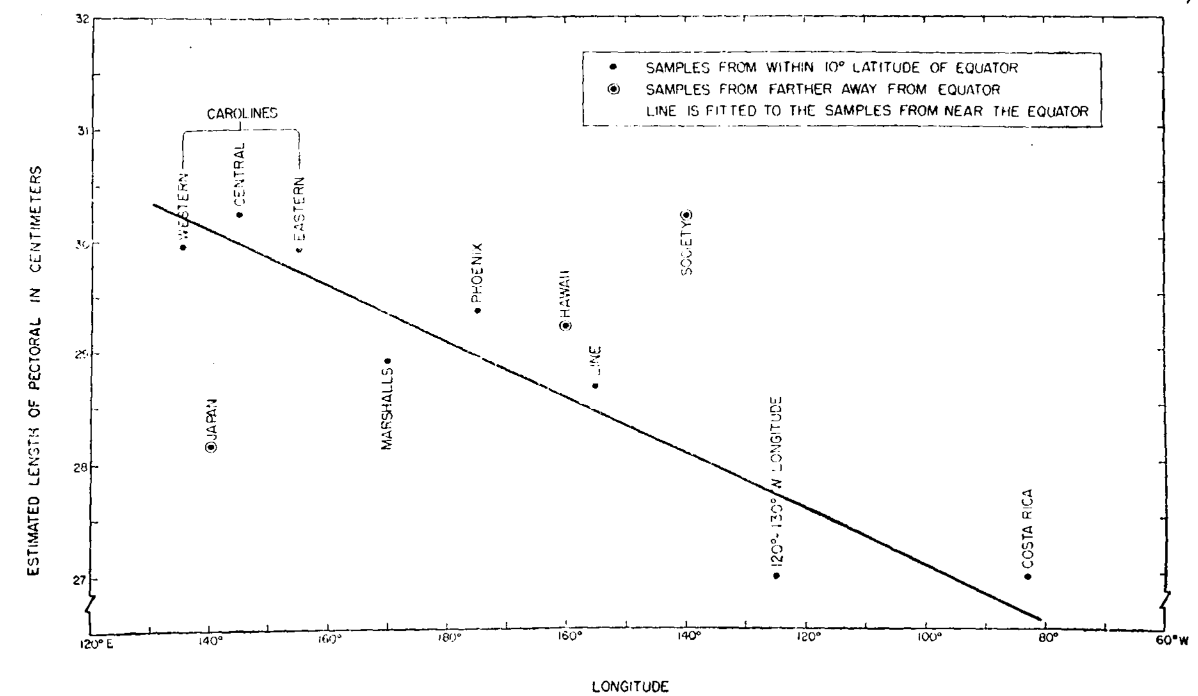

FIG. 4 ESTIMATED MEAN LENGTH OF THE PECTORAL FIN OF YELLOWFIN TUNA OF 100 CM FORK LENGTH

equatorial samples and longitude[1] are statistically highly significant. Head length has a correlation of 0.959 with longitude, the distance from the snout to the second dorsal insertion a correlation of 0.879, and the length of the pectoral a correlation of minus 0.952. Despite these high correlations, the plots of the characters snout to insertion of second dorsal and length of pectoral suggest that the cline is stepped, with breaks between the Caroline and Marshall samples and between the Line Islands and 120°-130° west longitude samples.

Another sample, which was omitted from the above analysis, consists of the three tuna measured in Ceylon by E.R.A. de Zylva. Tuna from this area are of special interest for nomenclatorial reasons and therefore it seems desirable to consider these specimens in spite of their small number. It is not possible to fit a regression line or undertake an analysis of covariance, but we have devised a substitute method of comparing these fish with those from other areas. For each of six characters and for each fish we have taken the actual total lengths and substituted them in the regression formula as derived for another area. For example, in the first observation in table 6 the actual head lengths of the Ceylonese tuna differ from the regression line for head lengths of the Costa Rican tuna by an algebraic total of 0.90 cm. When these values are totalled regardless of sign for the six characters, we note that the sum is least for the comparison with the Phoenix Island group and generally low for all of the samples from the central and western Pacific.[2] Markedly higher totals are obtained for the comparisons with Costa Rica and Angola, Africa, indicating a more distant relationship.

In order to compare simultaneously all of the characters in our larger samples we turn to a technique which has been in use for many years by anthropologists. This is the coefficient of racial likeness which was proposed by Pearson (1926). He suggested the following formula :

$$\mathrm{C.R.L.} = \Sigma \left\{ \frac{1}{M} \left(\frac{(m_s - m_{s1})^2}{\frac{\sigma_s^2}{n} + \frac{\sigma_{s1}^2}{n}} \right) \right\} - 1 + \frac{1}{M} \pm .67449\sqrt{\frac{2}{M}}$$

[1] Longitude was renumbered continuously in an easterly direction from zero.

[2] Comparisons with the Society, Fiji, and Philippine samples have been omitted because all six characters were not measured. Comparison with the sample from near the Equator at 120°-130° west longitude has been omitted because the latter fish were all much larger than those from Ceylon.

in which m_s = the mean of the sth character of the first group, σ_s the standard deviation, Σ = summation, M = number of characters and n = number of observations. The last term is the probable error. This formula is essentially an average among several characters of the difference between means divided by the standard deviation of the difference.

Other workers soon pointed out that this coefficient of racial likeness varied according to the number of observations and it was standardized for 100 observations by multiplying it by

$$50\left(\frac{\bar{n}_1 + \bar{n}_2}{\bar{n}_1\,\bar{n}_2}\right)$$

Table 6. The algebraic sum of the deviations of the measurements of three yellowfin tuna of Ceylon from the regressions for other areas

	Head Length	Insertion first dorsal	Insertion second dorsal	Insertion anal	Insertion ventral	Length pectoral	Total[1]
Costa Rica	-0.90	1.00	-2.80	-5.81	-2.27	5.33	18.11
Line Is.	-0.87	0.75	-0.71	-1.08	-1.93	2.38	7.72
Phoenix Is.	0.02	1.06	1.22	-0.10	-1.36	0.15	3.91
Marshall Is.	1.49	2.94	0.26	-0.19	0.08	0.16	5.12
East Caroline Is.	1.98	2.24	0.84	0.72	0.93	-2.26	8.97
Cent. Caroline Is.	2.10	1.95	0.93	-0.42	0.23	-3.25	8.88
West Caroline Is.	2.71	0.88	0.18	0.08	1.63	-0.60	6.08
Hawaii	2.76	2.03	0.44	-1.05	0.77	0.14	7.19
Japan	1.79	1.49	-0.70	-0.81	0.39	1.42	6.60
Angola, Africa	-1.30	-4.65	-4.85	-5.92	-2.58	5.27	24.57

in which $\bar{n}$ is the mean number of measurements per character for a sample. This became known as the reduced coefficient of racial likeness or R.C.R.L. Most workers also omitted the addition of $\frac{1}{M}$ because of its trivial effect on the total.

Application of this coefficient to our tuna morphometric data requires some further modifications. We are concerned with relative size rather than maximum attained size, and therefore we substitute our mean computed for a given length (in the case of yellowfin it is 100 cm.). We also substitute for the standard deviation the standard error of estimate, which is a measure of the deviation of the points around the line, and we assume that this is the standard deviation which would be obtained if all the tuna measured were of the given length. We also may drop the last term, which was proposed by Pearson as an estimate for the probable error of the coefficient of racial likeness. It is of doubtful validity and our discussion does not require a test of significance among coefficients of racial likeness. Therefore the reduced coefficient of racial likeness as we apply it to our yellowfin tuna data is

$$\text{R.C.R.L.} = 50\left(\frac{\bar{n}_1 + \bar{n}_2}{\bar{n}_1\,\bar{n}_2}\right)\Sigma\left\{\frac{1}{M}\left(\frac{(m_s - m_{s^1})^2}{\frac{\sigma_s^2}{n_s} + \frac{\sigma_{s^1}^2}{n_{s^1}}}\right)\right\} - 1$$

in which m_s is the mean of the sth character estimated for 100 cm total length, σ_s, the standard error of estimate of the regression of the sth character on fork length, n_s the number of observations of the sth character, $\bar{n}$, the mean number of observations of all characters in the first sample and M the number of characters. The symbols s^1 and n_2 refer to the characters in the second sample.

[1] Without regard to sign.

Summary comparisons for all characters among all our samples have been made as indicated in table 7. It will be seen that the values range from a low of 2.3 to a high of 456.4 The interpretation of these values is facilitated by noting that Pearson (1926), after applying this coefficient to anthropological data, proposed a complicated scale of association. He regarded coefficients of 1 to 13 as showing "association", 13 to 31 as indicating "divergence", and those greater than 31 as indicating "very wide divergence". There is no reason to expect our tuna comparisons to fit the scale proposed for human skull measurements, but the direction is the same, i.e., the smaller values show closer association and the larger values a greater divergence.

Examination of our data discloses that the samples from adjoining localities along the Pacific Equator (figure 1) have coefficients much smaller than average, but there are marked differences among them. The Costa Rican sample compared with the samples at 120° and 130°W. longitude has a coefficient of 14.5 whereas the latter, when compared with the Line Is. sample, has a much larger coefficient of 103.3. The comparisons of Line with Palmyra, Line with Phoenix, and Phoenix with Marshalls are again small, 14.7, 8.9, and 12.1 respectively, but then the Marshalls and Eastern Caroline comparison is 74.2. The Caroline areas seem very closely related, with the Eastern and Central Caroline comparison having a coefficient of only 2.3 and the Central and Western Caroline only 5.0. This substantiates the suggestion that the cline indicated by considering individual measurements is not a smooth one. There appears to be a much greater degree of separation between the Line Islands and 120°-130° west longitude and between the Marshall Islands and Eastern Caroline areas than between any of the other areas.

It should be noted further that most of the Pacific samples obtained some distance from the Equator are not related to other samples as closely as are many of the adjoining samples in the Equatorial area. Comparisons of the Hawaiian samples with other areas show the closest relationship with Phoenix and Central Caroline samples and the most divergence from Costa Rica. The Philippine samples are greatly divergent from the adjoining Caroline Island area and more closely related to the samples from the Eastern Pacific. The Japanese sample is more closely associated with the Fiji, Line Island, and Palmyra samples than with samples from either Costa Rica or the Caroline Island area. An unexpectedly close relationship between Japan and Fiji of only 3.0 was found. We have no explanation for this on the basis of the present data but those samples are very small and it is probably a vagary of sampling.

We also call attention to the comparison of Angola, Africa, with the several areas in the Pacific. These values, while generally high, are not as high as those found when comparing the Costa Rican samples with the Western Pacific samples.

DISCUSSION AND CONCLUSIONS

There are numerous reasons to be skeptical of conclusions based on data of this kind. Foremost perhaps is the fact that racial studies which have shown highly significant statistical differences between stocks have been contradicted by tagging studies. Other reasons for skepticism will occur to people who have had experience with this kind of data and who realize the extreme difficulty of obtaining exactly comparable measurements among different investigators working under greatly different and often trying field conditions.

Both of these factors have been considered and have been the reason for emphasizing the differences and relationships between samples rather than between populations. The comparison is only good if the samples are representative of the areas from which they were obtained. We have made great efforts to obtain large samples and consistent measurements, but we have no way of insuring that they are representative of a population. In fact, if we are to attain a representative sample, we must first describe the population in area and time and it is this very thing that our study is attempting to do.

Schaefer (MS.) has pointed out that better methods of statistical analysis are required. Such methods have been developed and applied by Fisher (1936) and others to racial problems. However, for our purpose of comparing tunas from widely separated parts of the world it does not seem practical to undertake analyses of greater precision, when such closely allied samples as Godsil's in the Central American area show statistically significant differences which are difficult of interpretation.

Despite these difficulties there are three features in our data which give us confidence in them. First and most encouraging is the close agreement between samples collected by different investigators in the same or nearby areas at different times. Second, the magnitude of the differences among some samples seems obviously greater than can be attributed to personal bias. The head length of tuna, which is defined as the distance from the tip of the snout to the most posterior part on the margin of the subopercle (depressing the fleshy flap

Table 7. Comparison of yellowfin tuna samples by means of the reduced coefficient of racial likeness

		Equatorial Pacific													
	n[1]	Costa Rica	120°-130°W. Long.	Line Is.	Palmyra (One of Line Is.)	Phoenix	Marshall Is.	Eastern Caroline Is.	Central Caroline Is.	Western Caroline Is.	Society Is.	Hawaii	Fiji	Japan	Philippine Is.	Angola, Africa
		8	9	9	5	9	9	9	9	9	4	9	5	9	5	5
Costa Rica ..	8		14.1	138.0	152.0	07.4	235.5	456.4	402.7	389.0	331.9	221.2	117.6	100.5	26.3	75.9
120°-130°W. ..	9			92.4	137.5	145.3	93.0	245.2	205.4	187.0	275.4	115.9	109.8	59.2	12.9	53.3
Line Is. ..	9				14.7	8.9	8.4	64.7	42.6	69.9	54.9	25.9	29.1	28.4	80.4	78.0
Palmyra Is. ..	5					7.3	5.2	57.0	34.9	38.9	22.6	29.2	9.0	31.6	173.5	147.8
Phoenix Is. ..	9						12.1	24.2	15.6	33.4	14.5	15.8	35.4	61.4	125.8	125.8
Marshall Is. ..	9							74.2	59.7	57.0	45.4	34.2	17.1	45.8	300.0	159.5
Eastern Caroline Is. ..	9								2.3	12.1	21.4	25.3	112.4	210.0	339.5	272.3
Central Caroline Is. ..	9									5.0	20.2	17.7	73.5	170.7	185.1	220.2
Western Caroline Is. ..	9										25.4	29.7	52.6	120.7	229.4	288.5
Society Is. ..	4											36.3	35.7	146.1	272.3	326.7
Hawaii ..	9												50.2	68.3	130.3	137.7
Fiji ..	5													3.0	161.7	174.6
Japan ..	9														106.1	68.0
Philippine Is. ..	5															35.0

[1] Number of characters

extending posteriorly), is a measurement which in our experience can easily be taken consistently by different investigators. The head and opercle are solid structures and the fleshy flap is so flexible that it does not interfere with the calipers. Therefore, there is little reason to expect variation among investigators. Yet the yellowfin tuna from Costa Rica (Schaefer's sample) and from the Western Caroline area show a difference of 1.6 cm in head length for a tuna of 100 cm fork length. The differences in the size of fins are even more marked, being 3.2 cm for the pectoral fin between Costa Rica and the Central Caroline area, 6.1 cm for the second dorsal fin between Costa Rica and the Eastern Carolines, and 7.2 cm for the anal fin between Costa Rica and the Eastern Carolines. Third and last, the gradient between Eastern and Western Pacific in the Equatorial area which exists for almost all characters which were measured by dozens of different investigators cannot possibly be attributed to personal bias. We therefore conclude:

1. Our samples have been taken from stocks which, with the exception of certain adjoining areas in the Equatorial Pacific, are at least semi-independent.

2. The facts that there are greater differences among samples from the Pacific area where the distribution is probably nearly continuous than between Angola, Africa, and any Pacific samples, and the close relationship of specimens from Ceylon to those of the Central Pacific suggest that the yellowfin tuna should be considered as a single species of world-wide distribution.

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5

NOTES ON THE FISHERIES INDUSTRY OF BRUNEI BAY AND LABUAN ISLAND

by

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1. THE BACKGROUND

The background study upon which the following paper is based was carried out by Headly in 1947, and covered that part of Brunei Bay and neighbouring islands which lie within the political confines of the Colony of North Borneo. The rough draft was passed to the Fisheries Department of the Colony for comment and criticism. Considerable correspondence ensued and further work was done by Tubb in filling certain gaps and checking technological data.

Pressure of other duties then caused cessation of work on the paper until February, 1951, when Anderson was posted to Labuan to establish a Fisheries Office there. This afforded ample facilities for a complete revision of the paper and all sections have as far as possible been brought up-to-date and relate directly to existing practices in the fishing industry of the area.

The methods of fishing described are generally widespread throughout the Brunei Bay Region, but within the waters of Brunei State there is a highly developed fishery for prawns by means of tidal traps which has not extended into the eastern and northern parts of the Bay. This fishery is represented in the Colony of North Borneo only on the northeast coast and hence has not been considered in the present paper.

Owing to the absence of Anderson on leave, the paper in its final form was prepared by Headly and Tubb, who are responsible for the opinions expressed and the conclusions drawn. The authors wish to record their deep appreciation of the help given during the compilation of the data by A. H. Jones, Fisheries Assistant, whose knowledge of the vernacular and intimate liaison with the fishermen produced much information otherwise unobtainable. The botanical identifications are based on Keith, H. G., *A Preliminary List of North Borneo Plant Names*, N.B. Forest Records No. 2, 1938.

Topography

Brunei Bay (Fig. 1) is roughly 35 miles square, and for the most part shallow, nowhere exceeding 20 fathoms in depth. On its northwestern side it is protected by the large Island of Labuan, and the smaller islands of Rusukan Besar and Kechil, and Keraman, whilst between Labuan and the tip of the Klias Peninsula lie Pulau Papan and Pulau Daat. In the north lie the swamps of the Klias Peninsula. Inland from the eastern shore a magnificent chain of mountains, the home of the Muruts, runs from Mount Kinabalu to the Sarawak border.

The only townships are Victoria on the Island of Labuan and Beaufort, which lies 18 miles from Weston by rail. Other land communications are few, and except on Labuan, are no more than bridle paths; the population is widely scattered in small villages (*Kampong*). These are important factors in limiting the distribution of fresh fish.

Between Kuala Padas and Kuala Klias the coast is fringed with mangrove, and mud banks extend far out into the Bay. Elsewhere the shores are sandy, at Labuan and the smaller islands, and at Sipitang, there is coral, with deeper water nearer the shore. Fishing methods at these places therefore differ somewhat from those employed along the mangrove shore.

The People

A number of different races inhabit the Brunei Bay Area. These include Bruneis, Kedayans, Bisayas and Dusuns. Although a few Kedayans and Bisayas make fish traps, and on Labuan there are some Kedayans engaged in net fishing, the majority of those who earn their living by fishing are Bruneis; when fishermen are referred to in this paper, therefore, Bruneis are nearly always meant. Along the Borneo coast wherever a river mouth affords protection, are scattered communities of Bruneis. The most important of these in

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Brunei Bay are at Sipitang, Weston and Lubok, and at Menumbok on the Klias Peninsula. Around Labuan there are a number of fishing Kampongs. In the Sipitang area, and on Labuan just inland from the coast are small kampongs inhabited by Kedayans who are almost exclusively employed in agriculture.

The Seasons

Any interpretation of the various seasons can give no more than a very general picture. The various winds in the inshore waters where the fishermen operate, and even in the middle of Brunei Bay, behave very erratically. The fishermen are for the most part only interested in those winds which affect their particular type of fishing, and in many cases do not recognise the others. Moreover, their knowledge of the points of the compass is not good; thus *Selatan* (South), may mean anything from S.W. to S.E. Answers by fishermen given regarding weather and the seasons are therefore apt to be misleading.

In North Borneo the two main seasons are the Northeast and Southwest Monsoons. In the area under discussion the Northeast Monsoon becomes a northerly wind. The Southwest Monsoon, however, blows across the China Sea from the Southwest.

In this area the seasons are as follows:—The *Iraga* (North Wind) blows strongly day and night from December to March, and the *Barat Tapat* (Southwest Monsoon) blows from July to October but only freshens during the afternoons. Between these two seasons are periods when the wind is variable (*Angin Champor*) and may blow in strong gusts from any direction, but in general from southwest it veers through west to north, and from north through east to south. The *Iraga* may blow up suddenly at any time of the year, particularly during the evening, bringing with it squalls of rain.

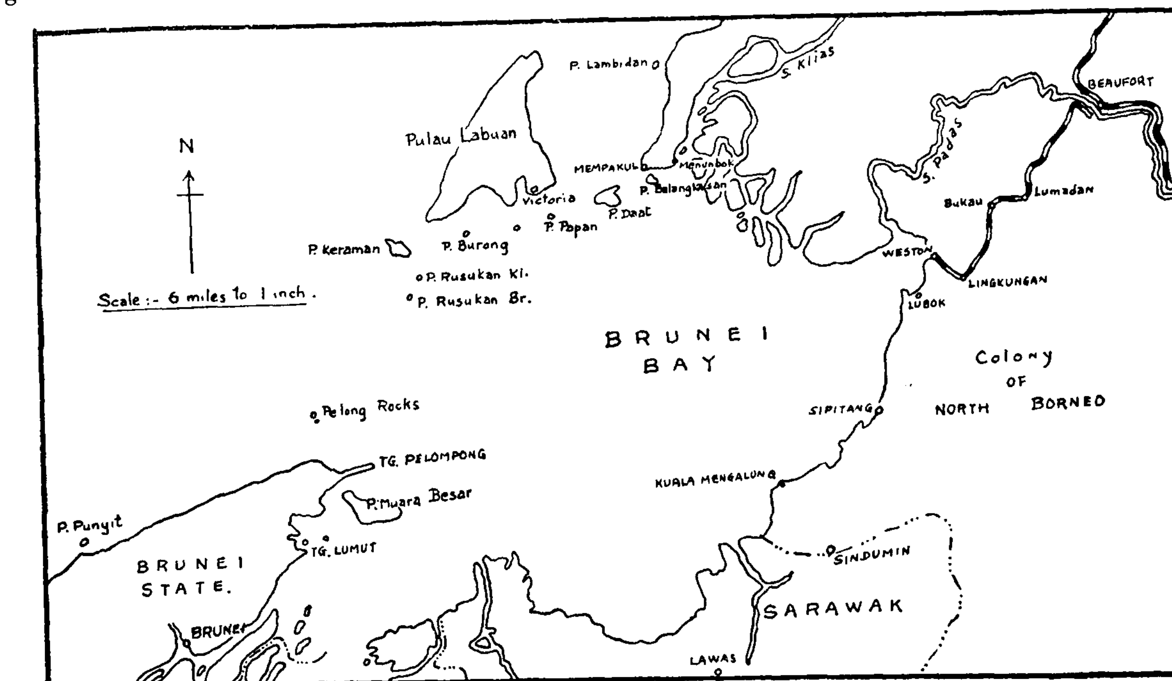

FIG. I. Map showing Brunei Bay, Labuan and adjacent islands.

The *Iraga* is the only wind which regularly stops the fishermen from going to sea. During the period when it is blowing strongly, the fishermen, particularly on the northern part of Labuan, may have to find some other occupation if they are losing too many fishing days. Generally speaking, however, it is possible to fish in all parts of the Bay throughout the year.

The Tides

As well as the winds, there are the tides to be considered. The fishermen recognise the following states:—

Tohor Barat—(Low Tides at night)—April to September.

Tohor Berdua—(Period of Change).

Tohor Pagi—(Low Tides in morning)—October to March.

The periods are not very clearly defined, and in all cases there is an overlap.

A glance at the above would give the impression that Tohor Pagi would be ideal for Kelong fishing, the fish entering the traps on the night flood. In most cases this is true, but the *Tohor Pagi* coincides for a time with the *Iraga*, and the *Kelong* fishing Kampongs on the north eastern side of Labuan are unable to take full advantage of this ideal state of the tide, as the kelongs would be damaged or washed away by the heavy seas if they were left in the water.

It is therefore a combination of the wind and tide which governs the fishing, and of the two, tide seems to be of least importance. While the tide may be a key to certain fishing methods, it is the wind which decides where and when a man shall fish.

2. FISHING CRAFT

The craft used are all indigenous types, and vary in length from 18′ to 42′. Exceptionally they are powered with outboard motors. The following are the most popular for fishing :—

Bidar—a small plank vessel, carvel built and double ended. Usually with a stern rudder, but sometimes a lee-board rudder is used when sailing.

Pakarangan—based on a shallow dugout with one broad plank fitted almost vertically along each side and with bow and stern pieces projecting much above the normal line of the hull, often fitted with a double outrigger.

Permukatan—generally similar to the Pakarangan, but the stern piece is appreciably longer than the bow.

An attempt has been made to associate particular craft with certain types of fishing, but the fishermen are apt to take what craft they can get, and price is the main consideration. Costs of the various types of gear are furnished in Table I.

There is no boat building carried out at Labuan, and fishermen there and at Menumbok usually purchase their craft from Weston, Lawas or Brunei. The following table shows the current prices :—

TABLE I

Length / Source	18′ - 22′ All types	30′ - 35′ All types	42′ All types
Weston	$ 100.00*	$200.00	$ 400-$450
Lawas	$ 70.00	$160.00	$ 400-

The above prices apply to boats built of *Medang Tabak* (*Dactylocladus stenostachys* Oliv.) which is the most common wood used for boat-building. Camphor wood, *Kapur* (*Dryobalanops lanceolata* Burek.) is also used, but costs about $ 50.00 more.

If well looked after a boat will last for about three years, and during that time it is maintained by shares from the proceeds of the catches and those fishermen who do not get advances from financiers will use these shares towards the purchase of their next new *perahu* (craft).

3. FISHING METHODS

The fishing methods used in the area can be divided into four groups, and will be dealt with in the following order.

1. Lines
   - (a) *Panching*
   - (b) *Rawai*
   - (c) *Bilanas*
   - (d) *Gurit*
2. Spears
   - (a) *Sangkap*
   - (b) *Sanapang Ikan*
3. Traps
   - (a) ***Belat, Balat, Kabat***
   - (b) ***Kelong***
   - (c) ***Bubu***
   - (d) ***Bintor***
4. Nets
   - (a) *Hanchau*
   - (b) *Pukat Ambid*
   - (c) *Pukat Tungap*
   - (d) *Pukat Paguyut*
   - (e) *Pukat Rumahan*
   - (f) *Pukat Belanak*
   - (g) *Pukat Kambura*
   - (h) *Pukat Surui*
   - (i) *Pukat Britus*
   - (j) *Rambat Udang*

* The dollars and cents mentioned are Malayan dollars and cents.

i Lines

(a) *Panching*

Panching covers all forms of handlining, and this method of fishing is carried out in all parts of the Bay except Weston and Lubok. Catches obtained from handlining form a large part of market landings. The following methods are in general use :

Jaul—With Sinker

Ambor—Without Sinker

Tunda—Trolling

Kail—With Rod and Lines.

The lines are usually of cotton, and vary in size from 12 to 15 ply. The use of Ramie seems to be confined to certain of the longlines, where it is used for the snoods because of its flexibility. It is very rare to see a complete nylon or gut line. The fishermen insist that it is both difficult and dangerous to endeavour to land a large fish on a nylon line, as the fingers may be cut.

Hooks vary in size from No. 1 to No. 17, and they are nearly all of the flat round bend Mustad type with flatted shanks. The fishermen seem to prefer the flatted shanks, and say that the hooks hang on the trace better and do not swing so loosely as the eyed type. In trolling, however, one often sees the eyed type. Traces are always used, and these are either of nylon or wire depending on the size of the fish sought.

A fisherman usually carries about six or seven lines, which are wound on *Kirekan* (wooden reels) and carried in a *Basak* (wooden box or gourd). This box also carries his *Tangsi* (nylon), *Batu Jaul* (weights), *Pemata* (hooks) *Dawai* (wire), and any other gear. Lines are never more than fifty fathoms in length and are usually much less.

Jaul (With Sinker). Two methods of rigging the gear are used, and they depend on the bait available, and on the strength of the current. If Bubok (mysid shrimp) is available, a bait-holding sinker is used. In this case the sinker has a hollow centre which is packed with shrimp. A sharp tug on the line releases a small quantity of this which acts as ground bait. If no shrimp is available, or if the current is strong, a solid sinker which is heavier is used.

Ambor (Without Sinker).—In this method the line is allowed to drift with the tide. A single hook on a nylon or wire trace is used.

Tunda—(Trolling).—For this type of fishing, thick cord, a single hook size 1, 2, 3, and a wire trace are used. Eyed hooks may be preferred, and if they are not available the fishermen may bore holes in the flatted shanks of the other types. It is stated that on occasions the fishermen make their own hooks from thick brass wire, which is chosen because it will take a very sharp point. The following fish are caught by trolling—*Tenggirri* (Spanish Mackerel), *Berkalang* (Queen-fish), *Alu-Alu* (Barracuda), *Pengaluan* (Large Barracuda), *Layaran* (Sailfish), *Menumbok* (Marlin), and *Yu Sangul* (Hammer-head Shark). Favourite baits are *Bakulan* (Tuna), *Temanong* (Yellowtail), and *Surui* (Half-beak). Sometimes an artificial lure made from white cloth may be used, but this is not usual. Trolling is carried out on the fishing grounds when the bottom fish are not biting, or when there are signs of game fish around. It may also be carried out when returning to the market, but although some of the above fish bring a high price to the fisherman, he does not seem to be particularly interested in putting a line out when returning home, and this time is spent in drying the lines.

Kail (With Rod and Lines).—When the fish usually sought are not biting, the fishermen may adopt this type of fishing for the small fish which are feeding just under the surface.

Normally, however, it is only carried out by women and children, particularly at Labuan, where they fish the rock pools. The *Jauran* (rod), is about 12′ long and made from bamboo, and it carries about 15′ of line, and a single hook of about size 16 to 17. The bait is usually small fish or worms.

Baits :—The following are all favourite baits :

Siar (Prawns), *Bubok* (Shrimp), *Pum Pun* (Red Worms), *Wak Wak* (White Worms), *Tamban* (Pilchards). The all-round favourite is Bubok, mainly because of its value as a groundbait. At certain times of the year, usually about July or August, there may be heard in the water a noise which was described as being like "an asthmatic wheeze". It is most noticeable around Sipitang. Fishermen sometimes use a paddle when listening for the sound. The blade of the paddle is submerged close to the perahu and the fisherman applies his ear to the handle of the paddle. The fishermen state that it is caused by worms on the sea bed, and they recognise two types, one which is found in deep water (*Ambolong*-2), and one in shallow water (*Tugau*-2). It seems, however, that these worms have never been seen, and it may be that the sound is caused by some kind of crustacean. It is, nonetheless, a fact that where the noise is loudest, the fishing will be good.

When setting out for the fishing grounds, the fisherman prepares his lines for the type of fish that he expects to catch. The following table shows how seven lines might for instance be allocated :—

TABLE II

Line 1. Ambor—Goronggong, Temanong (Hard-tail Mackerel and Yellow-tail).

Line 2. Ambor—Tenggirri, Bakulan (Spanish Mackerel and Tuna).

Line 3. Tunda—Tenggirri, Pengaluan (Spanish Mackerel and Large Barracuda).

Line 4. Jaul—Tenggirri, Pengaluan (Spanish Mackeral and Large Barracuda).

Line 5. Jaul—Bakulan, Mengkok-2 (Tuna, and Skipjack).

Line 6. Spare.

Line 7. Spare.

One fisherman will usually work about three or four lines at one time.

As far as can be determined no notice whatsoever is taken of the state of the tide by the handline fishermen. Throughout the year, both at Labuan and Sipitang, they leave the Kampongs at about 4 a.m. and proceed to catch bait by means of a cast net, after which they proceed to the fishing grounds, which may vary from day to day according to the wind. They usually start fishing about dawn. Fishing is good in the early morning, but may fall off about 9-10 a.m. but it is likely to improve when the afternoon breeze starts, usually about 11.30 a.m. If fishing is slack trolling may be resorted to, and the return to the village is usually at about 2 p.m.

Little fishing is done at night, but if it does take place, a moonlight night is chosen so that the fish will not be frightened by the luminiscence stimulated by the line and sinker.

Line fishing may be carried out by one or two men from a small perahu which is usually a *pakarangan*. One man usually owns the boat and the cast net, and the other is the assistant.

The catch is divided as follows :—

Each man	1 share
Perahu	½ share
Cast Net	½ share

Occasionally four or five men may fish from a large *perahu* 30-35′ long, and the catch will be divided on the same basis.

(b) *Rawai* (Fig. III)

The use of this gear is restricted to Weston and Lubok. It consists of a *talinting* (headline) of hemp or cotton which is 200 fathoms long. To this are attached at two fathoms intervals *perambut* (snoods). These snoods are of either single or double line, and each carries a single hook between sizes 5 and 9. The snoods are about 12 ply in size, and the headline about 12 to 18 ply.

The headline is buoyed at one end with *tilampong rawai*, (a bamboo float) and at each end of the headrope the *tali batu* (anchor line) which may be 25-30 fathoms long runs to the *sauh batu* (anchor stone) which acts as a weight.

The gear is shot at night, and the fishermen remain beside it. The end of the headrope which is not buoyed is held in the hand, and through it the fisherman feels any fish that has been hooked, and immediately removes it. The gear is shot across the tide, and worms or small fish are used as bait. If the water is murky the gear may be used during the day, but this is not usual.

If the gear is worked by two men, one man owns the lines and the boat, and the catch will be divided as follows :—

Owner	2 shares
Assistant	1 share
Perahu	½ share

The share for the cast net is included in the owner's two shares.

(c) *Bilamas*

Pre-war this gear was operated by fishermen throughout the area. It is a type of longline used for the capture of sharks, but as the public are now able to afford better quality fish, it is not often used today.

It consists of a headline of ½″ rope buoyed at each end about 90 fathoms long, to which are attached 3′ snoods of ramie fibre at intervals of 3 fathoms. The hooks are home-made from thick iron wire. The shank is 8-10″ long, and there is a gap of about 1½″ between the point and the shank.

The hooks are baited with fish, and the gear is shot in the morning and left for twenty-four hours. After shooting the gear the fishermen (usually two) return to their homes, and according to superstition they must remain indoors and make the least noise, otherwise the catches will be poor.

(d) *Gurit*

This gear is still seen at Weston, and its use seems to be confined to that place and Lubok. It is used for the capture of skates, rays, and sharks. It consists of a headline of ¼″ coir rope about 20 fathoms long, to which are attached short snoods

at one foot intervals. The headrope is buoyed every 6′ by a small *tilampong* (float-line). At each end of the headrope runs a (float-line) about 4 to 5 fathoms long from the headrope to the surface buoy. The gear is kept in place by wooden anchors. Each complete unit is known as *utas*.

Each snood, which is made from Ramie, carries a single hook. These hooks are the equivalent of No. 5, but they have no barb, and the bend is more than half of the length of the shank.

The *gurit* is worked from a boat by 4 or 5 men, the best time being during the Tohor Barat. No bait is used, and the fish are foul hooked as they swim along the bottom. The lines are worked at night, and each boat may work between 20 and 30 *utas*. No details were obtained as to how the catches were divided but the division is probably based on the number of *utas* each man provides, with additional shares for the owner of the boat.

Note : Most fishermen seem to be unfamiliar with both the Muslim and the European calendar. A fisherman will rarely say that the catches are good in such and such a month, but that they are good when the padi is being weeded, or flowering, or being harvested.

The padi planting season itself is governed mainly by the appearance and visibility of certain stars ; the actual day on which certain operations begin depends on omens, dreams, etc., and, in the case of Dusuns, on a propitious day of the month. Thus the seasons come round regularly and can therefore be considered a reasonable guide to what may be seasonal movements of fish, which are, however, given curious *post hoc* explanations by the local fishermen. For instance the fishermen state that when the *tugal* (dibble sticks) are driven into the ground to make holes for the dry padi seed, the fish in the sea are driven from the inshore waters giving rise to bad fishing at that time.

ii. **Spears and speargun**s

(a) *Sangkap*

Most fishing boats carry a spear of some sort. These are 7′ to 8′ long, and made from bamboo. The head is either one, two, or three pronged. The one pronged spear is called *tampuling* and all other are called *sangkap*. Many fishermen, however, do not recognise the distinction and group them all under the name *sangkap*. The head may be detachable and fixed to the shaft by a short length of stout cord. This type is used for catching largefish such as rays.

At Labuan and the smaller islands during the evening when the tides are low, the whole of the coral and sand flats are covered with twinkling lights, which are the flares of fishermen who are spearing fish. The flare, for which there seems to be no special name is made from a 4 or 5 feet length of bamboo. This is cut across just below a node, and the resulting cup is filled with kerosene, and stuffed with old rags etc., which serve as wicks. When the flame starts to die, the flare is held upside down and more kerosene is soaked up. One of these flares will last for about three hours.

Catches consist of coral fish, crabs, and cuttle-fish, and are kept in a conical basket on the fisherman's back. This basket is called *karanjang*. The catches are for home consumption only.

(b) *Sanapang Ikan*

This is a speargun, and is only seen at Labuan and the neighbouring islands where there is coral. It consists of a wooden gun stock with an extremely long fore-end, which is channeled throughout its length by a semi-circular groove of about ½″ diameter, and at the distal end of this groove is fixed a piece of brass or copper tubing by means of wire lashings. The stock and the breech are about 18″ long, and the fore-end about 3′ 6″. The whole is carved from one piece of wood.

Outside the barrel two stout " springs " of rubber are fastened with a wire lashing, and when at rest are about 12-18″ long. Wire loops are attached to the free ends of these rubbers. In the extended condition the springs have a pull of about 35 lbs.

In the breech end of the stock the *katik* (trigger) is inserted. The *dawai* (spear) consists of a piece of thick iron wire about 4′ to 5′ long. The tip is sharpened, and there is a single barb. At the other end is cut a notch into which the mechanism of the trigger will fit. About 4″ in front of the notch is a small spur over which the wire loops on the rubbers will fit when the gun is cocked. There may or may not be a sight.

The speargun is used by skin divers wearing home-made diving goggles. The fishermen operate amongst the coral near the shore and rarely go deeper than 2-3 fathoms. Catches consist of various types of coral fish and crayfish. Materials for the gun can be picked up at no cost.

iii. **Traps**

Traps of one sort or another are worked at all the fishing kampongs in the area. The *kelongs* and *belats*, which are stake traps, are usually owned by a number of men working in partnership, although *kelongs* may be individually owned. The *bubus* and *bintors* are always individually owned.

(a) *Belat*

The *belat* consists of a long fence of split bamboo which is erected on selected sites in estuaries and on mud banks. The fence is made up of sections which vary from 3 to 6 feet in height. The bamboo is split into strips slightly less than ½" wide, which are laid parallel and lashed with *akar lamiding* (stems of Swamp Fern *Stenochlaena palustris* bedd.)

On the site, which is selected by the *kapala* (leader) after general discussion, the *turus*-2 (a series of stout poles) are driven into the ground outlining the shape of the trap. The poles are set 1-3 fathoms apart depending on the strength of the current, and if this is strong they may be held in place with guys.

After the poles have been driven in, the sections of fence are laced together and lashed to the poles. The shape of the traps may vary, but the principle is the same, and the diagram shows a typical arrangement. The *amparan* (wings of the trap) direct the fish into the entrance, the form of which prevents the fish from coming out again. From the *pengalok* (first enclosure), the fish pass to the *ayangan* (second enclosure), and finally to the *bunuan* (terminal bowl).

The trap is visited at low tide, and two or three men drive the fish from the first enclosure to the last. A *penyasar* (small fence) about 2'-3' high and 10' wide is used for this purpose. It is moved through each enclosure driving the fish before it, until they are herded into the terminal bowl. The men engaged in this work are called *orang pengaran*, and they are also responsible for taking the fish out of the terminal bowl and since the trap may be completely dry at low tide, this is often just a question of collecting the fish from the ground. The fish are removed from the terminal bowl either by means of a scoop net or a fish spear.

A *belat* is operated by a group of three to eight men under a leader, and the partnership lasts for the life of the trap, usually about six months. The leader provides the money which he has almost invariably obtained in the form of a loan from a Chinese towkay. The bamboo for the trap is cut in the plantations, and if the fishermen are able to cut it near the shore, the owner of the plantation will charge them more than he would if they had to go inland a short distance. The fishermen also collect the *akar lamiding* themselves, but there is no charge for this. The whole group work together splitting the bamboo and cleaning and splitting the *akar lamiding*. When this work is completed they will call in outside help to assist in the tedious work of lacing the bamboo together. This help is always forthcoming, and takes the form of about 12 people working for two days. During this time they will receive no money, but the group has to keep them supplied with food and drink.

When the fences are complete the *kapala* outlines where the poles shall be driven, and the fences are then lashed to them. There do not appear to be any hereditary rights in this connection, but care is taken to see that they do not compete with another trap. The *lidah* is the final section of the fences to be assembled, and may be curved or straight depending on the current.

When forming a group the leader will choose people who can contribute *perahus*. One of these must be large, and this the *kapala* himself usually provides. There may be a boat for each man in the group, and there are never less than three.

(b) *Kelong*

Kelongs in this area are considerably smaller than those in the Malayan waters. The trap consists of an *amparan* about fifty fathoms long which leads from the shore seawards. Running obliquely from each side, but not touching the *amparan* are the *pengadahi* or *sayap* (wings). These are 10-15 fathoms long, and there is a gap of two to four feet between the inner terminal poles of the wings.

The three fences lead into the *pengalok* which is about 3 fathoms wide and 1½ fathoms long, and triangular in shape. The enclosure leads to the *ayangan* which is about 1½ fathoms wide, and 1 fathom long, and leads to the *bunuan* by a truncate apex.

The *Kelong* is operated by one or two men. They collect the bamboo, which is paid for in the same way as with the *belats*. They also collect the *akar lamiding*, but in the case of *kelongs* at Labuan this has to be purchased from the mainland. The procedure is as in the *belat*. After the group have split the bamboo and the *akar lamiding* they will call in outside help for two days to help with the work of lacing the bamboo together.

When concentrating the fish prior to removing them a *penyasar* is also used, and when removing them, the scoop net and the spear are used as in the *belat*. When the trap is in operation only one *perahu* is used, but during the building period there may be up to three and they may be borrowed. The trap is visited at low tide every day for about 15 days after which it is lifted and cleaned, and moved to a new site.

One or two men may operate the trap, and in the case of one Kampong at Labuan the proceeds were divided equally between the two men, and nothing was set aside for the trap or the *perahu*.

(c) *Bubu*

The *bubu* is a movable box-shaped trap seen at Labuan and the neighbouring islands, and to a lesser extent at Sipitang. A typical sea *bubu* measures 6' x 3' x 2' - 2½'. The trap is constructed from split bamboo, and has a funnel-shaped entrance at one end. The lattice work formed by the bamboo gives a square mesh of about 1'.

The first part of the trap to be made is the base, which is reinforced by battens of wood, and the two sides, the top and one end are made in one piece. The whole is placed on the base and lashed on with rattan, and the other end having the funnel entrance is then fitted.

Heavy stones which act as sinkers are tied to the four corners of the base, and some stones are placed inside, but as the trap becomes waterlogged, the latter are removed. A bunch of twigs with the leaves still on is placed over the funnel entrance and it is said that without these the trap is not nearly so effective.

The trap is raised and lowered by means of a hauling rope made from *Akar Galam-Galam* which is obtainable at Labuan. It is attached to the trap by means of a bridle, (a float) serving as a marker. The traps are shot in the channels between the reefs, in about 13 to 20 fathoms and they are lifted after three or four nights, when the fish are removed through a trap door in the base. A new trap takes about 5 to 6 days to mature, and rarely catches fish until then.

Bubus are usually shot singly, one man owning two or three. The materials for one trap cost about $4.00 and are all obtainable in Labuan. Kampongs which carry out handlining usually have *bubus*, and the same boats are used to work the traps. After three or four nights in the water a trap will usually catch between 10-15 katties of fish consisting mainly of *ikan merah* and *kerapu*. The reason why their use is not more common is probably because of the difficulty of transporting them in *perahus*, and the high losses of traps in bad weather.

(d) *Bintor*

This is a very simple but effective trap used for the capture of crabs. It consists of two cross pieces of round rattan about 1" in diameter. To these is lashed at the four corners a piece of net having a mesh of approximately 1" bar. The material for this net is obtained by unpicking sacks. There is a short line hanging in the middle for tying on the bait, which usually consists of salt fish heads or ray flesh.

The traps are operated in river estuaries and mangroves and are left for about ½ an hour and then lifted. This is normally a method of fishing carried out by women and children, but at Weston there are three fishermen each owning a *perahu*, and operating about 150 traps between them. They average about 25-30 katties of crabs per man per day.

iv *Nets*

All nets except the *hanchau* and the *rambats* are made in sections. Each section is called a *Benata*, and when the net is in use several sections are joined together. All nets are equipped with leads and all except the cast nets have floats. Floats are made of *Sadaman* (*Macaranga formicarium* P. & H.) or *Pulai* (*Alstonia* spp.).

Formerly it was usual for a man to own only one or two sections, but now there appears to be a number of people who own 6 sections or more, and this can only be attributed to the increased prosperity in post-war years. Individuals owning sections will go into partnership and the income from the sale of the catches is divided according to the number of sections each man provides. The *kapala* or *Pencharon* (leader) usually owns the *perahu* and more sections than the others, obtains the initial loan from the *towkay* and distributes the money or materials to the people forming his group. He also directs the operation of the nets and on occasions may get extra shares because of his work.

Some fishermen make their own nets with the assistance of their womenfolk, but more and more seem to be handing the work to net makers, who usually charge a price equal to the value of the materials used. All nets are preserved with the bark of *Kayu Malam* (*Diospyros* spp.), *Obar Pulot* (*Glochidion* sp.), or *Obar Suluk* (*Shorea pauciflora* King.) The net is immersed in the liquid extracted from the bark after it has been soaked in water and pounded.

(a) *Hanchau*

This net is confined to Labuan where it is used for the capture of shrimps. The net which is not made in sections, is about 35-40 fathoms long, and 2 fathoms deep. In the middle there is a *bunt*—which measures 2 fathoms across and is 2 fathoms deep. The cod-end is termed *Bidok*. To each end of the net there is attached by means of *teraju* (bridle), a *kalat* (hauling rope), which is about 15-20 fathoms long. The *teraju* is attached to a short stake, the *Perian*, which spreads the end of the net.

The whole net is made of *Sadak*, a loosely twisted thread made of fibres from the shoots of *Rumbia* (*Metroxylon sagu* Rottb., the Sago Palm). These threads are woven by the people of Kampong Pimping, a small village near Beaufort, which is the sole centre of production into open mesh mats, the meshes being $\frac{1}{8}$-$\frac{1}{4}$ inch square. The fishermen specify that the mats should be 6 feet long by 1 foot wide, the whole net requiring 500-600 mats.

The net is operated by 6 to 12 men including the leader. Three men stay on the shore, two men holding the hauling rope the other tending the perian. The other men go out in the *perahu*, the leader in the bow and another man at the stern paddling. In a small team the remaining man pays out the net around the shoal of shrimps. Once the net has been set, the full team is used to haul the net into shallow water near the shore.

When hauling is completed, one man, the *Rimak*, bunches together the lead-line to prevent the shrimps from escaping and the second man, the *Pemulas*, helps to lift it above water, at the same time, two other men, *Penapi*—2, raise the float-line of the net in the same way. The catch is concentrated into the *lundoh* and it is the responsibility of the leader to tend the cod-end. The perahu is then brought to the net and the shrimps are ladled from the net into the boat with a shallow basket or scoop made of closely woven split rattan.

The shrimps may be dried or prepared as a fermented paste, *blachan*. They appear in dense shoals near Labuan during the first quarter of the year and thereafter the net is seldom used. During the season, the pukat *tungap* (q.v.) is sometimes used in conjunction with the *tanchau* and is shot outside the latter to encircle the shoals of fish which feed on the Bubok.

It seems to be usual for the *pencharok* to own the complete *hanchau* and the *perahu*, and the remainder of the men are employed as assistants. The catch is divided in the following way :—

Net	2 shares (owned by *pencharok*)
perahu	1 share (" " ")
each man	1 share

When the net is used in conjunction with the *pukat tungap*, the leader will receive $1\frac{1}{2}$ shares from the operators of the Tungap.

(b) *Pukat Ambid* (*Ambit*)

This is a hauling net measuring up to 85 fathoms long and $2\frac{1}{2}$ fathoms deep. The net is made up in *benata* 12-15 fathoms long and $2\frac{1}{2}$ fathoms deep, of 1″ stretched mesh, and a middle section which may be up to 20 fathoms long with a mesh of $\frac{1}{2}$″ stretched. There may sometimes be a *lundoh*. The net is operated from a 30′ boat by 6-8 men under the supervision of a *kapala*, and it is either " shot blind " or payed out around a shoal, and hauled on to the shore. A *kalat* may be used at each end of the net.

In some cases the complete net is owned by the *kapala*, as is the *perahu*, and the catch is divided as follows :—

Net	$1\frac{1}{2}$ shares
Owner	1 share
Boat	$1\frac{1}{2}$ shares
Each man	1 share

If the various sections are contributed by the operators the catch is divided as follows :—

Each man	1 share
Boat	$\frac{1}{2}$ share (usually owned by *kapala*)
Each *benata*	1 share

The first method of dividing the catches is in force at Kampong Bulukut in Labuan, and the second is used at Sipitang. The net is operated from a 30′ *pemukatan*.

(c) *Pukat Tungap*

This hauling net is used only at Labuan. Each *benata* measures 20 fathoms long by $2\frac{1}{2}$ fathoms deep of 2″ stretched mesh. No hauling ropes are used. Usually 6 sections are joined together, and operated from a large *perahu* by 6-12 men, at either low or high water, during the day.

When a shoal of fish is approached, the *pencharok* shouts " Laboh ", and one of the men jumps into the water with one end of the net. Three men row while two others pay out the net around the fish, then all jump into the water each carrying a pole about 1 fathom long. This pole, held in one hand, is used to give added leverage, as the net, held in the other hand, is hauled. The net is used in conjunction with the *hanchau* (q.v.) when possible, and the catches consist of various Carangids which come close inshore to feed on the shrimps. The net is seldom used at other seasons.

Here again one man may own the complete net and the perahu, and the catch will be divided in the following way :—

Net	2 shares
Boat	1 share
Pencharok	$1\frac{1}{2}$ shares
Each man	1 share

This method, at Kampong Lubok Tamiang at Labuan, seems to be one of the rare cases where the *pencharok* gets a larger share by virtue of his position. If the sections are individually owned the division will take the usual form.

When two boats go out together, the crews combine and the following system is adopted. If the shoal appears on the left side then the left vessel will operate its net ; if on the right, the net from the vessel to the right is used ; if the fish appear in front, the *pencharok* who first sees the shoal orders his men to set the net. Usually, however, the first boat to reach the fishing ground will operate its net. There are frequently exciting races between the boat crews on their way to the fishing grounds and arguments and fights may develop as to who first sighted the fish.

(d) *Pukat Paguyut*

This net, used in the tidal reaches of large rivers at Weston, and Mempakul, has four sections on each side of the bunt, which measure as follows :—

Outside—	20×1 fathoms	—$2\frac{1}{2}$″	stretched mesh
Second—	15×2 "	—$2\frac{1}{2}$	" "
Third—	$10\times2\frac{1}{2}$ "	—$2\frac{1}{2}$	" "
Fourth—	8×3 "	—2	" "
Bunt—	2 - $2\frac{1}{2}$ "		diameter $\times$ 4-6 fathoms deep 2″-stretched mesh.

A kalat 25 fathoms long is attached at each end by a *teraju* which is fixed to the net by a *perian*. The net, operated by a *kapala* and 9 men, is hauled downstream on the ebbing tide, four men on each bank. A boat carrying the *kapala* and one man travels in front of the net to remove debris.

After the net has been hauled for about $1\frac{1}{2}$ hours, during which time they will have covered about $\frac{1}{4}$ mile of the river, the *kapala* dives in and ties a rope around the mouth of the *lundoh* to prevent the fish from escaping. This work and also the work of the man who dives in front of the net to remove logs and debris is dangerous, as they may meet crocodiles, sting rays, etc. Both ends of the net are then brought to the bank and the whole is hauled ashore and the catch removed.

A *bidar* is the boat most commonly used, and if bought at Weston would cost about $200.00. Mempakul fishermen would have to pay more.

In the case of a *paguyut* at Weston, the catch was divided in the following way :—

Net	2 shares (owned by *Kapala*)
Kapala	$1\frac{1}{2}$ shares (extra for dangerous work)
T. Salam	$1\frac{1}{2}$ shares (extra for dangerous work)
Each man	1 share

(e) *Pukat Rumahan*

This net is used throughout the area for the capture of *Rumahan* (*Rastrelliger kanagurta*), which occurs in dense shoals at various times of the year. Each section measures 12 fathoms long and 3 fathoms deep, and is made from cotton thread with a 2″ stretched mesh. When in operation 7-12 sections will be joined together, and the net is operated from a *perahu* by 5 to 7 men, one of whom is the *pencharok*.

The *pencharok* guides the boat to a shoal of fish which is surrounded by the net. On the shout " Parom " a *Penchabong* (scarer) which is usually a piece of wood, is used to strike the water and drive the fish into the net, where they are caught by the gills. The shoals are usually found near the beach and the net is dragged ashore and the catch removed. On a good night up to twenty piculs (2,600 lbs.) may be caught. The net may also be operated during the day, but it is usually worked during moonlight nights.

The catch is divided as follows :—

Each *benata*	1 share
Perahu	1 share (owned by *Kapala*)
Each man	1 share

Superstition says that if a shoal of fish has more than three " heads ", i.e. a large shoal breaching at more than three places simultaneously, there must be an expert *kapala* in charge of operations, otherwise one of the fishermen will be injured. When two different boats sight a shoal at the same time there are often fights as to who should be allowed to catch it.

(f) *Pukut Belanak* or *Pukat Jarang*

This net is designed for the capture of Grey Mullet (*Mugil* spp.)., the name *Belanak* relating to the adults of several species. The net is made in sections each of which is about 20-25 fathoms long, and $1\frac{1}{2}$ fathoms deep, with a mesh of $1\frac{1}{2}$″ bar. The net is only lightly weighted. Several species of fish may be caught by this net including *Kurau* (*Polynemus indicus*), *Bawal* or *Dual* (*Stromateus cinereus*), and *Berkalang* (*Chorinemus* spp.).

When fishing from 4 to 10 sections are joined together. The net is operated from a boat in shallow water not more than $1\frac{1}{2}$ fathoms deep and is used during the *Tohor Barat*, and only on dark nights, i.e. from the 1st to the 7th of the Malay month, and from the 18th onwards.

The net is shot around a shoal whose presence is detected by the sound of the fish leaping, and the shoal is frightened into the net, either by a stick, or by a lamp being waved, but many of the fish escape by leaping over the head-rope. The net is then either pulled into the boat or on to the shore.

The following shows two methods of dividing the catches. The first is carried out at Kampong Layang-Layang on Labuan where the *kapala* owned 6 sections which were operated as a complete net.

Boat	1 share (owned by *Kapala*)
Each man	1 share
6 *benata*	2 shares (owned by *Kapala*)

At Sipitang the catch was divided as follows :—

Boat	1 share
Each *benata*	1 share
Each man	1 share

(g) *Pukat Kambura*

This net is used in the Weston and Sipitang areas. The word *Kambura* denotes the young or small species of Grey Mullet (*Mugil* spp.). Each section of the net is 15 to 18 fathoms long and 5′ deep, with a mesh of ½″ bar.

When in use 10 to 15 sections may be joined together, and the net is operated from a boat by 4 to 5 men in water not more than 5′ deep. The net is operated in the same way as the *pukat belanak*.

The shoal is surrounded by the net, and the fish is scared into the net. Fishing may be carried out by day or night, but early morning and evening are best, and the tide should not be running too strongly. Many other fish are caught as well as the young mullet.

The catch is divided in the following way :—

Each *benata*	½ share
Each man	1 share
Boat	1 share

(h) *Pukat Surui*

This net is used for the capture of *Surui* (*Hemirhamphus* spp.). It is made in sections, and each section may measure anything from 12 to 20 fathoms in length and 3 to 6′ deep, depending on the district.

It is composed throughout of cotton thread and has a mesh of ½″ bar. The net is operated from a boat by four men, who encircle the shoal of fish, whose presence is detected by the noise they make in the water. When the shoal has been surrounded the fish are scared into the net.

The net is used during moonlight nights, and on a good night four sections of net will catch about 60 katties of fish. Up to six sections of net may be joined together and a hauling rope is attached to one end of the net only.

At Kampong Bulukut on Labuan all the sections of the net (4) were owned by the *kapala* and the catch was divided thus :—

Whole net	½ share
Boat	1 share
Each man	1 share

At Sipitang the division was as follows :—

Each *benata*	1 share
Each man	1 share
Boat	1 share

(i) *Pukat Britus*

This net is only used at Sipitang for the capture of *Tylosurus* spp. It is made up of sections which measure 10 fathoms long and 2½ fathoms deep and is composed throughout of cotton thread, with a mesh of 3″ x 8″ bar. When the net is in use 6 to 8 sections are joined together, and operated from a boat by three or four men.

It is operated during the day, and the net is played out around the shoal. When the shoal has been half surrounded, the *kalat* which is attached to the moving end of the net is taken across to meet the stationary end which is attached to a float.

While this rope is being taken across it is splashed on the water, and thus drives the fish into the net. The net is operated near to the shore.

The catch is divided in the usual manner :—

Each section	½ share
Boat	½ share
Each man	1 share

(j) *Rambat Udang* or *Perambang*

The use of this cast net is confined to Weston, Lubok and Sipitang. The net which is used for the capture of prawns, measures 5 fathoms from apex to skirt. At times one may count 20 boats in a small area, each with a man throwing the net, a job which takes considerable skill.

The net is made of cotton thread, and an expert worker will take four to five months to complete a net. The net is started by making 35 meshes on a circle, *Chandik*. This odd number is supposed to impart luck to the net. These 35 meshes are continued for 3½ rows, and in the next 3½ rows "creasings" are inserted until there are 70 meshes. This is followed by 3½ rows where every second mesh is a "creasing". This pattern continues until the "creasings" are appearing every 52nd

mesh and 2½ fathoms of net termed the *Anak* has been completed. The second 2½ fathoms where no "creasings" appear, is called *Pelayu*. The last 3½ rows are made of thicker cotton, and make up the fringe of the net, *Selisir*.

The net is operated in the estuaries and catches run to 30 or 40 katties of prawns per day.

One man may own the boat, and one the net, in which case the catches are divided equally. Sometimes one man may own both the net and the boat, and the latter is operated by a son or a friend who would receive a share of the catches.

4. PRODUCTION

It has not been possible to obtain any reliable estimate of the total production of fish in the area and the following paragraphs refer generally to that part of the production which passes through commercial channels. Throughout the year virtually every individual in the area engages in subsistence fishing and even when a surplus is taken this does not pass through the established markets, but is given away or bartered to friends or neighbours.

During the past few years, with the high ruling prices for rubber and copra, there has been evident a definite drift of labour from full time fishing to estate work with its attractive wages and a tendency for more and more of the operatives of the fishing industry to reduce to part-time their fishing activities.

Established retail markets exist at Labuan, Sipitang, Weston and Mempakul and it is from these markets with the exception of that of Mempakul that information showing the quantity of fish handled has been obtained.

No data are available to indicate the handlings at the Mempakul fish market, but estimated on a basis of fishing gear in use, the quantity should be of the order of one quarter of the handlings at Weston, or for the period 1951-52 approximately 675 piculs.

Table III shows the total handlings at the three major markets during the period July, 1951, to June, 1952, to be a quantity of the order of 5,450 piculs. Including the estimated handlings for Mempakul, the total retail sales for the area amounted to approximately 6,125 piculs in addition to that consumed by the fishermen themselves.

The rate of catch for the several types of equipment is shown in outline in Table VII from which it will be evident that all the equipment was not in daily use throughout the year and that the season of peak production is September, October and November.

Table IV gives an estimate of the total number of men engaged in the fishery, together with the number of boats in use and it will be seen that the commercially available production of 6,125 piculs was derived from the activities of more than 1,100 men, i.e. approximately 5.50 piculs per man per year.

TABLE III

Fish Market Handlings 1951-1952

(*piculs*)

		Labuan	Weston	Sipitang	Total
1951	July ..	219.65½	174.43	No Data	394.08½+
	August ..	212.28½	263.09	,, ,,	475.37½+
	September ..	196.59	359.07	20.10	575.76
	October ..	215.03	440.16	30.28	685.47
	November ..	192.62	336.38	31.28	560.28
	December ..	200.67	231.52	29.77	461.96
1952	January ..	114.14	242.17	19.45	375.76
	February ..	257.69	172.73	20.40	450.82
	March ..	321.14	84.58	22.51	428.23
	April ..	191.43	112.71	14.73	318.87
	May ..	149.37½	123.18	32.32	304.87½
	June ..	199.01½	155.61	29.03	383.65½
	Total ..	2,469.64	2,694.63	249.87+	5,414.14+

(Weston includes most of surplus catches from Lubok)

TABLE IV

Men & Boats Employed, 1951

Gear	Units	Men			Boats	
		Owners	Assistants	Total	Number	Value
Lines* ..	213	208	40	248	208	$20,800
Kelongs ..	84	84	30	114	90	9,000
Belats ..	37	185	30	215	120	15,000
Bintor ..	150	3	—	3	3	300
Nets ..	125	217	320	537	125	25,000
Total ..	609	697	420	1,117	546	$70,100

* includes also Bubu fishermen.

It will be shown later that at least in respect of *kelongs*, the trap is effective as a producing unit for only approximately one-third of the year. The remainder of the year is spent by the fishermen in other occupations notably repairing and maintaining their equipment, planting and harvesting the produce of small gardens and in labouring work. Again, for line fishermen, it can be shown for the people of Labuan Island that only one-tenth of the available time is spent in the production of commercially available fish as against the unknown quantity landed for domestic consumption.

Figures made available by the General Manager of the North Borneo Railways showing the quantities of fish transported by rail from Weston to Beaufort are given in Table V.

TABLE V

TRANSPORT OF FISH BY RAIL

Weston to Beaufort

(*piculs*)

Month	1947		1951	
	Fresh	Salt & Dry	Fresh	Salt & Dry
January ..	6.60	57.40	89.60	72.10
February ..	11.50	46.50	71.30	62.30
March ..	20.00	77.50	64.70	40.40
April ..	14.80	57.50	76.20	36.00
May ..	35.80	110.85	52.90	56.10
June ..	13.00	15.25	48.00	67.50
July ..	14.00	40.50	23.70	86.90
August ..	26.50	76.30	86.60	77.40
September ..	11.70	32.10	110.70	86.60
October ..	6.00	24.00	100.10	75.80
November ..	7.50	52.70	89.60	84.20
December	96.50	64.88	97.60	90.30
Total ..	263.90	655.48	911.00	835·60

These figures, comparative for 1947 and 1951, show a marked increase in handlings. Adjusting the figures on a basis of round weight by the use of the factor x 2.5 to convert from salt and dried to fresh fish, the gross handlings represent 1,902.60 piculs for 1947 with an increase of 60% to 3,000.00 piculs in 1951. This would appear to indicate that the rehabilitation of the industry following the war years has proceeded satisfactorily and the increased quantities handled, allowing for a small increase in domestic consumption due to population increases, are in fact a true indication of the increase in commercially available fish landings.

Tables VI, VII & VIII give analyses of the market handlings of fresh fish in Weston and Labuan by fishing gear and it is evident that net fishing is the most significant.

TABLE VI

Landing by Gear

Weston

(*piculs*)

Month	Kelong	Pukat	Rawai	R. Udang	Bintor	Total
1951 July ..	26.65	79.56	38.48	28.74	..	173.43
Aug. ..	66.20	91.29	60.40	29.05	16.15	263.09
Sept. ..	63.17	150.89	80.09	32.90	32.02	359.07
Oct. ..	150.14	121.36	81.72	64.27	22.67	440.16
Nov. ..	138.11	95.75	53.75	31.68	17.09	336.38
Dec. ..	63.12	91.77	45.45	22.70	8.48	231.52
1952 Jan. ..	51.10	78.40	37.79	70.26	4.71	242.17
Feb. ..	73.93	54.27	28.56	11.09	4.88	172.73
Mar. ..	24.15	18.52	16.71	19.70	5.50	84.58
Apr. ..	24.90	11.95	19.10	52.55	4.30	112.71
May ..	25.03	60.55	11.20	24.00	2.40	123.18
June ..	32.91	90.90	15.60	15.00	1.20	155.61
Total ..	739.32	945.21	488.76	401.94	119.40	2,694.63
Percentage ..	27.4	35.1	18.1	14.9	4.4	99.9

TABLE VII

Landings by Gear—Labuan

(*piculs*)

Gear	Kelong		Pukat		Panching	
Month	Quantity	Trap-days	Quantity	Man-days	Quantity	Man-days
1951 July ..	39.06	556	88.37	114	92.22½	560
Aug. ..	40.65	568	69.52	222	102.11½	595
Sept. ..	44.65½	530	59.69½	111	92.24	435
Oct. ..	64.20	635	33.26½	86	117.56½	638
Nov. ..	53.67	654	34.45	111	104.50	540
Dec. ..	83.39	758	30.26	101	87.02	525
1952 Jan. ..	39.48	282	6.94	24	67.72	472
Feb. ..	51.95½	591	105.82	210	99.91½	425
Mar. ..	49.57½	596	161.10	428	120.55½	708
Apr. ..	50.65½	664	53.10	158	97.67½	681
May ..	41.17	549	28.57	163	77.63½	555
June ..	47.76½	659	51.15½	143	100.09½	592
Total ..	606.22½	7,042	712.15½	1,871	1,159.26	6,726
Percentage ..	24.5	..	28.7	..	46.8	..
Average per unit ..	0.08½	1	0.38	1	0.17	1

From the statistics available for the Labuan market, it has been possible to indicate the relative effectiveness of kelong, net and line fishing, line fishing in this case including also landings from bubu traps in operation in that area. It will be noted that production for *kelongs* has been expressed in terms of trap-days. This unit is slightly higher than would be the case if the analysis were on a basis of man-days since a proportion of the *kelongs* are operated by two men.

The figures of effectiveness in relation to time quoted above have been derived from Table VII and it is evident from Table IV that a relatively small proportion of the gear available in the Labuan area was in operation daily. As shown in the earlier sections of this paper, net fishing is in some measure seasonal and an effective index for this gear could not be derived.

During the period of the survey, the fresh fish markets of the area were subject to price control. The maximum retail price for the several grades and for crustacea are shown in Table VIII (figures in brackets). The other figures given are estimates of the wholesale price received by or credited to the fishermen for fish delivered at the market or the drying platforms.

TABLE VIII

RULING WHOLESALE PRICES

1952 (Cents per Kati)

Grade	Market			
	Labuan	Weston	Sipitang	Mempakul
Fish No. 1	50-80 (100)	30-40 (45)	40 (45)	35 (45)
,, ,, 2	35-60 (80)	20-30 (35)	20 (35)	25 (35)
,, ,, 3	25-32 (50)	15-20 (20)	15 (20)	20 (25)
,, ,, 4	5 (20)	—	—	10 (15)
Prawns	—	35-45 (50)	—	—
Crabs	—	35-40 (45)	—	—

(Figures in brackets are controlled retail prices).

Table IX gives a calculation based on an estimated average wholesale price of the gross value to the fishermen of the fish landed at Labuan market during the period July, 1951, to June, 1952, and from this the calculated average price per kati received for fish landed by the three main methods.

TABLE IX

LABUAN FISH LANDINGS

1951-1952

(*piculs*)

Grade	Average Wholesale price	Kelong	Pukat	Panching
No. 1	65 cent	22.10	0.12	18.03½
No. 2	45 ,,	434.34½	385.18	835.72
No. 3	28 ,,	98.55½	312.23½	286.12½
No. 4	5 ,,	51.31½	14.62	19.38
Total	—	606.22½	712.15½	1,159.26
Calc. Gross Value		$23,992.29	$26,156.58	$46,888.07
Calc. Av. Price per Kati.		40 cent.	37 cent.	40 cent.

Figures derived from Tables IV, VII, VIII and IX have been combined from Table XI and from this has been calculated the value per share of daily landings for *kelong*, *pukat* and *panching* actually in use. Off-set against the apparent daily income per man is the fact that the equipment is only used part-time, thus throughout the year, a *kelong* operator would receive on the average only 34 cents per diem for his marketed catch and a handline man only about 22 cents.

TABLE X

	Kelong	Pukat	Panching
Number of Units	53 (3)	21 (1)	128 (1)
Number of Boats	53 (3)	21 (1)	128 (1)
Number of men	70 (4)	120 (6)	129 (1)
Av. Landing p.d.	0.08½ pcl.	0.38 pcl.	0.17 pcl.
Value	$3.40	$14.06	$6.80
Value per share	$1.02	$1.76	$2.26

(Figures in brackets show approx. ratios used in calculations).

5. FINANCE

Capital Investment

It was not practicable to obtain an assessment of the actual capital investment at the time of survey and the following figures are based on what might be regarded as replacement cost if all equipment was by some mischance destroyed. Reasonably accurate figures have been obtained for the actual fishing gear and are given in the following Table.

TABLE XI

FISHING GEAR 1951-52

Gear	No. of units	Av. Cost per Unit	Total Value
Panching ..	188	25.00	4,700
Rawai ..	25	40.00	840
Belat ..	37	190.00	7,030
Kelong ..	84	235.00	17,740
Bubu ..	22	4.00	88
Bintor ..	150	..	..
Hanchau ..	3	700.00	2,100
P. Ambid ..	20	47.00	940
P. Tungap ..	60	140.00	8,400
P. Paguyut ..	2	680.00	1,360
P. Rumahan ..	149	62.00	9,238
P. Belanak ..	130	56.00	7,280
P. Kambura ..	132	18.50	2,442
P. Surui ..	48	23.50	1,128
P. Britus ..	60	16.50	990
R. Udang	43	68.50	2,946
	1,153	..	$67,222

There is no cost in relation to the construction of *bintor* and all other figures are based on cost of materials alone. The cost of labour involved in the construction of nets, traps and lesser fishing gear may be assessed for purposes of calculation as equivalent to the value of the materials used. The boats employed in the area have been assessed at a total replacement cost of $70,100.00.

In round figures the total replacement cost of all fishing gear in the area would be as follows :—

(a) Fishing Gear	$67,000
(b) Labour	67,000
(c) Boats	70,100
Total	$204,100

It should be borne in mind that in the majority of cases, the actual labour of preparing the basic material for use in the industry is undertaken by the fishermen themselves and is, therefore, difficult to assess. Again, the current capital value of the equipment would be not more than half of the values shown above, the smaller boats last for two to three years with normal wear and nets usually for about the same period, but even at the end of three years, a significant proportion of the original net is still useful and is frequently incorporated in the body of the new piece of equipment.

Belats, *kelongs* and *bubus* are relatively short-lived and in general are replaced completely within periods ranging from six to eighteen months.

Assuming a total of 1,150 men engaged in the industry, the present investment *per caput* may be calculated as $170, the investment ranging from about $340 in the case of an owner of *pukat paguyut* plus probably $200 for his *perahu*, down to $70 to $100 for a crab fisherman who is concerned only with the cost of his boat. Again many of the fishermen, classed in Table V as assistants may have no capital investment whatsoever.

It was interesting to compare the current prices of fishing gear, as quoted by the fishermen, with the prices quoted in 1947 during the preliminary survey. From the figures given to us it appeared that there had been a general overall increase in costs by 1952 to about twice the 1947 costs.

Source of finance

Nearly all the fishermen are of indigenous stock, the exceptions being some six Chinese who operate the *pukat belanak* at Labuan. The great majority of the fishermen are financed by and indebted to a few Chinese fish dealers at each port. The system of financing is as follows :—

A fisherman requiring an advance with which to purchase gear will approach a dealer who, if he considers the applicant suitable will advance him either cash or give him the material with which to make the gear. If the applicant is new to fishing, or unknown to the dealer he may only be given a set of old secondhand gear which would be no great loss to the dealer. Initial loans are usually of the order of $50-100, but may on occasions reach $200-300. When the loan is made or the material handed over, the dealer and the fisherman make a verbal contract whereby the latter agrees to sell all his fish to the dealer. The loan is only repayable if the fisherman breaks the contract by selling his fish to someone else. Surprisingly enough, the dealer apparently does not enforce his rights in this respect, in which there having occurred flagrant breaches of contracts the dealer has taken no action, despite the fact that he knew what was going on. It is probably a matter of allowing the fisherman a few indiscretions, knowing that he will always come back to his financier.

The fisherman may also receive from time to time additional small loans of about $10-$20 for the purchase of materials with which to repair the equipment and he may also on festive occasions receive a small bonus from the dealer, who makes no stipulations regarding these latter sums, which are probably calculated to keep the fisherman " within the flock ".

There is no doubt that some method of financing the fisherman is necessary. Under normal circumstances he is a poor person living from day to day, and without advances of some kind he would never be able to purchase equipment. The only person who is interested in advancing the necessary capital is the dealer, which system for the time being appears inevitable. The average fisherman has neither the capital, the business experience nor the training to enter the retail side of the business. In any case, when he returns from the sea he has the work of repairing nets and other gear, he is tired after his day's labours and he must be assured of disposing of his entire catch immediately on landing. The dealer-financier is therefore fulfilling a useful and indeed an essential function.

The system however has obvious disadvantages. The fisherman to some extent loses his powers of bargaining, and he need not make the effort necessary to accumulate capital of his own. Dependent on his financier, who he knows will help him out when things are difficult, he is liable to become apathetic and would rather continue to be dependent upon the financier than try to help himself or accept conditional assistance from other sources.

Under the current system, the dealer is assured of a fairly regular supply of fish at a reasonable price, but he too has his difficulties. He can of course demand the repayment of any initial loans made to the fisherman and the handing back of any gear given, but he rarely does this, and it would probably not pay him to do so. He is dealing in a very perishable commodity, and when large catches are landed late in the evening, as they often are, he has no option but to accept them and salt them, often with serious loss. He is often accused by the fishermen of buying fish at No. 2 prices, and selling it at No. 1. Undoubtedly this does happen, but it is not a malicious or rife practice, as the public are aware of the grades of the various species, and if a No. 2 fish is sold at No. 1 price there must be a good reason. It happens also that fish which the dealer has purchased at No. 2 prices

may have to be sold at No. 3 price, and in practice this tends to off-set any apparent profiteering.

However, despite his difficulties the dealer makes his profits otherwise if he did not he would not be in the business. All things considered the system is a poor one, but *faute de mixux*, it will continue until some other source of capital is available, a satisfactory method of ensuring repayment is evolved, and the fishermen become sufficiently energetic to take advantage of such the new facilities.

A census of indebtedness by sampling was made at the beginning of 1952, and the following approximate figures were obtained. The figures were those given by the fish dealers, as it was considered that the dealer would give more reliable answers than the fishermen, who rarely if ever keep any record.

TABLE XII

Trap Fishermen—1951

	No. Kelongs	No. Belats	Persons Indebted	Amount	Average
Labuan ..	53	..	53	$4,020.00	$75.85
Sipitang ..	..	..	..	..	..
Weston ..	28	37	65	5,340.00	82.15
Mempakul ..	3	..	3	350.00	116.67
Total ..	84	37	121	$9,710.00	$80.25

Net & Line Fishermen—1951

	No. persons	Amount	Average
Labuan	99	$13,620.00	$137.58
Sipitang	77	1,000.00	12.98
Weston ..	203	10,115.00	49.83
Mempakul ..	8	385.00	48.13
Total ..	387	$25,120.00	$64.91

Summary of Indebtedness—1951

	Men	Amount	Average
Traps ..	121	$ 9,710.00	$80.25
Nets & Lines ..	387	25,120.00	64.91
Total ..	508	$34,830.00	$68.56

The following figures were collected during the preliminary survey in 1947 and are generally comparable with the figures given above.

TABLE XIII

Trap Fishermen—1947

	No. Kelongs	No. Belats	Persons indebted	Amount	Average
Labuan ..	48	21	45	$2,799.30	$62.20
Sipitang ..	..	25	22	1,217.45	55.34
Weston ..	..	8	7	343.53 +	49.75
Mempakul ..	..	8	..	..	..
	48	62	74	$4,360.28	$58.92

Net & Line Fishermen—1947

	No. of men indebted	Amount	Average
Labuan ..	64	$2,382.20	$37.22
Sipitang ..	21	1,186.00	56.47
Weston ..	122	3,519.00	29.00
Mempakul ..	20	1,200.00	60.00
	277	$8,287.20	$29.88

It is interesting to note that although the general costs of equipment have increased to approximately double the 1947 figures the average indebtedness of the operatives has only increased by about 50%. This indicates the attainment of a degree of stabilization in the industry and although the basic principles remain the same, the fisherman is under a somewhat smaller relative obligation to his financier.

From the figures quoted, it will be seen that, of 697 gear owners, 508 were in debt at the time of the survey, that is, about 73%, and the amount of the debts was equivalent to 17% of the estimated gross capital investment, or 25% of the capital cost of the gear, excluding labour charges.

This figure varies according to the season, and is probably lowest about the end of the south-west Monsoon, October to November, and highest about the end of the north-east Monsoon, April to May.

6. SOCIO-ECONOMIC ASPECT

Although an attempt has been made to give an outline of the more important gear and methods used in the fishing industry of the area, it was found impractical to attempt an assessment of the minor fishing activities undertaken by the great bulk of the people. The fishing methods described cover all those concerned with the commercial production of fish as recorded in the market statistics. It was not possible to obtain figures for the total quantity of marine products consumed in the area and the recorded market handlings bear little relation to the actual domestic fish consumption.

Fish is the staple animal protein in the local diet and is constantly in demand. But the recorded market handlings at Labuan for the period July, 1951, to June, 1952, of 2,477.64 piculs over a total population of 8,759 persons as recorded by the 1951 Census gives the *per caput* consumption of only 0.28¼ piculs or approximately 1.7 ozs. per day. Although there are periodic complaints of fish shortage from a minority of the public, it is obvious

Summary of Indebtedness—1947

	Men	Amount	Average
Traps ..	74	$ 4,360.28	$58.92
Nets & Lines ..	227	8,287.20	36.51
	301	$12,647.48	$42.22

that this is an unreal figure since only a comparatively small proportion of the inhabitants of the island obtain their fish from the market. At a conservative estimate of 5 ozs. (round weight) of fish per person per day, the total annual consumption of fish for the island would be of the order of 7,500 piculs, or about three times the recorded market handlings. Since the Sandakan fish market figures suggest a daily consumption of approximately 7.5 ozs. *per caput* in that area, even this estimate may be somewhat low.

It has been shown earlier that on a basis of market handlings, a *kelong* would produce fish at a value of 34 cents a day and a handline fisherman would land fish valued at 22 cents. If the above figure of 7,500 piculs may be accepted, then the effective incomes would be $1.02 for a *kelong* and 66 cents for a handline fisherman per day throughout the year, giving an approximate total income of $372 and $241 respectively. It is of course quite unlikely that these sums actually pass through the hands of the fishermen themselves or could be statistically recorded, and it is apparent that only rarely is the fisherman wholly dependent upon his fishing activities for his livelihood.

Hence, the present survey does not pretend to show more than a single facet of the sociological and economic complex affecting the lives of the people of the area. For any assessment of the organization of either individual family or village units to be of significance in defining the status of these people comprehensive socio-economic surveys including income from permanent or casual labour, effective income from agricultural pursuits and the incidence of indebtedness connected with these activities would have to be undertaken.

There is no doubt that the current system of financing is not in the best interest of the fishing industry, and the worst features of the system are aggravated by the habit which has developed for the financier to provide loans, frequently trivial and sometimes not even recorded, on festive occasions and, not uncommonly, simply at the request of the fishermen. These are obviously loans of

expediency designed to tie the fisherman more closely to his financier and from the point of view of the fish dealer himself are clearly justified since many of the fishermen are completely lacking in any sense of responsibility.

It has been found that attempts to regularise the issue of loans by drafting simple contracts are of little value since the fisherman is merely frightened away and in any case even if the contract is accepted by both parties, it is poor consolation to the financier should the debtor be jailed for breach of contract. Moreover if a financier resorts to legal action, he may find it difficult thereafter to attract other fishermen.

The major problem with which the industry is faced is the fisherman's own mental inertia, admittedly aggravated by the current system of finance, but nevertheless a basic characteristic of small-time coastal fishermen throughout the tropics. It is believed that all the difficulties of the industry, its low rate of production, the unsatisfactory system of finance and the obvious conservatism of the fisherman himself stem from this characteristic, and that the only means of overcoming the existing weaknesses within the fishing industry depends on the education of the fisherman and the implanting in his mind of an active discontent with his present way of living.

It is thought that the education of the fishermen should take two forms, firstly, the compulsory education of the fishermen's children in schools at least up to secondary school standard and, secondly, the provision of facilities and administrative machinery to encourage the gradual infiltration into the industry, by precept and example, of new ideas for the production of fish, the introduction of new and improved fishing methods and the establishment of sound financing and marketing systems.

It is evident that the process will be slow and evolutionary in nature and results may only become visible after a period of years.

It is possible that the introduction of modern fishing methods and equipment and the training of the better type of local fishermen in their use by skilled personnel from abroad would have a stimulating effect on the industry.

6

CHEMICAL STUDIES AND UTILIZATION OF SOME PHILIPPINE SEAWEEDS

by

J. I. Sulit,* O. B. Navarro* and R. C. San Juan*

Although many species of seaweeds thrive and grow luxuriantly along many marine shores of the Philippines, not much effort has been exerted to exploit them commercially. Some of them are used in limited quantities as food (Collado, 1926), and for botanical and pharmaceutical studies (Cantoria, *et al*, 1951, 1951a). One kind of seaweed, *Gulaman-dagat*, of the genus *Gracilaria* has commercial possibilities not only as food but as a source of agar (Wells, 1916). The work conducted by the Plant Utilization Division of the Bureau of Plant Industry and that of De Leon, *et al.* (1947) proved that agar extracted from *Gracilaria confervoides* may be compared favourably with imported commercial agar.

Before the outbreak of World War II the United States was a heavy importer of agar of which 90% of her supplies came from Japan. Because the imports from that country ceased to exist in the latter part of 1941, the commercial production of agar from *Gracilaria confervoides* (Hamm and Wolf, 1946) started in 1943 through the financial aid of the following entities :

1. General Education Board
2. Office of Production Research and Development
3. War Production Board

The inability of Japan to export agar due to the last World War made many countries turn to the

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sea to exploit their seaweed resources for the production of agar. India has made excellent progress in harnessing many of her rocky shores and coral reefs that are rich in algal growth for the production of human food as well as animal feed and fertilizer. At present practically every nation of the world realizes the importance of seaweeds which formerly were considered the weeds of the sea. It is, therefore, the purpose of this work to find some commercial possibilities of Philippine seaweeds by utilizing them directly as food and as a source of agar and alginic acid.

ECONOMIC VALUE OF PHILIPPINE SEAWEEDS

In the Philippines several varieties of seaweeds are being eaten by the people. In Manila Bay the agar-agar, also called *gulaman-dagat*, belonging to the genus *Gracilaria* was formerly a nuisance to the people who were residing near the sea. Lately, this marine plant has been giving economic livelihood to many people during the months of January to the latter part of May. At present the people of the city as well as those of the neighbouring provinces relish the *gulaman-dagat* as food. In fact, during the Japanese occupation in World War II many had been saved from famine and hunger by utilizing the seaweed mainly as food. The extract of the bleached and dried seaweed serves as a rare dessert.

Brackish fish-pond owners are now utilizing the seaweed as supplemental food for bañgos (*Chanos chanos*). Tons of this weed are being harvested everyday during the dry season to supplement the fish-pond algae, the growth of which is stunted during this period due to high salinity. The utilization of seaweeds as fish food enables fish-pond owners to continue the cultivation of fish unhampered.

Another kind of seaweed of great commercial possibility as food and livestock feed is *gamet* of the genus *Porphyra*. Gamet is similar to the *amanori* (*Porphyra tenera*) of Japan. Tseng (1944, 1944a) reported that Japan was able to convert 12,000 acres of her useless rocky shores into a sea garden of *amanori*, giving that country an annual income of no less than $3,000,000. Along the shores of Burgos, Claveria, Aparri, and other towns of the northern provinces of Luzon *gamet* is found in abundance.

Gamet may be cultivated by setting numerous twigs tied to bamboo poles stacked up along the shores at depths, from one to three fathoms. The twigs serve as anchor for the spores and thus afford them a chance to grow during the months of temperate climate. Sometimes big boulders are plastered with cement so that the growing *gamet* could be scraped off easily at harvest.

The plucked seaweed is collected and washed thoroughly in wooden barrels before drying. When partially dried, it is pressed and sold in the market at one peso a *ganta* or bartered for an equivalent amount of rice. *Gamet* is shipped to interior municipalities and barrios, where it is relished as food.

Gamet is reconstituted to nearly fresh condition by blanching in boiling water. It is then mixed with soya sauce to improve its taste. Others serve *gamet* as salad with vinegar, tomatoes, cucumber, and radish. The excess amount of the seaweed is packed in ball jars and is preserved with a hot pickled solution made by mixing spices and vinegar in order to insure longer preservation. *Gamet* with salted fish paste (bagoong) and onions is a common delicacy among the Ilocanos of the northern provinces of Luzon Island.

Two other species of seaweeds of Northern Luzon and likewise consumed as food are *pokpoklo* and *lato* of the genera *Codium* and *Caulerpa,* respectively.

In a recent trip conducted by the senior author he found a number of seaweeds growing in abundance in the Visayas, Mindanao and Sulu (Table 1).

The chemical studies made on the utilization of the aforementioned seaweeds may give incentive to culturing and propagating some of the edible ones for a wider and extensive utilization as food as well as for industrial purposes.

CHEMICAL STUDIES

Agar extraction.—The preliminary studies conducted on the extraction of agar revealed that *gulaman-dagat* gathered during certain months of the year gives a good yield of agar.

Table 2 shows that the agar yield during the early part of the season is much less than, and is very much inferior to, those gathered during the latter part of the season. The seaweed harvested during the months of April to June are not only mature or bigger in size but their yield of agar is more and of better jellying quality. In this connection, for the purpose of utilizing *gulaman-dagat* for agar extraction the best months recommended for harvesting the seaweed are April to the latter part of May.

The approximate chemical composition of *gulaman-dagat* and its mineral content (Tables 4 and 5) reveal that its utilization as food may be justified from the standpoint of its protein,

calcium, phosphorus, potassium, magnesium and iron contents. The iodine content of *gulaman-dagat* has an advantage over other vegetables.

The protein and phosphorus content of *gamet* is much higher than that of any other seaweed so far analyzed (Tables 4 and 5). As a source of calcium, phosphorus, and potassium, *gamet* may be recommended (Table 5). It is claimed by the people of Northern Luzon that those who are heavy eaters of *gamet* are sturdy and free from goitre.

Several varieties of Sargassum are known to exist in the marine waters of Batangas, Mindoro, Palawan and Cebu. Other alginic acid-bearing seaweeds are also known, such as those belonging to the genera *Turbinaria* and *Hydroclathrus*

Extraction of alginic acid.—Alginic acid-bearing seaweeds contain 15-40% alginic acid. It is extracted by disintegrating the dry seaweeds to a gelatinous mass with sodium carbonate solution. The mixture is diluted with water and then filtered. The resulting brownish liquid, after bleaching, is acidified with hydrochloric acid to precipitate the free alginic acid. By filtration and subsequent washing with 95% alcohol the purified alginic acid is obtained. When dried at 40-50°C a light brown amorphous powder is produced.

Table 3 shows the alginic acid content of some Philippine seaweeds. It shows also that Sargassum has the possibility of being used as a good source of commercial alginic acid.

The report of Woodward (1951) reveals that Great Britain is able to realize annually from seaweeds no less than 500,000 pounds sterling of alginate chemicals. About 30 foreign countries import these products from that country and use them in the food, pharmaceutical, medical, dental, textile, rubber, concrete, paint, and paper industries. Mannitol and laminarin are two potential industrial products from seaweeds.

Cady (1948), claimed that an excellent surgical textile could be manufactured with the use of an alginic acid salt. The commercial possibilities, therefore, of our Sargassum as an industrial source of alginic acid may be interpreted as a future boon to our seaweed industry.

Another kind of seaweed, *Digenea simplex*, found in the northern coast of Luzon, has an immediate value as medicine. It is locally known as *digenea* and *tserkoots' ai* or *hayen-ts' ao* in Chinese. Pharmaceutical preparations, such as macnin and helminol, are derived from this seaweed. It is an efficient vermifuge and is claimed to be much better than santonin as it gives no secondary bad effect, especially to children. It contains an appreciable amount of agar although of poor jellying quality.

Another constituent of digenea is an alkaloid, betaine, a quarternary ammonium base with the probable formula :

$$\begin{array}{l} N(CH_3)_3\text{—}OH \\ | \\ CH_2COOH \end{array} \quad -H_2O \quad \begin{array}{l} N(CH_3)_3\text{—}O \\ |\qquad\qquad | \\ CH_2\text{—}\quad C{=}O \end{array}$$

Betaine   Betaine anhydride

Betaine like choline may serve as a good source of essential transferable methyl group useful in the manufacture of trimethyl-amine.

To extract the alkaloid the powdered digenea is treated with acidified alcohol. The free alkaloid is liberated by the addition of ammonium hydroxide, from which betaine is obtained when extracted with ether.

Pokpoklo of the genus *Codium* is low in food value but it is exceptionally high in potassium. Fresh pokpoklo is highly watery as it contains no less than 93% moisture. It is much relished as food by some groups of people in Northern Luzon.

Lato of the genus *Caulerpa* is also low in food value but it is widely used as food in Northern Luzon, Visayas, Mindanao and Sulu.

SUMMARY

This study serves as a preliminary investigation on the commercial possibilities of our Philippine seaweeds. The report of our district fishery officers situated in strategic fishing grounds throughout the Philippines and the official survey conducted by the senior author revealed that our marine waters contained bountiful quantities of possibly commercially important seaweeds. The seaweeds belonging to the genera *Sargassum* and *Turbinaria* are good sources of industrial alginic acid. *Gulaman-dagat*, *hypnea* and *eucheuma* found in great quantities in our marine waters are good materials for the extraction of commercial agar. They are also being utilized directly as food in many parts of the Philippines.

Other seaweeds eaten directly as food are *gamet*, *lato*, *pokpoklo*, *gulaman-dagat*, *gaso* and a few others. One particular seaweed of the genus *Dcytela* found abundantly in Northern Luzon is known as the "lettuce of the sea".

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TABLE 1

Showing the sources of some Philippine seaweeds

Generic Name		Places where found
Amphiroa	..	Hundred Islands, Alaminos, Pangasinan
Caulerpa	..	Cebu, Opon and Cordova, Cebu ; Catbalogan, Samar ; Zamboanga, Sulu and Pangasinan
Codium	..	Burgos, Banguey and Currimao, Ilocos Norte ; and Sta. Ana, Cagayan
Deleseria	..	Pangasinan
Digenea	..	Sta. Ana, Cagayan and around the islands north of Luzon
Eucheuma	..	Cebu, Pangasinan and Cagayan (Gonzaga)
Galaxaura	..	Pangasinan
Gracilaria	..	Manila Bay, Zamboanga, Sulu and Cagayan (Sta. Ana)
Halimeda	..	Pangasinan
Halymenia	..	Pangasinan, Cagayan (Gonzaga) and islands north of Luzon
Hydroclathrus	..	Pangasinan
Hypnea	..	Manila Bay, Mindoro, Zamboanga, Mindoro and Cagayan (Sta. Ana)
Laurencia	..	Zamboanga, Sulu
Mastophora	..	Pangasinan
Manostroma	..	Cagayan (Aparri)
Padina	..	Pangasinan
Porphyra	..	Northern provinces
Sargassum	..	Cebu, Mindoro, Palawan and Batangas
Turbinaria	..	Pangasinan
Udotia	..	Pangasinan

TABLE 2

Dry agar yield per 60-gram samples of *gulaman-dagat* according to months of harvest

Months		First extract	Second extract	Total extract
		(Gm)	(Gm)	(Gm)
Jan.-February	..	15.20	4.90	20.10
March-April	..	18.16	6.10	24.26
May-June	..	19.32	6.90	26.32

TABLE 3

Analysis of some alginic acid-bearing seaweeds

Generic name		Moisture	Alginic acid	Source
		%	%	
Sargassum	..	9.88	23.90	Batangas, Mindoro and Palawan
Turbinaria	..	9.45	19.00	Cebu, Sulu
Hydroclathrus	..	10.54	16.70	Pangasinan
Eucheuma	..	..	traces	..
Hypnea	..	..	-do-	..
Gracilaria	..	..	..	..

TABLE 4

Comparative food value of some food plants—seaweeds, fish-pond algae, etc.

Local names	Scientific names	Moisture	Ash		Protein		Fat	
			Fresh	Dry	Fresh	Dry	Fresh	Dry
		%	%	%	%	%	%	%
Gulaman-dagat	*Gracilaria* sp.	6.92	15.31	16.48	11.98	12.89	0.92	0.99
Hypnea	*Hypnea* sp.	9.44	22.08	24.37	8.60	9.49	0.83	0.91
Gamet	*Porphyra* sp.	35.71	15.70	24.42	12.56	19.54	0.79	1.32
Pokpoklo	*Codium* sp.	93.59	2.98	45.89	0.15	2.34	0.08	1.21
Gosu	*Eucheuma* sp.							
Bitukang Manok	*Enteromorpha tubulosa*	81.35	6.02	32.27	3.66	19.61	0.48	2.57
Lumut jusi	*Chaetomorpha linum*	86.56	2.62	19.50	3.72	27.66	0.32	1.71
Cladophora	*Cladophora* sp.	57.24	9.90	23.16	1.96	5.16	0.84	1.96
Kangkong leaves	..	84.21	1.49	9.44	3.62	22.93	0.32	2.03
Talinum leaves	..	91.75	1.49	18.06	3.61	28.93	0.27	3.29
Native potato leaves	..	87.52	1.94	15.54	3.66	19.61	0.22	1.77

TABLE 5

Comparative mineral content of some food plants, estimated in grams per 100 grams of the samples listed in Table 3.

Local names	Scientific names	Calcium		Phosphorus		Potassium		Magnesium	
		Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
Gulaman-dagat ..	*Gracilaria* sp.	2.325	2.498	0.531	1.572	0.266	0.286	0.588	0.632
Hypnea ..	*Hypnea* sp.	15.818	16.711	0.127	0.140	3.568	3.936	0.601	0.663
Gamet ..	*Porphyra* sp.	2.250	3.499	2.009	3.124	0.977	1.519	0.034	0.048
Pokpoklo ..	*Codium* sp.	0.038	0.594	0.003	0.043	0.242	3.769	0.007	0.112
Gosu ..	*Eucheuma* sp.	0.038							
Bitukang manok ..	*Enteromorpha tubulosa*	0.202	1.080	0.179	0.961	0.445	2.384	0.314	1.684
Lumut jusi ..	*Chaetomorpha linum*	0.083	0.621	0.119	0.889	0.371	2.761	0.168	1.249
Cladophora ..	*Cladophora* sp.	0.422	0.988	0.403	0.943	1.520	3.556	0.785	1.838
Kangkong leaves ..	..	0.056	0.357	0.099	1.626	0.374	2.367	0.056	0.358
Talinum leaves ..	..	0.057	0.692	0.052	0.634	0.426	5.157	0.106	1.288
Native potato leaves ..	..	0.096	0.792	0.108	0.867	0.615	4.928	0.091	0.731

7

STUDIES ON THE RATE OF GROWTH OF MILKFISH OR "BAÑGOS" *CHANOS CHANOS* (FORSKAL), UNDER CULTIVATION

I. RATE OF GROWTH OF THE FRY AND FINGERLINGS IN FISHPOND NURSERIES[1]

by

H. R. Rabanal*, R. S. Esguerra** and M. N. Nepomuceno**

The bañgos fish-pond business in the Philippines is a lucrative industry which in recent years has grown very rapidly. As of December, 1951, the total area of developed fish-ponds in the entire country covers about 85,000 hectares producing some 30 million kilograms of fish a year valued at about 45 million pesos (₱45,000,000·00). There still remains over 400,000 hectares of virgin mangrove swamps, a great portion of which may be developed into fish-ponds.

In spite of the present extent and the potentiality of the bañgos fish-pond industry, scientific studies on the improvement of cultivation of this fish have been quite inadequate. This paper is an attempt to study the rate of growth of milkfish under pond conditions and the factors affecting it with a view to arriving at possible ways of improving the present cultivation techniques.

These studies were undertaken at the Dagat-dagatan Salt-Water Fishery Experimental Station fish-ponds situated in Malabon and Navotas municipalities, Rizal province, Luzon. In actual practice bañgos cultivation covers two phases, namely, the rearing of the bañgos fry and fingerlings in the nursery ponds and the rearing of the fish to marketable size in the larger rearing ponds. Due to the fact that these phases form two distinct stages, each being an industry in itself, we have found it convenient to break down the work into two parts. This paper covers the study of the growth rate of the fry and fingerlings in the nursery ponds.

The period of study covered the rearing seasons of the fish for the years 1943, 1951 and 1952.

The bañgos fry industry involves very large investments of money and is now of nation-wide importance. It consists of the catching, sorting, storage, transportation and distribution of the bañgos fry. The appearance of the bañgos fry is seasonal, occurring from April to as late as August of each year along certain sandy shores and in tidal creeks throughout the country. The most important fry grounds are along the coasts of Northwestern Luzon; Batangas province, Luzon; Cebu island; Panay, island; Zamboanga and Davao province, Mindanao island.

The fry are caught by means of traps, seines or dip nets made of fine-meshed abaca fiber cloth (*sinamay*). The fry are sorted from other extraneous species and stored in earthen jars or in tin can containers immediately after being caught. They are then transported and disposed of in the fish-pond centres of the country.

The bañgos nursery is very carefully prepared before it is stocked with fry. First it is cleaned of all its old stock of fish; it is then drained, levelled and dried. Drying takes several days or weeks or until the bottom cracks to dryness so that all potential predators are killed.

With the gates properly screened, water is admitted into the nurseries to allow growth of the natural food locally called *lab-lab*. This is the brownish, greenish or yellowish crust which develops on the pond bottom. It consists of microscopic plants and animals closely associated with the pond floor. When a good growth of lab-lab has developed the bañgos can be stocked in the nursery ponds.

MATERIALS AND METHODS

At the outset the characteristics and behaviour of the bañgos fry under observation were studied, then weekly samples were preserved, measured and weighed. The data obtained served as the basis upon which growth was reckoned after the fry were stocked in the nurseries. Sampling was done each week for a minimum of eight weeks and monthly thereafter in the nursery ponds.

Observations were made on the food available, depth and salinity of the pond water, growth of higher aquatic plants, presence or absence of pests,

[1] The writers acknowledge with gratitude the assistance rendered by Messrs. R. Ramos, Junior Fish Culturist, and G. Angeles, Fishpond Caretaker, in the collection and compilation of the data used in this work.

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nuisances and predators in the nurseries. There were some variations in management procedures used during the three seasons of observations (1943, 1951 and 1952), according to prevailing circumstances and with a view to seeking possible improvements. Pertinent data obtained in each case are fully discussed in the results. Further observations on the progress in the rate of growth were also taken after the fingerlings were transplanted into the transition ponds. The data obtained were tabulated and represented in graph form.

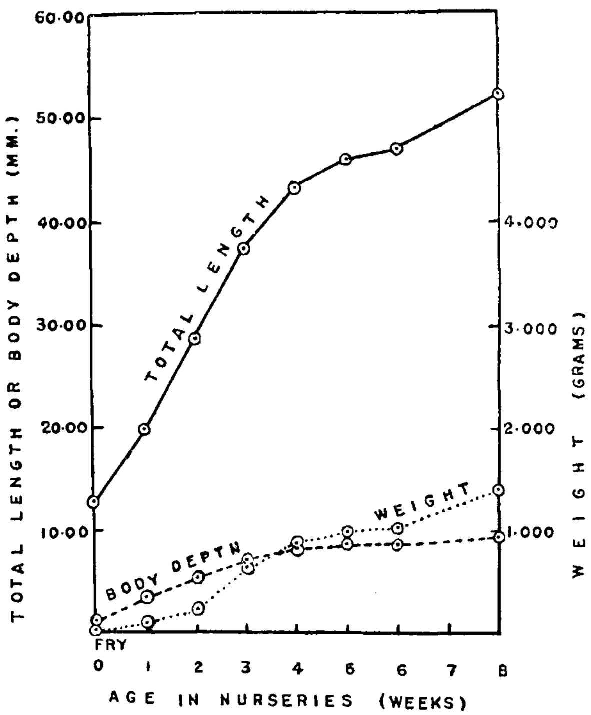

FIG. 1. Average measurements of age stages of bañgos in the nurseries during the 1943, 1951 and 1952 seasons.

RESULTS AND DISCUSSION

The bañgos fry.—The bañgos seems to spawn in the sea near sandy shores. The newly-hatched fry have very limited power of locomotion. They are carried by the waves and tidal current but they manage to approach sandy shores and tidal estuaries.

The bañgos fry when caught are almost transparent and very elongate, measuring from 10.0 to 15·0 mm in total length and 0.5 to 2.0 mm in greatest body depth. They vary in weight from 0.001 to 0.009 gram. On the average, they are 12.88 mm long and 1.05 mm in body depth, and weigh 0.005 gram. The eyes are clearly visible as prominent, black spots in the transparent and well-developed head and the mouth is slightly oblique. The pectorals appear early, and are well developed in the fry stage. The fry are scaleless at this stage. The alimentary tract is an almost straight tube parallel to the vertebral column. It terminates abruptly as it curves downward at the anus situated before the anal fin. The single dorsal fin shows a darker spot when viewed from the top. The homocercal caudal fin is well developed. When newly caught the fry are either devoid of or with very little pigmentation which is, however, soon developed in a characteristic pattern after a short period.

The actively swimming fry prefer the water surface, and are observed to swim in groups heading in the same direction. Their movements are fast and with practically uniform speed in a straight line. They are almost uniform in size with distinctly prominent eyes. Some of the newly caught fry may still exhibit rudiments of the yolk sac.

Growth of Bañgos Fry to Fingerling Stage

One-week old bañgos.—After the fry are stocked in the nursery ponds they easily become adapted to their new environment. They swim about actively and feed by browsing or nibbling on the lab-lab or benthic micro-biota which develops on the pond floor. With sufficient quantity of this natural food the fish grow very rapidly at this stage.

From the delicate, elongate and very transparent fry the young bañgos grow in length, thickness and depth. The excessively large head assumes a proper proportion to provide a streamline form with the body. The pigments which begin to assume a definite pattern even during the period of storage of the fry become more numerous and impart a definite dark hue on the dorsal portion of the body. The fish begins to develop simple cycloid scales on the seventh day. The young bañgos at this stage measure from 15.0 to 30.0 mm in total length and 2.0 to 6.0 mm in body depth, and weigh from 0.030 to 0.200 gram. On the average the bañgos fry after one week in the nurseries measure 19.96 mm in total length and 3.35 mm in body depth, and attain a weight of 0.096 gram. This represents a growth increment of 7.08 mm in total length or an increase of 54%, 2.30 mm in body depth or an increase of 218%, and 0.091 gram in weight or an increase of 1,820%.

Two-week old bañgos.—The two week old bañgos in the nursery ponds do not vary very much in morphology and behaviour from the one-week old fish. The body surface is still soft and quite delicate but the scales have become larger and more numerous.

In the ponds they feed actively and are able to evade enemies which may have gained entrance in the nurseries.

The young bañgos after two weeks measure from 21.5 to 49.0 mm in total length and 3.0 to 8.0 mm in body depth, and weigh from 0.009 to 0.480 gram. On the average, the bañgos at this stage measure 28.95 mm in total length and 5.22 mm in body depth, and weigh 0.221 gram. This represents a growth increment of 8.19 mm in total length or an increase of 41%, 1.87 mm in greatest body depth or an increase of 56%, and 0.125 gram in weight or an increase of 130% from the first week samples.

Three-week old bañgos.—At this stage the young bañgos begin to assume fully the form of the marketable-sized bañgos. The comparatively large and tapering snout becomes blunted and well-proportioned with the body. They have grown considerably and their bodies have become darker. The scales are fully developed and easily discernible by the regular network appearance on the body surface, which is not present in previous stages of the fish.

In life the fish are active, feeding heavily not only at the bottom but also on floating lab-lab and decaying organic matter on the water surface.

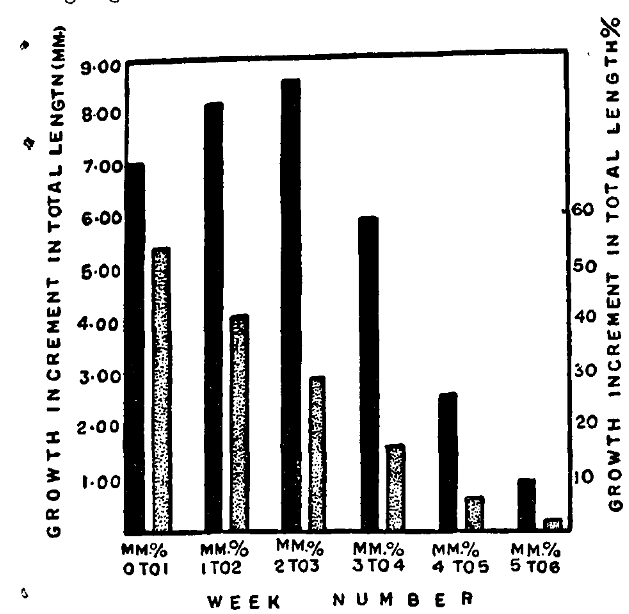

FIG. 2. Average weekly growth increment of bañgos in the nurseries.

The three-week old bañgos measure from 21.0 to 61.5 mm in total length and 5.5 to 12.0 mm in body depth, and weigh from 0.065 to 1.065 grams. On the average the bañgos at this stage measure 37.55 mm in total length and 6.99 mm in body depth, and weigh 0.600 gram. The growth increment is 8.60 mm in total length or an increase of 29%, and 1.77 mm in body depth or an increase of 171% from the second week samples.

Four-week old bañgos.—At this stage the fish attains a growth from 22.5 to 76.0 mm in total length, from 4.0 to 14.5 mm in body depth, and weigh from 0.085 to 3.500 grams. On the average they measure 43.92 mm in total length and 8.29 mm in body depth, and weigh 0.834 gram. This represents a growth increment of 5.97 mm in total length or an increase of 16%, 1.30 mm in body depth or an increase of 19%, and 0.234 gram in weight or an increase of 39% from the third week samples.

Five-week old bañgos.—There is an apparent decrease in the rate of growth of fish at this stage. The fingerlings measure from 26.0 to 92.0 mm in total length and 5.0 to 18.0 mm in body depth, and weigh from 0.200 to 6.920 grams. On the average they measure 46.08 mm in total length and 8.64 mm in body depth, and weigh 0.971 gram. This represents a growth increment of 2.56 mm in total length or an increase of 6%, 0.35 mm in body depth or an increase of 4%, and 0.137 gram in weight or an increase of 16% from the fourth week samples.

The six-week old bañgos.—The decrease in the rate of growth of the six-week old bañgos is even more pronounced. The fingerlings at this stage, on the average, measure 47.03 mm in total length and 8.69 mm in body depth, and weigh 1.005 grams. This represents a growth increment of 0.95 mm in total length or an increase of 2%, 0.05 mm in body depth or an increase of 0.6%, and 0.34 gram in weight or an increase of 4% from the fifth week samples.

Bañgos seven and eight weeks old, or older (stunted fingerlings).—It was noticed that from the fifth week and thereafter there was a slowing down of the rate of growth of the bañgos fingerlings in the nurseries. This condition was continued through the sixth, seventh and eighth weeks. When the rearing of bañgos in these small and shallow nursery ponds was continued it was observed that the fingerlings remained stunted even for three to six months. Surveys in the field also revealed that they could be kept for over one year and up to two years in the nursery ponds with their growth inhibited. This stunted state of the fingerlings was achieved when the fish were kept in crowded condition in the small and shallow ponds provided they were given enough food for their body sustenance and the pond water renewed often with new tidal water. Only very slight growth could be attained when these conditions were maintained.

Rate of growth of bañgos in the transition ponds.—The transition pond unit is a supplement to the nursery pond system. This type of pond is slightly bigger and deeper than the nurseries. Here the fingerlings from the nurseries are transferred in order to attain a slightly larger size. It is here that the fingerlings begin to feed on filamentous green algae or *lumut.* Another purpose of the transition pond is to raise the fingerlings to a size sufficient to enable them to avoid the predators in the big rearing ponds. Sometimes when the rearing ponds are not ready, the transition ponds serve also as a compartment where the young bañgos are further stunted.

The fingerlings kept in the nurseries are transplanted to the transition ponds. Here they are reared for a period of at least one month where they attain a growth of from 70.0 to 150.0 mm in total length, 10.0 to 30.0 mm in body depth, and 3.0 to 25.0 grams in weight. On the average they measure 105.55 mm in total length and 21.83 mm in body depth, and weigh 10.559 grams. This represents a growth increment of 53.18 mm in total length or an increase of 102%, 12.38 mm in body depth or an increase of 131%, and 9.142 grams in weight or an increase of 645% from the eight-week old bañgos fingerlings.

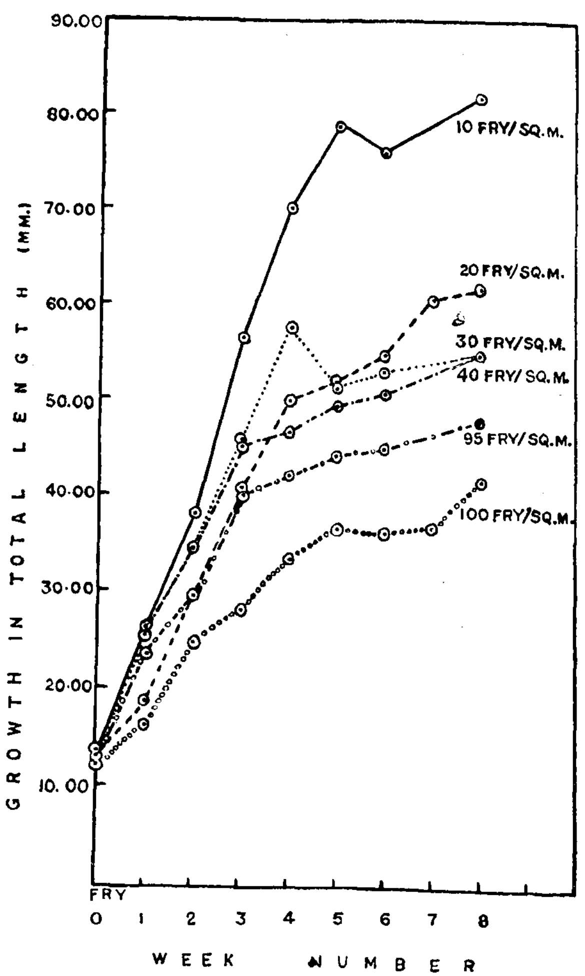

FIG. 3. Relative rate of growth of bañgos with different stocking rates in the nurseries.

Proposed Terminology for Age Stages of Bañgos in the Nursery Ponds.

For convenience in the terminology of the age stages of bañgos under cultivation in the nursery ponds and in consonance with the vernacular terms developed and with the steps in the management of the industry, the following groupings are proposed:

1. *Fry.*—The seed or the tiny elongate and almost transparent young bañgos collected along sandy shores or tidal creeks measuring from 1.0 to 1.5 cm in length. These are caught and transported to the fishponds for stocking purposes. This is equivalent to the local term *kakawag* or *kawag-kawag.*
2. *Pre-fingerlings.*—The intermediate size resulting from the growth of fry after stocking, scaleless or with tender scales, generally bottom feeding, measuring from 1.3 to 5.0 cm long, and which may have been reared in the ponds for a period not exceeding one month. This is equivalent to the local term *gadahon, gadahon-ng-dampalit* or *gadampalit.*
3. *Fingerlings.*—The stage after the pre-fingerlings of the active swimming young bañgos feeding from bottom to surface with morphology resembling marketable sizes of the fish, with scales fully formed, measuring from 4.0 to 10.0 cm in total length, and which may have undergone rearing in the nursery ponds of over four weeks or one month to an indefinite number of weeks if kept stunted. This is equivalent to the local term *hatirin.*
4. *Post-fingerlings.*—The stage after the fingerlings which are larger and more active resulting from greater space afforded in their rearing in the transition ponds, or in sparsely stocked nursery ponds, changing in type of food taken from the unicellular isolated organisms to the colonial types like filamentous algae and higher plants, and measuring from 7.0 to 15.0 cm in total length. Length of rearing period ranges from two months to an indefinite period in either the nurseries or transition ponds. This is equivalent to the local term *garongin.*

The Rate of Growth and Management Procedures used during 1943, 1951 and 1952 Seasons.

1943 Season.—In 1943 the nursery ponds had a layout wherein the different ponds varied in area. Stocks of bañgos fry were difficult to procure so that whatever was available was planted in seven nursery ponds at a more or less uniform stocking intensity of 20 fish per square meter. The nursery space with this stocking rate was quite more than sufficient for the stock during the season. The result thus produced showed that the fry grew normally and unimpeded to the fingerling stage until they were transferred to the transition pond and later in the rearing ponds. The fingerlings were quite uniform in size and no wholesale mortality of fingerlings was encountered.

1951 Season.—The nursery ponds during the 1951 season had their layout changed to form eight equally-sized nursery ponds, each pair of which had a common catching pond. There was a sufficient stock of fry available during the period so that an experiment was undertaken to determine the ideal stocking rate per unit area in the nurseries. The ponds were differently stocked as follows: (1) 10 fry per square meter, (2) 30 fry per square meter, (3) 40 fry per square meter, and (4) 95 fry per square meter. The rate of growth, in each of these ponds of varying stocking rate, showed very interesting results.

In the pond with a stocking rate of 10 fry per square meter the rate of growth was very rapid with the fish attaining the fingerling stage as early as from the second to the third week, and there was no definite slowing down of the growth rate even as far as the eighth week. It showed that there was sufficient space for the fish and the natural food might have been gradually replenished to maintain the stock. A great diversity in sizes was noticed but no wholesale mortality was encountered.

In the ponds with 30 fry per square meter the stock attained fingerling stage from the third to the fourth week. It showed a rapid rate of growth up to the fourth week, but from the fifth and subsequent weeks the rate of growth slowed down or levelled off showing crowding and probably exhaustion of the natural food. The apparent decrease in the fifth and subsequent weeks might have been due to insufficient sampling but this tends to show that the stunted fingerlings began to dominate the stock. When the stock was supplied with artificial feed of fine rice bran the rate of growth again gradually increased. The same results were likewise obtained when this stock was spread over a larger space. The stock of fish produced was very uniform in size and no wholesale mortality was observed.

In the ponds stocked with 40 fry per square meter there was a rapid rate of growth after stocking through the third week when the fingerling stage was attained. The growth began to slow down from the fourth and subsequent weeks. The slowing down of the growth may be attributed to the crowded condition of the fish and exhaustion of the natural food. Artificial feeding and spreading over a larger area of this stock likewise resulted in further growth. The stock of this intensity also showed very uniform sizes and no wholesale mortality was met with.

In the ponds with a stocking intensity of 95 fry per square meter, the resulting rate of growth was rapid within the first three weeks, but slowed down from the fourth and subsequent weeks to such an extent that the stock barely attained fingerling size as late as the eighth week. The stock appeared emaciated and stunted with a great variation in sizes unlike those with a stocking intensity of 30 and 40 fry per square meter. After four weeks or one month heavy mortalities were very common and, even when the fish were given artificial feed, the rate of growth remained slow.

1952 Season.—The nurseries in 1952 were stocked at a very high intensity rate. Four ponds were used for the original stock of fry at a uniform intensity of 100 fry per square meter. This provided a normal rate of growth for a period of two weeks after which the nursery ponds adjacent to each of the ponds previously stocked were opened to allow the spread of these fingerlings over these adjoining ponds. The resulting stocking intensity was therefore reduced to 50 fry per square meter. The pond over which the growing fingerlings were spread had the added advantage of having the natural food still intact upon which the growing fish could feed. With this management practice the rate of growth remained slow and gradual, and the sizes of the fish showed uniformity. After the fifth week a decrease in the rate was noticed so that artificial feeding with fine rice bran was resorted to and a gradual rise in growth was again attained. It is possible that as time goes on the rate of growth will slow down again, but it is planned to remedy this by " selective transplantation ". This consists of confining the larger batch of fish of this stock in the catching pond and transplanting it into the transition pond which should be prepared while the fish are still being reared in the nurseries. This is quite simple since bañgos love to go against the current and the larger group of bañgos fingerlings always get ahead in this procedure. Once the nursery is thinned out to the intensity which it could conveniently hold by transplanting the naturally vigorous group of the stock, the fullest utility of the nursery and other ponds in the system will have been availed of.

Factors Affecting the Rate of Growth

Food.—Food is probably the most important factor affecting the rate of growth of bañgos fry and fingerlings in the nurseries. *Lab-lab* is the natural and favorable food of the fry and fingerlings. The availability and maintenance of the growth of this fish food constitute one of the factors that determines the growth rate of the stock of fish in the ponds. The reason for the slowing down of the growth from the fourth week may be attributed mainly to the exhaustion or near exhaustion of the *lab-lab* or the natural food. This is also the reason why artificial feeding with fine rice bran is resorted to in order to maintain the fish in a healthy state and further increase the growth.

Stocking rate.—The experiment on stocking rate conducted in the nurseries in 1951 clearly shows that the rate of growth will vary under different stocking intensities. The stocking rate of 10 fish per square meter seems to indicate that the nursery is understocked. This is shown by the fact that there is a very wide range of variation in the sizes of the fish stock and a continuation of rapid growth which make the fish unsuitable for conserving as stock for a year round supply of fingerlings for the rearing ponds. The fact that the growth continues rapidly for several weeks shows that the growth of natural food is being replenished faster than the fish can make use of it and that a larger number of fish may very well be accommodated.

The stocking rates of 20 (1943 season), 30 and 40 (1951 season) fish per square meter show the desired rates of growth for a nursery stock of bañgos fingerlings. The advantages derived in these stocking intensities include the production of more or less uniformlysized fingerlings, the capacity to hold the maximum number per unit area of fish-pond, and the ability to hold their sizes at a certain level so that they would require less amount of food and space for rearing them. At the same time their capacity to grow to bigger sizes when finally transplanted into bigger ponds is not impaired.

Ponds stocked with 95 and 100 fish per square meter (1951 and 1952 seasons) or thereabouts appeared overstocked. The growth rate was too slow and there was the risk of encountering wholesale mortality in the overstocked ponds unless proper management practices were promptly instituted.

Salinity.—The salinity of pond water is a factor which affects the rate of growth of bañgos in the nurseries because the growth of the natural food is influenced by the salinity of the pond water. Favourable growth of *lab-lab* is possible only when the salinity of pond water is maintained at a more or less uniform condition. The coming of heavy rains and river freshets destroys the growth of this natural food. Fresh water also promotes the growth of undesirable higher aquatic plants.

Depth of the pond water.—Like salinity the depth of the pond water affects the natural food of the fish. *Lab-lab* in order to grow normally needs shallow water or usually a depth ranging from 10 to 20 cm. Pond waters maintained during a longer period of time at heights of 30 cm or more do not grow *lab-lab* and in many instances they produce the filamentous algae or higher aquatic plants. The absence of a suitable food and the development of an unfavourable type contribute to the hampering of the normal rate of growth of the fish.

Other aquatic plants and pests.—Higher plants and filamentous algae are not suitable for food of the fry, pre-fingerlings and fingerlings so that when these plants grow in the ponds the space which otherwise would serve as browsing areas for the young bañgos is occupied, resulting in the slowing down of the rate of growth.

Certain organisms are pests and nuisances in the nurseries in the sense that they compete with young bañgos during feeding. Such pests and nuisances include pond snails, annelids, crustaceans and omnivorous and herbivorous species of small fishes which may have gained entrance in the ponds. If these pests and nuisances are numerous they compete with and impair the growth rate of the cultivated species.

Predators.—Predatory species, particularly carnivorous species of fish which may have been stocked with the fry as well as other organisms like predatory reptiles and birds, harass the growing bañgos in the nurseries. Under these circumstances their feeding is disturbed especially for the slow growing batch in a stock of fish. This results in the general

slowing down of the rate of growth and great diversity in the sizes of the fish.

Weather conditions.—Inclement weather such as storms and heavy rains resulting in floods and highly turbid waters, has been found to inhibit the normal growth of the fish. The fish were observed to swim actively but refused to feed under these conditions so that, if prolonged, the rate of growth is impaired. Heavy rains also destroy the growth of the natural food of the fish.

SUMMARY

1. The operation of bañgos fish-pond nurseries for the rearing of bañgos fry and fingerlings has become a specialized phase of the bañgos industry in the Philippines. A study of the rate of growth of the fry and fingerlings in the nursery ponds is the subject of this paper.

2. This study was undertaken at the Dagat-dagatan Salt-Water Fishery Experimental Station, Malabon-Navotas municipalities, Rizal province, Luzon, during the rearing period covering the years 1943, 1951 and 1952. Studies at this Station were also supplemented by observations in the field.

3. Growth is reckoned from the bañgos fry which compose the seed stock for the nurseries. They are obtained from natural waters during certain seasons of the year. The bañgos fry are tiny, needle-like, elongate and almost transparent, measuring from 10.0 to 15.0 mm in total length and 0.5 to 2.0 mm in body depth, and attaining a weight from 0.001 to 0.009 gram.

4. When stocked in the prepared nursery ponds the bañgos fry grow very rapidly during the first four weeks at a rate of from 5.0 to 10.0 millimeters per week or at a rate equivalent to a weekly growth increment of from 10% to 60%. This rapid growth can be attributed to the availability of the natural food and sufficient space for their growth.

5. There is a slowing down or levelling off of the rate of growth from the fifth, sixth and subsequent weeks. This can be attributed to the exhaustion or near exhaustion of the natural food and the beginning of crowded condition of the stock as the young bañgos grow in size. Given sustenance feed, these bañgos fingerlings may be stunted for a prolonged period in the nursery ponds.

6. Stunted fingerlings when transplanted into bigger ponds where natural food is available will resume a very rapid rate of growth as shown by the growth attained in the transition ponds, the supplementary ponds to the nurseries.

7. The age groupings, namely: " fry ", " pre-fingerlings ", " fingerlings ", and " post-fingerlings " are proposed to provide a convenient distinction in age and size groups and morphological and ecological behaviour groups. These groupings are correlated to distinct management techniques as applied by the industry to such age groups. The corresponding local and vernacular designations for such age groups are also mentioned in this connection.

8. The rate of growth of bañgos in the nurseries is greatly affected by the availability of food and the stocking intensity and to some extent by such factors as salinity, depth of pond water, presence or absence of higher aquatic plants, pests, and predators, and the general weather conditions.

9. The stocking rate of 10 fish or less per square meter may be considered low for the nursery stage of cultivation resulting in a diversity of sizes of fish and a continued rapid rate of growth. To economize space and provide stock throughout the year the stocking rate should be above this level.

10. The stocking rates of 20, 30 and 40 fry per square meter produced healthy, stunted and uniformly-sized fingerlings which can provide stock for the year and for a subsequent season. This results in economy of space.

11. The stocking rates of 95 and 100 fry per square meter or thereabouts are too high resulting in the overstunting of the fish and the subjecting of the stock to wholesale mortality if the nurseries are not closely supervised.

12. Overstocked nursery ponds may be saved by providing adjoining ponds to which the stock may be dispersed, or by thinning the stock through " selective transplantation ".

TABLE 1. Average measurements of age stages of bañgos in the nurseries during the 1943, 1951 and 1952 seasons.

Age in the nurseries	Average total length (mm)	Average body depth (mm)	Average weight (grams)
Fry (original stock) ..	12.88	1.05	0.005
One week ..	19.96	3.35	0.096
Two weeks ..	28.95	5.22	0.221
Three weeks ..	37.55	6.99	0.600
Four weeks ..	43.52	8.29	0.834
Five weeks ..	46.08	8.64	0.971
Six weeks ..	47.03	8.69	1.005
Seven weeks ..	(x)	(x)	(x)
Eight weeks ..	52.37	9.45	1.417

(x)—Record incomplete, hence not used.

TABLE 2. Average weekly growth increment of bañgos in the nurseries.

Age stage	Growth increment in total length		Growth increment in body depth		Growth increment in weight	
	mm	%	mm	%	mm	%
One week from fry ..	7.08	54	2.30	218	0.091	1820
Two weeks from one week ..	8.19	41	1.87	56	0.125	130
Three weeks from two weeks ..	8.60	29	1.77	34	0.379	171
Four weeks from three weeks	5.97	16	1.30	19	0.234	39
Five weeks from four weeks (x) ..	2.56	6	0.35	4	0.137	16
Six weeks from five weeks (x) ..	0.95	2	0.05	0.6	0.340	4

(x)—Stunted state

TABLE 3. Measurements of age stages of bañgos in the nurseries during the 1943 season.

Age in the nurseries	Average total length (mm)	Average body depth (mm)	Average weight (grams)
'ry (original stock) ..	13.45	1.10	0.005
One week ..	18.86	2.99	0.121
Two weeks ..	29.82	5.24	0.254
Three weeks ..	40.97	7.52	0.701
Four weeks ..	50.17	9.47	1.203
Five weeks ..	52.35	9.70	1.422
Six weeks ..	55.01	10.16	1.619
Seven weeks ..	60.96	10.86	1.970
ht weeks (2 months) ..	62.11	11.39	2.228
elve weeks (3 months) ..	71.41	11.26	3.702

TABLE 4. Measurements of age stages of bañgos in the nurseries during the 1951 season.

Age in the nurseries	Average total length (mm)	Average body depth (mm)	Average weight (grams)
'ry (original stock) ..	13.05	1.14	0.006
One week ..	24.71	4.59	0.126
Two weeks ..	32.20	5.89	0.252
Three weeks ..	43.40	7.94	0.680
Four weeks ..	46.61	8.01	0.838
Five weeks ..	49.02	8.89	0.995
Six weeks ..	49.50	8.89	0.992
Seven weeks ..	(x)	(x)	(x)
Eight weeks (2 months) ..	53.14	8.75	1.198
Twenty-four weeks (6 weeks) ..	68.93	11.32	2.927

(x)—No records

TABLE 5. Measurements of age stages of bañgos in the nurseries during the 1952 season.

Age in the nurseries	Average total length (mm)	Average body depth (mm)	Average weight (grams)
Fry (original stock) ..	12.16	0.90	0.005
One week ..	16.32	2.46	0.042
Two weeks ..	24.84	4.52	0.156
Three weeks ..	28.28	5.51	0.419
Four weeks ..	33.78	7.44	0.461
Five weeks ..	36.86	7.32	0.495
Six weeks ..	36.59	7.03	0.403
Seven weeks ..	37.07	7.34	0.497
Eight weeks ..	41.86	8.22	0.825

TABLE 6. Relative rate of growth of bangos with different stocking rates in the nurseries.

Age in the nurseries	(xx) Pond stock 10 fry/sq. m. (total length in mm)	(x) Pond stock 20 fry/sq. m. (total length in mm)	(xx) Pond stock 30 fry/sq. m. (total length in mm)	(xx) Pond stock 40 fry/sq. m. (total length in mm)	(xx) Pond stock 95 fry/sq. m. (total length in mm)	(xxx) Pond stock 100 fry/sq. m. (total length in mm)
Fry (Original stock)	13.05	13.45	13.05	13.05	13.05	12.16
One week	26.21	18.86	25.38	26.19	23.64	16.32
Two weeks	38.38	29.82	34.63	34.52	29.67	24.84
Three weeks	56.78	40.97	46.14	45.38	40.35	28.28
Four weeks	70.47	50.17	57.71	46.82	42.30	33.78
Five weeks	79.02	52.35	51.76	49.67	44.66	36.86
Six weeks	76.24	55.01	53.34	51.15	45.36	36.59
Seven weeks	—	60.96	—	—	—	37.07
Eight weeks	82.50	62.11	54.70	55.91	48.25	41.86

(x)—1943 season (xx)—1951 season (xxx)—1952 season

8

A PRELIMINARY BIOMETRIC STUDY OF CERTAIN POPULATIONS OF HILSA, *HILSA ILISHA* (HAM.)

by

T. V. R. Pillay[1]

The Hilsa, *Hilsa ilisha* (Ham.), is a widely distributed species occurring in the Persian Gulf, W. Pakistan, India, East Pakistan, Burma and the Malay Archipelago (Day, 1889). Though it was generally considered an anadromous fish, Prashad (1919) pointed out that it is not so, as the fish belonging to one size group or the other are always to be found in the rivers throughout the year. De (1910) in his report of the fisheries of Eastern Bengal and Assam has also stated that " Hilsa is found in the sea and in all the principal rivers at practically all times of the year ". Such an extended period of occurrence in different localities throughout the year is not normally expected of a homogeneous stock of a migratory fish.

Hora and Nair (1940) have found from their investigations in the Pulta Water Works that the fish breeds in the river Hooghly throughout the year. Southwell (1914) stated that " there are several breeding grounds in the Ganges and it is quite likely that the spawning grounds change from year to year. Old Hilsa probably spawn in the higher reaches of the river, while younger Hilsa more susceptible to the changes involved in the transition from the sea to the fresh water, probably spawn lower down the river." Because of the occurrence of ripe males and females in the Pulta Water Works during the rainy season, Hora (1938) presumed that the fish could probably breed in confined waters also. The migration of the fish to the higher reaches of the Ganges as far as Bhagalpur and Monghyr and even upto Sone at Dehri, when there are breeding grounds in the lower reaches of the river, aroused doubts regarding the correctness of our knowledge on the migratory habits of the fish.

This apparent complexity of the bionomics of the fish probably induced previous workers to consider the possibility of the existence of different racial stocks of Hilsa. Day's observation (1873) that " there seem to be two classes of this fish which ascend the large rivers : those below one year of age, and which do not appear to breed, or if they do, it is at the very end of the year, or the commencement of the succeeding one ; secondly there are those which breed at the commencement of, or during the monsoon " is suggestive of the existence of two physiological races of the fish. Jenkins (1938) commenting on Hora's discovery of the spawning grounds of Hilsa in the Hooghly, for the first time posed the question : " Is it possible that there are two, or more, races or varieties of Hilsa, with different spawning grounds and habits ?" Mojumdar (1939) indicated that there are differences between Hilsa occurring in different rivers of East Bengal and also of the adjacent sea. According to him a fish of the river Padma is thicker in structure and of bright silvery colour, while that of the Meghna is a bit darker and the darkness becomes prominent in the flesh. He stated that when a type of each kind of fish is dissected the Padma fish looks much whiter than the other, and that the fish from Meghna is thinner in structure and a bit elongated in shape. Thus he recognised three types of Hilsa, viz., (1) those of the saline water of the seas, (2) the muddy freshwaters of the rivers like Padma or Hooghly and (3) those of the clear freshwater like Meghna, though some may migrate from place to place with the rise of water. However, he stated that enough remained in their special tracts to breed and propagate true to their own types. Naidu in his report on the fisheries of Bengal (1939) referred to this matter as follows : " The possibility that the small-sized Hilsas or some of them may be what is sometimes termed as ' acclimatised Hilsa ' in the freshwaters, living all the time in these waters never going to the sea at all like the others and from which these differ, may also be investigated.

" The question if there are any local ' Races ' of Hilsa as are in the European herrings i.e., those that have a life cycle between the Ganges and the sea, differing from those in the Bay of Bengal itself, that are visitants of the Godaveri or the Kistna or the Cauvery is also another point..... For the question may be asked why the Hilsa that migrate into the Mahanadi or the Ganges and found in the same Bay of Bengal should go lower down to replenish the depleted Hilsa fishery of the Cauvery or the Godavery.....

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" The Clupeid fingerlings called ' Jaitka ' bear a series of dark, lateral, median, transversely oval, blotches even upto 6 or 7 on each side. I have noticed these blotches, those nearer head more distinct and the first pair in all quite distinct in specimens upto 11.0" long in which there were 6 blotches on the right and 7 on the left, in a few others 4 and 5, and in the rest only the first distinct pair. But then there were hundreds without any. So the question if these bearing series of blotches form a distinct 'species' or ' race ', or the feature is only a variation of colouration in the same species, requires further investigation." Hora and Nair (1940) referred to Jenkin's (1938) remark and stated that so far as the form of Hilsa in the Ganges is concerned they found no differences in the specimens collected from the river Hooghly and those obtained from the Ganges at Allahabad. However, they reported that " the specimens from eastern Bengal are somewhat deeper and it is quite possible that in other large rivers different races of the species occur. Jenkins (1940) reviewing the further progress made in Hilsa investigations in Bengal, again raised the question whether there are two or more races of Hilsa, and whether the fish which spawn in the Sunderbans and those which spawn up the Ganges beyond Monghyr form distinct races, and if so, whether these races could be distinguished apart, as the races of herring in Europe. He also referred in this connection to the remarkable fact that the Hilsa specimens collected by Prof. Bhattacharya from Allahabad were marked with black spots, which is a characteristic feature of the young Hilsa. Hora (1941) referring to these comments stated that the Bengal investigations indicated the possibility of having several races or varieties of Hilsa in Indian waters. He distinguished the Hooghly Hilsa and the East Bengal Hilsa by the depth of body and the length of head as evidenced by the figures he has 1. This line of investigation has not received attention of later workers.

the 3rd Meeting of the Indo-Pacific Fisheries ncil the importance of studies on raciation in management of Hilsa fisheries of the Indo-fic Region was discussed and the Council re-nended consideration of these investigations 1 immediate assignment. It is of basic import- to know whether the Hilsa fisheries of various ities are drawing on a single or several different ilations and to ascertain the nature of their ations. The present preliminary study was mainly intended to examine statistically the available data for ascertaining the population characteristics and to determine the possibility of using the height of body and the head length as criteria for distinguishing Hilsa populations.

MATERIAL

In connection with the investigations on the probable role of Hilsa in the maintenance of cholera endemicity, I had the opportunity of collecting five samples of Hilsa specimens consisting of 68 specimens from the river Hooghly at Nawabgunge from March to June 1952[1], and the head length and the body height of these specimens were measured. Hora and Nair (1940) and Prashad, Hora and Nair (1940) have published the total length and the height of the samples of Hilsa examined by them from East Bengal and Orissa. These published raw data were also utilised for the study. Besides these, the head length measurements of three samples collected from Chandipore, and the head and height measurements of two samples of the fish from Allahabad obtained during the Hilsa investigations in the Zoological Survey of India were available. Though the Allahabad samples consisted of 24 and 10 specimens respectively, the caudal fins of most of these were damaged and so the measurements of total length were available only for 6 and 4 respectively. Thus the material under discussion has been drawn from 4 geographic regions, viz., (1) East Bengal, (2) West Bengal, (3) Uttar Pradesh and (4) Orissa coast. The details of these samples are given in Table I. The different localities in each of these regions from where material was collected are shown in Fig. 1.

METHODS

In early racial investigations of fishes biometrical indices have been widely employed. But they have often been found to be unsatisfactory and much inferior in utility to regression equations. As Kesteven (1950) points out, the test of significance of the difference between means is falling into disuse and improved methods of work involving analysis of variance and covariance are now being employed. Regression analysis and analysis of covariance methods have been used by Godsil (1948), Schaefer and Walford (1950), Godsil and Greenhood (1951), and Roedel (1952), in their studies of fish populations.

[1] Regular collections are now being continued and more detailed morphometric studies made.

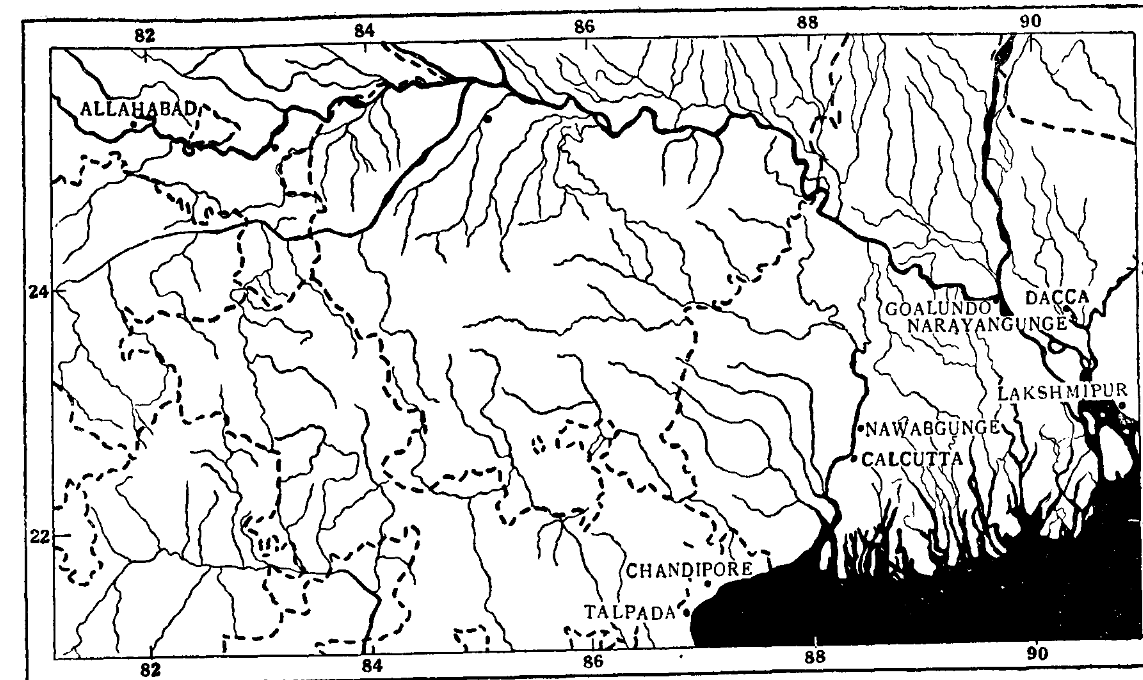

FIG. 1. Map showing the localities from where material for study was obtained.

TABLE I

Details of the samples studied from different regions

Region	Locality	Sample No.	Period of collection	No. of specimens	Size range (Total length in cm)	Measurements available
East Bengal	Lakshmipur	1	Feb. 1940	10	8.5-14.1	Body height.
,,	Narayangunge	2	Mar. 1940	30	11.6-16.4	Do.
,,	Goalundo	3	Mar. 1940	29	8.6-16.3	Do.
,,	Dacca	4	Mar. 1940	20	9.5-14.2	Do.
,,	Dacca	5	April 1940	41	9.1-12.2	Do.
,,	Dacca	6	May 1940	8	11.8-14.3	Do.
West Bengal	Nawabgunge	1	18th Mar. '52	4	23.7-25.9	Body height & head length.
,,	,,	2	24th March '52	3	8.7-12.6	Do.
,,	,,	3	8th June '52	3	6.9-8.7	Do.
,,	,,	4	19th June '52	20	11.3-18.5	Do.
,,	,,	5	26th June '52	20	6.2-16.7	Do.
,,	,,	6	30th June '52	18	4.8-13.9	Do.
Uttar Pradesh	Allahabad	1	1st Aug. 1940	4	7.2-9.2	Do.
,,	,,	2	11th Sept. '40	6	33.7-44.4	Do.
Orissa	Chandipore	1	26th Nov. '39	149[1]	19.6-45.6	Do.
,,	,,	2	26th Dec. '39	43	19.6-45.8	Body height.
,,	,,	3	11th Jan. '40	24	25.8-47.5	Do.
,,	,,	4	1st Feb. '40	21	19.5-44.1	Do.
,,	,,	5	25th Feb. '40	67	23.5-36.7	Do.
,,	,,	6	10th March '40	22	28.2-43.2	Do.
,,	,,	7	26th Aug. '40	10	39.1-44.6	Body height & head length
,,	Talpada	8	5th Sept. '40	10	34.4-48.2	Do.

[1] Data for only 148 specimens have been published in Prashad, Hora & Nair (1940).

In the present study tests for linearity of regressions were initially made for the pooled samples from each region and these showed that the regressions are highly significant and that there is no departure from linearity in the two variables (height of body and length of head) in the samples examined. As a further check the linearity of regressions of separate stocks determined from each region was tested and the results are given in the Appendix, which clearly show highly significant linearity. More than one sample collected at different points of time were available from certain localities in each region. So the different samples for each locality were first tested for homogeneity of regressions to ascertain whether the differences between samples were the result of chance variation or due to probable true differences in the relative length of head or relative height of body. Regression analysis and covariance methods as described by Snedecor (1950, Chapter 12) were employed. If the samples were found homogeneous they were pooled together and compared with the samples from other localities of the particular region. On the other hand if the samples were found to be heterogeneous each of them was compared with the other samples of the region so as to determine the similarity between the various samples and to ascertain the number of homogeneous populations identifiable in that region. For comparisons between two samples only, 't' test was employed wherever convenient. After ascertaining the number of stocks in each region, a comparison between the different stocks were made to ascertain the homogeneity or otherwise of these stocks.

Roedel (*op. cit*) has employed in addition to regression analysis and analysis of covariance, the comparison of adjusted means in his study of the populations of the Pacific mackerel. In the present study also adjusted means were intially compared; but gave very surprising results in that every sample showed significant differences in adjusted means. The calculation of the correlation coefficients for the samples from each region very soon revealed the reason for these anomalous findings. Comparison of adjusted means is made on the assumption that the variable considered may, apart from the random variation, be affected by two factors viz., the regression effect and the effect arising out of the characteristic of the population to which the samples belong. So, means are compared after they are adjusted for the regressions. The 'r' values in the present case were mostly of such a high order as 0.9 and above indicating the presence of perfect correlation in body height and length of head in these populations. The coefficients of correlation between height of body and total length of specimens in the samples which proved to be homogeneous are presented in Table II. These show that total length is the only factor that affected the height of body and head length in each case and the problem was to compare only the regressions of the various samples.

TABLE II

Correlation coefficients of pooled homogeneous samples in different regions

S. No.	Sample	r
1.	Pooled samples from Nawabgunge.	0.9926
2.	Pooled samples from Dacca and Narayangunge.	0.9693
3.	Pooled samples from Lakshmipur and Goalundo	0.9835
4.	Pooled samples from Allahabad	0.9963
5.	Orissa samples 1, 7 & 8 pooled	0.9905
6.	Orissa samples 2 to 6 pooled	0.9381

BIOMETRIC COMPARISONS

Height of body

East Bengal : In this region, from Dacca alone there were three samples collected during March, April and May. The regressions of these three samples were analysed to test their heterogeneity. The results are presented in Table III which show that the samples are homogeneous. Then the data for the three samples from Dacca were pooled and compared with the samples of Lakshmipur, Goalundo and Narayangunge. Table IV showing the results of this analysis clearly indicates significant heterogeneity among the samples. An examination of the data revealed close similarity between the within regression coefficients of (1) Lakshmipur and Goalundo samples and (2) Dacca and Narayangunge samples. To examine the degree of difference between the two sets of samples the 't' test was employed. The error of the difference of regressions was estimated from the corrected within sum of squares of the samples and the result is as given below:

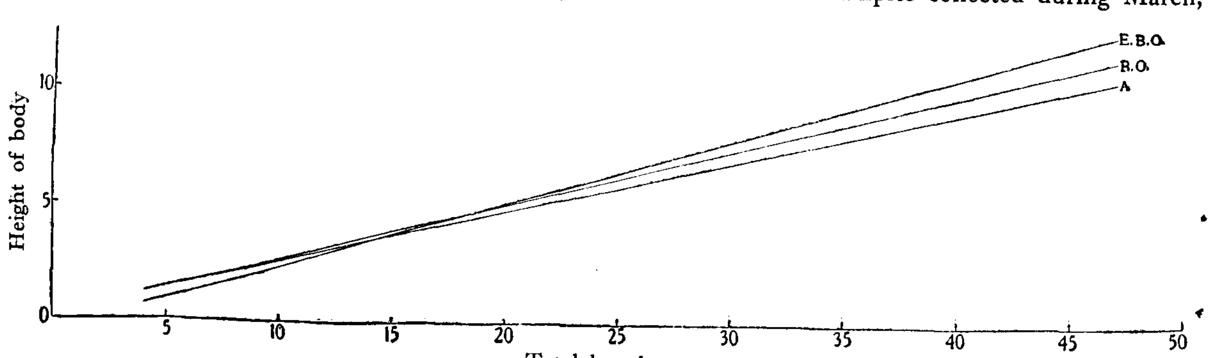

FIG. 2. The regression of body height upon total length of the three populations.
E.B.O. Stock, samples of which were collected from East Bengal and Orissa.
B.O. Stock, samples of which were collected from West Bengal an
A. Stock represented by samples from Allahabad.

Samples	Error	D.F.	Difference of regression	't'	Significance
Lakshmipur and Goalundo.	0.0935	35	0.0032	< 1	Not significant
Narayangunge and Dacca	0.0258	95	0.0185	< 1	-Do-

The above shows that the difference between Lakshmipur and Goalundo samples is not significant and they form a homogeneous stock. So also, the difference between Narayangunge and Dacca samples is not significant and they appear to have been drawn from the same stock. Thus, two stocks could be detected from East Bengal which can be referred to as East Bengal Stock I (Lakshmipur and Goalundo) and East Bengal Stock II (Narayangunge and Dacca).

TABLE III

Analysis of covariance of the body heights of three samples from Dacca

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. Corrected for regression	D.F.	'r'
1	19	27.3820	5.9960	1.5580	0.2190	1.3131	0.2449	18	0.9180
2	40	14.5191	3.5917	1.1995	0.2474	0.8886	0.3109	39	0.8604
3	7	6.1787	1.9437	0.7087	0.3146	0.6115	0.0972	6	0.9288
Total	66	48.0798	11.5314	3.4662	0.2398	2.7652	0.7010	63	0.8932

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs. F.	5% F.
Deviations from total average regression	65	0.7010			
Deviations from individual regressions within samples	63	0.6530	0.0104		
Difference	2	0.0480	0.0240	2.3677	3.14

D.F. = Degrees of freedom.
x = Total length.
y = Height of body.
x^1 = Mean of values of x.
y^1 = Mean of values of y.
b_{yx} = Regression coefficient of y on x.
S.S. = Sums of squares.
Obs.F. = Observed F.
S = Summation.

TABLE IV

Analysis of covariance of the body heights of samples from East Bengal

Sample	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.	'r'
Lakshmipur	9	29.6690	8.5210	2.5290	0.2872	2.4472	0.0818	8	0.9839
Narayangunge	29	43.6417	10.4834	2.8347	0.2402	2.5181	0.3166	28	0.9425
Goalundo	28	104.4083	30.3207	8.9117	0.2904	8.8051	0.1066	27	0.9940
Dacca (pooled)	68	105.6531	27.3339	8.0122	0.2587	7.0713	0.9409	67	0.9395
Total	134	283.3721	76.6590	22.2876	0.2705	20.7363	1.5513	130	0.9646

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs. F.	1%F.	5%F.
Deviations from total average regression	133	1.5513				
Deviations from individual regressions within samples	130	1.4459	0.0111			
Difference	3	0.1054	0.0351	3.1589	3.94	2.68

West Bengal : The samples from Nawabgunge in West Bengal were first tested for the heterogeneity of regressions. The results set out in Table V show that the samples are homogeneous. These samples were then pooled and compared with East Bengal Stock II with which it showed some similarity (Table VI). The results prove that they are homogeneous. This stock is hereafter referred to for convenience, as the Bengal Stock.

TABLE V

Analysis of covariance of the body heights of samples from West Bengal (Nawabgunge)

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-y^1)$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.	'r'
1	3	2.8875	0.7550	0.2100	0.2615	0.1974	0.0126	2	0.9696
2	2	7.6467	2.5433	0.8467	0.3326	0.8459	0.0008	1	0.9995
3	2	1.6800	0.3800	0.0867	0.2262	0.0860	0.0007	1	0.9958
4	19	41.7690	11.0400	3.2800	0.2643	2.9179	0.3621	18	0.9432
5	19	190.3695	51.2570	14.0020	0.2693	13.8035	0.1985	18	0.9928
6	17	111.7294	31.8689	9.1978	0.2852	9.0890	0.1088	16	0.9941
Total	62	356.0821	97.8442	27.6232	0.2748	26.8876	0.7356	56	0.9866

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs. F.	5% F.
Deviations from total average regression	61	0.7356			
Deviations from individual regressions within samples	56	0.6835	0.0122		
Difference	5	0.0521	0.0104	<1	2.38

TABLE VI

Analysis of covariance of the body heights of Nawabgunge samples and East Bengal Stock II.

Sample	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.
East Bengal Stock I.	98	319.9935	79.5677	21.0584	0.2487	19.7885	1.2699	97
Nawabgunge	67	1768.1652	460.6685	121.8145	0.2605	120.0041	1.8104	66
Total	165	2088.1587	540.2362	142.8729	0.2587	139.7591	3.1138	163

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.
Deviations from total average regression	164	3.1138			
Deviations from individual regressions within samples	163	3.0803	0.0190		
Difference	1	0.0335	0.0335	1.7	3.91

Uttar Pradesh : The samples from Allahabad were first tested for the heterogeneity of regressions. The results given in Table VII indicate that they are homogeneous. These samples were therefore pooled and compared with the Bengal Stock and the East Bengal Stock I. The results are presented in Table VIII and Table IX, respectively, and these clearly show that the Uttar Pradesh stock is distinct from others,

TABLE VII

Analysis of covariance of the body heights of samples from Allahabad

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.	'r'
1	3	2.2400	0.4800	0.1100	0.214286	0.102857	0.007143	2	0.9668
2	5	105.3683	29.8067	8.9734	0.282881	8.431749	0.541651	4	0.9679
Total	8	107.6083	30.2867	9.0834	0.281453	8.524283	0.5591	6	0.9687

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs. F.	5% F.
Deviations from total average regression	7	0.559117			
Deviations from individual regressions within samples	6	0.548794	0.091466		
Difference	1	0.010323	0.010323	0.1129	5.99

TABLE VIII

Analysis of covariance of the body heights of Allahabad samples and Bengal Stock

Sample.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	yx	$b_{yx} S(x-\bar{x})(y-\bar{y})$	S.S. Corrected for regression	D.F.
Bengal Stock	166	2089.5981	540.4770	142.9133	0.2587	139.8214	3.0919	165
Allahabad samples (pooled).	9	2598.6000	579.9700	129.5000	0.2224	128.5405	0.9595	8
Total	175	4688.1981	1118.4470	272.4133	0.2386	266.8615	5.5518	173

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	1%F.
Deviations from total average regression	174	5.5518			
Deviations from individual regressions within samples	173	4.0514	0.0234		
Difference	1	1.5004	1.5004	64.1197	6.81

TABLE IX

Analysis of covariance of the body height of Allahabad samples and East Bengal Stock I.

Sample	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx} S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.
East Bengal Stock I.	38	137.0092	40.4985	12.3769	0.2956	11.9714	0.4055	37
Allahabad samples (pooled)	9	2598.6000	577.9700	129.5000	0.2224	128.5405	0.9595	8
Total	47	2735.6092	618.4685	141.8769	0.2261	139.8357	2.0412	45

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs. F.	1% F.
Deviations from total average regression	46	2.0412			
Deviations from individual regressions within samples	45	1.3650	0.0303		
Difference	1	0.6762	0.6762	22.3168	7.24

Orissa : The five samples from Chandipore and one sample from Talpada were first tested for the heterogeneity of their regressions (Table X). It was found that there is significant heterogeneity among these samples at 5% level of significance. To ascertain the homogeneous samples among these, the ' t ' test was employed as shown below :

Samples	Error	D.F.	Difference of regressions	't'	Significance
1 and 7	0.0950	155	0.0068	<1	Not significant
1 and 8	0.0905	155	0.0357	<1	-Do-
1 and 2	0.0132	188	0.0549	4.16	Significant
2 and 3	0.1489	63	0.0419	<1	Not significant
3 and 4	0.2317	41	0.0118	<1	-Do-
4 and 5	0.1164	84	0.0279	<1	-Do-
5 and 6	0.1054	85	0.0211	<1	-Do-

TABLE X

Analysis of covariance of the body heights of Orissa samples

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S. S. corrected for regression	D. F.	'r'
1	148	1356.8700	373.4151	110.8354	0.275203	102.764956	8.0704	147	0.9628
2	42	2236.5316	492.6542	114.5081	0.220276	108.519897	5.9882	41	0.9735
3	23	1045.5600	274.1400	85.8800	0.262194	71.877863	14.0021	22	0.9148
4	20	822.0981	205.8262	61.0729	0.250367	51.532088	9.5408	19	0.9300
5	66	307.5287	68.4295	22.4098	0.222514	15.226522	7.1833	65	0.8243
6	21	291.0127	70.8791	24.5186	0.243560	17.263314	7.2553	20	0.8391
7	9	25.8040	7.2780	4.6010	0.282049	2.052753	2.5482	8	0.6679
8	9	169.9640	40.7000	11.3050	0.239462	9.746103	1.5589	8	0.9285
Total	338	6255.3691	1533.3221	435.1308	0.245121	375.849446	59.2814	330	0.9294

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.	1%F.
Deviations from average total regression	337	59.2814				
Deviations from individual regressions within samples	330	56.1472	0.1701			
Difference	7	3.1342	0.4477	2.6316	2.03	2.69

The above data clearly reveal the representation of two homogeneous stocks in the samples. To establish the identity of these two stocks they were compared with East Bengal stock I and the Bengal stock. Table XI represents the comparison of the Chandipore samples 1 and 7 and the

TABLE XI

Analysis of covariance of the body heights of Orissa Stock I and East Bengal Stock.

Sample	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	byx	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.
Orissa Stock I.	168	8102.4344	2435.2188	746.0870	0.3006	732.0268	14.0602	167
East Bengal Stock	38	137.0092	40.4985	12.3769	0.2956	11.9714	0.4055	37
Total	206	8239.4436	2475.7173	758.4639	0.3005	743.9530	14.5109	204

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.
Deviations from average total regression	205	14.5109			
Deviations from individual regressions within samples	204	14.4657	0.0709		
Difference	1	0.0452	0.0452	<1	3.89

Talpada sample (which may together be named the Orissa stock I) with the East Bengal Stock I. This shows that the two stocks are homogeneous. In Table XII are represented the results of comparison of Chandipore samples 2 to 6 (which may be called Orissa Stock II) with the Bengal Stock II. Homogeneity of these stocks is clearly indicated by the results of the analysis.

TABLE XII

Analysis of covariance of body heights of Orissa Stock II and Bengal Stock

Sample	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S.S. corrected for regression	D.F.
Orissa Stock II.	176	6895.2106	1848.1330	562.9208	0.2680	495.2996	67.6212	175
Bengal Stock	166	2089.5981	540.4770	142.9133	0.2587	139.8214	3.0919	165
Total	342	8984.8087	2388.6100	705.8341	0.2658	634.8925	70.9416	340

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5% F.
Deviations from average total regression	341	70.9416			
Deviations from individual regressions within samples	340	70.7131	0.2080		
Difference	1	0.2285	0.2285	1.10	3.86

Head length

The head length data of the six samples from Nawabgunge (West Bengal) were tested for the heterogeneity of regressions. Table XIII wherein the results are presented shows homogeneity in this respect also. Allahabad samples

TABLE XIII

Analysis of covariance of the head lengths of the Nawabgunge samples

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S. S. corrected for regression	D.F.	'r'
1	3	2.8875	0.6300	0.1400	0.2182	0.1375	0.0025	2	0.9909
2	2	7.6467	2.1700	0.6200	0.2838	0.6158	0.0042	1	0.9966
3	2	1.6800	0.4600	0.1267	0.2738	0.1259	0.0008	1	0.9972
4	19	41.7620	9.7280	2.3520	0.2329	2.2657	0.0863	18	0.9816
5	19	190.3695	50.4275	13.4175	0.2649	13.3582	0.0593	18	0.9978
6	17	111.7294	28.8811	7.5778	0.2585	7.4658	0.1120	16	0.9926
Total	62	356.0751	92.2966	24.2340	0.2592	23.9233	0.3107	56	0.9936

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.
Deviations from average total regression	61	0.3107			
Deviations from individual regressions within samples	56	0.2651	0.0047		
Difference	5	0.0456	0.0091	1.9362	2.38

y = head length

were similarly tested and Table XIV gives the results. Homogeneity was found among these samples also. Then the Orissa samples were tested for heterogeneity of regressions (Table XV) and homogeneity was found among these sample with regard to length of head. Now it was le to examine whether any heterogeneity could b detected among the samples from the three region

TABLE XIV

Analysis of covariance of the head lengths of the Allahabad samples

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-x)(y-y)$	S.S. corrected for regression	D.F.	'r'
1	3	2.2400	0.4400	0.0875	0.1964	0.0864	0.0011	2	0.993
2	5	105.3683	28.4585	7.8083	0.2701	7.6866	0.1217	4	0.992
Total	8	107.6083	28.8984	7.8958	0.2686	7.7627	0.1337	6	0.991

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.
Deviations from average total regression	7	0.1337			
Deviations from individual regressions within samples	6	0.1228	0.0205		
Difference	1	0.0109	0.0109	<1	5.99

TABLE XV

Analysis of covariance of the head lengths of the Orissa samples

Sample No.	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})^2(y-\bar{y})$	$S(y-\bar{y})^2$	b_{xy}	$b_{yx}S(x-x)(y-y)$	S.S. corrected for regression	D.F.	'r'
1	148	1356.8700	330.0210	83.7614	0.2432	80.2611	3.5003	147	0.9
7	9	25.8040	6.0360	2.5840	0.2339	1.4118	1.1722	8	0.7
8	9	169.9640	36.3920	8.9960	0.2141	7.7915	1.2045	8	0.9
Total	166	1552.6380	372.4490	95.3414	0.2399	89.3505	5.9909	163	0.9

Test of heterogeneity of regressions within the samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.
Deviations from average total regression	165	5.9909			
Deviations from individual regressions within samples	163	5.8770	0.0361		
Difference	2	0.1139	0.0570	1.5789	3.06

viz., West Bengal, Uttar Pradesh and Orissa. Pooled samples from each of these regions were compared (Table XVI) and it was found that no significant difference in head length could be seen among the samples.

TABLE XVI

Analysis of covariance of the head lengths of pooled samples from each region.

Sample	D.F.	$S(x-\bar{x})^2$	$S(x-\bar{x})(y-\bar{y})$	$S(y-\bar{y})^2$	b_{yx}	$b_{yx}S(x-\bar{x})(y-\bar{y})$	S. S. corrected for regression	D.F.
Nawabgunge samples	67	1768.1652	452.9747	116.6106	0.2562	116.0521	0.5585	66
Allahabad samples	9	2598.6000	650.6800	163.1000	0.2504	162.9303	0.1697	8
Orissa samples	168	8102.4344	2043.7568	521.8391	0.2522	515.4355	6.4036	167
Total	244	12469.1996	3147.4115	801.5497	0.2524	794.4067	7.1430	241

Test of heterogeneity of the pooled samples

Source of variation	D.F.	S.S.	Variance	Obs.F.	5%F.
Deviations from average total regression	243	7.1430			
Deviations from individual regressions within samples	241	7.1318	0.0296		
Difference	2	0.0112	0.0056	0.19	3.04

CONCLUSIONS

The present study has shown that the height of body can be used successfully for distinguishing Hilsa stocks, but the available data fail to indicate the usefulness of head length as a criterion for distinguishing populations.

Two stocks co-extensive from East Bengal to Orissa have been recognised by this study. Representatives of one stock have been examined from East Bengal in February and March; and from Orissa in July, September and November. Samples belonging to the other stock were present in East Bengal in March, April and May, in West Bengal in March, May and June and in Orissa in December to March. A regular morphometric study of samples from these three regions is likely to throw light on the migration of these two stocks within this area. Hora's (1951) assumption that the Hilsa caught in East Bengal, West Bengal and Orissa waters probably come from the same stock and that unregulated intensive fishing in any of these states is likely to affect the fisheries in the other states, seems to find some support in the results discussed here.

A third stock of Hilsa recognisable is the Allahabad stock which appears to remain distinct from the rest. This probably substantiates the assumption of previous workers that the Hilsa that spawns in the higher reaches of the rivers might be separate stocks that spend their life cycle in freshwater.

An important fact indicated by this study is the need for a well-organised and systematic investigation for a clear understanding of the delimitation and nature of the Hilsa stocks in our waters. After ascertaining the characters that are likely to be useful in distinguishing stocks, samples will have to be examined from various significant localities in each region at different points of time. The probability of the occurrence of different populations in the same locality at different periods of the year as suggested above, shows that a mere comparison of samples collected at random from different regions is not likely to yield much useful information about the Hilsa stocks.

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APPENDIX

Tests of significance of linear regressions

i. *East Bengal Stock I.* (Height of body).

Source of variation	D.F.	S.S.	Variance	Obs.F.	1%F.
S.S. due to average regression	1	11.2524	11.2524	2163.92	7.39
S.S. due to deviations from average regression	36	0.1883	0.0052		

ii. *East Bengal Stock II* (Height of body).

S.S. due to average regression	1	9.5791	9.5791	725.6894	6.90
S.S. due to deviations from average regression	96	1.2678	0.0132		

iii. *Nawabgunge* (Height of body).

S.S. due to average regression	1	26.8876	26.8876	2222.12	7.08
S.S. due to deviations from average regression	61	0.7356	0.0121		

iv. *Allahabad Stock* (Height of body)

S.S. due to average regression	1	8.5243	8.5243	106.69	12.25
S.S. due to deviations from average regression	7	0.5591	0.0799		

v. *Orissa Stock I* (Height of body)

S.S. due to average regression	1	114.3661	114.3661	1524.88	6.76
S.S. due to deviations from average regression	165	12.3753	0.0750		

vi. *Orissa Stock II* (Height of body)

S.S. due to average regression	1	262.8600	262.8600	987.08	6.76
S.S. due to deviations from average regression	171	45.5294	0.2663		

NOTES ON THE FISHERY OF THE CYPRINID FISH, THYNNICHTHY VAILLANTI IN INDONESIA

by

H. Saanin*

From the point of view of protein supply to the population of Indonesia, fishes of the genus *Thynnichthys* must be considered as very important. Every year salted and dried fish, caught in the swamps, lakes and rivers of Borneo are sent to Java at the rate of about ten thousand tons a year. The greater part of this product is known as " repang ketjil ", by which white-fish is meant, chiefly consisting of various *Thynnichthys* species.

This fish, belonging to the Cyprininae, has a silverish-white colour with a blackish back and occurs frequently in fresh water in India, Sumatra and Borneo. Three important Indonesian species are : *T. vaillanti* W. & de B. from East Borneo, *T. thynnoides* (Blkr.) from South Borneo, South and South-east Sumatra and Riouw, and *T. polylepis* (Blkr.) from South Sumatra and West Borneo. The number of scales indicated the most conspicuous difference between them, as shown in the following table.

Moreover, the scales of *T. vaillanti* are not as soft as those of the two other species and *T. thynnoides* has a black patch in the caudal corner of the operculum.

Studies on the life habits of this fish are almost entirely lacking, and in the following some notes on the biology of *T. vaillanti* only are presented.

The most important fishery grounds in East Borne are those of the lake district West Kutai, whe large lakes, such as Lake Djempang (surfa 15,000 ha at a water level of 3 m), Lake Semajar (13,000 ha) and Lake Melintang (10,300 ha) a situated, together with a number of smaller lak ranging from 450 to 1,300 ha each.

The total production in this area amounts about 10,000 tons fresh fish, which figure rose 17,500 tons in the past three years.

About 75 per cent. of this amount consists what is known in the salted-fish industry as 'r pang ketjil " and again 75 per cent. of this produ is *Thynnichthys vaillanti*. Consequently this fis is caught at the rate of about 10,000 tons a yea

Although *T. vaillanti* is originally a fish from t lakes it does not remain there during its entire lif time, as will be described below.

FEEDING HABITS

Before the war the contents of guts were studie at the Laboratory for Inland Fisheries at Bog by Dr. J. J. Schuurman who examined 56 fi caught in East Borneo with cast nets and vario other implements. All fish contained many Di toms (*Melosira*) and 55 fish also contained vario

TABLE 1

Difference between three species of *Thynnichthys*

Species	Scales in linea lateralis	Rows of scales between linea lateralis and dorsal	Vernacular name
T. vaillanti	47	11	*kendia*
T. thynnoides	58 - 60	13	*menangin* (S. Borneo) *lumoh*, (Palembang) *lambak ringan* (Djambi) *pingan* (Riauw)
T. polylepis	60 - 75	16 - 17	*lomopoko*

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ılant parts, 10 contained some filamentous algae, 0 contained sponge-needles and 13 mud. During he period of high water the *kendia* can be observed ıibbling grasses and inundated shrubs, feeding on he periphyton. *T. vaillanti* may be classed as a ·egetable and periphyton feeder.

LIFE HABITS

As was indicated earlier, *kendia* is originally a ish from the lakes. At the beginning of the dry eason, when the water subsides, acid and turbid vater having previously inundated the surroundng grounds and having absorbed the products of he mineralisation of leaves, plants and shrubs, lows into the lakes. This acid water is deficient n oxygen and, because such a vast surface of inındated ground is involved, this large amount of vater upsets the oxygen balance in the lakes.

White-fish are most vulnerable in this respect nd notably the large ones. For this reason the ull-grown *kendia* moves from the lakes towards he river Mahakam, which river, notably during he high water period, flows through many of the akes and is connected with all of them. This phenomenon takes place from the end of June until the middle of July. As the water subsides the smaller fish also leave the lake and swim towards the river, and towards the end of July all adult *kendia* will be found in the river Mahakam. As the dry period progresses, the water in the river also falls and fairly hot water from the exposed lakes enters. For this reason the *kendia* moves upstream in search of cooler, better aerated water. At this stage the bigger fish has already proceeded farther upstream, as follows from a comparison of catches from different localities in the Mahakam. The large upstream migration of the *kendia* is called " ruaja ". Migration of bigger fish usually takes place at night and only then can the *kendia* be captured with the so-called " penjangga " or " sangga ", a large dip net handled from rafts.

The *kendia* swims in shoals and in a single haul a large number can be caught, as for instance in the neighbourhood of Muara Muntai, where in a single haul 3 tons of fish were gathered in a dip net of 5 metres.

Upstream migration of smaller *kendia* (11-20 cm) takes place in a later period, and this fish also swims in large shoals during the daytime as well as at night ;

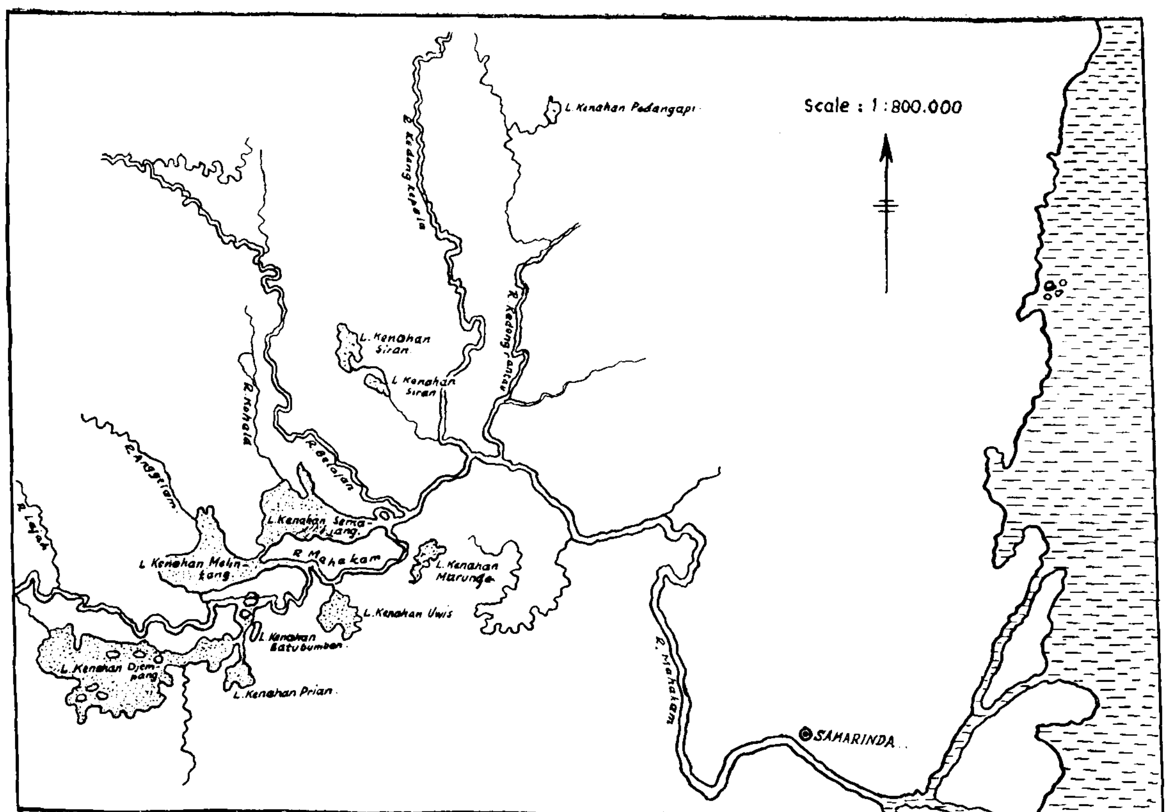

Fig. 1. Map of the Lake District of West Kutai in East Borneo.

the fishes can not only be seen but also heard, because when frightened or when chased by predatory fishes the *kendia* jumps out of the water and a large shoal may make a noise something like a heavy shower.

When the migration sets in, the eggs of the *kendia* begin to ripen or small eggs are already visible.

During severe dry periods the fish moves farther upstream. Sometimes it moves up into the Mahakam only, but sometimes it turns into the rivers Kedung Pahu, Teruk Pahu and Perak (1944). How far the *kendia* will go upstream depends on various circumstances.

Each time the water rises, as a result of rains in the mountains, migration ceases. Sometimes the fish even turn back for a short distance. In the absence of floods they may proceed towards the sources of the Mahakam, as was the case in 1941, when they were only stopped by the rapids beyond of the village Long Iram, situated at a distance of about 450 km from the lake district.

The *kendia* remains in these regions where the egg ripening stage is reached. Towards the end of October the West Monsoon rainy season begins when heavy rains in the mountains cause the water in the Mahakam to rise rapidly.

The *kendia* moves down with the current. Mahakam water enters the lakes via connecting streams and in the lakes the water inundates the shores and their vegetation.

The area around the lakes having dried out thoroughly during the dry season furnishes ideal spawning grounds for the *kendia* and other fish. The water rushing in from the rapidly rising river is well oxygenated and the eggs having ripened in the meantime, spawning appears to take place on the newly inundated shores, usually about November.

Unfortunately the author never encountered the eggs, and he is therefore unable to state whether they float on the surface, sink to the bottom or are attached to inundated vegetation. He was only able to observe that after about two to four weeks after inundation of the shores, in various places in the lakes, and notably in Teluk Berawan (S.E. part of lake Djempang), Tandjung Suling (N.E. part of Lake Melintang) and Tandjung Selinsingan (N.E. part of Lake Semajang) fry of *kendia* of 1½-2 cm could frequently be found. It may therefore be assumed that the spawning grounds must be in the vicinity. It may also be assumed, however, that ripe eggs measuring about 1½ mm in length will sink, because old eggs forced out of the belly by hand also sink in water. At about New Year the water level in the lakes is very high and since conditions for growth of periphytic algae are favourable, the young *kendia* will not lack food.

Towards the end of January or at the beginning of February, the rains are less heavy, the water level in the Mahakam falls slightly, and water from the lakes enters the river.

This situation continues until the middle of March and is known as " intermediate east monsoon ". If the water falls rapidly, part of the *kendia* and other fish swim towards the river and start migrating again, but not very far upstream, because towards the end of March the rains increase once more and the water again enters the lakes. During this second migration towards the lakes, a second spawning as is sometimes found in other species, such as *Helostoma* never takes place. During January and February gonads were always found to be slightly developed only, and moreover a second generation could never be observed among the fry in subsequent months.

Towards the end of March the west or rainy monsoon reaches its maximum. Very heavy rains fill both the river and the lakes. The highest water level is rapidly reached in May. Not only the lakes and their surrounding grounds are flooded but also higher plains and forests. The extremely high water level inhibits fishing and the young *kendia* can grow unharmed. The only fishing activities carried out during this period are hook and line fishing for predatory species. The hooks are usually baited with small fish such as *Trichogaster* and *Anabas*, caught with tempirai, and " S " shaped bamboo fyke. Young *kendia* are rarely used for this purpose as they die too soon, and live bait is preferred. Only occasionally, when absolutely necessary, are pieces of sliced *kendia* used.

GEAR

During the intermediate east monsoon and the real east monsoon *kendia* is caught with cast nets. At the change of the Monsoons migrating full-grown fish are caught with dip nets and at the high-water season also with gill nets. The catch in the gill nets is often used for making " peda ".

PRESERVATION

Kendia is dried with the head on. Gills and guts are removed. When the fish has been washed it is salted with dry salt ; sometimes brine is used. The process of salting takes about 12-24 hours and salt is used at the rate of 10-12 per cent. of the wet and washed fish. The fish is then sun-dried for about two or three days.

From 100 kg wet and washed fish 35-40 kg dried and salted fish is made. In this form *kendia*, usually measuring 14-22 cm is sold as " repang ketjil ".

In many small lakes, such as Lakes Suhui, Mensidan, Lawa and Barong large *kendia* 30-35 cm are caught, and the salted and dried product is known in the fish trade as " repang tanggung " or " repang besar ". Another form of preservation is th making of so-called " peda ", usually with larg fish exceeding 20 cm. They are gutted, washe and stuffed with salt for 24-48 hours and then drie for 3-4 days. The fish is not sufficiently dry afte this treatment. In this case 100 kg of wet fish wil give a net yield of 70 kg. More salt and longe drying is unnecessary in this case as this fish i sold singly in local markets. This product i locally known as " peda."

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FISHERIES IN THE LAKE DISTRICT ALONG THE RIVER KAPUAS IN WEST BORNEO

By

K. F. Vaas*

During September and October, 1949, the author, and Dr. B. Polak, Botanist (Peat Specialist) at the Institute for Soil Research, General Agricultural Research Station, had the opportunity of joining Dr. Schophuys, Agricultural adviser for Borneo, on a journey along the river Kapuas in West Borneo. While Dr. Polak studied the vegetation of the area with special interest in peat-formation, the author was able to study the lakes and rivers from the fishery point of view. Nearly all data on the vegetation and many on hydrology given in the present article were derived from an unpublished report by Dr. Polak, kindly placed at the author's disposal. As at that time the water level was unexpectedly high, hardly any fishing was observed and most data on this subject were derived from a report by the Fisheries Officer, W. van der Heyden, who investigated the area in July-September, 1945. Moreover, many data on the historical development and resent situation of the fisheries industry were btained from Departmental Reports, such as the nes by Hips, Marzuki and others. The author most indebted to the Fisheries Officer, G. Klay, ho acted as a guide during the journey.

he River Kapuas

The Kapuas is the main river of western Borneo. ts drainage area covers 102,000 km² and the total ngth is 1,143 km. The altitude of its origin 850 m, but the end of its upper-course lies mere 40 m above sea level. The Kapuas is therefore navigable beyond Putus Sibau at a dis tance of 910 km from the sea. In its upper-cours roughly from the source to Putus Sibau, the Kapua is a torrential mountain stream; from there o all the way to the sea, the river flows slowly, becaus at the end of the upper-course is situated the Lak District, a plain of 6,555 km², surrounded by sem circular mountain ranges in the north and in th south by the river itself. On the southern borde of the Kapuas there are also mountains in th area. This plain, with its numerous lakes of vario size and connecting water courses, acts as a buff for the floods of the river during the monsoon an regulates the velocity of the flow further dow *Molengraaff* (1900) named the part of the Kapu south of the lakes, between Putus Sibau and Suhai the " pseudo-course-lower ", as this part, althoug having all the characteristics of a lower-cour (widening, decrease in velocity, deposition of fi sand, many curves) does not end in the sea, b leads into a middle-course followed by the real lowe course, ending in the delta. In its " pseudo-lowe course " the slope of the Kapuas is very slight a the river flows in large bends. By a natural proce of erosion of the concave and sedimentation alo the convex shore these bends widen gradually a eventually the river makes a short cut from one e of the loop to the other. Along the part of t Kapuas south of the lakes, we find many loop crescent-shaped depressions filled with water a isolated from the river during the dry season to

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regarded as old parts of the river itself, thus cut off. During the monsoon period these meanders are either connected with the Kapuas or totally inundated. Immediately alongside the river bed in its minimum extension the land is slightly raised, but beyond lower plains are found again.

Three types of vegetation are encountered. The original vegetation of the river banks is the so-called " putat-vegetation ", named after its most important constituent *Barringtonia spicata* Bl. It is a vegetation of low shrubs, most resistant to inundation. During the period of maximum water level these shrubs can be completely inundated. Other shrubs are *Ilex Cymosa* Bl, *Vaccinium* and *Elaeocarpus* sp. When the forest is burned for the purpose of shifting cultivation, the putat also disappears after some time and a vegetation of floating grasses known as " Kumpai " follows. This kumpai was described by *Endert* (1925) from the Mahakam in East Borneo. These grasses, *Panicum stagninum* Retz. and its associates such as *Sorghum propinquum* (Kort.) Hitchcock, together with *Cyperaceae* such as: *Cyperus* and *Fimbristylis* spp. grow rooted in the banks and extend over the water surface, forming a sort of floating mat. This mat moves up and down according to the water level. Mixed with these grasses and sedges are plants well known from marshy areas such as *Jussieua* spp., *Limnophila* and some shrubs *Melastoma malabathricum* L. and *Cassia alata* L. Beyond the Kumpai and the putat the inundated forest is found. Large trees also resistant to inundation with *Fragraea peregrina* Bl, *Gluta renghas* L, *Dipterocarpus Warburgii* Br, *Hibiscus tileaceus* L. and *Lagerstroemia* spec. as typical representatives.

As was pointed out repeatedly in the literature on plankton-organisms occurring in rivers (e.g. *des Cilleules* 1928 and *Blache* 1951) a rapidly flowing stream contains much silt and not much plankton, but when the rate of flow is less, more will develop, notably when the river is in contact with lakes, marshes or other stagnant waters. The same situation was found in the Kapuas. In 1925 *Winkler* took one sample near Djongkong, described by Kolkwitz (1927-1937). Only a few Diatoms were found. The composition of our samples is given in table I. The plankton samples were studied at the Laboratory of Inland Fisheries by M. Sachlan.

TABLE I.

Plankton in the Kapuas at Various Stations

Station	*pH.*	*Plankton*
(1) Upper course near mouth of R. Mendalam	7	Diatoms, *Phacus longicauda* O.F.M. VERY POOR.
(2) Upper course near Putus Sibau.	6	*Navicula*, *Peridinium*, *Bosmina longirostris* O.F.M. VERY POOR.
(3) Meanderous pseudo-lower-course near Mission post " Nazareth ".	5½	*Monostylia.* EXTREMELY POOR.
(4) Near mouth of R. Embalok		*Navicula*, *Brachionus falcatis* Zach., *Keratella cochlearis* Gosse. VERY POOR.
(5) Near Bunut	6+	*Arcella discoides.* VERY POOR.
(6) South of Lake District near Djongkong.	6½	*Staurastrum longibranchiatum* (B) Gutw., *Triploceras gracile Bail*,
(7) Near connection with Lake Kedabang	7	*Peridinium* sp., *Keratella cochlearis* Gosse., *Bosmina longirostris* O.F.M., *Euglypha* sp.
(8) Middle Course near Lake Setabai.	7	*Staurastrum longibranchiatum* (B) Gutw., *S. formosum* Bern., *Closterium kützingii* Breb. *Peridinium* spp., *Dinobryon cylindricum* Zach., *Melosira* sp., *Polyartha* sp., *Bosmina longirostris* O.F.M. *Arcella discoides* Ehb.
(9) Middle Course, mouth of R. Silat.	5½	*Staurastrum formosum* Bern., *Synedra* sp., *Keratella cochlearis* Gosse., *Bosmina longirostris* O.F.M., *Arcella discoides* Ehr.

It will be seen that the Kapuas enters the lake district with neutral water, poor in plankton. Many of its tributaries, e.g., the R. Mendalam and R. Silat, drain swamps, and are situated farther inland. These rivers contain acid water, dark-brown coloured and transparent. Along the R. Mendalam pH values of 5-5½ were found, in other rivers even a pH as low as 4. The plankton is very poor, not only in those rivers themselves but also in the swamps fed by them. Such waters immediately lower the pH of the Kapuas. As a result of influx from the lakes, the meanders and dead river arms, the plankton of the Kapuas south of the Lake District is much richer, containing Desmids and Peridineans, Crustacea and Rotifera. The middle course is only rich near the outflow of lakes, and beyond the connection with the R. Silat it is as poor as before it reached the Lake District.

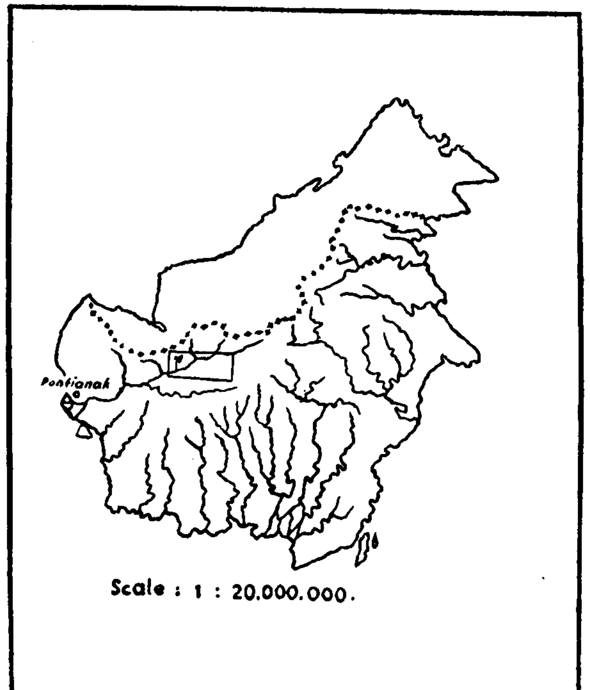

FIG. 1. Survey map of Borneo, indicating the Lake District.

The Lakes

As the water level of the lakes can rise up to 10 m and over, it is impossible to indicate their proper borders on a map. Only those grounds permanently inundated and those hardly ever inundated can be shown. On the map attached to the present article the borders of the putat vegetation are drawn.

These lakes were visited for the first time by the Austrian explorer, Miss *Ida Pfeiffer*, in 1852 (*Pfeiffer* 1856). She mentions the inundated forest and the inky-black waters. *Beccari* (1904) mentions these and describes the flora. *Teysmann* (1875) described the putat and the floating grasses. *Gerlach* (1881) saw the dry shores at low water level.

Molengraaff (1901) comments briefly on vegetation and fisheries. Similar lakes in East Borneo were described by Endert (*loc. cit*). In his departmental report, the Fishery Officer, van der Heyden, described how he visited the lakes during a period of extremely low water level. He found the dry shores overgrown with a dense vegetation of quickly growing and flowering grasses. The mineralisation of this vegetation after inundation creates an enormous quantity of fish food. Seeds of these grasses were often encountered in the guts of various fishes. Of the three types of vegetation mentioned for the Kapuas, the inundated forest is most important, as is the putat. Instead of the kumpai, the ephemeric grasses are found. These lakes receive two kinds of water. The small rivers rising in the surrounding hills and mountains mostly drain swamps and bring in an acid, brown-coloured water; during the rainy season the Kapuas provides an enormous influx of clear river water with recent rain, not yet having absorbed much material from the drainage area. For this reason the water in the big lakes is less acid and clearer than that from the inundated forests, small lakes and river arms fed with peat water from neighbouring swamps. Some data on plankton and hydrochemistry of the lakes are summarized in table 2.

As follows from a perusal of table 2 the lakes are rather similar. All show a plankton characteristic for a large body of rather acid, stagnant water. The maximum plankton was found in the largest lake: L. Luwar. The predominance of Desmids and absence of Cyanophyceae is striking. The strongly variable water level, together with the scarcity in calcium and the slight transparency of the dark-coloured water is the reason why submerged vegetation is practically absent. Some floating *Uticularia* was seen. Near the temporary villages there was some *Spirogyra*.

As an example of the ancient river arms along the Kapuas, south of the lake district, some data are summarized in table 3.

These small lakes have not so much in common as the large ones, because they are more dependent on the water they receive from inland sources. Being situated in more inhabited areas they show a certain amount of eutrophiation in the appearance

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TABLE 2

Limnological data for the lakes

(organisms occurring in great numbers in bold type)

Locality	*pH*	*Ca++* (mgr/l)	*CO₂* (mgr/l)	*Plankton*
(1) R. Tawang. Main effluent of the Lakes. Colour brown.	5+	2	17	*Staurastrum longibranchiatum* (B) Gutw., *S. sexangulare* L., *S. furcatum* Bern., ***Triploceras gracile*** B., *Cosmarium moniliforme* (T) R., *Arthrodesmus curvatus* T., *Bosmina longirostris* O.F.M., *Nauplii*, *Dinobryon cylindricum* Zach., *Peridinium* spp., *Euglena acus* Ehr., ***Melosira*** sp., *Surirella* sp., *Pedalion* sp., *Polyarthra* sp., *Keratella cochlearia* Gosse., *Rattulus* sp., *Brachionus* sp.
(2) Lake Seriang. Secchi-disc reading: 80 cm, brown.	5	2.4	12	*Staurastrum longibranchiatum* (B) Gutw., ***S. sexangulare*** L., ***Triploceras*** B., *Closterium kützingii* B., ***Cosmarium moniliforme*** (T) R., *Arthrodesmus curvatus* T., *Bosmina longirostris* O.F.M., Nauplii, *Difflugia* sp. ***Dinobryon cylindricum*** Zach., ***Peridinium*** spp., *Euglena acus* Ehr., *Pandorina* sp., *Pedalion* sp., *Polyarthra* sp., ***Keratella cochlearia*** Gosse.
(3) Lake Belida. Saturated with oxygen.	5	2	12	*Staurastrum longibranchiatum* (R) Gutw., *S. gracile* R., ***Triploceras gracile*** B., *Closterium kutzingii* B., Nauplii., ***Dinobryon cylindricum*** Zach., *Peridinium* sp., ***Euglena acus*** Ehr., ***Pandorina*** spec., *Pedalion* sp., *Polyarthra* sp., ***Keratella cochlearia*** Gosse.
(4) Lake Sekawi. Deep lake, Secchi-disc = 90 cm, photosynthesis active.	5	3	20	*Staurastrum longibranchiatum* (R) Gutw., ***Triploceras gracile* B.**, *Penium* sp., **Peridinium** sp., *Pandorina* sp., ***Synedra*** sp., *Diatoma* sp., *Keratella cochlearia* Gosse.,
(5) Lake Genali. Very dark water. Visibility poor, much detritus, $KMnO_4$= 160. O_2=65% saturation.	5	2	14	*Staurastrum sexangulare* L., *Triploceras gracile* B., ***Dinobryon cylindricum*** Zach., ***Pandorina*** sp., Nauplii, *Microcystus aeruginosa* Kutz.
(6) Lake Luwar. 8,500 ha., visibility poor. O_2=80% saturation. $KMnO_4$=160.	5+	2.1	13	*Staurastrum longibranchiatum* (R) Gutw., *S., sexangulare L.*, ***S. bullardi*** Sm., ***Triploceras gracile*** B., ***Cosmarium moniliforme*** (T) R., *Dinobryon cylindricum* Zach., ***Peridinium*** sp., *Bosmina longirostris* O.F.M., *Diaphano soma brachyurum* Lien., *Nauplii*, ***Surirella*** sp., *Navicula.*, *Keratella cochlearia* Gosse·, *Cathypna* sp.
(7) Lake Sumber. Visibility 40 cm.	5	2	—	*Staurastrum furcatum* B., ***Triploceras gracile*** B., *Dinobryon cylindricum* Zach., *Peridinium* sp., *Surirella* sp., *Polyarthra* sp., *Keratella cochlearia* Gosse.

of Protococcales and other green algae, Rotifera and Crustacea.

As the whole area is characterized so much by the dark-brown water we shall consider its origin. This water is usually perfectly clear and does not contain any form of colloidal silt. It is very acid, shows a high content of organic material and a low content of lime and other minerals. It is derived from the swamps and contains soluble dark humus substances which find their origin in complex lignine-protein compounds of peat and contain a high percentage of nitrogen in a very stable form. Mineralization is extremely difficult and a Biological Oxygen Demand determination yields very low figures. What is encountered here could be called an acid conservation. All the organic and nitrogen-containing material preserved in this manner is a total loss in connection with the productivity of the inland waters, but it is probable that in the sea, the estuarine areas profit by these substances. As these waters absorb a great deal of light in the red part of the spectrum, photosynthesis is greatly reduced. For these reasons also plankton production is poor. The main group of phytoplankton is the Desmids, occurring in many species—a total of 52 was found—but not in many individuals. Besides, most of these organisms are small single

TABLE 3

Limnological Data on small Lakes along the Kapuas, South of the Lake District

Station	*pH*	Ca^{++} (mgr/l)	CO_2 (mgr/l)	*Plankton*
(1) Lake Menjabau 30 km². max. depth 5 m, minimal 2m. Crescent shaped, low convex shore near the river with putat vegetation, high concave shore with inundated forest (*Dipterocarpus warburgii* Br.) No kumpai.	6	4.2	10	*Peridinium* sp., *Euglena* sp., *Difflugia* sp., *Keratella cochlearia* Gosse. POOR.
(2) Lake Termabas. Still in direct connection with R. Kapuas at low level, turbid.	6	3	—	*Staurastrum longibranchiatum* (B) Gutw., *Peridinium* sp *Euglena* sp., *Navicula* sp., *Difflugia.*
(3) Lake Sinau. Small lake. Water very brown, fed by R. Sinau coming from swamps. In connection with Kapuas.	4½	2	17	***Peridinium*** sp., *Keratella cochlearia* Gosse., ***Asplancha*** sp., *Cyclops.*
(4) Lake Bika surface 200x200m. Max. depth 22m—min. 15 m. never totally dry. Formed by the River Bika, not originally a river arm.	7	4.5	17	*Euglena acus* Ehr., ***Pandorina*** sp., *Melosira* sp., ***Keratella cochlearia*** Gosse., *K. asymmetrica* Gosse., ***Brachionus falcatis*** Zach., *Asplanchan* sp., *Diurella* sp., *Cyclo*[ps] sp., Nauplii.
(5) Lakes Ara and Bajur, true ancient river arms.	5½	3.2	12	***Peridinium*** sp., ***Eudorina*** sp., *Melosira* sp., ***Keratella cochlearia*** Gosse, *Brachionus capsuliforme* Bull., ***Elorcate rotifera*** *Euglena acus* Ehr., ***Eudorina*** sp., *Pandorina* sp., *Brachionus angularis* Zach.
(6) Lake Tembuwan dead arm of R. Palin tributary of Kapuas, water clear, brown, visibility 60 cm.				
(7) Lake Sempingan, same as Lake Tembuwan, 220 ha, never dry, totally isolated at low level.	4	2.1	25	*Triploceras gracile* B., *Cosmarium moniliforme* (T) Ralf *Peridinium* sp., *Eudorina* sp., *Difflugia*, *Keratella cochlearia* Gosse, *Monostylia* sp., *Brachionus capsuliforme* I *Pedalion* sp., *Polyarthra* sp.

cells. The large development of blue-green algae and Diatoms encountered by Blache (*loc. cit*) in the Grand-Lac of Cambodia is lacking in our case, probably because the soil and therefore the water is less fertile. Fortunately the plankton is not the only source of fish food in this area, as will be stated in the next section.

Fish Food Production

Considering the above evidence from the viewpoint of primary fish-food production—autotrophic organisms independent of others—it stands to reason that submerged vegetation and the periphyton attached thereto—one of the principal sources of fish food in shallow lakes and ponds where the water level does not oscillate to a great extent—are almost entirely lacking here. Moreover, the plankton is not greatly developed. In spite of a great display of genera and species, the total numbers are rather low and the bulk of it consists of smaller cells (Desmids). Fortunately there is another most important source. As will be mentioned in table 4, where the results of the examination of the gut-contents of the fishes are briefly summarized, the land vegetation provides food for many fish species in various ways. In the first place, the fruits and leaves of the putat and the forest, falling in the water, are eaten by *Leptobarbus*, *Puntius* and other fish. Secondly the leaves of these plants, when recently inundated, are eaten too, either when decaying or even directly from the inundated trees or shrubs. Thirdly, the grass growing on the shores of the lakes, are eaten after having been inundated, either directly or after certain degree of mineralisation. The seeds of grasses could be recognized in the guts of many fish. As all these types of food are available in large quantities and because the food-chains of those fishes subsisting on this kind of food are as short as is theoretically possible the area can still produce a considerable amount of fish.

TABLE 4

Fish fauna of the Kapuas and adjacent Lakes and River arms, classified according to their feeding habits

(main food=xx. additional food=x)

		Phytoplankton	Periphyton	Thread algae	Bottom algae	Submerged plants inundated land plants, fruits seeds	Small zooplankton	Cladocera, Copepods Rotifera	Insects and their larvae.	Air insects.	Shrimps	Insect larvae in the bottom worms	Fish, prawns, crabs.
Plankton feeders.	*Helostoma temmincki* C.V.	xx					x						
	Thynnichthys thynnoides (Blkr.)	xx	xx		x		x						
	Thynnichthys polylepis Blkr.	xx	x		x		x						
	Dangila ocellata (Heck.)	xx	x	x			x						
	Dangila festiva (Heck.)	xx	x	x			x						
Periphyton and Vegetable feeders.	*Amblyrynchichthys truncatus* (Blkr.)	x	xx		x		x						
	Osteocheilus melanopleura (Blkr.)	x	xx	x	x	xx							
	Osteocheilus brevicaudata W. de B.	x	xx	x	x	xx							
	Osteocheilus waandersi (Blkr.)	x	xx	x	x	xx							
	Osteocheilus vittatus (K.v.H) C.V.	x	xx	x	x	xx							
Vegetable feeders on submerged higher plants inundated land plants, fruits and seeds.	*Puntius waandersi* (Blkr.)			x		xx			x				
	Puntius nini W.de B.	x		x	x	xx	x	x	x				
	Puntius bulu (Blkr.)			x		xx			x				
	Puntius schwanefeldi (Blkr.)			x		xx			x				
	Leptobarbus hoeveni (Blkr).			x		xx							
	Leptobarbus melanotaenia (Blkr.)			x		xx							
	Pristolepis fasciatus (Blkr).			x		xx							
	Osphromenus goramy Lac.			x	x	xx			x				
Omnivores feeding mainly on insects and larvae, zooplankton.	*Balantiocheilus melanopterus* (Blkr.)	x						xx	x				
	Cyclocheilus repasson (Blkr.)					x			xx				
	Luciosoma trinema (Blkr.)	x				x	x	xx					
	Rasbora argyrotaenia (Blkr.)	x				x	x	xx					
	Rasbora vaillanti Popta	x				x	x	xx	x	x			

TABLE 4—(*Contd.*)

Fish fauna of the Kapuas and adjacent Lakes and River arms, classified according to their feeding habits

(main food=xx. additional food=x)

		Phytoplankton	Periphyton	Thread algae	Bottom algae	Submerged plants inundated land plants, fruits seeds.	Small zooplankton	Cladocera, Copepods Rotifera.	Insects and their larvae	Air insects	Shrimps	Insect larvae in the bottom worms	Fish, prawns, crabs
Eaters of insects at surface.	*Chela oxygastroides* (Blkr.)						x	xx	x	x			
	Toxotes chatareus (H.B.)						x	x	x	xx	x		
Omnivorous bottom feeders.	*Barynotus microlepis* (Blkr.)					x			xx		x		
	Pangasius pangasius (H.B.)					x			x			xx	
	Pangasius polyuranodon Blkr.					x			x			xx	
	Mastacembelus armatus favus B.					x			x			xx	
	Mastacembelus argus Günther					x			x			xx	
Omnivorous predators.	*Macrones nigriceps* (C.V.)							x	xx		xx		x
	Macrones nemurus (C.V.)							x	xx		xx		x
	Hemisilurus chaperi (Vail.)							x					xx
	Hemisilurus scleronema Blkr.							x					xx
Predators on small fish and small animals, insects, shrimps.	*Lycothrissa crocodilus* (Blkr.)								x		x		xx
	Cryptopterus cryptopterus (Blkr.)								x		x		xx
	Cryptopterus schilbeides (Blkr.)								x		x		xx
	Cryptopterus limpok (Blkr.)								x		x		xx
	Cryptopterus micronema (Blkr.)								x		x		xx
	Macrochirichthys macrochirus (C.V.)								x		xx		xx
	Setipinna melanochir (Blkr.)												xx
	Datnioides microlepis Blkr.										xx		xx
	Hampala bimaculata (Popta)								x		x		xx
Large predators eating fish of all size, shrimps, prawns and crabs.	*Ophicephalus striatus* Bl.										x		xx
	Ophicephalus micropeltis C.V.										x		xx
	Ophicephalus pleurophthalmus Blkr.										x		xx
	Ophicephalus lucius C.V.										x		xx
	Notopterus chitala (H.B.)										x		xx
	Wallago leeri Blkr.										x		xx
	Silurodes hypopthalmus (Blkr.)										x		xx

The Fish Fauna

The fish fauna of the Kapuas and adjacent waters was investigated by Pieter Bleeker in the nineteenth century and is at the moment fully described in Weber and de Beaufort's well-known works. This description covers taxonomy only and all biological evidence on the fishes, important in the fisheries industry, is lacking.

The famous work of Molengraaff and Weber (1919) called attention to the wealth of species in West Borneo compared with that in East Borneo (River Mahakam).

The Kapuas derives its great number of fish species from its association with the extinct Sundaplat river system, at the moment covered by the sea, but in pleistocene times a vast stream, flowing into the China Sea between the present coast lines of Borneo and the mainland of Asia. The rivers of East Sumatra, India, Thailand and even Indo-China were tributaries of this large river and this fact explains the strong similarity between the faunas of these rivers and the paucity of species and genera in the eastwards flowing Mahakam, which river did not absorb the influx of species from this river system, not having been connected with it. Molengraaff and Weber distinguish 119 species from 53 genera of typical fresh-water forms, barring brackish water genera and marine immigrants. The author collected 205 fish, belonging to 71 species and 47 genera. In table 4 the principal species are listed according to their feeding habits as revealed from the microscopy of numerous samples of their gut-contents.

The fauna gives the impression of a preponderance of predators, which assumption is easily borne out by an analysis of the catch and exports. Vegetable-feeding white fish such as *Dangila*, *Thynnichthys* and *Leptobarbus* are caught in great quantities and also *Helostoma*, but the bulk of the catch consists of the predating Siluridae or Ophicephalidae and *Notopterus*. Van der Heyden witnessed the cropping of the entire fauna of a deep pit in one of the rivers in the lake district by means of fish poison and gave the following list, a good example of the above assumption (table 5).

Many of the predating fishes are large animals, notably the *Ophicephalus* spp., *Notopterus* and *Wallago leeri*. It is evident that the existing amount of food would be converted into fish flesh in a more economical way when the number of large, old predators, having a long food-chain and having consumed a large amount of maintenance food, would be lower. These fishes are not easily caught and the scarcity of good hooks and gear during and immediately after the war, together with reduced activities in the entire fishing industry—a result, mainly, of difficulties in transportation and general deterioration of economic conditions,—resulted in untoward development. A definite state of underfishing exists and if more predators could be removed a better utilization of the existing recourses would be achieved.

TABLE 5

Fauna of a Deep Pit in the River Tenghidap Near Lake Genali (After Van der Heyden)

Predators		*Number*		*Weight in kgs.*
Cryptopterus spp.		150		25
Ophicephalus spp.		1		
Macrones spp.		18		
Datnioides microlepis		3		12
Notopterus chitala		3		
Lycothrissa crocodilus		1		
Wallago leeri		1		13½
	Total	177	Total	50½ kg.

Vegetarian and omnivorous fish		*Number*		*Weight in kgs.*
Polynemus sp.		2		
Glossogobius sp.		4		
Pangasius spp.		2		
Balantiocheilus melanopterus		2		
Leptobarbus melanotaenia		2		16
Leptobarbus hoeveni		1		
Amblyrhynchichthys punctatus		1		
Helostoma temmincki		1		
Osteocheilus spp.		15		
Puntius schwanefeldi		8		
	Total	38	Total	16 kg.

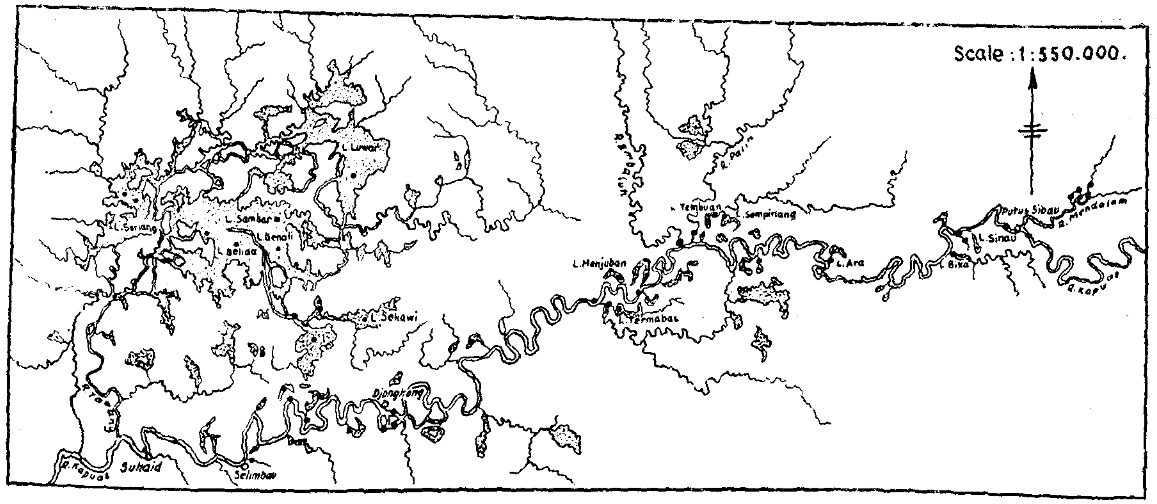

FIG. 2. Map of the area investigated. Samples were taken at the stations indicated.

Historical development of the fishing industry

The historical development of the industry until 1941 was divided by the local magistrate Marzuki in three periods (Departmental Report).

(1) Until about 1900 no export took place, fisheries provided for the needs of the local population only. The native rulers possessed all fishing rights and enforced strict laws upon the population, thus preventing depletion of the resources.

(2) Between 1900-1917 river traffic with motor-boats made export to the coast possible and intensified the industry; new methods were introduced, preservation methods came into use. A real industry developed.

(3) Between 1917 and 1941 the industry increased rapidly due to a heavy demand for fish in Pontianak and Java. Not only the number of fishermen increased but also the number of middlemen and their financial hold on the fishermen.

The Central Government discontinued the rule of the local princes and the fishery laws in force during their time were abolished. But no new regulations were established and local depletion of stocks took place, because too great a number of fykes and weirs interfered with migration. Many fishes were cut off from the main rivers and being imprisoned in closed bodies of water during the dry season, had to die without being caught. On the other hand salting and drying were greatly improved. Floating stores of salt in boats were stationed in the area and prices of salt were lowered.

(4) The Japanese occupation and the difficult years following the capitulation of Japan between 1941 and 1945 did an enormous amount of damage to the industry because transport became rare and hooks and yarns could not be replaced. It was a time of great hardship for the entire population of Borneo and notably for the fishermen. Predating fishes profited by the decrease in fishing intensity and were able to develop to the extent of the present day.

(5) In 1945 the Fishery Officer van der Heyden was stationed in Pontianak, together with two field officers in the Lake District. Normal conditions were re-established and the fishing industry was rehabilitated. In the first place hooks and yarns were imported from abroad and sold to the fishermen at a low price.

The Industry

These fishermen are mostly Malays and in the more remote areas also Dajaks, living in the towns and villages along the rivers and settling in temporary camps on the fishing grounds during the season. When not fishing they are occupied in agriculture, trade and other activities. Their standard of living is rather poor, the hold of the middle-men upon them is strong and cooperative movement among them, already initiated by the Fisheries Department, can do much towards improving their existence. Four forms of preserved products are exported by barges via the Kapuas to Pontianak, where part is sold and the rest exported to Java, viz. (1) Balur—salted and dried fish, (2) Salai—smoked fish, (3) Djukut—wet-salted fish and (4) Krupuk—dried fish cakes to be fried in oil, made of ground *Notopterus* sp. mixed with sago. Live fish is also exported, usually *Ophicephalus* spp., stored in the lake district until the season is over and prices are high. Large transports—at times many thousands of kilos—are floated down to Pontianak in bamboo cages.

It is difficult to estimate the total production. The amount exported from Pontianak to Java is well known, but the amount consumed on the lakes, along the Kapuas and in and around the town of Pontianak can only be estimated roughly. For the whole of West Borneo a figure of 20 million kilo fresh fish was estimated for the years 1948-'50, including the production of swamps and estuaries along the coast. The bulk undoubtedly comes from the lakes.

Fishing Methods

Many methods are used and only the most important ones will be summarized below.

(1) Fishing with hooks. This is a most selective way of fishing, in use throughout the year. As reliable hooks cannot be made locally, the importation and distribution of this material is one of the most important concerns of the Department.

(2) Fishing fykes and bamboo mats. Bamboo fykes of various shapes are placed in the water, either baited or not, during the time the water moves quickly, either rising or falling. Those spots where migrating fish is likely to be captured are chosen. On the other hand bamboo mats are used in shallow water by a gang of cooperating men who try to encircle the fish collected in a certain small area. This method works most unselectively.

(3) Fishing with nets. Many types and sizes are in use. Small fishes living on the surface in shallow waters (*Luciosoma, Rasbora*) are caught with dip nets. Cast nets are very common. Large fixed nets such as the " djermal ", placed in the opening of a fence and used to capture migrating fish (*Thynnichthys, Dangila, Leptobarbus*) are among the largest and most frequently used implements; 30 m. long and 15 m high are the usual dimensions.

(4) Spears and lances are used, often at night from canoes illuminated by a lamp, to catch large predators such as *Notopterus, Macrones* and *Wallago.*

(5) Fish poison, although prohibited by law in 1920, is often used, the most frequent poison being the sap of Derris roots containing rotenone. Under normal circumstances the use of such poisons is detrimental for the stock because not only small fishes and fry are killed but also other biota. During the time of rapidly falling waterlevel when a small body of water is completely cut off from all connections with rivers or large lakes, and for this reason the whole fauna is bound to die because evaporation will eventually create depletion of oxygen, the use of Derris powder provides a means to catch a crop which otherwise would become a total loss. In these special cases it might be advisable to grant permission to Civil and Fisheries Officers to use poison.

Fish Enemies and Parasites

Voracious fish eaters are crocodiles, iguanas, snakes and cormorants, occurring in large numbers throughout the area. The occurrence of *Argulus* parasites on the gills of Ophicephalids stored for dispatch was reported. As large quantities of fish are confined in cages under unnatural circumstances the *Argulus* can sometimes do considerable damage.

Improvements in the Industry

Barring improvements of preservation methods and socio-economic improvements, the following measures might be suggested:

(1) Distribution of hooks and yarns on a large scale in order to cut down the predating fish.

(2) Abolishment of the prohibition of the use of Derris, in the case of impounded stocks bound to decay if not fished.

(3) Introduction of *Trichogaster pectoralis* (Regan), Sepat Siam. As the insignificant *Trichogaster leeri* Blkr. does occur in the area it is most probable that the prolific, rapid-growing, periphyton feeder *T. pectoralis* will find suitable conditions when introduced into the inundated forests, thus relieving the strain on the other vegetable feeder by the continuous predation of too many fishes of prey.

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11

INTERNATIONAL FISH SEED EXCHANGE

(FISH SEED CONSERVATION AND DISTRIBUTION IN THE INDO-PACIFIC AREA)

by

T. J. Job*

Side by side with the exploitation of the natural marine harvest, the development and utilization of the widely-distributed inland aquatic resources through fish-culture have begun to receive increasing attention in most Indo-Pacific countries. Even the incomplete estimate of cultivable waters in this area given in the Fish Culture Sub-Committee's latest Report to the Council would indicate that at least 5% of the total areas of these countries is composed definitely of cultivable waters and only a fraction of these is at present farmed systematically.

Special efforts are, however, being made generally to bring every hectare of cultivable water under aquicultural utilization with a view to providing adequate animal proteins to the rice-eating populations so densely distributed in the area. With such an extensive awakening to fish farming, the various State Departments and private water-owners are often confronted with the primary problem of obtaining sufficient supplies of suitable fish seed. The symposium on fish transplantation held during the Madras Meeting of the Indo-Pacific Fisheries Council has duly brought out the salient features of this aspect of fishery work.

Seed sources of most of the main culturable species are limited in extent. Thus the major carps such as Catla (*C. catla*), Rohu (*Labeo rohita*), Calbas (*L.calbasu*), Mrigal (*Cirrhina mrigala*) etc. of India and Pakistan and the Grass Carp (*Ctenopharyngodon idellus*), Silver Carp (*Hypophthalmichthys molitrix*), Black Carp (*Mylopharyngodon piceus*), Mud Carp (*Cirrhina molitorella*) etc. of China do not usually breed in confined waters. Their spawn, fry and fingerlings have to be collected seasonally from selected riverine seed grounds and transported over long distances by rail, road, water or airways for stocking fish farms. Besides these river-breeding carps, there are other culturable species which are also in frequent demand.

In the case of the Milkfish (*Chanos chanos*) and Mullets (*Mugil* spp.) breeding in coastal waters, the young have to be collected there and transferred to embanked brackish waters or inland fresh waters. The handling of such euryhaline species and their acclimatisation to fresh-water from their normal salt-water habitat need special attention. Various countries are interested in obtaining also other species such as *Tilapia* (*T. mossambica*), Gourami (*Osphronemus goramy*), Pearl Spot (*Etroplus suratensis*), the Common Carp (*Cyprinus carpio*) and the Mirror Carp (*C. carpio* var *specularis*) which can breed in confined waters. Similarly there are demands of varying extent for larvicidal fish such as *Gambusia* and *Aplocheilus*, cyclopscidal ones such as *Ambassis* and other allied public health fishes. Numerous varieties of ornamental species like gold fish and of sport fishes such as trout (*Salmo* and *Salvelinus* spp.) Bekti (*Lates calcarifer*) and Tarpon (*Megalops cyprinoides*) are also popular items for transplantation. The culture of oysters, prawns and other shell fish, turtles and even edible aquatic vegetables such as the water potato (*Aponogeton monostachyon*), water chestnut (*Trapa bispinosa*), water cress (*Nasturtium officinale*) and "pug boong" (*Ipomea aquatica*, which is regularly cultivated in "klongs," i.e., wide shallow canals, in Thailand) could also be extended to new areas with advantage. Thus, seeds not only of food fishes but also of public health fishes, ornamental species and sport fishes as well as of edible aquatic vegetables are of vital interest to the aquiculturists in the area.

Apart from the intra-national fish seed trade concerned with internal distribution, the demand for international distribution of species of proved culturable value is steadily on the increase. The Report of Malayan Fishing Activities for June, 1952, cites that the two major importers of Chinese Carp fry in Singapore, viz., Buan Lee and Soon Lee Huat, after an interruption of several months due to export restriction in China, received the first shipment with 40% mortality. The Fish Seed Syndicate at Barrackpore organized in 1951 with Baboos N.C. Dhar, R. Biswas, Sreepathi and others for inter-regional distribution of carp seed from Bengal, effected successful despatches by rail and air to a number of States within India, but it had difficulty in coping with the growing demands, especially

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those which had begun to flow in from other countries such as Ceylon, Malaya, etc. Desire has been expressed lately for the introduction of Sepat Siam (*Trichogaster pectoralis*) into West Borneo (vide IPFC/C52/TECH 11). *Chanos* culture which has advanced considerably in Indonesia holds great possibilities of extension in other places such as Philippines, Formosa etc. Korea is preparing for planned development of fisheries including fish farming. Thailand and Malaya have shown interest in Chinese Carp and even countries outside the Indo-Pacific area such as Israel are desirous of obtaining Chinese and Indian carps. In fact, a number of governments proposing extensive fish culture would be in urgent need of seed supplies from countries such as China, India, Pakistan etc. Recently the Director General of Fisheries, Thailand, felt it convenient to have seed supplies of *Tilapia* to Travancore-Cochin and of Grass Carp to Israel to be channelled through the FAO.

In order to meet these growing seed demands, three steps have to be taken :

(i) Systematic expansion of seed sources is necessary, and as Mr. W. H. Schuster in his Madras Symposium paper has emphasised, "more intensive collection from existing grounds and the survey of possible new sources are imperative".

(ii) Even with the available sources, conservancy measures have to be directed in a concerted manner against the destruction of brood fish by dynamiting and other ruinous methods of fishing in breeding grounds, especially in the spawning season, and the use of destructive fish traps designed to catch schools of young fish moving about in channels and fields, and due attention paid to proper handlir of spawn, fry and fingerlings at the diffe ent stages of collection, transport an stocking.

(iii) In addition to making adequate quantiti of healthy seed of the right type availab for distribution, prompt transport arrang ments have to be ensured by negotiatior with international airlines and shippin agencies and customs and clearance auth rities so as to prevent official procedur from holding up and destroying consigr ments of delicate baby fish en route t their destinations. Further, the biologic feasibility of introducing desired speci to a new environment without the risk upsetting the balance of nature or transmitting parasites and diseases woul also need sound judgment and advice.

Steps (i) and (ii) could be primarily attended t by the countries concerned. As regards step (ii there is manifestly an immediate need for centralize direction and rational channelling of fish seed di tribution in the area. A centralized Seed Distr bution Service could facilitate the charting of avai able sources of aquicultural seed supplies, the pr curement of these from surplus areas in the differe seasons of availability, and their prompt, safe an economic transport to deficit places. This See Unit would also have to advise interested parti on the suitability of the various species for intr duction to any particular locality and on the esse tial nursery techniques relating to those specie It is felt, therefore, that such a Service directe towards the promotion of fish culture in the Ind Pacific area should be established as early a possible.

12

MECHANICS OF *BAGOONG* (FISH PASTE) AND *PATIS* (FISH SAUCE) PROCESSING

by

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Bagoong and *patis* constitute the two most popularly known condiments of the Philippines. Bagoong is pasty in consistency and has a characteristic flavour basically not different from fish pastes of other nations. Patis is the clear liquid sauce, straw yellow to amber in color, obtained from the liquefaction of the mixture of fish and salt. A fully aged bagoong or patis has a rather strong salty taste with a cheesy flavour and with traces of fishy odor. Bagoong, although chiefly classified as a condiment, is a protein food to the poorer segments of the population, especially in places far from the seashore where fresh fish is seldom available. Patis is a condiment and is widely used for flavouring food in the preparation of native dishes, often taking the place of salt on the dining table.

Patis is to the Philippines as soy sauce is to China and Japan, and maggi sauce to Europe. Patis, like soy sauce and maggi sauce, is a dissolution of the degradation products of proteins in a strong brine solution. It differs from them only as to protein source and in the manner the proteins are broken down. The protein source of maggi is animal meat; soy sauce, vegetable proteins; and patis, fish proteins. The *nam-pla* of Thailand and *nuoc-mam* of Vietnam and Cambodia are the counterparts of Philippine patis. There are French reports which state that the *nuoc-mam* is used both as a condiment and protein food by the natives of Indo-China. Table I shows a comparison of the different fish sauces. Below is a comparison of the different fishes used in the preparation of nuoc-mam and patis.

Family	Nuoc-Mam	Patis
I. **Engraulidae**	*Ca-com—Stolephorus* spp. *Ca-lep—Engraulis mystax*	*Dilis—Stolephorus commersonii.* *Tuakang—Stolephorus indicus*
II. **Clupeidae**	*Ca-com—Clupeoides lile*	*Silag—Clupeoides lile* *Lapad—Sardinella perforata* *Tunsoy—Sardinella fimbriata* *Tamban—Sardinella longiceps*
III. **Dorosomida**	*Ca-moi—Dorosoma nasua*	*Kabasi—Anodontostoma chacunda* *Suagan—Nematolosa nasus*
IV. **Carangidae**	*Ca-nuo—Decapterus* spp.	*Galonggong—Decapterus macrosoma*
V. **Miscellaneous**	*Ca-tap*—Mixture of various species	*Jako*—Mixture of small fishes, mostly *e-im, Leiognatus* sp.

REVIEW OF LITERATURE

There is a dearth of local work on the chemical changes involved in the processing of bagoong and patis. Most of the papers on the subject are descriptive in nature, like those of Montalban (1930) and Umali (1939). The species of fish used and the manner of processing are described for the different areas in the country. Gibbs (1912), an early American worker of the Philippine Bureau of Science, for lack of understanding of the true nature of these products, described bagoong as "wholly or in part of a filthy, decomposed, or putrid animal substance and in many cases dangerous to health." Taylor (1919) calls it an "evil-smelling substance, which is greatly relished by many Filipinos." Later investigations, however, have proved these statements to be ill-founded. In fact, well prepared

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TABLE I

Comparative chemical analysis of maggi, soy, nuoc-mam and patis

	Acidity g. H_2SO_4/L.	Absolute grams/L.						Relative (per cent)			
		NaCl g./L.	Total	Organic	Formol	Ammoniacal	Amino	Organic	Formol	Ammoniacal	Amino acid
(1) Maggi	13.50	202.00	62.72	53.65	33.60	9.07	24.53	85.50	53.60	14.50	39.10
(2) Soyou	6.80	253.00	28.00	24.08	14.78	3.92	10.86	85.08	52.80	14.00	38.80
(3) Soy (Hongkong, commercial)	..	272.30	14.04	12.43	8.32	1.61	6.71	88.50	59.25	11.48	47.77
(4) Soy (Local, commercial)	..	260.40	5.72	4.89	4.16	0.83	3.33	85.30	72.72	14.54	58.18
(5) Soy (Local, not commercial)	2.08	248.00	24.40	21.72	14.14	2.68	11.47	89.02	57.96	10.94	46.99
(6) Nuoc-mam (Annam)											
a. Premiere Qty. (Non-commercial)	..	269.30	25.00	21.00	16.40	4.10	12.30	84.00	66.00	16.00	50.00
b. Premiere Qty. (Commercial)	..	269.70	20.00	15.20	14.10	4.80	9.40	76.00	71.00	24.00	47.00
c. Duxiemo Qty. (Commercial)	..	272.00	16.00	10.60	11.70	5.40	6.30	66.00	73.00	34.00	39.00
d. Trexieme Qty. (Non-commercial)	..	251.60	11.80	7.30	9.10	4.50	4.60	62.00	77.00	38.00	39.00
e. Nuoc-mam (concentrate)	8.40	231.70	66.08	43.76	43.01	12.32	30.69	66.30	65.10	11.60	46.50
(7) Patis											
a. Extra (Non-commercial)	4.23	247.30	27.30	23.97	17.26	3.33	13.90	87.80	63.23	12.19	51.04
b. Extra (Non-commercial)	5.34	246.20	28.70	24.88	17.05	3.85	13.20	86.61	59.34	13.39	45.95
c. Extra (canned, non-commercial)	5.62	252.13	25.12	22.96	13.73	2.15	11.57	91.41	54.65	8.59	46.06
d. Extra (commercial)	5.11	282.08	22.02	20.22	11.75	1.81	9.95	91.80	53.36	8.20	45.16
e. Extra (,,)	4.60	275.59	21.84	19.50	13.73	2.34	11.39	89.29	62.85	10.71	52.14
f. Especial (,,)	4.09	281.75	18.98	17.11	11.65	1.87	9.77	90.14	61.36	9.36	51.50
g. Especial (,,)	3.50	285.20	17.42	15.86	10.60	1.56	9.09	91.05	60.89	8.95	51.94

bagoong and patis have come to be regarded by some Americans as valuable culinary accessories.

Hamm and Clague (1950) are of the opinion that bacterial growth is of little, if any, significance in the conversion of fish proteins into soluble proteins in patis. They based this opinion on the fact that bacterial counts during and following the initial salting operation and through the period of active digestion were always on the decrease.

The meagre local investigations on this subject are compensated by several works of French chemists both in France and French Indo-China. Published papers appeared as early as 1869. Detailed and more comprehensive aspects of the processing of nuoc-mam were originally revealed by Rose (1916a, 1916b, and 1916c), Mesnard and Rose (1920), and Gullierm (1928). The work of the French scientists on nuoc-mam is quite thorough and a section of this paper is devoted to a presentation of their more important work on the chemistry of nuoc-mam for the convenience of non-French readers. They have also gone as far as setting standards in the classification of their nuoc-mam, and legislation to this effect was promulgated at various times since 1916 to combat the manufacture and sale of fraudulent nuoc-mam.

OBJECT OF THE WORK

It is common knowledge that the processing of patis has for its object the breaking down of insoluble fish proteins into their soluble constituents, chiefly amino acids. This breaking down or hydrolysis of proteins into their degradation products, namely, proteoses, peptides, peptone and amino acids, is made possible by (1) microbiological processes or (2) enzymetic processes or both. The first is through the intercession of microbes, and needs a proliferation of microbial growth to accomplish the end. The second can be further differentiated into two: (1) hydrolysis of the proteins through the action of the enzymes present in the muscle tissue itself or (2) hydrolysis of the proteins through the action of the enzymes of the digestive organs.

Because gas formation is commonly observed in the incipient stage of the processing of bagoong and patis, which are popularly described as fermented products, and because fermentation is closely associated with microbial action, it has been commonly taken for granted that the process is due to the action of microbes, as in the manufacture of wine, vinegar and soy sauce. This belief rapidly lost ground when more intensive work was started on this fishery product by the Philippine Fishery Program of the United States Fish and Wildlife Service and by the Philippine Bureau of Fisheries. The authors, unaware of the extensive work on nuoc-mam by French investigators, believed that the hydrolysis is enzymetic rather than microbiological and attempted to prove this view by adding different strong germicidal agents to the mixture of fish and salt. The changes in pH were also observed in the processing of bagoong and patis and compared to those occurring in rotting fish so as to differentiate between the two phenomena.

EXPERIMENTAL WORK

Dilis (*Stolephorus commersonii* and *Stolephorus indicus*) and common solar salt from Parañaque, Rizal Province, were used in this work. As stated before, the authors believed that the process is enzymetic, so they proceeded to find out whether the enzymes responsible are those of the muscle tissue or the digestive organs. Fresh fish were carefully cut into two sections, namely, the head and tail portions. The head portion included all the digestive organs. Extreme care was taken so that no part of the viscera was left on the tail portion The head and the tail portions were salted separatel with the same ratio of salt to fish (1:3) by weight Another mix of the same batch of fish was preparec in the round to act as control. Observations wer made on the rate of disintegration of the fish body Periodic pH readings were taken. The pickl formed was analyzed for amino-nitrogen conten using the Van Slyke Monometric Blood Ga apparatus. The pickle, before being subjected t analysis, was treated with phosphotungstic acid an then centrifuged to eliminate the dissolved ra proteins. The results, expressed in grams amin nitrogen per 100 ml. of the pickle and their corre ponding pH values, are presented below :

Time in days	Head Portion		Tail Portion		Whole Fish	
	Amino-N_2%	pH	Amino-N_2%	pH	Amino-N_2%	pH
1	0.39	6.00	0.18	5.92	0.22	5.72
4	0.81	6.15	0.21	6.22	0.40	5.81
7	1.11	6.01	0.23	6.13	0.53	5.68
10	1.06	6.03	0.21	6.12	0.52	5.67
31	1.54	6.10	0.38	6.25	0.86	5.84

The above tabulation reveals that the head portion had four times as much amino-nitrogen as the tail portion and that the mix of whole fish had only half as much. It is very apparent that more proteins were hydrolyzed on the head portion, which contained the visceral organs than on the tail portion. Organoleptic inspection of the three samples revealed that the head portion appeared after the 13th day to be typical bagoong and that the body tissues were more pasty in consistency than the control which had undergone bagoong fermentation characteristically. The tail portion was still intact while the fish in the control still retained their original shapes even after the lapse of five months. This seems to point out that the enzyme or enzymes responsible for fish protein hydrolysis are chiefly situated in the visceral organs.

In another experiment another kind of anchovy, *tuakang* (*Stolephorus indicus*), was used. This fish is much bigger than *dilis* (*Stolephorus commersonii*), averaging 12 centimeters in length. It was, therefore, easy to separate the viscera and head from the rest of the body. After gutting, the fish was washed thoroughly and freed from contamination of the visceral juices. The gutted fish and the whole fish were salted separately, using 1:4 ratio. These were placed in stoppered bottles and allowed to stand for seven and one-half months, and then filtered to get the pickle of each.

During the processing it was noted that the whole fish disintegrated gradually as in typical bagoong or patis processing. After seven months, this batch was fully deprived of intact muscle tissue and the bare skeletons left were very apparent. As for the gutted fish, the body tissues were still intact. Although the fish in this batch were softened, the muscle tissues were still firmly attached to the skeletal system. More pickle was drained from the batch of whole fish than from the gutted batch. The pickle from the whole fish had the typical patis colour, whereas that from the gutted fish was light in colour and turbid. The odor of the pickle obtained from the whole fish was also typical, while that from the gutted batch was ammoniacal and quite unpleasant. Nitrogen partition analysis was performed on the pickles and the results are tabulated below :

	Acidity g.H_2-SO_4/L.	NaCl g./L.	Nitrogen grams per litre					% of total nitrogen			
			Total	Organic	Formol	Ammo-niacal	Amino	Organic	Formol	Ammo-niacal	Amino
1. *Tuakang* gutted	..	241.546	14.950	8.606	10.400	6.344	4.056	57.56	69.56	42.43	27.13
2. *Tuakang* whole	5.152	208.74	20.280	17.472	11.232	2.808	8.424	86.16	55.38	13.84	41.54

The nitrogen partition shows that the pickle obtained from the whole fish is typical *Patis*, while that from the gutted batch is not patis because the ammoniacal nitrogen exceeds the amino-nitrogen. As regards the nutritive value of the two pickles, that from the gutted fish (8.606 grams organic nitrogen) is less than half of that from the whole fish (17.472 grams organic nitrogen). The total nitrogen content of the sauce from the gutted fish is 14.950 grams compared with 20.280 grams of that from the whole, but even this total for the gutted batch is more than half ammoniacal nitrogen. The acidity is expressed in grams of H_2SO_4 per litre of patis.

Effects of Varying Salt Concentration

Another experiment was performed on the influence of different salt concentrations on the hydrolysis of fish proteins and their pH reactions. Fish were salted separately at the different ratios of 1:3, 1:4, and 1:5. Periodic examinations of the pH and amino-nitrogen content of the samples were made as before. The results are shown below :

Influence of salt concentration on the amino-nitrogen formed.

Time in days	Amino-nitrogen grams per 100 ml. of pickle		
	1:3	1:4	1:5
10	0.29	0.56	0.66
17	0.46	0.79	0.95
26	0.93	1.45	1.70
100	2.07	2.16	2.68

pH of the above mixtures

Ratios	1st day	3rd day	5th day	2nd week
1 : 3	5.70	5.71	5.72	5.70
1 : 4	5.81	5.80	5.80	5.75
1 : 5	5.88	5.87	5.85	5.90

The above table shows that the amount of amino-nitrogen formed varied inversely with the salt concentration. This relationship was observed throughout the experiment. The pH of the mixes are typical of good quality patis. There was none above pH 6 which, according to the authors' experience, is the demarcation between the typically good patis and the tainted or spoilt one. Treating fresh fish at these salt-to-fish ratios appears to check adequately the development of spoilage organisms which are responsible for the production of basic substances. To prove this, a batch of fish was left alone unsalted and allowed to spoil. Within a short time putrescence developed accompanied by a rise in pH to as high as 7.6. Poor quality patis is always high in ammoniacal substances. This is shown later in this paper in the presentation of nitrogen partition of patis and nuoc-mam.

Effect of Bacteriostatic Agents

In this experiment the workers wanted to eliminate microbiological activity and prove that hydrolysi takes place through the activity of enzymes. Severa mixes of salt and fish in the ratio of 1:4 were prepare and to each were added the different bacteriostati or germicidal agents like sodium benzoate, mercuri chloride, phenol, iodine and merthiolate in con centrations known to inhibit microbial activity Other mixes of the same proportion of salt to fis were prepared, and one was left immersed in toluene while another was brought to pH4 by the additio of sodium carbonate. These pH concentration were maintained throughout the experiment.

Other batches of the same fish were not salte but were treated separately with toluene, sodiur benzoate and mercuric chloride. One sample wa left without adding anything in order to observe th spoilage processes, and still another was prepare as a normal mix (1:4) without any treatment whatsc ever, except with salt to serve as control. Weekl amino-nitrogen analysis, together with pH dete minations, were made on these samples. Table I

TABLE II

pH reading with time of contact of fish and salt*

Types of treatment	Time of contact of fish, salt, etc. — First Week (Days): 1	2	3	4	5	6	7	Weeks: 2nd	3rd	4th	5th	6th
Tail portion (1 : 3)	5.92	6.02	6.23	6.22	6.17	..	6.13	6.12	6.20	6.25		
Head portion (1 : 3)	6.00	5.96	6.10	6.15	6.03	..	6.01	6.03	6.06	6.10	..	..
Whole (1 : 3)	5.72	5.84	5.90	5.81	5.72	..	5.68	5.67	5.70	5.84	..	..
Fish (No salt)	..	..	7.20	7.25	..	..	..	7.35	7.60	..	..	..
Fish : salt (1 : 3)	5.70	..	5.71	..	5.72	..	..	5.70	..	..	..	..
Fish : salt (1 : 4)	5.81	..	5.80	..	5.80	..	..	5.75	..	..	..	..
Fish : salt (1 : 5)	5.88	..	5.87	..	5.85	..	..	5.90	..	..	..	..
Fish : toluene	..	..	6.85	..	..	..	..	7.10	..	7.25	7.36	7.33
Fish : salt (1 : 3) + Sodium benzoate	5.81	..	..	..	..	..	..	5.87	..	5.90	5.85	5.90
Fish, salt (1 : 3) + $HgCl_2$	5.61	..	..	5.60	..	..	5.63	5.55	..	5.53	..	5.45
Fish : Sodium benzoate	6.70	6.76	..	..	7.46	..	..	7.40	..	7.42	..	7.50
Fish : $HgCl_2$	6.72	..	..	5.70	..	..	5.75	..	5.78	..	..	..
Fish, salt (1 : 3) : Toluene	5.75	..	..	..	5.95	..	..	6.00	..	5.85	5.83	5.62
Mackerel (small) (1 : 4)	5.75	..	..	..	..	..	..	5.80	..	5.82	..	5.77

* Leeds and Northrup pH meter was used.

shows that unsalted fish treated with sodium benzoate gave a pH from 6.7 to 7.50. This mix was spoiled within a week and it developed putrescence. Even toluene did not prevent unsalted fish from turning ammoniacal. The pH rose to as high as pH 7.33, although in this case the sample did not turn putrid nor very ammoniacal as in the former case, and as in the case of the fish left alone to spoil without any treatment. No other sample became putrid or ammoniacal. This appears to show that salt, when added in the ratio of 1 part of salt to 4 parts of fish, prevents the development of spoilage organisms. That untreated fish, when allowed to spoil, developed putrescence and ammoniacal odor, is reflected in the continuing increase of the pH which in this experiment rose to 7.6 on the third week. Poor quality patis is always accompanied by high proportion of ammoniacal nitrogen and low organic nitrogen. Table III gives an analysis of the nitrogen partition of tainted or spoilt patis. Because of the obnoxiousness of the unsalted samples and the difficulty of obtaining a clear pickle, no amino-nitrogen analysis was performed on them.

Table IV presents the amino-nitrogen analysis of the different samples expressed in grams protein ($N_2 \times 6.25$) per 100 ml. of the pickle. This table shows that, using the control as the basis of comparison, the bacteriostatic agents added also inhibited the hydrolysis. Fish treated with phenol, iodine, mercuric chloride and the samples whose pH were maintained to pH4 and 10 showed inhibition on

TABLE III

Analysis of tainted or spoilt patis

Samples	Acidity $g.H_2SO_4/L$	NaCl g./L.	Nitrogen grams per litre: Total N_2	Organic	Formol	Ammoniacal	Amino	% of total nitrogen: Organic	Formol	Ammoniacal	Amino acid
1. Pickle of unsalted fish	..	..	17.65	5.04	14.14	12.64	1.51	28.52	80.00	71.48	8.52
2. Spoilt patis	..	82.46	21.84	14.51	16.02	7.33	8.68	66.43	73.33	33.57	39.76
3. Spoilt patis (9 months)	3.50	225.31	22.02	17.58	13.94	4.44	9.49	79.85	63.28	20.15	43.13
4. Spoilt alamang patis boiled and filtered, (1 week old)	1.84	156.82	23.53	15.00	17.26	8.53	8.74	63.26	73.37	36.74	36.63

TABLE IV

Effect of bacteriostatic agents and other salts on hydrolysis of fish protein

Types of treatment of fish	Amino-Nitrogen protein in 100 cc. of pickle (Van Slyke): 1st day	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week
(1 : 4) : HCl, pH—4	5.3	..	7.1	9.0	..	9.8	..	10.0	..	10.1
(1 : 4) : $NaCO_3$, pH—10	..	..	7.0	7.3	6.9	7.1	..	7.5	..	7.7
Control (1 : 4)	4.18	9.8	11.6	19.0	20.2	20.25	..	22.5	23.0	23.6
(1 : 3)	4.7	7.1	12.8	13.5	17.9	18.00	18.50	..	..	..
Sodium benzoate + fish + salt	3.5	8.2	..	15.3	..	17.5	..	20.8	..	20.5
Phenol	3.3	..	5.7	7.0	8.0	8.3	..	9.1	..	9.5
Iodine	3.0	..	5.1	5.7	..	8.4	..	8.3	..	9.9
Merthiolate	4.2	..	13.2	16.8	..	20.8	..	20.7	..	..
$HgCl_2$, NaCl	4.2	..	10.6	11.4	11.5	..	12.2	11.9	..	12.0
$CaCl_2$, NaCl	2.9	..	..	11.0	11.87	12.5	14.2	..	14.0	15.4
$CaSO_4$, NaCl	4.1	..	12.2	14.4	15.7	16.5	20.2	20.25	..	22.5
$MgCl_2$, NaCl	3.6	7.5	..	16.0	17.9	16.5	..	19.6	..	19.31
$MgSO_4$, NaCl	3.6	6.8	..	14.5	..	15.7	18.9	19.9	..	19.5

protein hydrolysis to the extent that the dissolved amino-protein concentration of each is about only half as much as that of the control.

The authors attempted in these experiments to check microbial action of the process by addition of the commonly used bacteriostatic or bacteriocidal agents. In spite of these additions there was still noted hydrolysis of the proteins as evidenced by the increase of amino-nitrogen. It is not claimed, however, that the treatment with these bacteriostatic agents rendered the pasty mix completely sterile as bacterial count numbered a few thousands per gram of the paste at the end of the experiment. Normally this low density count is not sufficient to bring about hydrolysis.

The pasty consistency of the mix prevents complete and absolute sterility, and the authors have found no way to accomplish this except by heat sterilization which is impractical for their purposes because enzymes are also destroyed by such heat treatment.

Effect of Other Salts

To the same mixtures of salt and fish of the same ratios as above calcium chloride, calcium sulphate, magnesium chloride and magnesium sulphate were added separately to study the effects of salts, other than sodium chloride, on the processing of bagoong and patis. The concentration of each of the added salts was fixed at 10 per cent of the sodium chloride used for salting the fish. Only calcium chloride showed some inhibition on the hydrolysis, the other salts showing effects not differing much from the control. The use of impure salt with high calcium content should, therefore, be discouraged in this process.

Acid-Hydrolyzate Patis

The manufacture of patis requires no less than five months for completion. Several ways of increasing the rate of hydrolysis of proteins have been advocated. Hamm and Clague (1950) recommend a temperature increase up to 45 degrees Centigrade. Westenberg (1951) reported the use of chloroform and chloropicrin as preservative by some French workers in order to hydrolyze their fish without the use of salt. By this method much protein was dissolved in five days as compared with months required in the local process. This method is covered by a patent (Kremph, brevet d'invention 571.118).

The authors are introducing for the first time the acid-hydrolyzate-method which they find very feasible for patis making. This method is the fastest of all known methods used so far, and can be employed on any kind of fish. The processing as practised in the region holds good only for small fishes like the anchovies and herrings, whereas the acid-hydrolyzate process can even utilize fish meal.

The method is basically a refluxing process for a few hours using a fairly strong hydrochloric acid, cooling and gradually neutralizing the excess acid with a saturated sodium hydroxide solution to a desired pH reading. Table V gives an analysis of some of the acid-hydrolyzate patis. It will be noted that the new method produces patis of a high organic nitrogen, amino-nitrogen and low ammoniacal nitrogen based on the total nitrogen. The product is not as ammoniacal as the local patis and consequently the odor is not as strong. Some people who find the strong odor of patis unappetising prefer the new product. The total dissolved nitrogen is less than half of the typical first percolate

TABLE V

Analysis of acid-hydrolyzate patis

Samples	Sodium chloride grams /L.	Nitrogen in grams per litre					% of total nitrogen			
		Total	Organic	Formol	Ammoniacal	Amino	Organic	Formol	Ammoniacal	Amino acid
1. *Dilis* 2 hrs. reflux	201.81	8.19	7.67	5.82	0.52	5.30	93.65	71.11	6.35	64.76
2. *Dilis* 8 hrs. ,,	205.22	8.71	8.09	6.45	0.62	5.82	92.83	74.03	7.17	66.86
3. *Dilis* 12 hrs. ,,	226.61	8.71	7.90	6.86	0.81	6.06	90.75	78.80	9.25	69.55
4. *Dilis* of (3) evap. to 1/2 volume	293.30	15.34	13.83	11.23	1.51	9.72	90.16	73.22	9.84	63.38
5. *Dilis*, decolorized	216.40	8.84	8.09	6.86	0.83	6.03	90.59	77.64	9.41	68.23
6. *Lapad* 8 hrs.	227.38	10.40	9.72	7.07	0.68	6.40	93.50	68.00	6.50	61.50
7. *Lapad*, decolorized & evap. to 4/5 vol.	293.76	13.26	12.38	9.36	0.88	8.48	93.34	70.58	6.66	63.92
8. *Sapsap* fish meal	293.32	12.48	9.93	9.41	2.55	6.86	79.59	75.41	20.41	55.00

because of dilution. The dark colour of the new product is another disadvantage which could be removed by decolorization with activated charcoal. The details of the new process will be published in a subsequent paper.

SALIENT POINTS OF THE FRENCH WORK ON NUOC-MAM

The nuoc-mam of Indo-China is the result of the maceration of fish in a concentrated salt solution. Analysis of nuoc-mam revealed dissolved proteins and various hydrolytic products like proteoses, peptones and amino acids. A typically finished product of the nuoc-mam contains traces of albumins and peptones and around 25 grams of total nitrogen per litre. Another form of nitrogenous substance found in it is ammoniacal nitrogen. The intermediary products formed between the albumin and ammonia are the products of transformation, essentially the amino acids. Autret and Vialard-Goudou (1939) found tryptophane to be present and this is an index of the profound disintegration of protein bodies.

The studies on nuoc-mam reveal the interesting follow up of the nitrogenous substances existing under different forms and in different proportions. Rose (1918) introduced the nitrogen partition of nuoc-mam which led to a better understanding of the chemical changes involved in its processing. This led ultimately to better characterization, standardization and the detection of fraudulent nuoc-mam.

The nitrogen partition as described by Rose made known the quantity of nitrogenous matter and its degree of disintegration in the solution. Total nitrogen is the measure of the nitrogenous matter in solution. He also determined the nitrogen remaining in organic form which is a true expression of the nutritive value of nuoc-mam. The degree and the mode of disintegration of the dissolved nitrogenous matter is measured by (a) the proportion of nitrogen titratable in formol and (b) the proportion of amino acids and ammoniacal nitrogen computed relatively from the total nitrogen. The last two values indicate particularly the mode of disintegration. All of the above determinations are the result of operations relating to three items, namely, total nitrogen, formol nitrogen and ammoniacal nitrogen. Salt concentration and acidity in phenophthalein determinations were also made and their absolute values represented. From the qualitative standpoint and in order to facilitate the comparison between the different classes of nuoc-mam, the relative percentages of the different nitrogen portions were determined with reference to total nitrogen.

Tables VI and VII show the chemical composition of the products at different stages of nuoc-mam processing in two centres of production in Vietnam.

Table VI shows that the total nitrogen, organic nitrogen, and amino acid nitrogen follow a parallel increase. These values increase with the time of contact of the fish and salt (3-5 months). If nuoc-mam of five months passes into various dilutions (second quality, non-nuoc-mam and washings) the above values decrease correspondingly. The ammoniacal nitrogen increases likewise. Expressed in percentage relative to the total nitrogen, it is large initially, then passes into a minimum in 5 months, and rises with inferior nuoc-mam and increases enormously with the washings. The practice of several washings after the extraction of nuoc-mam is economical but it raises the proportion of ammoniacal nitrogen in the future nuoc-mam. But this is not beneficial. If the values of the nitrogen

TABLE VI

Chemical composition of the products drained at the different stages of Nuoc-mam processing

(*Samples collected from Mui-no*)

Samples	Nitrogen grams per litre.					Relative to 100 parts nitrogen			
	Total	Organic	Formol	Ammoniacal	Amino	Organic	Formol	Ammoniacal	Amino-acid
Liquid recovered from contact of fish and salt during 3 days	7.7	6.5	..	1.2	..	84.4	..	15.6	..
1 month	17.1	14.5	7.9	2.6	5.3	84.8	46.2	15.2	31.0
2 months	19.0	16.2	12.1	2.8	9.3	85.3	63.7	14.7	49.0
5 months	25.5	22.8	15.7	2.7	13.0	89.4	62.6	10.6	52.0
Nuoc-mam of inferior quality	11.6	7.7	8.5	3.9	4.6	66.4	73.3	33.6	39.7
Non-nuoc-mam	8.4	4.3	6.6	4.1	2.5	51.2	78.6	48.8	29.8
1st washing	5.0	0.9	4.5	4.1	0.4	18.0	90.0	82.0	8.0
2nd washing	4.5	1.0	3.7	3.5	0.2	22.2	82.5	77.8	4.7

TABLE VII

Chemical composition of the products drained at the different stages of Nuoc-mam processing

(Samples collected from Phan-Thiet)

Samples	Nitrogen grams per litre.					Relative to 100 parts nitrogen			
	Total	Organic	Formol	Ammo-niacal	Amino	Organic	Formol	Ammo-niacal	Amino-acid
Liquid of 12 days	10.1	7.1	..	5.0	..	70.3	..	29.7	..
Liquid of 1 month	13.0	9.3	9.0	7.0	5.3	71.5	69.3	28.5	40.8
Liquid of 5 months	15.4	12.2	12.0	5.2	8.8	79.2	77.9	20.8	57.1
1st washing	10.1	4.8	8.7	5.3	3.4	47.5	86.2	52.5	33.7
2nd washing	4.8	1.7	3.9	5.1	0.8	35.4	81.3	64.6	16.7

partition are graphed against time we notice the following: The two curves are exactly alike; the absolute quantities of the useful products (organic nitrogen and amino nitrogen) increase with the time of contact and decrease with the number of subsequent washings. Two different products have the same total nitrogen values, 10.1. The first is nuoc-mam of 12 days, and the other its first washing. In organic nitrogen concentration the first has 7.1 and the other 4.8 which is only slightly more than half of the former. This shows that true nuoc-mam cannot be clearly defined by expressing the total nitrogen alone. In the case of nuoc-mam of 12 days the product is still in the process of formation. This stage (one may call it pro-nuoc-mam), has little dissolved nitrogen but the degradation of this dissolved nitrogen is well advanced. In the case of the first washing, the dissolution of nitrogenous material is already completed, it has passed its maximum, and the product is only a part of the true nuoc-mam, but the disintegration has already advanced to its final ammoniacal stage. The organic nitrogen decreases correspondingly with the increase of ammoniacal nitrogen. With the curves on their relative proportions, it can be seen that the ammoniacal nitrogen in the early stages is relatively high. This value decreases with the time of contact of the fish and salt, passes into a minimum, and then rises very rapidly with the washings. The amino-acid nitrogen curve follows the exact opposite of the ammoniacal curve. For a perfect nuoc-mam (5 months) the two values, amino-acid nitrogen and ammoniacal nitrogen, present a maximum of divergence. At this stage ammoniacal nitrogen has a minimum value and amino-acid nitrogen a maximum value. It appears that at the point of crossing of the two curves or just immediately before it, the designation nuoc-mam ceases for a product which presents these characteristics. It can also be seen, moreover, that the product designated by the salters as non-nuoc-mam is in effect situated at this considered point. From here on the ammoniacal nitrogen becomes greater than the amino-acid nitrogen.

Table VIII is a presentation of the chemical composition of the products harvested at regular intervals during the processing of nuoc-mam. Here is a more detailed presentation on the analysis of the pickle drained from the first day to 6 months duration. The table shows that the absolute values of the organic and amino nitrogen, of which we are more concerned on account of their usefulness, increase up to the fourth or fifth month. It is also at about this time that the total nitrogen becomes stationary and the meat of the fish is more or less disintegrated and ceases to dissolve. The pickle is saturated with respect to the dissolution of the meat of fish and is therefore in a state of equilibrium. The formation of nuoc-mam from the quantitative point of view with respect to the meat of the fish has ceased.

Hence, while it is true that quantitatively the action has stopped, some qualitative changes continue to occur, involving the transformation of the nitrogenous matter into amino acids and ammonia. During this time the formation of amino acids ceases, and the ammoniacal formation continues. With respect to the relative proportions with 100 parts total nitrogen, there is a high concentration of ammoniacal nitrogen at the start, and a minimum value at 20 to 50 days. The organic nitrogen and the acid amines have maximum values around the period from 35-55 days. The formation of the useful products, organic nitrogen and amino nitrogen is therefore maximum towards the end of the second month.

A perfect nuoc-mam characterized by a large proportion of amino acids coupled with a small amount of ammoniacal nitrogen is produced at the end of the second month. Later, the organic nitrogen concentration diminishes while the ammoniacal nitrogen increases. The amino acids maintain their values up to the fifth month.

TABLE VIII

Chemical composition of the products drained at regular intervals during the processing of nuoc-mam

Pickle of	Nitrogen					% Proportion of Total Nitrogen			
	Total	Organic	Formol	Ammo-niacal	Amino-acid	Organic	Formol	Ammo-niacal	Amino-acid
0 day	..	..	..	..	..	..	..	..	..
1 day	5.320	4.648	..	0.672	..	86.8	..	13.2	..
3 days	8.960	7.840	..	1.120	..	87.7	..	12.2	..
10 days	11.200	9.856	5.152	1.344	3.808	88.4	45.5	11.6	33.9
15 days	14.000	12.376	7.620	1.624	5.936	88.6	53.5	11.4	42.1
20 days	16.744	13.092	8.176	1.652	6.524	89.8	49.1	10.2	38.9
25 days	16.800	14.924	8.400	1.876	6.524	88.7	50.0	11.3	38.7
30 days (1 month)	18.620	16.604	9.520	2.016	7.504	89.2	51.1	10.8	40.3
35 days	18.620	16.514	10.976	2.106	8.770	88.7	58.9	11.3	47.6
40 days	19.880	17.696	11.256	2.184	9.072	89.0	56.6	11.0	45.6
45 days	20.300	18.077	11.312	2.223	9.089	89.1	55.7	10.9	44.8
50 days	21.000	18.648	11.872	2.352	9.520	88.8	54.5	11.2	43.3
55 days	21.280	18.771	11.984	2.509	9.475	88.2	56.4	11.8	44.6
60 days (2 months)	21.840	19.180	12.208	2.660	9.548	87.8	55.9	12.2	43.7
70 days	23.800	20.930	12.208	2.870	9.338	87.9	51.3	12.1	39.2
80 days	22.120	19.152	11.872	2.968	8.904	86.6	53.7	13.4	40.3
90 days (3 months)	22.680	19.600	13.104	3.080	10.024	86.4	57.8	13.6	44.2
105 days	22.960	19.712	13.144	3.248	9.896	85.9	57.2	14.1	43.1
120 days (4 months)	23.800	20.384	13.888	3.416	10.472	85.6	58.4	14.4	44.0
135 days	24.080	20.692	14.672	3.388	11.264	85.9	58.9	14.1	44.8
150 days (5 months)	23.800	20.160	14.784	3.640	11.144	84.7	62.1	15.3	46.8
165 days	24.080	20.384	14.448	3.696	10.752	84.7	60.0	15.3	44.7
180 days (6 months)	23.800	19.012	14.672	4.788	9.884	79.9	61.6	20.1	41.5

The total nitrogen in solution increases only up to the fourth month. This period may be fixed as the maximum limit of useful contact between the fish and salt. If maceration is continued beyond the fifth month, the total nitrogen becomes stationary and the ammoniacal nitrogen continues its formation in greater quantity at the expense of the amino acids. This diminution of the amino acids and, for that matter, of the organic nitrogen, consequently lessens the nutritive value of nuoc-mam. This practice of having too long a maceration period works against the interests of the producer and lessens the quality of the product.

For a better understanding of the rate of hydrolysis the increases of the different nitrogen values for every 15 days period for the first two months of the process were computed, and also for every monthly period thereafter. The corresponding average daily increases during the periods are tabulated (see Table IX).

TABLE IX

Total and mean daily increases of the different nitrogen values in the processing of Nuoc-mam

Periods of processing	Increase				In			
	Total Nitrogen increase		Organic Nitrogen increase		Ammoniacal N_2 increase		Amino-acid N_2 increase	
	15 days	Daily	15 days	Daily	15 days	Daily	15 days	Daily
From 1-15 days	8.680	0.620	7.728	0.552	0.952	0.068	5.936	0.396
From 15-30 days	4.620	0.308	4.228	0.282	0.392	0.026	1.568	0.105
From 30-45 days	1.680	0.112	1.473	0.098	0.207	0.014	1.585	0.105
From 45-60 days	1.540	0.100	1.103	0.074	0.437	0.029	0.459	0.031
	30 days	Daily	30 days	Daily	30 days	Daily	30 days	Daily
From 60-90 days	0.840	0.028	0.420	0.014	0.420	0.014	0.470	0.016
From 90-120 days	1.120	0.037	0.781	0.026	0.336	0.011	0.448	0.015
From 120-150 days	000	000	0.224	.007	0.224	0.007	0.672	0.022
From 150-180 days	000	000	1.148	.038	1.148	0.038	1.260	.042

It was revealed that the proportion of useful products (total organic and amino acids) increases greatly at the start as compared with ammoniacal nitrogen and thereafter decrease very rapidly. Between the second and fifth months, the values are very similar to each other. Between the fifth and sixth months, the increase of total nitrogen levels off to zero, while that of the ammoniacal nitrogen increases. The organic and amino-acid nitrogen takes negative values. The absolute values of the last two diminish.

A graph of the time of contact against the nitrogen values shows the very rapid transformation of the nitrogenous matter into the corresponding degradation products at the start. This is followed by the levelling and subsequent cessation of the formation of the first series of products. The formation of the other (ammoniacal) product continues to increase to high values. Nuoc-mam formation, therefore, commences with a very rapid transformation of the meat of the fish into soluble products, which are chiefly amino acids. Ammonia is also formed, at first in large amounts, later in smaller proportions. Subsequently, the proportions of the dissolved nitrogenous products cease to increase, but the relative proportions of the ammoniacal nitrogen which have passed into a minimum value increase rapidly at the expense of the amino-acids and the latter decrease their concentration in nuoc-mam. These are two series of phenomena which cannot occur at the same time. One stage precedes the other, and the second continues after the first has ceased.

Other Findings of Rose

Other findings of Rose will here be stated. For details of his work, the original paper should be consulted.

Salt is essential in the production of nuoc-mam. It regulates the transformation of the hydrolytic products of the fish protein. A weak concentration of salt encourages the strong disintegration of the protein material and pushes it further than necessary to the ammoniacal stage. Nuoc-mam with salt less than the accepted concentration will soon be invaded by micro-organisms and will turn putrid and give a nauseating odor. The concentration of salt necessary to ensure the conservation of nuoc-mam and at the same time fix the degree of disintegration must not be less than 200 grams per litre of first class nuoc-mam. A greater salt concentration is required for nuoc-mam of inferior quality.

Grinding or mincing of fish meat does not increase the rate of hydrolysis. Nuoc-mam obtained from ground or minced fish does not differ from that obtained from whole fish in the rate of disintegration nor in the products formed in the different stages of processing.

Analysis made on a sample of fish salted and sterilized and kept sterile for 150 days showed that very little formol titratable nitrogen was formed. This reveals that the agents responsible for hydrolysis of the protein are thermolabile. Nuoc-mam in formation or finished nuoc-mam added to a sterilized mix of fish and salt does not yield new nuoc-mam. It does not appear to contain the agents responsible for the breaking down of fish protein. The micro-organisms that one encounters in the liquid of the seeded vats do not produce nuoc-mam; they manifest their presence more often by the production of ammonia which becomes more pronounced with the time of contact. The agent responsible for hydrolysis of the fish protein is not contained in the finished nuoc-mam or nuoc-mam undergoing formation, for seeding with these does not produce nuoc-mam in sterilized fish and salt mix. The microbial elements applied on sterilized fish or on finished nuoc-mam lead to putrid fermentation. The nature of the agents responsible for hydrolysis of fish protein is the subject of the subsequent work of Mesnard and Rose (1920), salient points of which are discussed below.

AGENTS RESPONSIBLE FOR HYDROLYSIS OF THE FISH PROTEIN IN NUOC-MAM

Mesnard and Rose (1920) worked on the agent-responsible for hydrolysis of fish protein in nuocs mam by using separately glycerine and chloroform extracts of the digestive organs and muscular tissues of fish, and the microbial cultures obtained from nuoc-mam on their proteolytic action on three kinds of proteinaceous materials, namely, gelatin, coagulated beef albumin and peptone.

Working on the pickle of fish and salt of three days maceration, they found microbes which were few in kind and in number. The bacterial density decreased with the time of maceration and with the increase in salt concentration. The three or four species of microbes found in nuoc-mam were susceptible to culture in salt solutions. These were the organisms they used in their work on the proteolysis of gelatin, beef albumin and peptone. They possessed solely a liquifying action on gelatin. The proteolytic enzyme is not found in the pickle nor on cultures of the microbes which it contains.

The glycerine extracts of the digestive organs are the only active ones at all times and in appreciable manner in gelatin, coagulated beef albumin and peptone. The extracts of digestive organs, therefore,

are the only agents capable of converting the proteins of the fish into their successive degradation products up to the amino-acid state, and the enzymes found therein are solely capable of producing complete digestion which effects nuoc-mam formation. The pickle is inactive on coagulated beef albumin. It appears that the digestive juices themselves act directly on the tissues without the mediation of the pickle.

Mesnard and Rose also studied the influence of environmental factors on the degree of proteolysis effected by the extracts of the digestive organs on the above mentioned classes of proteinaceous materials and found a temperature range of 36-44 degrees Centigrade and a neutral to slightly alkaline medium as optimum conditions.

DISCUSSION

Bagoong and patis processing should be differentiated from the phenomena of decay and putrefaction. Decay and putrefaction are chemical decompositions of organic matter (proteins) with or without the presence of atmospheric oxygen. Bagoong and patis processing is actually a digestion of the proteins under the influence of ferments into substances which are assimilable. Decay and putrefaction are due to bacterial activity in which an alkaline reaction usually develops in the digest due to the accumulation of the basic products of the proteolytic cleavage. In patis processing the reaction of the products produced are always on the acid side except when bacterial activity interferes in the process. The chemical decomposition involved in decay and putrefaction processes is pushed much further than in digestion and more ammoniacal substances are liberated. In extreme cases elementary forms of the protein constituents are also liberated. In patis processing the decomposition is limited chiefly to the amino acid stage whereby the development of ammoniacal fractions is discouraged, thus conserving the nutritive value of the product and at the same time retaining its assimilability.

The hydrolysis of proteins in patis is basically enzymetic. Microbiological action has been found to be of minor importance in hydrolysis because the strong salt concentration of the patis is not conducive to bacterial development. Only halophiles can thrive in such high salt concentrations and the bacteria found in this process have no similarity with the known halophiles which are generally reddish or pinkish in color. The bacterial population of patis are few in kind and in number. Their densities diminish rapidly with the time of contact of the salt and fish, and with the salt concentration. Furthermore, if the process in patis making is bacterial, the production of the desired cleavage products could be encouraged by seeding with patis in formation or, better still, with patis taken at the time when maximum hydrolysis is taking place. However, unlike microbiological fermentations, such as are found in wine and vinegar making, the process does not respond to seeding which makes continuity of operation unfeasible.

The bacteriocidal or bacteriostatic agents like toluol and chloropicrin, which the French investigators have used, and phenol, mercuric chloride, iodine, etc., which the present workers have tried, show that hydrolysis still proceeds in spite of their presence. The authors do not claim, however, complete sterility in these experiments for the pasty consistency of the mass prohibits it. However, it is very noticeable that a high concentration of salt actually provides the best bacteriostatic agent. Heat would of course constitute the best means to accomplish sterilization but, unfortunately, it also affects the thermolabile enzymes.

Our new process of patis making by the use of acid in hydrolyzing the fish protein accomplishes the end sought with the complete elimination of bacterial activity. The odor of the patis made by the new method is similar to that of locally produced patis except that it is less strong. If microbiological activity plays a part in the process, it is likely that its function is the elaboration of substances responsible for flavour development, and not for the cleavage of fish protein which is chiefly done by enzymes of the digestive organs.

The work of Rose on the nitrogen partition of nuoc-mam illustrates clearly the degree and mode of the breaking down of proteins. It should be utilized for the characterization, standardization and detection of over-diluted patis.

Based on total nitrogen as 100 parts, patis must contain 60 to 77 per cent formol titratable nitrogen; not more than one half of the formol nitrogen must be ammoniacal nitrogen. The salt concentration necessary for fixing the degree of hydrolysis and the preservation of the same must not be less than 200 grams per litre for the best products. A higher concentration is necessary for the lesser quality. The total nitrogen or, better, the organic nitrogen which determines the true nutritive value of the product, and consequently its quality, must be 15 to 25 grams of total nitrogen and 10 to 20 grams of organic nitrogen per litre.

Patis is sold locally under the following classes, "Extra" or "Especial" and "Primera". The total nitrogen content is as variable as the number of manufacturers. Classification based on the nitrogen partition work of Rose should be encouraged so that consumers might know what they are getting for their money.

SUMMARY

Soy and maggi sauce, nuoc-mam and patis are compared on the basis of chemical analyses. The differences lie in the source of the protein and in the manner in which it is broken down into its degradation products.

Nuoc-mam and patis making are identical in all respects, as in the kind of fish used, the manner of processing, and the nitrogen partition of the nitrogenous substances. Important aspects of the French work on nuoc-mam are brought out in this paper to elucidate on the chemical transformations of the fish proteins in the processing of these products.

It is pointed out that the proteins are broken down chiefly by the enzymes of the digestive organs and not through microbiological activity, as has previously been thought of. Mircobes in the processing of patis are more of a nuisance in the sense that they generally increase the unwanted ammoniacal nitrogen fraction.

A new way of patis making using the acid-hydrolyzate-method is introduced and analysis of the new product is presented. The new method has the advantage of converting any kind of fish flesh into patis, thus making available fish not previously utilized. The breaking down of the fish proteins is accomplished in a few hours as compared with the four or five months required for the traditional manufacture of patis.

The authors recommend that the quality of local patis should be standardized, using the nitrogen partition of Rose.

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13

A PROPOSED SYSTEM FOR CATALOGUING THE BOATS USED IN THE FISHING INDUSTRIES OF SOUTH AND EAST ASIA

by

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The object of the proposed system, the scheme for which was drawn up in 1951 and to which some modifications and additions have since been made, is to provide a means of cataloguing the fishing and fish-carrying boats used in Southern and Eastern Asia in terms of their essential qualities. It is not put forward as a substitute for adequate descriptions of the boats. It is, in fact, held to be essential that descriptions should be prepared in all cases where they do not already exist, even if the available data permit of the boat's classification here. Certain items of considerable anthropological and historical interest (such as the manner in which the floats are attached to the outrigger booms, and the use of tripod masts and sewn or lashed hulls) find no place in it, and we should undoubtedly have a record of them. They have been omitted in this instance solely so that the arrangement should not become too complicated, and its primary function, a consideration in terms of working qualities, be thereby obscured.

The study of possible historic relationship between certain of the boats used in our area is by no means purely academic. Any attempt to improve local conditions of working must start from a full understanding of existing methods, and this in its turn must include an analysis of why they are being employed at the present time. It is clear that many current forms occurring in sections of our area have been acquired from neighbouring localities, or from extralimital regions. Fishing gear and technique may very well have been adopted at the same time. Thus methods may be in use, not because they have been evolved naturally to suit the locality, but because they have been brought in by interlopers preferring their own ways of working, or more efficient with them. Relative efficiency under these conditions, without controls, is not necessarily an indication of ultimate superiority or suitability.

It is suggested here that brief analytical accounts of all the local boats should be prepared from field data, or from published works, where these are available. Subsequently these accounts should be codified and arranged along the following lines to permit easy comparison between the boats of one area and those of another in any or all of the qualities likely to effect their value as functioning units of fishing gear. Boats from different places which are identical in their essential qualities would then be found grouped together, in spite of variations in their "finish", or the confusion arising from the use of local names of limited distribution.

In the proposed system the boats are to be define by four figures, which between them give (a) tl effective range and the normal method of propulsio (b) the form of hull construction, (c) the profi of the hull and (d) the presence or absence of ou rigger floats, and the method of steering. Tl fourth figure would be followed by a decimal poi if the boat normally carries sail (s), and figures aft the point used to show the approximate sail pla Further details are given below.

Where boats of a form intended primarily f propulsion by paddles or sail(s) are fitted with motor, this could be shown after the last figure l the letters PO (=Power, Outboard), or PI (=Powe Inboard). This will, among other things, allc a return to be made from a district where the bo is of a standard form and some of the examples use, but not all, are employed with motors. such a case the designation would read in the for "3753.05, —% with PO"; or if all in the distri were fitted to take outboard motors, "3753.05, PO if none "3753.05", if say one, "3753.05, 1 PO", if an indeterminate number, "3753.05, some (mostly) PO".

Finally it may be remarked that no cognizance h been taken of rafts or floats, and it seems that th must be indicated as such. All attempts to fit the into the present scheme have resulted in considerat complication and, for all practical purposes, tl wastage of valuable units required for the class fication of boat characters. Nor have I included category for frame and skin coracles, since so far I am aware these are employed in only one part our area, and then only on inland waters. It felt that any boat sufficiently unusual to possess character in those covered by the second to four numbers in the key below which is not defined the can best be expressed by the insertion of a ze

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("O") at that point, and an explanatory note in brackets after the last figure. Should there prove to be many such boats it would, of course, be necessary to revise the list of definable characters again, but so far as a study of the existing literature goes there are few if any beyond the coracles. A sewn hull (of which several versions are still extant) can be classified adequately under the second figure, without taking the form of fastening into consideration. This applies again to those boats in which the keel is longer than the remainder of the hull. These points are of considerable interest historically, and should certainly appear in the brief descriptions, but they do not appear to be of great significance when the boats are analysed solely as working units of gear.

The proposed classification runs as follows :—

First Figure : effective range and normal method of propulsion.

1 Boats fit only for use in swamps, rivers, estuaries or very close inshore in sheltered waters : normally carrying only one or two persons, and propelled by paddles or oars.

2 Boats fit only to be used fairly close inshore, normally carrying only one or two persons, and propelled by paddles, oars or sails.

3 Boats used over deeper water, carrying three or more persons and normally propelled by sails : beam less than about 7½ feet, length along the waterline less than 45 feet.

4 Boats used over deeper water, and in long voyages across open sea, carrying a crew of five or more persons, and propelled only by sails ; beam typically more than 8 feet.

5 Boats designed to be driven by power.

Second Figure : hull construction.

1 Simple dug-out.
2 Expanded dug-out.
3 Dug-out base with one plank or strake added on each side.
4 Dug-out base with two or more strakes added on each side.
5 Keel-less plank-built boats.
6 Keeled boats, wood, clinker-built.
7 Keeled boats, wood, carvel-built.
8 Composite hulls (metal frames with wood skins).
9 All-metal hulls.

Third Figure : hull shape.

1 Square-ended fore and aft.
2 Rounded fore and aft.
3 Narrow bow panel and a broad transom stern.
4 Pointed (sharp) bow and transom stern.
5 Pointed (sharp) bow and rounded stern.
6 Hull pointed at both ends, keel long, ends almost plumb.
7 Hull pointed at both ends, keel moderately long, ends (stem and stern post) raked.
8 Hull pointed at both ends, keel short, fore foot and heel normally well rounded, ends (stem and stern post) markedly raked.
9 Hull pointed at both ends, stem raked, stern post plumb or almost so.

Fourth Figure: presence or absence of outrigger floats, and method of steering.

1 With a single outrigger float (*i.e.* on one side only).
2 With a double outrigger (*i.e.* floats on both sides of the hull).
3 No outrigger, steered with a single paddle or sweep.
4 No outrigger, steered with a paddle and/or a lazy rudder.
5 No outrigger, steered with two sweeps or quarter rudders.
6 No outrigger, steered with a stern rudder and tiller (Chinese style : *i.e.* the rudder can be raised and lowered).
7 No outrigger, steered with a stern rudder and tiller (Western style : *i.e.* the rudder is not intentionally capable of vertical movement).
8 No outrigger, steered with a stern rudder and lines.
9 No outrigger, steered with a stern rudder and wheel.

First Figure after the Decimal Point : presence or absence of jib or headsails.

.0 No jib or headsails.
.1 One jib or headsail.
.2 Two jibs or headsails.
.3 Three jibs or headsails, and so on, if necessary.

Second Figure after the Decimal Point : sail set on the main (only) or foremast.

1 Boomless lugsail (standing lug).
2 Boomed lugsail (either a balance or dipping lug).
3 Lateen sail.
4 Spritsail.
5 Gaff-headed sail.
6 Gaff-headed sail with topsail.
7 Triangular (Bermuda) sail.
8 Chinese batten-sail, rectangular.
9 Chinese batten-sail, peaked.

Third Figure after the Decimal Point : sail set on mizzen mast, if a second mast is stepped: figures to have the same significance as for the second place after the decimal point.

It should be repeated that if the boat does not carry sail, no figures are to be shown after the decimal point. If it steps only one mast, two figures appear after the decimal point, if two masts, three figures, and if, like the Car Nicobar canoe, it steps three masts, there should be four figures after the point (in this case, .0222, or possibly .02³, if the notation seemed preferable). The tallest mast should be indicated by a bar over its sail number. Thus a gaff-headed ketch with two headsails and no topsails (something on the lines of the Singapore Timber Tongkang) would be shown as .25̄5, the Palari if she really were schooner-rigged as .366̄, and the Trengganu Pĕrahu Payang as .022̄.

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THE EXPERIMENTAL INTRODUCTION OF POWERED FISHING VESSELS WITHIN INDIA AND CEYLON

by

K. Chidambaram[1]

Introduction

At the third meeting of the Indo-Pacific Fisheries Council held in Madras in February 1951, it was resolved to request me, subject to the approval of the Member Government concerned, to widen the scope of the technical paper on the experimental introduction of powered fishing vessels within India and Ceylon for the fourth meeting of the Council. It is with gratitude to the Council for the honour done to me in inviting me to present a paper on the introduction of experimental power fishing in this part of the world, which is engaging the attention of fisheries experts, that I place before the Council a short history of the efforts and results of the experiments in power fishing in the Indian coasts and the present attempts on exploratory and commercial fishing by power vessels.

Earlier Surveys

The methods of fishing and the types of fishing craft in use in the Indian seas are no doubt best suited to fishing the inshore belt of 7-10 miles. There is practically no off-shore or deep-sea fishing in the true sense of the term and in any scale of commercial importance excepting a few attempts made recently off the Bombay Coast. The necessity for extending the field of fishing operations has been more keenly felt now than ever before in the far Eastern countries, especially in view of the shortage of food to meet the basic requirements of the people in the region. Efforts had been directed towards this line of development early this century. There had been attempts on the Indian coasts to have power vessels for conducting surveys and fishing on a commercial scale, mostly by means of large sized trawlers. Experimental trawling was tried in the Indian seas in 1902 (Herdman, 1903 ; Malpas, 1926). The Ceylon Company of Pearl Fisheries carried out some exploratory trawling in 1906-07 (Hornell, 1915-16), followed by the Ceylon Government in 1913-14 and between 1919 and 1928 (Pearson). The fishing surveys conducted off Bombay (Hefford, 1923), Calcutta (Southwell, 1915), Madras (Sundar Raj, 1913,1933) and Ceylon in the earlier part of the century on board S. T. *Premier*, S. T. *William Garrick* and S. T. *Madras*, S. T. *Golden Crown*, and S. T. *Margarita*, *Sutherland*, M. V. *Turbinella*, the *Sea Scout* and S. T. *Lady Goschen* deserve particular mention in view of the exploratory nature under exceptional and unfamiliar conditions with practically no background knowledge and data available on the fishing banks and fishing conditions. Details of the names of the vessel, the year of survey, area surveyed, methods of fishing tried and their results are presented below in order to give an overall picture of the experiments conducted in the Indian waters in power fishing before the last World War.

Results of Surveys till 1930

Exploratory fishing has heretofore to a large extent been a failure in the economic sense. Although it was proved that some of the types of

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Year	Vessel	Area surveyed	Methods of fishing tried	Results
1	2	3	4	
		Bengal		
1908-11	S. T. *Golden Crown.*	Northern portions of Bay of Bengal.	Otter Trawl	The marine survey has shown t the Bay will yield an ample sup of fish and that the catches be put on the Calcutta market good condition.
		Bombay		
1900	S. T. *Premier*	Bombay coastal waters.	Beam trawl.	Not known.
1921-22	S. T. *William Garrick.*	Bombay waters.	Otter trawl.	Good catches but financially u successful.
1923	S. T. *Madras*	-do-	-do-	Not known.
		Madras		
1908	S. T. *Margarita*	Malabar coast and Laccadives.	Experimental trawling.	Too small and uneconomical f trawling.
1909	*Sutherland* 12 tons.	Beyond the usual range of fishing, i.e., 15 miles off Cannanore.	Experimental fishing.	Reported to be too big for small wo but not big enough for large work
1909	M. V. *Turbinella* 25 tons.	Beyond the usual fishing range off Tuticorin.	-do-	Too big for small work and tc small for large works.
1922	*Sea Scout* 48′ 6″: 30 H.P.	Off Cochin in 1923.	Danish seine.	Its equipment and design nc suitable for seine.
1927-30	S. T. *Lady Goschen*	West coast & East coast of India	Preliminary exploratory survey for charting and fishing with trawls.	Located a few good trawl ground and fishing grounds. Had to b abandoned because of her ba condition and administrative diffi culties.
		Ceylon		
1902 1906-07	S. T. *Violot*	Ceylon & adjacent waters.	Otter trawl.	Government projects.
1913-14	-do-	-do-	-do-	-do-
1920-23	S. T. *Lilla*	-do-	-do-	-do-
1924-26	S. T. *Nautilus* (Freeze hold).	-do-	-do-	
1928-35	*Bulbul.*	-do-	-do-	Recommended trawling.
1928-29	*Tongkol*	-do-	-do-	Private company liquidated; fish could not be brought hard frozen.
1945-47	*Raglan castle.*	-do-	-do-	Defective coal; fairly successful (Government).
1947	*Aringa*	-do-	-do-	Private.

vessels were effective fishing units they were not a commercial success because of the high cost of maintenance, lack of adequate knowledge of the fishing grounds, lack of trained personnel, the necessity to combine exploration and investigation on virgin grounds with practically no oceanographical data available, loss and damage to gear, lack of information on the suitability of the different types of vessels to Indian conditions, lack of harbour facilities and the difficulties met with in the handling and disposal of the different kinds of fish from the time of capture to marketing. It is also necessary to appreciate that any change involving power fishing, expansion of the fishing areas, increased intensity and efficiency, better methods of preservation, transport and marketing will alter the economic structure of the industry and affect the fishing community. These will also influence the ways of life and the social institutions of the fishermen, e.g., any system of Deep Sea fishing would involve change in their established pattern of behaviour and economic relationship in the community. All these factors were not properly assayed in the earlier years of experimental power fishing.

Fishing Surveys in India Since 1930

Central Government

During the preliminary fishing surveys, important fishing grounds were located off both the coasts of India and Ceylon. Based on the experience of these attempts at power fishing, the Government of India and Ceylon again launched fresh efforts to conduct fishing from power vessels during the last war and at the termination of hostilities.

A pilot deep sea fishing station was established (Chopra, 1951) in Bombay in 1946 and the fishing operations by S.T. *Meena* commenced in January, 1948. She was a single screw vessel with a tonnage of 159.85 tons and a length of 153′-5″ and had a cold storage plant. She was in commission only for 513 days and due to berthing difficulties, she was out at sea only for 212 days. During the period she landed about 157 tons with an average catch of 1,600 lbs. per day's absence from port in addition to charting of fishing grounds. In view of the high cost of maintenance and operation of the coal burning vessel, she was decommissioned in June, 1949.

Besides S.T. *Meena*, two Dutch cutters M.T *Ashok* and M.T. *Pratap* and two Reekie boats, M.F.V. *Bumili* and M.F.V. *Champa* were also operating off Bombay. The two Dutch cutters were fishing in 1949-50 in the areas charted during the earlier surveys and they landed 1,760 lbs. and 1,260 lbs. of fish respectively per day's absence. In 1951 the landings were 68.75 tons and 67.14 tons respectively.

Bengal

After a lapse of over 4 decades, a scheme for exploring the possibilities of deep sea fishing in the Bay of Bengal was launched in 1950 by the Government of West Bengal "to determine the location of the best fishing grounds, the proper sea fishing seasons, the types of fish, surface, midwater or bottom, types of gear and nets most suitable for working in these waters" (Chopra, 1951 a). The Danish trawlers, *Sagarika* and *Baruna* commenced fishing at the head of the Bay of Bengal on 26th December, 1950. Upto the end of October, 1951, the vessels made 13 voyages and fished in 11 banks; they operated four types of trawls. The vessels *Sagarika* and *Baruna* were actively fishing for 86 and 87.5 days respectively and their catches amounted to 241.7 tons, giving an average of nearly a ton per day's absence from port. It is to be pointed out here that due to lack of harbour facilities in the Bengal and Orissa coasts, the vessels had to be berthed at Calcutta, a distance of about 100 miles from sea; this caused delay in journey and hence reduction in the catch per day's absence.

Bombay

In Bombay, the development towards the introduction of power vessels for fishing was directed towards installing power in the existing fishing craft which are admirably suited and in providing fast carrier boats to take fish from production centres to consuming centres.

The number of power vessels used as carriers increased from 2 in 1933-34 to 50 in 1948-49 (Setna, 1950) and these accounted for the transport of 55.520 lbs. and 63,16,828 lbs. of fish respectively. In the same manner, in recent years the fishing vessels known as *Machwas*, have also been mechanised by fitting of inboard motors of Diesel types. The vessels built were deckless, 45 ft. long, 11.5 ft. broad and 5 ft. deep. They are fitted with 22-24 B.H.P. marine diesel engine The quantities of fish caught by five such vesse amounted to 75,000 lbs., 17,000 lbs., 7,000 lb 23,000 lbs. and 50,300 lbs. respectively and the catches averaged twice or sometimes thrice tho of sailing boats and they cover a range of over miles from the port.

Madras

In Madras State, exploratory surveys were ma with Motor fishing vessels bought from the Nav mainly for the use of long lines, hand lines ai whiffing and the location of fishing grounds. The details of catches of M.F.Vs. in Madras State during the year 1949-50, 1950-51 and 1951-52 are given below :

	1949-50	1950-51	1951-52
Total quantity of fish caught	432,947 lbs.	277,564 lbs.	..
Total quantity of liver obtained	24,842 lbs.	67,941 lbs.	..
Receipts.	Rs. 25,686-12-0	Rs. 30,778-13-4	..
Expenditure		Rs. 1,78,357-9-6	..

Results on the Deep sea fishing operations conducted during the year 1951-52

		(Lbs) Wt. of the fish caught.	(Rs) Sale proceeds.
Assistant Director of Fisheries,	Vizag.	42,366	6,431 5 6
-do-	Vellore	30,355¾	4,328 4 10
-do-	Tanjore	40,289	2,309 9 2
-do-	Madurai	29,526	4,677 13 0
-do-	Tuticorin	36,425¾	6,277 7 0
-do-	Mangalore	180,321	4,412 5 4
	Total	3,59,283½	28,436 12 10

It is pointed out that though catches are not very high, the fishing indicated the presence of good fishing grounds within easy reach of a small power craft. In earlier years, attention was directed more towards fishing for sharks and this led to the special designs of revolving chain hooks.

The M.F.Vs. were serving mostly as mother vessels and for towing the fishing canoes to the off-shore fishing grounds. A few methods of fishing such as R.C. lines for sharks, long lines, hand lines and troll lines were successfully operated. Fishing experiments with mid-water trawls based on the local types of nets were also tried ; but to work them properly certain items of equipment, winches etc. are to be provided ; this naturally involved the proper inspection of the vessels to find out whether they would take the additional strain. As most of the vessels are old and are constantly in repair, this added to the handicaps of successful operation of the vessels, besides the main difficulties met with due to lack of harbours, adequate means of transportation for marketing, etc.

Based on these experiments, it was recommended that " fishing with hand lines may be taken up immediately on an organised scale with a fast 45 ft. sea worthy power vessel to enable the catches to be brought ashore quickly for prompt disposal and marketing. This should encourage the development of line fishing with a mother vessel and small boats for fishing and with adequate facilities for storage in the mother vessel or speedy transport in other power vessels to the shore at periodic intervals. Simultaneous with this type of fishing further efforts have to be made to make trawling commercially successful by modifying the designs of trawlers to suit local conditions (Chidambaram and Rajendran, 1951).

In addition, small vessels, 21 ft. long are built and are powered with inboard diesel engines of 7.5 B.H.P., as the designs of local craft are not suitable for installing engines straightaway. The use of these boats will enable the fishermen to extend the area of operations considerably, while the increased speed will enable them to prolong their stay in the fishing banks and will reduce the risk of their catches being spoiled before they reach the market. The Department has built 11 such boats at a cost of Rs. 6,000/- each and the results are encouraging.

Private Company

The Taiyo Fishing Co., Ltd. of Japan brought to India last year a fishing trawler *Taiyo Maru No. 17*. The vessel is a steel built trawler, 30.20 metres long, 7.20 metres wide with a draft of 4.05 metres and a gross tonnage of 276.11 tons. It is fitted with a 330 H.P. engine, cold storage room for 65 tons of fish, radar, fathometer, radio apparatus, etc. The vessel commenced fishing operations in November, 1951. In 6 trips from 27-11-1951 to 10-2-52 she landed 301,65 tons valued at Rs. 166, 955/- in 39 fishing days.

She made 6 more trips during the period from 18-2-52 to 10-5-52 and landed 303.65 tons. She was out for fishing on 127 days, during the period from 27-11-1951 to 10-5-52 and landed on an average 4.77 tons of fish per day's absence from port, thus definitely proving the richness of the banks in the Indian coasts. With this rate of fishing, the business aspect has been found to be quite encouraging.

Results of the Later Surveys

The results of the experimental fishing in different types of power vessels operated on the different regions of Indian seas are presented in the following two tables (Tables 2 and 3).

Table 2. Presents an interesting history of the fluctuating results of trawling on the Indian seas. The earlier surveys did not yield results of much commercial value but it should be admitted that they were mainly exploratory. The difficulties met with in the early stage were overcome subsequently and the results of trawling have been found to be encouraging in recent years in fishing grounds which have been established as rich banks during the early surveys. The organisational and personnel difficulties met with in the early part of the century did contribute to a large extent to the failure in commercial fishing as is evident from the results of the vessels operated by the Danish and the Japanese crew.

Table 3. Gives details of the efficiency of power fitted to the existing types or sizes of fishing craft.

Discussion

The results of experimental fishing in the Indian waters have indicated the potentialities of rich fishing grounds in the off-shore regions both for trawling and for pelagic fishing. But still the exact design of vessels to be employed, have yet to be decided. The trend in which development of power fishing should be planned and pursued is still under controversy, leading to two schools of thought, viz., (1) gradual conversion from existing boats to power boats of the same size and then extending to the larger sized power boats and (2) to jump off to larger sized power boats without going through the intermediary stages.

The difficulties met with in commercial fishing with trawlers in the earlier surveys have already been referred to in the paper. In such cases, very many factors like the nature of the coast, extent of and distance to the fishing grounds, kinds of fish, the socio-economic conditions, lack of adequate trained personnel, lack of harbour facilities, etc. play a great part in selecting the right type of large sized trawlers for fishing.

Hickling (1951) referring to the possibilities of deep sea fishing off Ceylon indicates that " a fleet of trawlers could be profitably based on Colombo, but that the possibilities of expansion of this specialised type of fishing are probably limited " and suggests that small power fishing craft 35 ft. long can work from small creeks and intermediate sized vessels, 75 ft. long, from selected good harbours

TABLE 2

Details of fishing operation by large trawlers in Indian Seas.

Section of the coast.	Name of the trawler	Year of operation & No. of days absent for fishing	Average catch per days' absence (100s of pounds)	Remarks
South Indian Coast.	*Bulbul*	1928-35 - 175.5 days	42.07	Fishing in Wadge bank.
	Tongkol	1928-29 - 58.5 days	28.52	,,
	Raglan Castle	1945-47 - 71.0 days	55.11	Fishing in Wadge bank.
	Aringa	1947 - 154.0 days	64.07	,,
	Lady Goschen (a)	1927-28 - 47 da s	5.54	Wadge bank Pedro
	(b)	1928-29 - 67 days	9.23	Bank, Coastal waters.
	(c)	1930 - 117	6.25	East Coast.
Bay of Bengal.	*S.T. Golden Crown*	1908-09 - 233.5 days	14.4	Head of the Bay of Bengal.
	Sagarika	Dec. 1950-Oct . 1951 120 days	21.92	,,
	Baruna	Dec. 1950-Oct. 1951 118 days	21.92	,,
Bombay Coast.	*William Garrick*	1921-22 - 118.8 days	12.57	Off Bombay.
	S.T. Meena	1948-49 - 212 days	16.00	,, and Saurashtra)
	Taiyo Maru No. 17	1951-52	106.84	,,

TABLE 3

Details of Power Vessels used for experimental fishing off Bombay coast after the war.

S. No.	Name of Vessel	Dimensions L	Dimensions B	Dimensions D	BHP of Engine	Tonnage	Period of operation	Range of operation	Quantity of fish caught
1.	S. T. *Meena*	153'-5"	..	..	..	† 159.85	212 days-Jan. 48-June, 1949	N.N.W. of Bombay	157 tons.
2.	M. T. *Ashok*	38'-4"	..	..	240 BHP	† 23.44	1949-1950	,,	
3.	M. T. *Pratap*	,,	..	..	,,	,,	,,	,,	
4.	*Sagarika*	74'-0"	20'-7"	..	260 BHP	‡ 91.98	26-12-50 to 31-10-51	The mouth of Kulea river in the Ganjam to the Natea in 24 Parganas	241.7 tons
5.	*Baruna*	72'-7"	19'-6"	..	260 BHP	‡ 75.84	,,		
6.	*Jayabharati*	45'-0"	11'-5"	5'-0"	22½ BHP	† 11.67	1-4-1950 to 15-3-1951	35-40 miles from Bombay	33.4 ,,
7.	*Vijayanti*	36'-0"	12'-0"	5'-0"	24 BHP	—	27-10-1950 to 15-3-1951	10-15 Miles	7.5 ,,
8.	*Bharat Mata*	42'-0"	11'-0"	5'-0"	22.5	—	2-2-1951 to 31-3-1951	35-40 Miles	3.3 ,,
9.	*Shanta Durga*	45'-0"	11'-5"	5'-0"	22.5	† 11.67	16-12-1950 to 15-3-1951	15-30 Miles	10.7 ,,
10.	*Jala Prashad*	45'-0"	11'-3"	4'-8"	80	† 12.09	2-4-1950 to 15-3-1951	30-35 Miles	22.5 ,,
11.	*Taiyo Maru* No. 17	120'-0"	21'-5"	12'-1"	330	‡ 276.11	27-11-1951 to 10-5-52	Off Bombay, Kutch, Saurashtra	605.3 ,,

† Net tonnage.
‡ Gross tonnage

along with necessary training facilities for the local fishermen.

Kesteven (1948, 1950) while reviewing the trawling operations in Pakistan, India and Ceylon points out that all the seventeen trial operations in trawling in Indian and adjacent waters, excepting a few have been failures commercially. He indicates the causes of these failures to be mainly organisational and personnel difficulties in addition to the unsuitability of the large sized vessels like S.T. *Meena* and *Arundel Castle*. He recommends that smaller types of trawlers less than 100 ft. in length, involving less initial outlay would be more suitable for conditions of work and mode of operation, even though large vessels may have more of fishing potential. Further, these smaller vessels can be utilised for operating Danish Seines or lines or may be used as motherships employing dories for actual fishing.

Setna (1950) while referring to the growth of the fishing industry in Bomaby, emphasises on the need to tackle the problem of the use of power propelled vessels and mechanised gear in the country rather cautiously, " as the economy of our fishing industry is not yet fully prepared... Approach to it has to be cautious due regard being paid to the age-old customs......the most prudent course, in the circumstances, would be to associate the fishermen, from the very outset, with every scheme designed for the improvement of their craft ". He stresses on the use of small powered vessels in conjunction with the various types of drift nets and lines for effective use for fishing in the early stages of development. And though the effectiveness of large trawlers has been demonstrated, the economics of this type of vessels should be clearly understood.

While analysing the results of experimental introduction of powered fishing vessels within India and Ceylon, it is equally important and necessary to compare the results of such fishing in other countries of the Indo-Pacific region, so that further attempts can be directed towards development of suitable and successful methods of mechanised fishing.

Bottemanne (1951) commenting on the trawl fishing in the tropics, refers to the success of trawling near Surabaya in 1938-39, besides the one in Ceylon. The trawling conducted on a commercial scale off Java in a 40 H.P. wooden cutter, 42 ft. long was found to be successful and it became a paying proposition. In 1949, a 50 ft. cutter, fitted with a 90 H.P. motor landed one ton of fish per day's absence. The quality of fish brought by these small cutters has been reported to be very good in view of the short trips. Power vessels of smaller sizes, less than 54 ft. in length, have been recommended for trawling in tropical waters instead of large steam trawlers.

The fishermen themselves realising the great advantages of a self-propelled fishing vessel in the seas of Hongkong, especially under the difficult conditions, have taken up the mechanisation of the Junks. The mechanised fleet had increased in number from 17 in 1948-49 to 81 in 1949-50 (Anon, 1950).

In the Philippine waters, first attempt at trawling was made in 1909 by an English trawler, and it had to be abandoned. After the first World War, Japanese trawlers entered into the picture and they were mostly sail driven till 1920. Experimental trawling was conducted in 1940 by the Government. In 1947-49 two trawlers, *Theodore McGill* 97 ft. long and *David Starr Jordan* 54 ft. long, conducted experimental fishing which proved that trawling is effective within 35 fathom line, average production being 151 pounds per hour. In 1950 the trawling fleet consisted of 200 vessels ranging in size from 5 to 80 gross tons (Warfel & Manacop, 1950).

In Japan, offshore trawling was first conducted successfully in 1908 with an otter trawler built in England. This type of fishing developed rapidly, mainly because of the encouragement given by the Government, and the fleet included 150 trawlers in 1912. Since 1918, their number was restricted to 70 by regulations. Before 1918 the tonnage of most of these trawlers was less than 100 gross tons, in 1928 they were of 250 gross tons and in 1937 of the 70 trawlers 12 large diesel trawlers were of 400 to 500 tons. Most of these were owned by large fishing companies (Bourgois, 1950).

Recommendations

In recapitulating the results of experimental fishing with power vessels in the Eastern waters, it may be pointed out that the development of mechanised fishing has to be planned simultaneously on the following lines :

(1) The provision of power to the existing types of craft, suitably modified, if necessary, so as to increase their efficiency and coverage. As far as possible the existing types of gear is used. If exotic types are introduced, it is desirable to demonstrate the operation by a trained set of men.

(2) The introduction of power vessels, 30 to 50 ft. in length fitted with diesel motors for pelagic fishing and line fishing within a range of 40 miles.

(3) The fishing experiments with ring nets and purse seines from 50'-60' long, power vessels.

(4) The system of "Dory fishing" to be recommended for adoption for fishing in known fishing grounds in the first instance; at times the mother vessel may be used for exploration.

(5) Fishing experiments have to be conducted with small trawlers, 70′-90′ long and systematic surveys and charting of the seas upto 100 fms. have to be initiated.

(6) Fishing with large trawlers will be advantageous at a later stage with more data on fishing banks in view of increased fishing potential.

(7) Simultaneously, the socio-economic structure of the fishermen should be gradually changed to adjust to these changes in development.

(8) Adequate training should be given to the fishermen in handling the power vessel and mechanised gear.

(9) The smaller vessels can be efficiently operated through the cooperatives with the aid of the Government in the initial stages and by providing adequate loans.

(10) Larger vessels can be operated only by Government in the first stage in the far east and after providing the efficiency private capital can be attracted.

(11) Facilities for anchorage and harbours should be provided.

(12) Associated with the development, provision should be made for adequate facilities for handling, preservation, storage, transport and marketing.

Conclusion

In concluding, it is my duty to point out the magnitude of this problem in the development of the fishing industry and the limitations. Even though it has not been possible for me to present all the details, I have made an attempt to review the history of the experimental trawling in the Indian seas from 1902 onwards, the results of those fishing surveys, the causes for their failures, the renewed efforts and attempts to improve on the type of vessels from 1945 onwards and the plans for development of the right approach to this intricate and interesting problem of mechanised fishing in the light of the peculiar socio-economic structure of the fishing community of the Indo-Pacific region. I have also tried to indicate the manner in which this problem can be tackled with the different kinds of results achieved in different countries. Some of these suggestions are already being carried out in the T.C.A. programme.

If this paper initiates sufficient interest and discussion to formulate an integrated plan of approach for the proper development of mechanised fishing in this region, I would consider that I have succeeded in my duty, in accepting the proposal of the Indo-Pacific Fisheries Council during the last meeting in Madras in February 1951.

SUMMARY

There has been practically no off-shore or deep-sea fishing in the true sense of the term and in any scale of commercial importance in the Indian seas till recently. Efforts had been directed towards extending the field of fishing operations with the aid of power vessels both for conducting surveys and fishing on a commercial scale during the early part of the century.

The fishing and the survey indicated the presence of rich fishing grounds off-shore, but these exploratory fishing have been failures in the economic sense till 1930.

Based on the experience and results achieved earlier both by the Indian and Ceylon Governments on power fishing by the use of trawlers, they launched fresh efforts after the termination of the last war, mainly off the coasts of Bombay, Madras, Travancore, Ceylon and Bengal. Recently a Japanese firm also has been conducting commercial fishing with a trawler off Bombay and Cochin coasts.

The results of experimental fishing in the Indian waters have indicated the potentialities of rich fishing grounds in the off-shore regions both for trawling and for pelagic fishing.

During the last decade considerable interest has been evinced in the introduction of power for fishing in the eastern waters; and based on the results of such experimental fishing, the lines on which the development of mechanised fishing has to be planned simultaneously, are indicated in the present paper.

This paper is an attempt to review the history of experimental trawling in the Indian seas from 1902 onwards, the results of those fishing surveys, the causes for the failures, the renewed efforts and attempts to improve on the type and design of the vessels from 1945 onwards and the plans for development of the right approach to this intricate and interesting problem of mechanised fishing in the light of the peculiar socio-economic structure of the fishing community of the Indo-Pacific region.

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15

THE SOCIO-ECONOMIC PROGRAMME WITH SPECIAL REFERENCE TO CONDITIONS IN THE INDO-PACIFIC REGION

by

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The Socio-Economic Programme is concerned with social elements as economic factors in production. It is its responsibility to describe these elements from the point of view of the contribution which they make to the production process and to determine, if possible, the factors which influence the functioning of those social elements within the production process. Further, it is its responsibility to take action initially to affect these factors in a way which will bring about improvements for those elements and in the industry, and subsequently to consolidate and preserve these gains. The programme therefore holds equal status with other programmes in the fishery field and, like them, falls into divisions concerned respectively with Research and Administration, and the latter may require, during a period of accelerated evolution, a special development division.

Before attempting to describe the activities in each of these divisions, it will probably be best to enumerate some of the recognised socio-economic problems and to consider each of them in some detail. By this means it should be possible to identify some of the scientific principles by which this programme is constituted, and in this way to establish a firmer basis on which to construct an enduring programme of work.

THE MAJOR PROBLEMS

The Risk Element

As human enterprise, the fishing industry is probably most characteristically identified by the word "risk". Fishing, and the secondary and tertiary industries which work on the fish catch, are uncertain occupations. It is true that fish culture closely resembles agriculture and is perhaps more stable in its annual cycle of events. But even this is subject to the exigencies of climate, and to all manner of natural phenomena which may cause the fish culturist a complete loss of his livelihood. The source of fry may fail. The fry may die from some obscure disease or from some unfortunate mishap in handling them. A well-stocked, well-managed pond may become subject to disease or some extraordinary event may disturb the complex of ecological factors and drive this cycle in to a regression whose changes may lead to a mortality of the entire stock. And so it goes on. It would be futile to attempt to argue whether fish farming is any more risky than any other kind of agriculture but certainly it contains a large element of uncertainty. When we turn to natural stocks of fish, we find a measure of risk or uncertainty which is considerable and the history of commercial fisheries is crowded by what might be called an almost regular appearance of irregular unpredictable events. A fisherman must always be prepared that on any particular occasion when he goes fishing he may fail to take a catch, and that over an entire season the sum total of his catches may be insufficient to yield income to cover the costs of his operations. In addition, there is always a risk to life which, of course, increases with the distance that the fisherman moves away from the shore. There is also the risk of spoilage of the catch, and another risk concerned with the disposal of the catch and its exchange for money. This element of risk, directly in the operations, and economically and otherwise within the industry, must be the dominant note to which the ears of the socio-economist must be turned, and most of the specific problems which can be discussed in relation to the industry have their origin in the circumstances which establish this characteristic, or at least are particularised for the industry by this characteristic. Probably it would be correct to say that the principal objective of fisheries administration is to reduce—it could never eliminate—this risk, and the task in the socio-economic field is to measure the intensity of this risk and of its effect on the social element and on the operations, and to try to devise means of alleviating the consequences of the risk element.

The existence of this risk element has considerable influence on the industry. It undoubtedly exercises a selection of the persons who take this as an occupation. It has a profound influence on the attitude of the insurers towards the industry, leading to high interest rates and special conditions of loans. It places the operatives in a vulnerable position when they bargain in a buyers' market but it strengthens their hand when they bargain in a sellers' market.

Status of the Operatives

Throughout the world, with a few exceptions, it has been accepted in the past that fishing is a lowly occupation. This may seem curious when one thinks of high seas fisheries and of the measure of enterprise and courage required of those who accept the arduous and dangerous existence in such fisheries. But it is natural enough when one turns to the labours of those people who form the bulk of the active fishing population of the world, those who operate along the coasts and in the rivers and lakes. Here one finds single operatives or small groups of fishermen working with a low-level of skill, very often with a low intensity of persistence, to win a relatively small allotment of natural produce per person; their literacy is low; they have little property. The condition of these people is the result of a combination of factors; of the social factors which cause concentration of populations on the coast and along the rivers, and of those which impose restraint on these populations of fishermen, denying them educational and other opportunities. Their ability and their wish to evolve new gear is low and they are unable to extricate themselves from this situation which keeps them poor and, because they are poor, prevents them from buying the craft and the gear which would take them where they could exploit other resources to catch more fish to get more money and cease to be poor. In the world the total of such people must number millions. One of our major problems is to break for them this vicious circle of circumstance which holds them illiterate, semi-skilled and impoverished.

Indebtedness

It is recognised that the attack-point on this vicious circle is the indebtedness of the fishermen. In its way the indebtedness itself constitutes another cycle which is, as it were, geared to the larger cycle of circumstances, and as things go in the world it is the smaller special cycle of indebtedness which drives the larger one. We know that most fishermen in undeveloped fishing industries are in debt. They borrow money constantly; and in doing so they place themselves in contractual positions from which it is apparently impossible for them, unaided, to discharge their debts or to achieve a position where they would not need to borrow, or in which at least their borrowing would be to their advantage. Year in, year out, they borrow money to be able to fish to be able to pay back some of the money in order to be able to borrow more, and thus continue their lives trudging away on this treadmill of debt. We know that these debt situations (it would be fallacious to speak of specific debts) may persist for many years. It has been said that they may be handed down from father to son and, in fact, be more than half a century old. It is not simply a matter of money. We know that in some communities the debt system cannot be regarded in the same light as the financial transactions of communities of highly-geared financial systems. In truth, such debt situations are really a form of monetary system. Again, there are problems of tradition, custom and profound psychology which must be recognised and measured in our investigations, and it is extremely doubtful whether any socio-economic programme which proposed to provide the operatives with money with which to discharge their debts would ever succeed unless it were supported and extended by concomitant technical developments and by educational and other programmes. Somehow these programmes must drive to the inner core of the problem which we must recognise as being identified by the word "incentive".

Incentive

It is, of course, a truism that individual people differ in respect of what they expect to do with their life and what they expect to be able to receive from the physical world about them. Groups of people in communities or nations also differ in their attitude towards these problems. Each such difference is associated with a fundamental difference in the attack which the individual or the group will make upon the physical world to receive those things which he expects and which he is to have. In the one case we may have to deal with an energetic and enterprising people who want much and who are willing to do much in order to get those things which they want. Such people set themselves high targets and they will make great demands upon their physical and mental resources in order to hit those targets. Other people are content with little and they consider it unreasonable and wasteful to use their energies beyond levels which, in the eyes of other people, seem low indeed. If a man is content with simple shelter, with just so much clothing as is essential for his ideas of comfort and decency, not complicated by social formality, and with a simple and adequate diet, and if he can have these things by a small amount of daily work, it would be difficult to persuade him that he should undertake a great amount of daily work. There is, of course, the problem of why his attitude is as it is and, if we believed that we should induce him to work more, how we might persuade him to change his attitude. I leave entirely to one side the ethical questions of whether we ought to change him. The simple fact today is that people are being changed; and another

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simple fact is that these changes are being effected in ways which, to some observers at least, must seem crude. I may here recount a situation which existed in, I believe, Africa.

I understand that in one of the African colonies an enterprising merchant established a processing plant for handling surplus fish which, from time to time, was available in his neighbourhood. Unfortunately he was able to pay fairly good prices for the fish and it was not long before the fishermen were able to accumulate more money than they had use for in their community and consequently they lost interest in gaining more money, and they therefore ceased, or at least reduced, their fishing operations. This, of course, did not appeal to the merchant who then directed his attention to the problem of how he could make the fishermen want to have more money and therefore need to catch more fish. His solution was to install an electric power plant and open a shop which he stocked with electrical equipment which then, by an effective promotion programme, he began to sell to the fishermen. The fish production immediately returned to its previous level. However, as is the case with all markets, there was a saturation point and in his community the market for radios and other electrical equipment was not very great; and when the fishermen had enough of this equipment, the fish catch again began to fall.

Although my account of this incident might be inaccurate in some respects, one can well recognise its general outline and one can easily imagine this merchant shifting from one field of consumer goods to another, creating demands and thereby providing incentives for increased expenditure of effort. This, of course, brings us again to the question of why do people want certain things, and is it possible by various educational processes to make them aware of better things and better able to take advantage of them, and thus give them a wider cultural horizon, ranging on which they will be obliged to undertake a greater share of the total production programme. Yet, coupled with this is another process which in one way augments and in another way offsets this development of the expenditure of effort. I refer to the process by which mankind is harnessing the physical forces of the universe to perform his physical work for him in order that he should have more leisure to exploit his intellectual and spiritual capacities. It might seem to some that our efforts to induce certain groups of fishermen to work more in order to be able to get more money in order to have more equipment in order that eventually they should have more leisure would, in effect, bring them back to their present position, and thus would be to despatch them on a needless saga of human trial. It might be argued that we should proceed directly to educational activities concerned with their use of leisure and let them in their succeeding generations accept in due course the economic benefits of the technical revolution which would take place simultaneously. I think this must be a basic argument for those who wish to bring to some of the countries of this region large-scale mechanised operations which can be introduced without the participation of the indigenous fishermen. On the other hand it might very well be argued that it is essential, as part of human experience, for this group of people to traverse the evolutionary path which has already been traversed by fishermen in other parts of the world, although it might perhaps be unnecessary for them to travel exactly the same path. A decision on this point would be difficult, and no decision could hold for all situations.

Conditions of Living

Our key problem of incentive stands in relation on the one hand with the general social context in which the fisherman lives and on the other hand with the conditions under which he is employed.

In their underprivileged condition the fishermen usually form an isolated segment of the community. Their isolation is frequently geographic as well as social. Fishing villages are often located on remote parts of coastlines, with inadequate communication with more developed centres of civilization. One calls to mind immediately a picture of fishing villages floating by the shores of the Great Lakes of Cambodia and on the banks of the vast network of channels in the Gangetic Delta, or a cluster of palm huts huddling on the sand dunes of Danushkhodi. At best the fishing village is a slum fringe to towns and cities. In all parts of the Indo-Pacific one can find these detached communities living in sub-standard dwellings with a bare minimum of what are now regarded as the essential elements of reasonable human living. And not only do the houses of the fishermen fall far below reasonable standards of hygiene, comfort and efficiency, but these villages also lack the essential services of civilised communities. Sanitation, fire-fighting facilities and so forth are poor, or missing altogether, and medical and educational services are in the same state. It is unavoidable that the environment prevailing under such circumstances must make its contribution to restraining the potential imagination, ambition and energies of the people who live there.

Conditions of Employment

Parallel with these conditions under which the fishermen live on land or in their houseboat dwellings, the conditions under which the majority of them are employed are also sub-standard. It would not be wrong to say that in general there are no reasonable standards of comfort and safety in fishing vessels of this region, whether working in ~~coastal waters~~ or at sea. Probably the situation of the fishermen who use catamarans from Southern India and from Ceylon represents the extreme. I suppose these people continue their fishing operations with a cheerful acceptance of the slender thread which secures their safety. I do not know whether they regard their work as uncomfortable but I cannot imagine that there can be many days in any fishing season in which the fisherman can really say that he enjoyed his work. Beyond this it is probably academic to speak of conditions of employment in a legal sense. As far as I know there are few, if any, contracts—enforceable by law—between employers and employees in Asian fishing industries, although the traditional arrangements under which the work of any fishing unit is shared among the members of the team, and conversely the rewards are disbursed, might be invariably accepted and honoured. It could hardly be said that any employer accepted the full range of his responsibilities towards his employees as these responsibilities are stated nowadays. Of course the converse is also true, and probably of equal importance: that is, that the employee's responsibility towards his work and his employer is not formalised and, just as the employee has no security of employment, the employer has no guarantee that his man-power will continue to be available.

Organization of the Industry

This situation, in which there is no legal or other form of stabilization of the conditions of employment of the operatives in the industry, is associated with the institutional forms under which the industry is organized and in many places lacks organization. Fishing is essentially a cooperative enterprise in which labour is shared by agreement, and the risks are also shared and the proportion of the rewards of any operation are shared in relation to both the labour contributed and the risk carried by each individual. The industry is founded on the efforts of owner-operators who use gear which is their own property and who contribute the greater part of the labour and take a large share of the risk. To him may be added a number of team mates who, owning no gear, contribute their labour and intelligence and share the risks. From this point there fans out a number of organizational forms in which, on the one hand, ownership passes away from the operative and, on the other hand, it is spread among the operatives who compose the team. The pattern of organization along any one of these lines may or may not be formalised in some kind of legal document, and in the absence of any such document the forces of tradition and custom may be fairly strong and sufficient to preserve the rights of individuals. In some cases the replacement of a customary form by some legal document might have deleterious effects but it would be probable that the effects would be deleterious only where the replacement was made ineptly. It seems fairly clear that an essential requirement of the situation in the Indo-Pacific is that these organizational patterns should be appropriately crystallised in legal documentation fully supported by the relevant legislation of each country. It has to be recognised also that, in their present unorganized state, the fishermen of this region generally lack any means of corporate expression of opinion or of securing presentation of their views in proper form. In other parts of the world fishermen are organized into political and technical associations, leagues, unions and so forth, which serve to protect their interests and to present their views to administration, to Government and to the public generally. Such organizations act as mediators in the design of employment contracts and they act to supervise the observance of such contracts. But what is perhaps more important to administration is the contribution which can be made by the fishermen, through such associations, to the formulation of governmental policy in respect of industry and to the creation of an effective body of opinion to support the implementation of their policy.

Distribution of Earnings

An essentially practical aspect of these problems, and one in which the fishermen are themselves keenly interested and about which at times they become greatly agitated, is the distribution of earnings. It is possible that the status of problems in connection with this may be taken as an index of the socio-economic status of the fisheries industries of a country. Probably all fishing communities have their formulae according to which a partitioning is made of the earnings drawn from the fishing operations and a first distinction among countries in respect of these formulae would be based on the degree to which the ownership of the equipment took over a major share of the earnings. Within the two broad categories thus established there would be many grades of what might be called selfishness or, conversely, enlightenment, which would signify the degree to which there was recognition of the justice of the claims of the true operative in respect of his contribution of labour and intelligence and his bearing of the risk involved. In some countries these formulae are not set out in written form but are observed according to customs. In other countries formulae may be established in a legal contract. Thus, at this stage, there are two principal aspects of this problem. The first concerns the fairness or otherwise of the present system of distribution of earnings, while the second concerns the need for new patterns of distribution and also the legislation of such new patterns—the whole being based upon new patterns of organization, new equipment, new allotment of labour and new concomitant risks.

The Theory of Cumulative Social Causation

The preceding brief survey of some of the outstanding socio-economic problems of the fishing industry emphasizes the particular relevance of the theory of cumulative social causation. This theory recognises that any social situation consisting of a large number of closely interacting elements may be caused to change in a certain direction contrarily to the energies of a system or, alternatively, restrained from change, again contrarily to the energies or the system, by virtue of the summation of a series of mutually stimulating factors. The theory was excellently expounded by Professor Gunnar Myrdal in his study of Negroes of Northern America and his account of their situation, and how this situation contributed and yet was itself caused by the attitude of the white population to the situation of the Negro might well have been written in respect of the situation of certain fishing communities. In general, we have the situation that the fishermen are poverty-stricken which causes their social status to be low, their health to be poor and their capacity to change their situation to be very small. This condition makes each individual vulnerable to inimical factors of his environment and it denies him the means whereby he might be able to change his situation.

The theory of cumulative social causation is not, however, a purely descriptive technique but furnishes various corollaries which serve as a guide for the conduct of social work. One of these described by Professor Myrdal is of particular importance ; he states it in the following words :

> " A rational policy should never work by inducing change in only one factor, least of all should such a change of only one factor be attempted suddenly and with great force."

This corollary might well be condensed, perhaps into a few Chinese characters, and then inscribed over the portals of all institutions concerned with economic development.

One of the immediate applications of this corollary would be in connection with appreciation of the balance between the forces of industry for co-operation and those for competition. We have said that probably, one of the most characteristic features of the industry is the risk which accompanies every phase and out of this springs an intensity of competition which at times brings disaster to the individual, to the industry and to the resource. On the other hand we have also remarked that fishing operations as such are essentially co-operative, the basic urge for which derives from the fundamental necessity to share work and to fend off the hazards of environment.

GOVERNMENTAL SOCIO-ECONOMIC RESPONSIBILITY

In my view Governmental responsibility in the socio-economic field is analogous to that of an employer towards his employee but will vary to the degree that governmental policy dictates the extent to which administration should intervene in the functioning of the industry. Briefly stated, modern political and legal theory holds that the employer must assume certain responsibilities towards his employees : he must ensure their safety whilst they are at work ; he must provide them with minimal conditions of comfort and hygiene whilst engaged on that work; and he must pay them a proper wage. The requirements in each of these respects, and the stringency with which governmental regulations relating to them are applied, vary from country to country; but, beyond governmental requirement in these respects, it is now very generally accepted (by some as merely expedient, by some as profitable and by others as ethically obligatory) that this employer responsibility should be regarded as extending toward ensuring the highest possible efficiency of the operative in his work, thereby ensuring that no time is lost because of illness on the job, no money is lost because of injuries received on the job, and that the greatest efficiency of the human machine should be obtained by best possible conditions, and by having the employee happy and intelligent. For the vast majority of the fishing operatives of the Indo-Pacific region, the assumption of these responsibilities seems unavoidably a demand on government and in considering the governmental programme in this field we should take this as a basic assumption.

Research

For the research worker in this field the fundamental questions are :

(1) What is the status of the people of any fishing village, community or province with which administration might be concerned and what action is there which could and should be taken to change this status ?

(2) What are the determinants of this status and how susceptible are they likely to be to influences brought upon them ?

(3) What are the effects of this status or the industry generally and how would these be influenced by any changes which might take place in the status ?

In any field of work the first task of the research unit is to furnish a description of the system under consideration, describing the units of which the system is composed, the environment in which the system functions, and the operation of the system under various conditions. Such analysis should lead, if possible, to quantitative measures of the relationships between the elements of the system and those of its environment and should seek to furnish equational descriptions of such relationships which would permit perhaps of predictions of the changes which might be expected in one part of the complex when changes are observed and measured elsewhere in the system.

In this particular field the research work moves along three distinct lines : First, to give an accurate description of the system ; secondly, to discuss the means whereby the economic potential of the social factors is mobilised and, thirdly, to measure the influences which determine the efficiency of operation of these factors and, beyond that, the manner in which this efficiency itself exercises an influence on the efficiency of the system as a whole.

Before discussing some of the possible types of research work along these lines, there are certain general aspects which should be touched upon. In the first place, it is important to emphasize the degree to which this programme, as a responsibility of a fisheries administration, must be reliant upon the activities of other departments and institutions. The Fisheries Department, for instance, may be interested in the influence of health on the general efficiency of the fishery operatives but it may be questionable whether the Fisheries Department should take any steps to ascertain the condition of the health of fishing operatives, and certainly it should not undertake a health programme. It should, however, take the data furnished by the Health Department and interpret them in relation to the particular conditions of the fishing industry. It should then offer advice to the Health Department and, in this connection, might need to make representations in Cabinet and other quarters. This does not say that absolutely the Fisheries Department would have no executive function in respect of the health of its operatives, but the role which it would play would depend upon the general organization of Government. Thus, applying the same argument to education, in general the provision of instruction to fishery operatives must be the responsibility of educational services. Nevertheless, the activities of various fisheries departments, for instance in Bombay, Madras, Hong Kong and elsewhere, in establishing fisheries schools where insufficient educational facilities exist is, of course, to be approved. This may be summarised by saying that the Fisheries Department's socio-economic programme is concerned with the economic aspect of the operatives within the fishing industry and not with the operatives as members of the wider community to which they belong.

A second point to make at this general level is the significance which derives from the fact that this work lacks experimental opportunity, so that its methodology must be based upon observational technique. This is true even in respect of what are sometimes called " Social Experiments", among which might be included development activities in education, housing and health. Such experiments do not in fact conform to the exact criteria of scientific experiment in which the influence of certain factors is controlled.

The first task is to develop an accurate and up-to-date description of the fishing population. A simple formalized representation of the structure of any economy must show successive levels of organization in which the basic level consists of individuals. For the fishing industry these levels may be signified in the following table which has correspondence with the formalized diagram. It is to be remembered that just the same as there is a multiplicity of individuals and fishing units there also is a multiplicity of unit fisheries and these, combined, make up an industry which is one among a number of industries within the economy.

Now, our task is to prepare a description of this system which is the unit industry and to adopt a measurement of the forces which determine its working and in order to do this we must keep in mind the social hierarchy which parallels the industrial levels shown here in the diagram.

If we begin with the individual we may describe him in respect of many characteristics of which those which at the moment seem most likely to exercise influence on his capacity as an economic element have been listed, and these characteristics will sum through the family, community and nation into certain cumulative characteristics on this ascending scale of organization. Each of these characteristics of the individual is capable of division into a certain number of categories some of which of course are very obvious, but for some of which a simple classification has been prepared.

Some of this information is required simply in order to furnish the precise specification of the populations, whilst other data may assume special significance in particular situations. Thus, religion might seem to be entirely irrelevant, yet in Ceylon the religion of the fisherman indicates the institutions with which the fisherman is associated. In India an understanding of caste and race is essential to any appreciation of the social position of the fisherman. In some countries where populations are mixed, for example the Malay Peninsula, the racial composition of the fishing population is important. In Hong Kong the different origins of the fishing groups are associated with important differences in their ways of living and in the kind of fishing activity in which they engage.

In the Indo-Pacific region there are undoubtedly several million men and women engaged in fishery activities. At present we have no reliable count of these people nor any realistic estimate of how many people are dependent upon them but there is no doubt that the total fishing population runs into many millions. Our first interest is to have an accurate estimate, or preferably tally, of these numbers and to have the individuals properly described in respect, first, of the standard demographic features and then in terms of social, economic and other status.

Such count will generally be made in the course of the usual demographic census which, however, the Fishery Department may need to assist by furnishing definitions and instructions for the field workers. The Fishery Department may wish further to make use of the census machinery to have particular information collected for the special purposes of its programme. At times, however, the specialised extensions might be beyond the capacity of the Census and at those times, if sufficiently urgently required, would become a charge upon the Fishery Department. As an example of such extension I may refer to a task which was examined at the Indo-Pacific Fisheries Statistics Training Centre. We wished to know the numbers of people in the households to which the operatives of fishing units belonged, the numbers of such household members who were dependent upon the labour of these operatives and those who contributed, either from work in other fishing units, or from other work in the fishing industry, or from other work altogether. We made up the following classification which, it will be readily recognised, permits a great deal of overlap. The identification of individuals according to a classification such as this involves much time and can be accomplished only by someone familiar with the community and with a long assignment with the community, such as a fishery field officer. It will be recognised that an inquiry such as this should sort out relationships, between fishing units *per se*, between the units and the households from which they are drawn, between the households *per se*, and between the households and other sections of the community. The results of this inquiry may have considerable bearing on the understanding of the source of manpower for the industry and the forces with which the industry must compete for such manpower.

In effect the task is to establish an enumeration and detailed classification of the manpower concerned in fishery industries, or dependent upon such operatives; then there is required an analysis of the factors which determine the distribution in that classification and a measurement of the rate at which this distribution may change; thence there is required an analysis of the susceptibility of the distribution, and its rate of change to various influences. Thus what is the level of literacy in a particular fishing village or community and is it changing and if so at what rate? Can the level and its rate of change be related reliably to any features of the community at large and would they respond to special influences which might be introduced? Again, what would be the effect of altered literacy on the situation of the group as a whole and how would it be accommodated by the system? Similar enquiries might be pursued in respect of technical skill and health.

At this stage it might be well to sound a note of warning: such a large part of this work is statistical that there is a risk of the socio-economic programme becoming identified with the statistical function of Government, just as fishery biology has tended to be in the minds of some people.

At the next stage of these enquiries we start with the detailed classification and enumeration and proceed to measure what this represents, potentially and actually, as effective economic contribution, and how that contribution is mobilised. There is a sector of the classification which contains the potentially effective proportion of the population. The normal expectancy of usefulness of each sub-group of this classification can be worked out by the use of actuarial methods. A given number of individuals represents less than the same number of fully occupied man-years because of illness, diversion to other occupations, industrial disorders, and other diversions such as traditional holidays and feasts. Having allowed for these factors we must consider the factors which determine the efficiency of the work done. These factors fall under at least five main headings: medical, psychological, social, economic and technological. The medical factors concern the conditions of living, the conditions of work, the diet and so forth. The psychological include those questions of incentive mentioned earlier, and those concerned with the intelligence of the individual. The social include the organizational forms and the customs, traditions, etc. The economic factors include the distribution of earnings, industrial organization, and the factors which cause indebtedness, with which are related, of course, the state of the market and the price which is offered for the fish and the ease with which the fish can be sold. The technological factors include, of course, those concerning the equipment available to the operatives.

We must keep in mind the fact that these forces operate at two distinct levels: what may be called the microcosmic level of the individual fishing unit and the macrocosmic level of the industry and community within which the unit operates. Again, we must emphasize at this point the complexity of the problem with which we are confronted in the sense not only of the multiplicity of elements of which we must take cognizance but also in the sense of the fact that second, third and perhaps even higher degrees of relationship exist between different sets of elements. It is inappropriate in a treatise such as this to embark on a detailed analysis of the methodology of observation of these relationships and of the data drawn from such observations. But, in order to reassure certain members of my audience, I may refer to the fact that this section of the work will include the determination of measures such as production per unit effort, indices of price and cost, and various individual and group indices of efficiency.

Administration

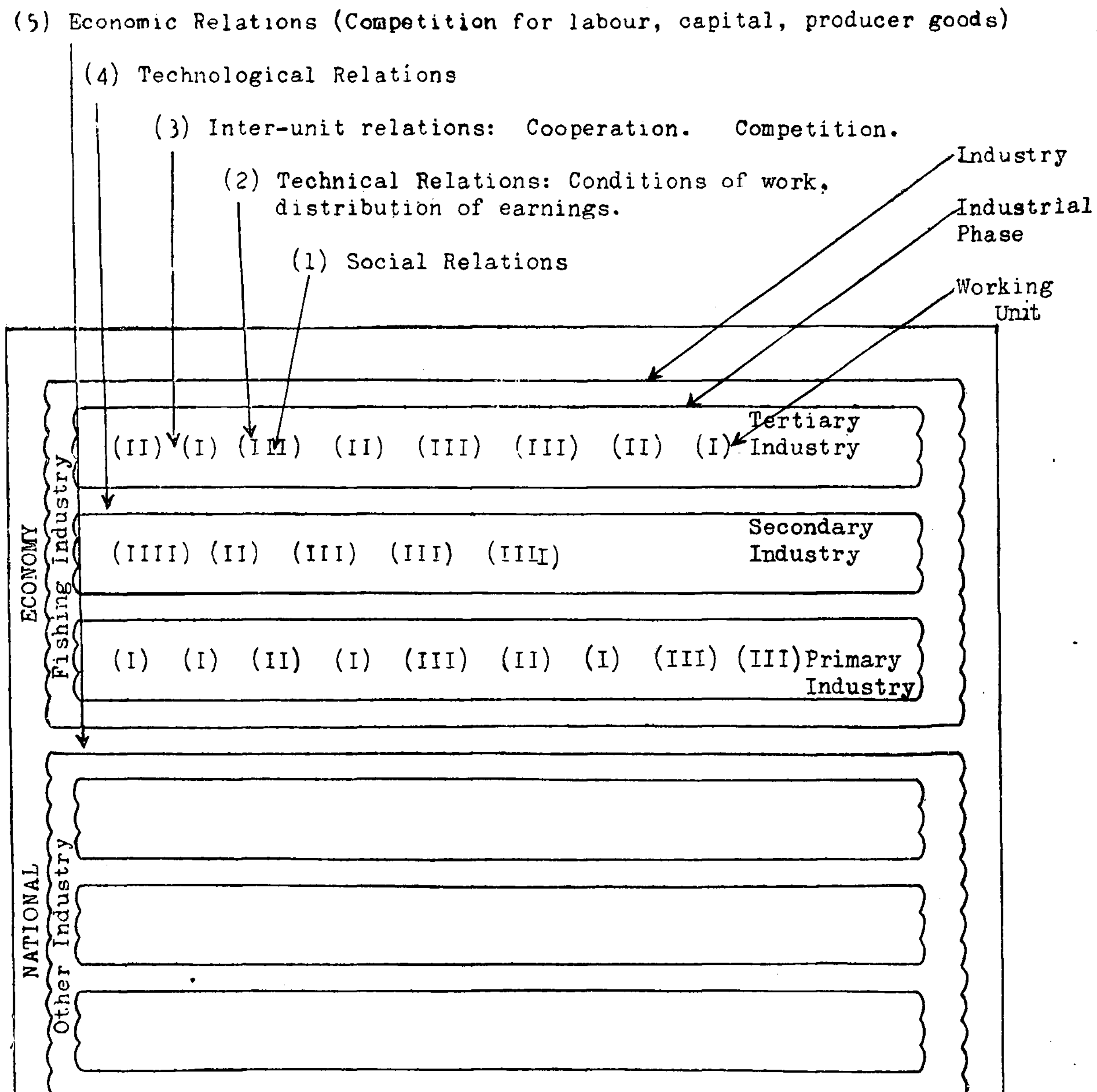
Whilst we may generalize to say that it is the responsibility of the administrative side of Government's socio-economic programme to maintain touch with the operatives and to assist them, in all ways, to reduce the risks attendant upon their occupation and to eliminate the disabilities of their situation, we can be more specific in speaking of the tasks to be undertaken. These may first be set out in simple list as follows :—

- registration,
- attention to health, educational and other requirements of the operatives,
- supervision of employment contracts and labor law concerning the industry,
- supervision of co-operatives,
- implementation of financial assistance projects,
- special educational programmes,
- promotion of co-operatives,
- insurance,
- provision of safety-at-sea arrangements (lifeboat service), etc.

These are the special tasks in connection with this industry which recent experience has shown to be capable of making useful contribution to the development of the industry. They are indeed only a part, albeit a special part, of the full range of any governmental activity and it is of course assumed that all the other functions of government, including the administration of law, collection of tax, and so forth will, *pari passu*, bear upon the fishing population. Again, this list is not necessarily a list of Fishery Department functions, but of the functions which the Fishery Department will advocate, advise upon and, where necessary carry out. Sometimes the Fishery Department will perform this work by itself, sometimes it will place one of its officers within another department to advise and assist the officers of the other department, conversely another department may assign one of its officers to work within the fishery department.

It is both unnecessary and undesirable for me to go further into detail in these administrative matters, and it remains for me only to list some important principles which should guide the planning and conduct of the work. Some of these have already been stated, but the importance which attaches to them requires that they should be restated. Firstly, it is always to be kept in mind that the material which is the subject of this programme is human, neither inanimate nor inarticulate, and while some part of the work constitutes an external contribution of thought and decision to the group —the group itself also can think and express opinion, and the sooner the programme can induce such internal energy for development, the better; in fact it may be said that Government's share is to stimulate the latent capacities for thought and decision and that once this is done the matter will be taken out of Government hands. Secondly, although extremely obvious it is also so extremely important that I will risk being thought platitudinous in reminding you of the responsibility of the field-workers in this programme and thus, of the importance of selecting them carefully, training them well, and supervising them effectively; they must be well-informed men, patient and sympathetic; they must be very human, and since they must implement an essentially human programme, they too must be treated as humans by their department. Thirdly, I must refer to the importance of the administrative programme being planned on the basis of an accurate understanding of the situation, derived from research; if the information should be inadequate, the programme must be modest in conformity; and this links with the final point, which is to stress the importance of the corollary, stated earlier, to the law of cumulative social causation: namely, that a programme such as this ought not to deal haphazardly with isolated factors but should instead treat the system as a whole.

And in conclusion I wish to say that there is nothing new in what I have said. Certainly nothing new in my reference to the problems of the industry, for these are probably as old as the industry itself. And nothing new in the listing of research and administrative activities. I can hope only that I have been successful in putting together in a useful way, to serve as a basis for some original and creative thinking, the most important of the points which so many of us have discussed and belaboured for long hours in most countries of this region during the past eight years.



This diagram is intended to indicate the kinds and directions of relations which must be considered in this work. Each 'I' in the figure represents an individual person, on operative working alone or with others. The first set of relations are the social relations of the individual; the second set consists of the relations between individuals of a working unit; the third set consists of the relations between working units (in the primary phase, these are the relations between fishing units); the fourth set consists of the relations, within the industry as a whole, between its separate phases; finally, the fifth set consists of the relations between different industries within the total national economy. These relations are discussed in the text.

TABLE I

LEVELS

Social	*Economic*
Individual	Individual
Family	Fishing Unit
Community	Unit Fishery
Nation	Unit Industry
	Economic Unit (National economy)

TABLE II

CHARACTERISTICS AT VARIOUS LEVELS

Proposed Identification of the Individual

Age
Sex
Relationship
Marital Status
Nationality (Race) (Caste)
Religion
Literacy (Languages)
(Birth Place)
Economic Status
— Industry
— Occupation (Skill)
— Social Status
Medical Condition

of the Household

Size
Composition
Economic Status

of the Community

Size
Composition
Economic Status

of the Nation

Size
Composition
Economic Status

Marital

Married, now
Married, but now
Divorced
Widowed
Never married

TABLE III

STATUS

Domestic

Head of Establishment
Related
Directly
Prior
Subsequent
Indirectly
Non-related
Servants
Guests

Economic

(for economically-active only)
1. *Industry*
— if not Fisheries, what industry (including domestic duties).
— if Fisheries, what phase (I, II, III)
— if Fisheries I, what fishing unit
— supplementary industries
2. *Occupational Status* (TVO)
3. *Social Status*
a. Employer = operator (single : associate)
b. Employee = paid operative
c. Unpaid family worker
d. Independent

TABLE IV

OCCUPATIONAL CLASSIFICATION

Primary Industry

Owner-directors
Owner-operators
Fishermen
Leaders
Specialists
Fishing hands
Laborers

Secondary Industry

Owner-directors
Managers
Specialists
Factory hands
Laborers

Tertiary Industry

Collectors
Carriers
Storage Plant Operators
Wholesale Agents and Staff
Managers
Supervisors
Clerk
Laborers
Market Retail Operatives
Itinerant Retail Operatives
Supervisory Staff
Suppliers of produced goods
Suppliers of Capital

TABLE V

OWNERSHIP

Single owner—operative
non-operative
Shared ownership—sharing by simple agreement
Co-operative
partnership (formal)
corporation
Alienated ownership—by mortgage
by lease

16

CAMPAIGN AGAINST INDEBTEDNESS AMONG FISHERMEN OF BOMBAY STATE

by

S. B. Setna[1]

Ignorance, poverty and conservatism are the principal factors which have stood in the way of the advancement of fishermen in Bombay State. Compared with other sections of the population they are extremely backward. Their unprogressiveness is due, in no small measure, to their isolation. The most populous fishermen's areas are the coastal tracts of Karwar, Ratnagiri, Bombay, Thana, Kolaba and Surat. The numerous handicaps under which they labour may plainly be set down to their illiteracy. Living, as they do, more or less in seclusion, they have not felt the pulsating advantages of those living in more organised and developed environments.

Fishermen the world over are confronted with similar problems, among which indebtedness looms large. Their vocation is a constant gamble with the elements, which are often the winners. The behaviour of the elements over any given period can never be forecast with any reasonable degree of precision. The uncertainty of the returns for their endeavour is one of the main reasons for their impoverished condition. Even at the height of the season, they cannot be sure whether catches will be copious and profitable or scanty and unremunerative.

Meanwhile, a fisherman has to live, and, taking a gamble on the success of the season, he has recourse to the moneylender, a fish merchant of means, who being naturally astute, throws a halter round his neck by liberal advances of cash. The cash is, as a rule sorely needed in order to pay not only for him and his family's daily subsistence but also for purchase of essential tackle and repair of damaged gear. He requires cloth for sails, twine for nets, hooks, coal tar, timber, nails, ice for preservation and salt for curing. Money is needed for all these items, but the fisherman does not generally have the ready cash at his disposal.

He falls back on the time-honoured expedient of a visit to the capitalist of his trade, who never misses any opportunity to get the primary producer into his clutches. Money is advanced, but for a price. This may take various forms. The fisherman may mortgage his wife's or his children's ornaments, even his own house. He thinks nothing, because he is helpless, of paying interest at the rate of 16 to 20 per cent. His helpless condition makes it impossible for him to invoke the law which explicitly forbids loans at usurious rates.

His bargaining power is nil, for often he mortgages the catch of the entire season to the moneylender, who cashes in on the desperate poverty of the fishermen. A millstone is thus slung round his neck and not only he but also his offspring often are weighted down with this oppressive burden until the debt is redeemed. Repayment of loans within a generation is often a forlorn hope, and so the sordid story of the fishermen's indebtedness is carried on from generation to generation.

Even in the worst season, the moneylender is never a loser. His profit is always assured, as he makes doubly certain of it when the loan is given. He then decides the rate at which he will buy throughout the season the catch landed by the fisherman, who is unable to reap the benefit on account of his contractual obligation of such high prices as may be realised by his "saukar". He gets a flat rate, which is generally fixed at about the lowest level.

It has not been possible to estimate the extent of indebtedness among fishermen along the entire coastal tract, as such information has, unfortunately, never been collected. The extent of indebtedness among fishermen is, however, appalling in some areas. Some attempts to gauge the incidence of indebtedness among fishermen have been made in two districts of the State, namely, Ratnagiri and Kanara (vide appendix) where the information compiled reveals a sorry tale.

The main reason for this hopeless economic backwardness of the fisherman is his appalling illiteracy. Our fishermen are not the only victims of this unpleasant state of affairs. They have their counterparts in even the most advanced countries, where they have to fall back on the resources of moneyed merchants in order to ply their trade.

[1] Director of Fisheries, Bombay, India.

This picture, with minor variations, portrays the condition of fishermen all over our State. The only difference is that whereas fishermen in the remote coastal tracts are ruthlessly exploited, those round about Bombay are not in the grip of moneylenders to the same extent.

Fishermen in urban and populous cities have benefited by association with a wider class of people, so much so that they have acquired a status to be reckoned with. They have benefited by the progressive movements around them. They are commercially alert and politically vigilant.

Their improved status is due, in no small measure, to the benefits of education, which has awakened them to the importance of financial solvency and economic independence. They have realised the benefits flowing from the trade conducted on a co-operative basis. Finding that they were being exploited by middlemen, they have come forward to seek Government's aid in the establishment of their trade on co-operative lines, so that they do not have to pay fantastic prices for essential accessories. The Government is also convinced that the fishermen's salvation lies in pursuit of their calling on co-operative lines, and has, accordingly, been helping them in this direction.

Never before in the annals of the fishing industry in this State has so much stress been laid on the need for improvement of the socio-economic condition of the fishermen as during the past ten years. This objective forms the main theme of every scheme formulated by this department for expansion of the industry. The vigorous efforts being made by the Government to improve the status of fishermen have been accompanied by a great awakening among them in the coastal region. Fishermen have now come to realise, more largely, the advantages of organising themselves and conducting their trade on a systematic and co-operative basis.

Interest in the subject was quickened by creation of the post of Assistant Registrar, Co-operative Societies (Fisheries). His duties were to explore the possibilities of formation of new co-operative societies and to supervise and control their administration. His headquarters were in Bombay, where he worked in close co-operation with the Fisheries Department. His post was retrenched as a measure of economy in 1950. This is unfortunate as fishermen will for a long time to come, require to be guided and advised in matters pertaining to their economic welfare. The co-operative principles require to be widely diffused among them, and a strong staff, adequately officered, is necessary for this purpose.

The co-operative approach is radically different from the commercial one, for the former will seek to promote the welfare of the fisher-folk, whereas the latter will direct its efforts towards improvement of the industry. Improvement of the condition of fishermen is bound to lead, in the fulness of time, to betterment of the industry. Much benefit has resulted to fishermen from the presence in their midst of such staff as have been instrumental in bringing home to fishermen the value of properly kept accounts. Maintenance of such accounts at once opened the eyes of fishermen, to the manifest advantage of organisation of their trade on co-operative lines. The start was on a modest basis, but the success which attended the venture caused the co-operative idea to catch on, as the following statistics will show.

At the end of 1951-52, there were 66 fishermen's societies with a membership of 16,215. The total share capital of the 66 societies amounted to Rs. 4.75 lakhs. They had a reserve fund of Rs. 35,000/-, and a working capital of Rs. 13.84 lakhs. During 1947-48, the value of their purchases of rationed food stuffs and essential fishing gear aggregated Rs. 20.78 lakhs. These societies are producers', marketing and multipurpose societies. The Superintendents of Fisheries serve as ex-officio members of the managing committees of the societies in their respective districts.

The number of fishermen's co-operative societies in Bombay today is 69, of which fifteen are in the Thana District, ten in Surat District, four in Kolaba District, eleven in Ratnagiri District and ten in Kanara District. The number of societies is now large enough to facilitate establishment of district organisations to protect the interests of members of the constituent societies. Such federations are already in the process of formation in several districts. One of their main functions will be to purchase, in bulk, items of equipment and other stores and supply them to fishermen through the various primary societies at concessional rates.

The various district federations will have over and above them an apex society. Such a central parent organisation has already been established in Bombay with a capital investment of Rs. 100,000/- under the name of the Bombay Provincial Fishermen's Co-operative Society. This association has achieved inspiring results within the short period of its existence.

It has established an office at the central fish market, equipped with a telephone and a depot at the main fish landing bunder. The fundamental objective of the association is to undertake the marketing of fish caught by its members in order that profits realised are distributed among fishermen and are not diverted into the pockets of middlemen.

This objective is foremost among the aims of Government, which also desire that fishermen ought to be the chief beneficiaries of their own efforts.

In consonance with this objective, the association has arranged for transport of fish caught by fishermen of villages in the north of the City. This arrangement will gradually be extended to villages both to the north and the south of Bombay. This enterprise of the fishermen is a big stride towards development of the industry on modern lines which is so eagerly desired now.

The aggregate value of fish sold by it during the last three years was Rs. 2,050,000/. The encouraging record of the central organisation to date is a happy augury of yet greater expansion of its activities in the future.

Financial solvency of fishermen in the State is not the only goal of the Government, which is at the same time striving to secure, also, the educational, economic and cultural development of the community. Indicated below are the types of help afforded by Government to encourage the spread of education.

Improvement of the condition of fishermen cannot be secured unless educational facilities are made available to their children. In fact, mental enlightenment and financial prosperity are interlinked. The main problem is to awaken in the minds of fishermen a realisation of their present backwardness. It is only when this is done that they will be stimulated to emulate the example of their more progressive countrymen.

Educational welfare of the community is achieved by establishment of fisheries schools at important fishing centres. These schools impart such education to fisher-children as is directly related to their trade. There are ten fisheries schools in our State. Their capacity for good and the beneficial influence they will eventually exercise are unquestioned.

The growing attendance at the schools furnishes proof, if any were needed, that they meet a long-felt need. Parents send their children to such schools more readily than to the usual primary schools, as they feel that the instruction imparted would be directly useful later in life. The encouraging support given to the schools furnishes the best justification for multiplication of such schools.

Modernisation cannot, however, be accomplished without mechanisation, and this is, in the opinion of the Government, the key to the future prosperity of the industry. Serious and concentrated attempts are being made to use powered vessels to land bigger hauls by extension of the usual range of operation of sailing craft. Achievement of this objective is sought by mechanisation of indigenous craft and by improvement of existing gear in the State.

For this purpose, the department built two 45 feet vessels in 1947 and equipped them with 22½ B.H.P. engines. Fishermen expressed the opinion that hulls of these vessels, though suitable for the catching of fish, were not adapted to the special needs of the various fishing localities. Further, hulls built by the department were costly and could be built by their societies at a considerably smaller cost. Accordingly, the scheme to provide power-propelled boats to fisheries co-operative associations was modified as under :—

(1) Government's acceptance of a proposal for construction by fishermen of hulls, half the cost being borne by their societies and the other half being treated as a loan. The hulls will be built by fishermen in consultation with the Department of Fisheries.

(2) Supply of marine diesel engines to fishermen's co-operative associations on the basis of 50 per cent subsidy. Bombay today has 150 vessels, all of which are owned and manned by fishermen. The use of these vessels has enabled fishermen to extend the area of their operation. Their quicker speed has enabled them to prolong their stay at fishing fields and also minimise the ever-present risk, in our unfavourable climate, of deterioration of their catch before it reaches the market.

Installation of a small engine (22½ B.H.P.) in a 45 foot vessel increases generally its productive capacity about four-fold. Records maintained by fishermen at Satpati furnish a basis for comparison of the catches of individual boats during a fishing season. The average catch of powered vessel amounts to 2000 *dara* per season, which lasts about five to six months, while sailing craft land, at the maximum, 500 *dara*. The better performance of powered vessels is not accidental, as they have shown consistently good results since they were first used for the purpose.

These facts furnish evidence of a healthy awakening among fishermen, who are coming forward in large numbers to seek Government's assistance in the purchase of engines. Already, 23 engines have been installed in hulls, while applications for allotment of a further 60 engines are under the consideration of Government. A significant development is that fishermen are acquiring these engines on a subsidy-cum-cash basis.

Fisher-children are also trained as mechanics and navigators of fishing vessels, in order that at the end of two years they may sit for the examination conducted by the Mercantile Marine Department of the Government of India. Successful candidates

are put in charge of powered fishing vessels. An essential feature of the great development visualised for our fisheries in the future is that the industry must, as far as possible, be conducted by members of the fishing community, in order that its status is raised and that it occupies its due place among activities contributing to the country's economic progress.

The advantages of the scheme of apprenticeship are manifest to youths of the community, who are coming forward in increasing numbers to avail themselves of the facilities being provided by the Government. The number of stipends which originally stood at five, has now been increased to 26. Each stipend is of the value of Rs. 30/-. Board and lodging are provided gratis by the owners of the vessels.

The economic development of the community is furthered by the grant of loans, on liberal terms, to enable fishermen to build boats, prepare nets and to attend to overhauls and repairs. The loans are advanced against security of boats and nets and, in some cases, landed property. The total amount sanctioned by way of loans during the six years ended 1952, exceeds Rs. 1,800,000/-.

Facility for insurance of boats and nets is one of the ways by which the Government has sought to help fishermen. Previously, fishermen and co-operative societies were required to insure their assets (boats and nets), whatever their value, by way of security against loans given. This practice did not benefit fishermen as insurance companies discharged their obligations only if the insured assets were completely destroyed at sea. No allowance is made by the insurance companies for reparable damage. Accordingly, Government ruled that the terms of insurance should be waived for loans not exceeding Rs. 5,000/- granted to fishermen or their co-operative societies under the State Aid to Industries Rules, 1935. The rate of interest is 3½ per cent in cases where assets are insured and 7½ per cent when they are not insured. Out of the 7½ per cent interest, 4 per cent is credited to a separate fund called " Fishermen's Relief Fund ". The fund is utilised in the following manner :—

(a) If any loan is required to be written off on account of loss of assets at sea, the loan should be repaid to Government from the fund.

(b) The balance remaining in the fund is to be utilised for grant of relief to fishermen, who suffer loss at sea, according to the merits of the case.

Already, striking progress has been achieved, through these measures by some co-operative societies functioning at fishing centres near Bombay. Thus, the advance made by the fishing industry at Satpati, a fishing port to the north of Bombay, during the past five years surpasses its achievement in the previous 100 years. Casting aside age-old habits, the fishermen have now begun to give a new look to their industry. A pioneering zeal has seized them, and they are manifesting intiative, enterprise and resourcefulness of which they would normally have been thought incapable. They are bitten by the bug of modernisation, and their one anxiety is to gear their industry to the tempo of the age.

The Satpati Fishermen's Multipurpose Co-operative Society conducts a ration shop, maintains a gear and tackle depot, runs a bus service between their village and the station, owns four motor trucks for transport of fish to Bombay—a distance of 100 miles—and has now taken over the management of the ice and cold storage plant erected by Government at a cost of Rs. 117,000/-. One-third of the total cost of the plant is treated as a subsidy to the Society within ten years. The society has also put up, at a cost of Rs. 75,000/- a building to house a ten-ton ice and 30 ton cold storage plant. The building provides for the following expansion :—

Space for cold storage of fish up to a limit of 300 tons ;

Space for 10 tons of quick frozen fish ;

and one glazing room.

The ice factory has been so successful that the society has approached the Government for another 10 ton plant to meet the expanding needs of the industry in its area.

Provision of the ice factory at Satpati has solved one of the biggest problems facing the industry in this area, namely, insufficiency of supplies of ice and the inadequacy of cold storage space. The presence of the factory has given a great fillip to expansion of the fishing industry.

The importance and value of education have fully been realised by the fishing community of Satpati, which has taken a keen interest in its spread ever since the establishment of a fisheries school in the village. Their proposal for an up-to-date building to house the school was accepted by Government. Accordingly, a building was put up at a cost of Rs. 90,000/-, of which the villagers contributed Rs. 22,500/-. The building has 18 class-rooms and is capable of accommodating 600 pupils at a time. The number of pupils on the rolls in 1945 was 330, which today has shot up to 525.

Equally encouraging are the results of the praiseworthy lead given by this society in employment of power-propelled vessels for the capture of fish. This has been attended by promising results and the village leads the entire State—nay the entire country

—in the number of vessels equipped for the purpose. There are thirty-two vessels plying at this village and applications for 28 more engines are under the consideration of Government. The activities of this village will form a conspicuous chapter in the history of power-fishing in our country when it is written. The society has set an example which is being emulated by neighbouring villages.

A marine fish farm, also, has been established at Kharekuran, a fishing hamlet near Satpati, by the Kharekuran Machlimar Vividha Karyakari Sahakari Society Ltd. Government have helped the society by the grant of a subsidy of Rs. 5,000/- and a loan of equal amount. The land required by the society for the farm was provided on lease by the Revenue Department. The lay-out of the farm is arranged in consultation with the Department of Fisheries.

The society has also established a boat building yard at the village with a dual object. Not only will boats be built cheaper and in accordance with their special requirements but also the fishermen will be independent of external agencies, and a fresh avenue of employment will be created for the villagers.

The progress of the village would not have been so rapid but for the help of the Government, which has endeavoured to make it as self-contained as possible. Thus, through the Government's assistance, the society is no longer dependent on local traders for its supplies of vital hemp twine. Permission for the direct import of such twine from Italy was accorded to this society, which in the past five years obtained twine worth five lakhs of rupees.

Another example of the benefits of co-operative endeavour is furnished by the fishing village at Versova, one of Bombay's nearer suburbs. Fishermen of this village were, till 1946, at the mercy of middlemen, who, for insubstantial advances, made the fishermen mortgage their entire season's catch to them. The wealth of the village was thus steadily being drained away, but a full stop to this wretched process of exploitation was put when the fishermen sought Government's assistance in the formation of co-operative societies, which, they felt were the only means of their salvation.

Today unregistered societies in this village own 13 trucks. These are employed for the transport of fish from Versova to markets in the City where fishermen have stalls. Thus, ownership of trucks by fishermen has dealt a crippling blow to middlemen at Versova, who have completely been ousted. There are two registered co-operative societies and three unregistered motor associations in this village.

The degree of prosperity which has attended the fishing community since the concentration of the trade in its hands is visible from the Society's purchase of two cars (a Studebaker and a Pontiac) to serve the needs of its members in an emergency. Thus, the cars are run to carry ailing members of the fishing community when they are in need of medical relief.

The societies conduct three shops for the sale of essential items of the trade at concessional rates, thus securing to themselves profits which formerly went to retailers. For the first time, fishermen have not only been seeing but handling big money. Some unregistered societies have declared dividends of 100 per cent. Real fear exists that the attraction of substantial monetary gains may exercise a harmful effect on the fishermen. Already, the lure of large profits has led to multiplication of societies, inasmuch as members of established societies have set up smaller units to cater exclusively for the transport of fish. This tendency is undesirable, and is bound to be injurious in the long run, as may be seen in the evil of fragmentation of agricultural holdings, which are sub-divided until they become uneconomic. Thus, fishermen at Versova had two registered co-operative societies to serve thir various interests, but the generous profits declared by the society gave some fishermen an idea. With unimaginable initiative and surprising resourcefulness and energy they organised three associations to transport fish. The societies purchased 14 trucks, the underlying object being that the eventual profits from their enterprise would be distributed among only their small circle of members. Such was their avidity that membership of these units was confined to persons residing in particular lanes in the village. In fact, the three units have been formed on the absurdly local basis of lanes. This unhealthy development called for Government's intervention. Government have now ruled that co-operative societies at a village should be merged into one society. They have also directed the Co-operative Department to concentrate on the formation of only one society in each of the villages which are at present without the beneficial influence of co-operative organisation.

An inevitable result of two or more societies at one village is that achievement of the goal of actual co-operative endeavour is frustrated, the energy of members being dissipated in unhealthy rivalry. Schemes for improvement cannot be put into execution as co-operation from societies is not forthcoming. Primary attention must, therefore, be focussed on the actual achievement of societies rather than on multiplication of their number.

An outstanding fact emerging from even the most cursory observation is the wide disparity between

the economic condition of fishermen in small villages and those in towns. Fishermen in small villages live on a mere subsistence level. Their earnings are so paltry that they are unable to make any saving for a rainy day. On the other hand, fishermen round about Bombay and in large coastal towns are in comparatively affluent circumstances. Thus, at Versova, in Greater Bombay, fishermen own houses, the value of which may, conservatively, be estimated at rupees thirty lakhs.

The smallness of individual output in the past was not due to lack of effort or resources, but to their failure to move with the times. Their methods show great skill and ingenuity. What was lacking was their inability to gear up their industry to the tempo of the mechanised age. This inability was due to the fact that opportunities had not been placed at their disposal. Hopes now exist that they are on the proper path. Experience has shown that fishermen are capable of enterprise and initiative once they are given the right lead and put on the track of modern methods.

Yet, one has to be watchful if progress is not to be retarded. Illiteracy is only one among the curses of fishermen's stagnancy compared with other communities. There is a more potent cause and this is their contentious tendency. Even a superficial survey shows that a factor accounting for much of the unprogressiveness of the fishermen is their internecine strife and their petty animosities. A cure for this factious tendency is promotion of the co-operative ideal.

Application of the principles of the co-operative movement may not root out overnight their present unhealthy tendencies, but there is no doubt that their welfare will immeasureably be promoted by spread of the principle of co-operation to their industry.

The greatest need of the fishermen is their extrication from the clutches of middlemen, who are the bane of the industry. These middlemen have large sums at their disposal, which are readily made available to fishermen in their need. Fishermen encounter much difficulty before disposal of their applications by co-operative societies, whereas middlemen act expeditiously and decisively. Further, co-operative societies do not command substantial sums of money, and even the apex society is often unable to help federating units. Societies will have an uphill struggle as long as sufficient liquid cash is not at their disposal. Thus, their paramount need is grant of short term loans before the commencement of the season by the Bombay Provincial Co-operative Bank to enable the societies not only to accommodate their members but also fight middlemen on their own ground.

Admittedly, most societies at present are unable to play the useful role expected of them because of financial and organisational weakness. The societies must be placed in a strong position vis-a-vis their members in a village and this end may be promoted if members are made to depend more largely on the societies, only thus will societies be able to have a strong and effective hold on members. This objective may be achieved if facilities to promote members' interests are made available through the agency of societies. The manner in which this is capable of attainment may best be indicated in the context of the present arrangement for allocation of engines. The present arrangement is to allot engines to fishermen through the co-operative societies of which they are members on half subsidy and half cash basis. This practice was satisfactory as long as the demand for engines was small, as then co-operative societies could not only acquire the engines on subsidy-cum-cash basis but also attend to other urgent needs of members, such as supply of twine, hooks, coal tar, sail cloth, etc. Circumstances have now altered and fishermen are now coming forward in increasing numbers for mechanical equipment. The resources of co-operative societies are limited, and, lacking sufficiency of funds, the Societies are unable to meet the demands of members in their villages. Accordingly, a suggestion has been made to Government to allocate engines on subsidy-cum-loan basis to fishermen. Relieved of the resposnibility of direct procurement of engines, societies will be in a better position to organise the marketing of additional supplies of fish which will be available. Members will make over their entire catch to the societies through which engines have been purchased, and the societies will arrange for the sale of the fish on the most attractive terms. Unhealthy competition among individual fishermen will be eliminated; thus the economic status of fishermen as a whole will generally be improved. Controlling sales of catches made by an individual member, the society will be in a far better position and will be able not only to collect instalments but to liquidate the cost of the engines made available through their instrumentality.

Provision of financial aid is not the only means by which to help the fishermen. Grant of funds must be accompanied by schemes bearing on not only technical but also on essential engineering projects such as good roads, bridges, easily accessible harbours, and properly equipped landing sites at ports, all of which play an important role, not yet realised, in the rapid movement of fish from the catching to the landing centres.

Increased catches are only one part of the problem, even more important is that the consumer gets fish quickly and in a wholesome condition, for if this is not done, the primary producer will continue to languish. With more ready cash at his disposal, he will be in a better position to introduce necessary reforms. Provision of marketing and transport facilities is thus important, for in their absence the middleman will always have a field day. The advantages of the introduction of power-propelled vessels and modern techniques of fishing have already been realised by the fishermen, but these benefits are largely negatived by the presence of middlemen, whose control of the wholesale markets hits both the purchaser and the consumer. The primary producer does not get a fair return for his risky labours, while the consumer pays more.

The middleman, of whose undesirable kind there are so many at each stage, impoverishes both the producer and the consumer to his own advantage. Middlemen finance fishermen in one way or another. Therefore, an essential function of any fisheries department is to break as many links as possible on the oppressive road which must be traversed before the fishermen's catch reaches the consumer. Considerable progress in this direction has been made by the Bombay Fisheries Department.

APPENDIX

A close study of the economic condition of fishermen in Kanara District reveals that the annual catch per fisherman today is 2.3 tons as against 1.41 tons in 1931. The value per ton of fish, has, likewise, risen from Rs. 95/- to Rs. 250/-. Almost all fishermen in this area are dependent on the sea for their livelihood, although a small percentage is engaged in agriculture as a secondary occupation.

An appreciable number, specially along the southern half of the coast between Gangawali and Bhatkal, work in the forests as labourers when fishing slackens, and also as sailors on country-craft. The earnings of fishermen in this area are much smaller than those of fishermen in the northern half from Gangawali to Majali. The two regions have more or less the same length of coastline, about 38 miles each.

The northern half of the coast is more favourably endowed by nature with a deeper inshore and is fringed by a long row of islands. As a result, greater protection is offered to shoaling fishes, such as mackerel and sardines. Inshore fishing is very profitable in this region. All fishing hamlets in this belt are connected with main roads by either motorable approach roads or waterways.

The southern half of the coast is, on the contrary, shallow, rocky and surfbeaten. Most of the fishing villages have no approach roads, so that transport of fish is difficult and uneconomical. The fishing population in the northern half is 10,000 and in the southern half, 9,000. Output of fish in the northern half is 13½ thousand tons and 4½ thousand in the southern. There is also considerable disparity between the wholesale and retail prices of fish in the two regions. For instance, during the peak fishing period from November to December, mackerel fetches Rs. 15-20 per 1000 in the northern half and Rs. 10-15 in the southern half.

The marked difference in the nature of the coastline has compelled fishermen in the two areas to evolve tackle suited to the local conditions thus enabling them to net the maximum quantity of fish in their respective regions. Fishing in inshore waters with shore-seines in the northern area is commonly practised from October to January.

Out of 52 shore-seines in the district, 40 belong to the northern region. These are about thrice as long as those employed in the southern section. A large shore-seine consists of 500 pieces, each piece being 10′ long and 40′ deep. A net of this dimension operated in deep inshore waters is capable of landing, on an average, two or three lakhs of mackerel per haul. The largest haul ever made by one such net was 28 lakhs of mackerel at the village of Chendia in 1950.

With the introduction of fish carrier launches in 1935, fishermen in this region devised an ingenious method to keep fish alive and thus dictated their terms to purchasers and obtained a better price. The method is simple Nets are kept upright in shallow water by means of poles, so that fish still being in their natural element, cannot leap over and escape. The purchasers may be curers, launch owners or inland merchants.

Besides inshore fishing by shore-seines, offshore fishing for seer fish, sharks, catfish, jew fish and pomfrets is also done in small outrigger boats with drift nets, bag nets, cast nets, and hooks and line. This fishing is of shorter duration, lasting from September to October and February to May. Catches by these nets are, however, not so copious as those by shore-seines. The total value of fish landed in this region averages Rs. 3,625,000/- yearly. Some of the fish (about 7 million lb.) is bought by launch-owners, who not only offer attractive prices but also pay spot cash to the fishermen, who thus enjoy comparative prosperity.

In the southern division fishing with shore-seines is also practised, but the nets are smaller, each net being made up of about 100 pieces. The rocky nature of the coast compels fishing by this method to be confined to small stretches of sandy areas. Fish cannot be impounded as the coast is surf beaten. The shore-seine has to be dragged ashore and the catch disposed off immediately.

Off-shore fishing is, on the other hand, practised more intensively. Boats are big and capable of sailing a considerable distance from the shore. The nets used are the same as those in the northern part. The total value of fish landed in this region is about Rs. 1,125 000/-. Thus, the annual output of fish in the Kanara District is 18,000 tons worth Rs. 4,750,000/-.

Ratnagiri District, too, has a rocky and shallow coastline, which is thus unfavourable to the use of seine nets for inshore fishing. Shore-seines of small dimensions are, however, used in the southern half of the district. These seines are operated throughout the year except in the monsoon. Miscellaneous varieties of fishes are caught.

The size of the mackerel catch is trivial, as only small shoals occur off Ratnagiri. As the mackerel fishery in this area is not so important as in Kanara District, Ratnagiri fishermen resort to off-shore fishing, being away from port from 8 to 10 days at a time.

Accordingly, fast-sailing boats, claimed to be the biggest and the best of their type in India, have been evolved and built by the fishermen to serve their special requirements. Drift nets, cast nets and long lines are used. Fish caught include seer, tuna and sharks among others. Fishing conditions being more or less uniform throughout this area, no marked differences in the earning power of fishermen are noticeable. The annual output of fish is 28,572 tons valued at Rs. 7,000,000/-.

Generally, individual fishermen own small nets, but large shore-seines costing about Rs. 20,000/- are owned collectively. Every fisherman contributes his own yardage of netting. The several pieces are united to form one big net. Usually, about 40 to 50 fishermen pool their resources for this purpose. The catch and the sale proceeds are distributed proportionately among the fishermen, according to their share of the net, after deductions to allow for repairs, renewal of gear and tackle.

The system of sharing of proceeds from fishing by seines owned by individuals and groups is slightly different. The owners advance money to fishermen during the monsoon for maintenance and thus bind them by a contract to work for them during the fishing season. Each fisherman is given enough ration for his maintenance. At the end of the year a balance is struck.

First, expenses incurred on food and other sundry items supplied to fishermen are deducted. The balance is divided into two equal shares, one going to the owner and the other being divided equally among the fishermen. The owner looks after the gear and tackle.

Co-operative ownership of "rampans" (shore-seines) is decidedly beneficial to fishermen. If the mackerel season is good each member in the northern part of the district receives Rs. 300-400 as his share, and in the southern part of the district Rs. 100-150.

A shore-seine fishermen's earnings in Ratnagiri District does not exceed Rs. 200/-, co-operative ownership of rampans being a common feature. The annual income by other methods of fishing varies from Rs. 100/- to Rs. 150/- in Kanara District and from Rs. 300/- to Rs. 400/- in Ratnagiri District.

The fishing communities on the Kanara coast differ in the degree of their supplementary income. Nearness of a village to good agricultural land, to a forest, a river, or a small town tends to open up additional avenues of employment.

For example, at Karwar, a small town with a population of 20,000, fishermen live almost entirely by fishing. They do not practise any agriculture or forestry. Women augment the income of the family by sale of fish in local markets, and also by sale of twine prepared from hemp. Some fishermen work as labourers at the port, loading and unloading merchandise. When fishing is slack some fishermen ply their boats on hire to tourists for angling or pleasure cruises to the nearby islands.

The total contribution to income from these subsidiary callings is difficult to estimate. Fishermen are illiterate, and do not keep any accounts of earnings and expenditure, but personal inquiries showed that, on an average, such earnings did not exceed 25 per cent of those from actual fishing.

Conditions in Ratnagiri District are slightly different. One or two members of a family usually seek employment in Bombay in mills, the police, the Army and the Navy. Many are also employed as merchantmen. The joint family earnings are thus augmented. The quantum of earnings of the fishing community in Ratnagiri District is thus much higher.

The fishermen's appalling illiteracy accounts for their improvidence. No written accounts of income and disbursements are kept, and the fishermen are generally without resources for unforseen exigencies. They spend as they earn, and if their income falls short of their requirements, they borrow in the expectation that the next season will be propitious.

Economic conditions in towns and villages are quite dissimilar. Incomes and expenditure of a typical fisherman's family in Karwar, a small town, as furnished by its head, are indicated here. A family consisting of four men, two women and two children live in a two-roomed tiled house. The family owns a small boat, a payawada (a small drag net), a ghol net and one or two cast nets, and has also four shares in one of the local " rampans " (inshore-seines). Earnings by fishing, if the season is good, are in the neighbourhood of Rs. 2,000/- and from subsidiary occupations about Rs. 500/-

Against this aggregate income of Rs. 2,500/- expenditure on the maintenance of the family is roughly Rs. 2,200/-. Savings are utilised largely for repairs and purchase of new nets. If the fishing season is bad, the family is forced to take a short-term loan from the fishermen's credit society or from private money-lenders. The debt is usually paid off in the next fishing season.

Conditions in villages are different. The levels of income of fishermen here are definitely lower, and the standard of living is also low. A detailed economic survey of a most backward fishing village was recently conducted at Murdeshwar, in Bhatkal Taluka, in the Kanara District. For this purpose, a random sampling of 51 fishermen's families was made.

The average income of a family of four earning members and a child below 14 years, amounting to about Rs. 267/-, is derived exclusively from fishing (for eight months), and Rs. 50/- from secondary occupation. The average annual expenditure per family works out at Rs. 468/-, of which about Rs. 50/- is spent on repairs and renewal of gear and tackle. All the 51 families are indebted and the average debt per family of fishermen is Rs. 149.9.

A survey, conducted by the Bureau of Economics and Statistics, of the indebtedness of the fishermen in the Kanara and Ratnagiri districts on December 31, 1951, revealed the following figures :—

Percentage of indebted families	41.5
Debt per indebted family	Rs.351/-
Average debt per family of fishermen	Rs.145/-

The fishermen are thus in perpetual debt from generation to generation. In view of their low earnings, fishermen in small hamlets cannot carry on their profession independently and are always at the mercy of money-lenders. The season is of short duration, ending in February. The shortness of the season is due to the strong northerly winds prevailing at this time of the year, and making it impossible for the fishermen to venture out in their small craft.

In rural areas, the middleman curer is the money lender. The pattern of the fisherman needs someone who will arrange to market the catch and make advances to him until the final account is settled. In this way middlemen curers step in as financiers. By virtue of their sole monopoly enabling them to market fish at distant markets, the middlemen corner all the fish at prices much below the prevailing market rates. When accounts are struck at the end of the year, the whole money transaction is so cleverly manipulated by the middleman that, in spite of the year's entire catch being handed over to him, the fisherman finds himself still indebted to the middleman. His indebtedness is thus perpetuated. It is not possible to give here any approximate estimate of the extent of indebtedness among fishermen in the two districts.

The incidence of poverty among fishermen in this area is more pronounced than that of fishermen elsewhere. Their fare is, in consequence, frugal from February to September, when they experience great difficulty in obtaining wholesome and nourishing food. Many fishermen's families obtain permits from the forest authorities for free removal of " talichakki ", the central pithy portion of wild palm trees. The pith is chopped into small bits, dried, powdered and used for preparing gruel for food, on a starvation diet.

In the towns, if fishermen need any financial aid either to tide over the monsoon or to renew and repair nets they have recourse to monied persons for loans usually at a higher rate of interest, varying from 12 to 24 per cent. Since the introduction of the Money Lenders' Act and the Bombay Agricultural Debt Relief Act, fishermen find it hard to obtain loans from private money lenders. The Government aids fishermen by grant of loans on easy terms at a low rate of interest.

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SOCIO-ECONOMIC UPLIFT OF THE FISHERMEN ENGAGED IN ROAK* FISHING IN ALLAHABAD DISTRICT, UTTAR PRADESH, INDIA

by

B. S. Kaushiva**

It has been emphasized by the fishery workers from the earliest time that socio-economic uplift of the fishermen should be one of the main activities of the Fisheries Departments. Recently the Indo-Pacific Fisheries Council has stressed the urgent need in the countries of South-East Asia for a comprehensive study of the socio-economic aspects of the fishing industry as it is realized that the socio-economic factors have been responsible to a great extent for the slow and unsatisfactory development of the fishing industry in these areas. The Uttar Pradesh Fisheries Department in 1945 undertook a programme of socio-economic uplift of fishermen engaged in *roak* fishing in Allahabad District. *Roak* fishing is one of the most effective and widely practised methods of barrier fishing by stationery nets supported by stakes. The fish enter at night and are collected at intervals during the day. Costly equipment such as large nets, boats, and stakes are essential which the fishermen are not in a position to provide and the fishermen have, therefore, to depend on contractors who take a major share of the profits and pay the fishermen a low price for the fish they catch.

A stretch of 80 miles of Ganga River was requisitioned in 1945 under the Defence of India Rules for ensuring a supply of fish to the Civil and Military Fish Marts under the Fish Marketing Scheme sponsored by the State Fisheries Department. At that time the capitalists were taking advantage of the great demand for fish during the war and they exploited the fishermen who were paid only Rs. 8 per maund, while the major portion of the catch was exported to Calcutta by contractors and sold at a high rate of Rs. 120 per maund. It was realized that a reasonable price should be fixed to provide legitimate wages to the fishermen who are the real producers and who had inadequate means to invest any money to bring about further development of the industry through their own efforts. Accordingly Rs. 18/- per maund instead of Rs. 8 per maund was fixed and was regularly paid by the Government Fish Mart to the fishermen from 1945 to 1947. The Department used to allot each year the four *roaks* in the controlled area and to issue licences to the fishermen working the *roaks*. The allotment of the *roak* was made on the basis that the *roak* owner who supplied the largest quantity of fish to the Mart was given the first *roak*. Since the fishermen from outside districts were also attracted, licensing was considered essential to avoid unhealthy competition. The practice of giving licences ensured that only those fishermen who belonged to that stretch of river and earned their livelihood from fishing in the Ganga river were allowed to operate on the *roaks*. The control exercised through issuing licences gave encouraging results and improved the conditions of the local fishermen. After 1947 the price control was lifted, but in order to enable the Department to continue the benefits conferred on the fisher families of Allahabad, control of the 80 miles stretch was kept.

Since 1948 a revised system is working. An Association of Fishermen was formed. It elects 4 Panchayats, one for each *roak*. The payment of Rs. 18 per maund to the fishermen is attested by a departmental representative, the Panchayat, and the *roak* owners. The Department has effectively ameliorated the earning capacity of the fishermen by providing them a fair return of Rs. 18/- per maund of fish caught by them. All the fishermen working on the *roaks* are registered with the Fisheries Department but no licence fee is charged. They are, however, required to pay to the Department a royalty of Rs. 2/- per maund of the fish netted. The four *roaks* now work jointly and share the profits and no new *roak* owner is allowed to set the *roaks* in this area as the aim is ultimately to make the fishermen of this locality the owners of the *roaks*. At present the permit for setting up the four *roaks* is given in the name of the Association and not in the name of any individual *roak* owner.

According to a recent survey made, there are 20 villages in the *roak* area in which 13 families consisting of 146 members earn their livelihood by fishing. In these villages there are 318 families comprising 1,679 members who are not engaged

* *Roak* fishing is a special barrier type of stake net fishing practised in the rivers of Uttar Pradesh.

** Deputy Director of Fisheries, U.P. Lucknow, India.

in fishery professions but are cultivators and *Moonj* workers. The *roak* fishing is not a feature all the year round and is operated for about 5 months from February to June when the floods subside. During the remaining part of the year the fishermen carry on their own fishing by other methods but no statistics are available with regard to their catch and income.

A Benevolent Fund has been instituted and contributions on a maundage basis are made to it on a voluntary basis by both the fishermen and the *roak* owners. The Benevolent Fund up to 1951 has amounted to Rs. 10,154-13-6 which is deposited in the Co-operative Bank in the name of the Fish Marketing Officer, Allahabad, from which amount loans to the fishermen for the purchase of equipment and other necessary things are given. The Department hopes that out of this fund complete equipment for one *roak* may be purchased so that when the *roak* is owned by the Association it will be in a position to earn at least Rs. 60 per maund of fish instead of Rs. 18 which is the amount given by the *roak* owners at present. The aim is that ultimately the fishermen may own the four *roaks* and manage their own affairs without outside intervention.

This is entirely a new venture in the field of socio-economic uplift of fishermen in Uttar Pradesh and is bound to be beneficial to both the fishing industry as well as to the fishermen. If this experiment is spread throughout the State great benefits are likely to accrue to the fishing industry. In order to put the Association on a more firm basis it has been decided to form a registered cooperative society of *roak* fishermen which will soon start functioning. The society will have the following aims and objectives:—

(*a*) To create unity and develop the spirit of mutual help among its members.

(*b*) To foster among its members the habits of performing their work honestly, punctually and methodically.

(*c*) To introduce better and improved methods of production.

(*d*) To arrange for the purchase and supply to its members of essential articles such as yarn, *sutli*, timber, iron sheets, coal tar, etc.

(*e*) To arrange the marketing of the produce.

(*f*) To provide subsidiary occupation to its members during the off-season.

(*g*) To raise funds to carry out the aims of the society.

(*h*) To encourage thrift among its members by inducing them to lay by regularly a fixed sum as a provision for old age, illness, premature death, retirement, marriage and education of their children or other unforeseen requirements.

(*i*) To improve social, moral and economic conditions of its members and generally to do all such other things as are incidental or conducive to the attainment of the aforesaid objectives.

It is also contemplated to extend such cooperative societies to other sections of the Ganga River and its tributaries after ascertaining the results in order to improve the fishing industry of the State.

18

A PRELIMINARY STUDY OF THE PHYSICAL, CHEMICAL & BIOLOGICAL CHARACTERISTICS OF SINGAPORE STRAITS

by

Tham Ah Kow*

This study, which was started in January, 1948, and concluded in December, 1949, includes (1) the determination of the sea water temperature, salinity, phosphate, volume of settled plankton and pigment content of plankton, (2) the estimation of phytoplankton numbers and zooplankton numbers and (3) the recording of the daily catches of several fixed fish traps in Singapore Straits. This type of fish trap is known locally as the *kelong* and a detailed description has been given by Le Mare & Tham (The Kelong Fishing Method. Fishery Conference convened by the U.K. Special Commissioner for South East Asia at Singapore. 1947 Paper No. 1 Mimeo.).

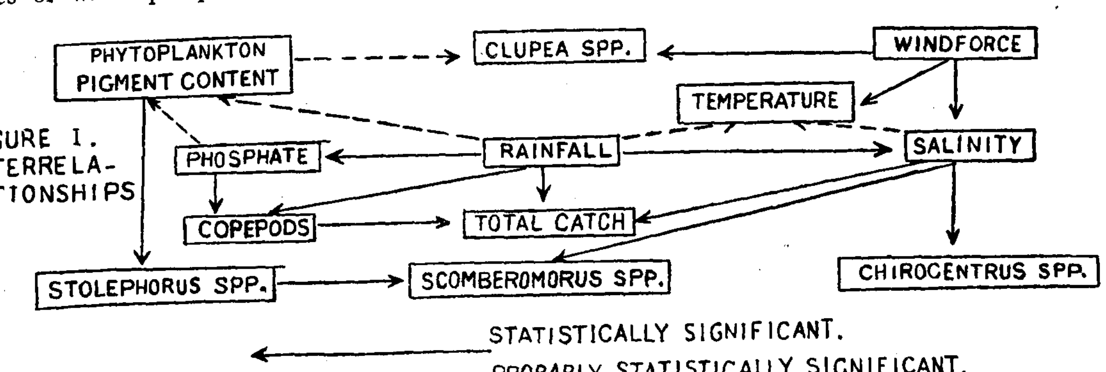
The important features of this method of fishing are (1) in Singapore Straits its fishing intensity is practically constant, (2) the positions of these traps are fixed and the fish in Singapore Straits are brought on to the long leads of these traps by the tides and (3) all fish lured into these traps are caught by means of fine-meshed lift nets. Meteorological data (rainfall & windforce) for the same period and locality were made available to the Malayan Fisheries Department by the Director of the Malayan Meteorological Service.

Temperature, salinity and phosphate were determined by the usual methods. Pigment content was determined by Harvey's method. The plankton samples were collected by filtering known volumes of water pumped from different levels between the surface and sea bottom. The filter was made of fine silk with a mesh equivalent to No. 20 bolting silk, when wet. The numbers of plankton organisms in the sample were estimated by counting sub-samples under the microscope. A detailed consideration of the accuracy of the methods used is given in detail in the full paper. The data obtained were subjected to correlation analysis.

The fluctuations in temperature, salinity, phosphate, phytoplankton cell count pigment content, copepod count and fish catches have been shown to be periodic. There are indications that the annual patterns of these fluctuations are closely integrated and that there exists some interrelationship among the elements of the physical, chemical and biotic environment, or between all these elements on the one hand and some central controlling (possibly astronomic) force. The interrelationships which have been found to be statistically significant or probably statistically significant are shown in Fig. I.

Some possible applications of the results to fisheries development, including the formulation of a prediction system in the form of an equation with 'fish catch' as the dependent variate and rainfall, windforce, temperature, salinity, phytoplankton, and copepod numbers as the independent variates, are discussed.

FIGURE I. INTERRELATIONSHIPS



* Fishery Officer (Research), Department of Fisheries, Federation of Malaya & Singapore.

19

EQUIPMENT AND METHODS USED IN OCEANOGRAPHIC INVESTIGATIONS IN THE PHILIPPINES

by

T. G. Megia*

and

A. R. SEBASTIAN**

In the Philippines oceanographic investigations are carried out using the equipment and instruments turned over to the Bureau of Fisheries following the termination in 1950 of the Philippine Fishery Program of the United States Fish and Wildlife Service. The methods and chemical procedures being followed are patterned after those in practice at the former Oceanographic Laboratories of the University of Washington, U.S.A. Slight modifications in carrying out the chemical determinations have been adopted to suit local needs. Nomenclature and units are in accordance with international standards.

* Oceanographer
** Fishery Technologist, Bureau of Fisheries, Manila, Philippines.

20

SOME OBSERVATIONS ON THE TUNA FISHERIES OFF THE BOMBAY COAST

by

S. B. Deodhar*

Recent observations indicate that Tuna abounds on the Ratnagiri coast of the Bombay State where about 50 per cent of the catch of fishermen from Jaigad to Ratnagiri comprises Tuna. The taxonomic study of the species visiting the coast and their populations have not yet been completed. Attention of research workers and fishermen is invited to the treasure of this valuable fish inhabiting the waters off Bombay, which lies comparatively unexploited.

The Tuna season on the above coast lasts from September to December. Hauls are abundant when the winds are either westerly or easterly, dark nights being most suitable. During season, shoals of Tuna occur in 12 fathoms of water, approximately 7-15 miles off the coast.

The craft employed at present comprise small canoes locally known as 'hodi' and bigger vessels called 'machwa'. Both are unmechanised craft which operate on sails or oars. Drift nets made of hemp twine are employed. The net is locally known as 'wawri'.

The catch today represents only an insignificant proportion of the potential supply available. Provision of mechanised craft promises immense returns. Bulk of the catch at present is cured with salt, hardly ¼ of it being sold in fresh condition.

* Department of Fisheries, Bombay, India.

21

A NOTE ON THE TUNA FISHERY OF INDIA

presented

by

the Indian Delegate

The Tuna fishery of India appears to consist of two species, *Euthynnus affinis* (Cantor) and *Thynnus tonggol* (Blkr.). The annual landings are estimated at 5,000 tons. Other species also probably exist. The major part of the catch is landed along the Travancore coast and is composed primarily of *Euthynnus affinis*. *Thynnus tonggol* is taken in smaller quantities off the coast of Tuticorin.

The season for *Euthynnus affinis* in Travancore begins in October and continues until the end of February or March. *Thynnus tonggol* is landed off Tuticorin mainly from May to September. However, experimental deep-sea fishing has indicated that year-round Tuna fishing may be possible.

Along the Travancore coast the Tuna are landed by shore seines; in Tuticorin and elsewhere troll lines are employed, as the fish are found some miles offshore.

22

THE ECONOMIC MARINE ALGAE OF MALAYSIA AND THEIR APPLICATIONS

III THE RHODOPHYTA*

by

J. S. Zaneveld**

In the third and last paper of this series, a review is given of the red seaweeds, or *Rhodophyta*, of Malaysia.

The first paper of the series dealt with the blue and green seaweeds (*Cyanophyta* and *Chlorophyta*), and was published in the Proceedings of the First (Singapore) Meeting of the Council. The second paper, listing the brown seaweeds, or *Phaeophyta*, and their uses, was contained in the Council's Third (Madras) Proceedings.

It is pointed out that from ancient times, seaweeds have been used by man, not only for food, but also in medicine (e.g. for the treatment of goitre) and in farming. At present, however, the most important use is in industry, because of the unique physical and chemical properties of their colloids (agar-agar, algin). As a result of scientific investigations and experiments, the interest shown in marine algae has increased rapidly and has established seaweed industries on a firm footing in the northern (N. America, Great Britain, Japan) as well as in the southern hemisphere (Australia, New Zealand).

In Malaysia, no concerted effort was made to exploit the marine algal resources on an industrial scale, and the utilization of the seaweeds is of a rather primitive nature. However, in recent years a demand has grown up for the establishing of a seaweed industry in the overcrowded countries of the South West Pacific. The question as to which species are to be used, forms the background for all industrial work in the future. To contri-

* This paper will be published separately together with a reprint of parts I and II which are under revision by the author.

** Phycologist, Herbarium, Bogor, and Laboratory for Marine Investigations, Djakarta, Royal Botanic Gardens of Indonesia.

bute in solving this problem, the present author, in a series of three papers, has made a survey of the marine algae already economically used in the vast region of Malaysia, a term covering the Malay Archipelago *sensu latiore*, the Malay Peninsula, the Philippines, and New Guinea.

In order to make this survey more easily accessible to non-botanists, short diagnoses are given of the genera and species. These have not been arranged taxonomically, but alphabetically. Vernacular names of the species are inserted.

The literature mentioned for the individual species and varieties concerns only the original description, the place where the combination of the specific epithet was introduced, and the publications dealing with the economic application of the species involved.

A full bibliographic list concerning the taxonomy of the species under discussion is given at the end of part III, for the use of the more scientifically interested readers, and an extensive list of the literature relating to the economy of the Malaysian marine algae is added.

23

STUDIES ON THE PREPARATION OF SALTED FISH PASTE (BAGOONG) FROM DRIED DILIS (*Stolephorus Indicus*)

by

C. Martin†, and J. I. Sulit††

1. Dried dilis (*Stolephorus indicus*) was freshened and used as the material for the preparation of salted fish paste.
2. Different amounts of water were added to several batches of dried dilis to obtain the right amount for "freshening".
3. Salt was added to each batch of dilis freshened for 24 hours in the proportion of 1 part salt to 4 parts fish. This mixture was then allowed to ferment at temperatures ranging from 37° to 45° C.
4. Analyses of the original dried dilis, freshened dilis and the mixture during the different stages of the fermentation were made for protein, moisture and sodium chloride content.
5. Bacterial counts were also taken to determine the numerical trend of the bacteria during the fermentation process.

† Chief, Division of Fisheries Technology.
†† Chemist, Bureau of Fisheries, Manila.

24

THE DIFFERENT METHODS OF PROCESSING FISH

by

R. Lafont*

ABSTRACT

An account is given of the different methods used in the Indo-Pacific Region for processing fishery products, incorporating information supplied by the Governments of India & the Philippines. A short description is given of the following processes used in the Region; sun drying; salting and drying; conservation in brine; kench cure; cooking with and without drying; smoking; canning; fish pastes and sauces.

* Chief, Laboratory for Technology, Fisheries Research Institute, Phnom Penh, Cambodia.

25

MANUFACTURE OF 'ELASMIN PEARLS' AT THE FISHERIES TECHNOLOGICAL LABORATORY, BOMBAY

by

S. M. Arsiwala*

ABSTRACT

The Fisheries Technological Laboratory, Bombay, manufactures and markets shark liver oil products along with other by-products of fish. A notable achievement during recent years is the encapsulation of the oil in order to facilitate its consumption. Encapsulation is effected by putting shark liver oil between two thin layers of gelatin, which later are pressed in specially provided moulds of the encapsulation plant under hydraulic pressure of 30 to 40 tons per square inch. The capsules thus formed, when washed in Acetone, are free from any smell and are ready for the market.

* Department of Fisheries, Bombay, India.

26

FISHING BOATS OF PAKISTAN

by

M. Rahimullah Qureshi*

ABSTRACT

There are three distinct types of sailing boats on the Sind and Makran Coasts (Arabian Sea), besides the small canoes and outriggers. The details of their structure, dimensions, sails etc. are given, and an attempt is made to classify them. Some fishing boats of the rivers of East Pakistan and the Bay of Bengal have also been described.

* Director, Central Fisheries Department, Pakistan.

27

THE 'TUGOH' NET

by

J. A. Tubb*

The Tugoh is a large pyramidal net open at the base and used in tidal waters and estuaries for the capture of prawns and small fish. The origin of this net is obscure, but it is reported to have been introduced into Brunei Bay from Kuala Trengganu, Malaya. The date of introduction is unknown. The net was introduced into he Labuk area from Brunei about 1929 and the ishery rapidly developed to its present level. The base of the Tugoh net is approximately fifteen feet square and the net is about fifty feet deep. The net is built of cotton twine with the meshes diminishing in size from the base, i.e. the opening of the net, to the apex or cod-end. The meshes at the base are approximately one and one half inches stretched mesh and the meshes of the cod-end one half inch. In most cases, the small mesh at the cod-end is composed of double cotton and the cod-end itself is about ten feet long. The cotton normally used is 14/6 or 20/12 for the main

* Director of Fisheries, British North Borneo.

body of the net and there are usually from two to ten meshes of 20/24, at the base or mouth of the net. The net is strengthened by means of longitudinal lengths of heavy cotton twine running from the base of the apex. This is usually about 20/105 or similar. From four to eight strengthening lines may be used and these are tied on after the completion of the net proper. The base or mouth of the net is hung to a stout line of $\frac{1}{2}$ to $\frac{3}{4}$ inch Manila or Sisal. At about two feet intervals along these lines, lengths of cotton are attached to enable the net to be fastened to the frame. The cod-end is closed by means of a draw string.

The useful life of a net is approximately three years, and the nets are regularly treated with a fresh-water infusion of mangrove bark.

28

FISHING-GEAR OF EAST PAKISTAN

by

Nazir Ahmad*

A short description is given of 30 Gill nets, 30 Seine nets, 11 Drag nets, 6 Trawl nets, 6 Clap nets, 5 Fixed Purse nets, 9 Stake nets, 16 Dip nets and 3 Cast nets used in different districts of the Province together with the names of fish caught. In addition to nets, 26 traps, 8 spears and harpoon and some other fishing implements are briefly described.

* Deputy Director of Fisheries, Comilla, E. Pakistan.

29

NON-INDIGENOUS MARINE FISHING GEAR OF KOREA

by

Chyung Moon Ki†

Twenty-four items of marine fishing gear—all non-indigenous to Korea—having been adopted from Japan during the period 1903-1940 and distributed mainly along the coasts of Kyung Sang-Do and Cholla-Do Provinces in South Korea are described.

† Fisheries Inspection Station, Pusan, Korea.

30

DEVELOPMENT OF A COAL TAR NET PRESERVATIVE

by

J. I. Sulit*, B. Datingaling**, P. Pañganiban***.

Undiluted coal tar net preservative does not easily dry in a warm climate, thus making the net too heavy, messy and hard to handle. To solve this problem, a coal tar net preservative, diluted with gasoline was developed with the purpose of facilitating net preservation in the Philippines where tan bark extract and blood are commonly used. The diluted preservative reduces the amount of coal tar deposited in the gear to an extent that the increase in weight is quite negligible.

Diluted coal tar showed preserving qualities with cotton twines exposed to the atmospheric weather and with those immersed continuously or intermittently in brackish and marine waters. However, the imported coal tar containing rosin showed better preserving qualities.

* Chemist, ** Asst. Fishery Technologist, *** Asst. Fishery Technologist, Bureau of Fisheries, Manila, Philippines.

31

AN INVESTIGATION OF INDEBTEDNESS IN A FISHING VILLAGE IN THE EAST COAST OF THE MADRAS STATE

by

K. N. Anantharaman*

ABSTRACT

An enquiry into the socio-economic condition of the fishermen of Sadras, a typical fishing village on the East Coast of Madras, was conducted. The data collected include details relating to the population, active fishermen, census of craft and tackle, the value of property owned by the fishermen, the indebtedness and the means of obtaining credit and clearing of the debts, mode of marketing etc. In this paper, it has been indicated that the one possible way to redeem the fishermen of their indebtedness is to give adequate facilities to market their products.

* Director of Fisheries, Madras.

32

SOCIO-ECONOMIC PROBLEMS OF THE FISHING INDUSTRY IN UTTAR PRADESH

by

D. S. Sarbahi†

The fishermen of the State fall an easy prey to financiers and middlemen owing to their poverty, ignorance, superstition and conservatism, which preclude the improvement of methods or concerted action. Their immobility, together with the scattered and seasonal nature of the potential fisheries, bring about the depletion of the more easily accessible grounds and underfishing of those further afield. They have little intervention in the marketing of their products.

Improved socio-economic conditions are indispensable to the development of a prosperous fishing industry and statistics are required for the framing of an administrative programme which should include the organization of fishermen's cooperative groups with centralized banking and consumer store facilities. Fisheries courses should be encouraged in fishing village schools. The question of fishing rights should be investigated.

† Assistant Fisheries Development Officer, Uttar Pradesh, India.

33

SOCIO-ECONOMICS OF FISHERFOLK IN EAST PAKISTAN

by

Nazir Ahmad*

The low socio-economic condition of the fishermen of East Pakistan is described and the relative status of fishermen in Hindu and Muslim communities is discussed.

Suggestions are offered for the amelioration of the fishermen through special training of selected literate fishermen and through them of the illiterate ones as a long range programme, fisherchildren's schools, lantern lectures, films, radio, demonstrations, co-operatives, loans and assistance for the procurement of fishing requisites, and lastly, of medical aid.

* Deputy Director of Fisheries, Comilla, East Pakistan.

34

SUMMARY OF THE MOVEMENT OF FISHERIES ORGANISATION IN INDONESIA

by

G. M. Charidjie Kasuma*

ABSTRACT

The division of responsibilities between the departments of the Central Sea Fishery Service in Indonesia is explained. A brief history is given of fisheries associations prior to World War I, during the Japanese Occupation and subsequent to the proclamation of independence. The author considers that the co-operatives have yielded satisfactory results and gives an analysis of their organization and functions.

* Pusat Djawatan Perikanan Laut, Djakarta, Indonesia.

35

FISHING WITH THE DÄY NET IN THE TONLE—SAP (CAMBODIA)

by

M. Sao-Leang*

and

M. Dom-Saveun**

The *Däy* is a large net which is principally used for fishing in fast running waters; it has, in fact, been considered as over-destructive because its use in the great migratory channels during the period of reproduction might endanger the schools of brood fish and their young. The method is therefore, only authorized between November and February each year, and that in a small portion of one river of Cambodia, the Tonle-Sap, which is the channel communicating the Great Lakes with the Mekong River and which changes its direction of flow according to the varying hydrological conditions.

The *Däy* net is essentially a large net in the form of a truncated cone, the mouth being kept extended against the current by means of a bamboo raft composed of two floats. The cod end terminates in a cylindrical basket fastened by a line attached to a hand winch installed in a *sampan*, by means of which the catch is raised from time to time.

An analysis is made of the fish caught at different lunar periods, which affect the migrations of the different species, and the use to which the catch is put.

* Chief, Division of Fisheries, Kandal.
** Chief, Fisheries Cantonment, Phnom-Penh, Cambodia.

36

A CONTRIBUTION TO THE KNOWLEDGE OF FISHING GEAR IN VIETNAM

by

Tran Van Tri[1], and R. Serene[2]

ABSTRACT

Although several papers have appeared and others are in preparation by the Nha Trang Oceanographic Institute in an attempt to group the fishing gear used in Vietnam according to Mr. T. W. Burdon's tentative classification, several difficulties have been encountered. Different names are in use for the same gear in different regions and not all the forms fall easily and unequivocally into the various divisions.

The authors believe that no method of classification as yet devised is adequate, and suggest that some confusion may exist between the requirements of ethnologists on the one hand and fisheries technologists on the other.

Although the classification of fishing gear is of little immediate use to the native fisherman it will become essential so soon as he finds it necessary to order his gear from abroad. It is suggested that a museum of fishing gear would only partially solve the problem since it would not in all cases demonstrate the use of the gear; moreover, the cost would be prohibitive.

[1] Chief, Bureau of Fisheries, Oceanographic Institute, Nha Trang, Vietnam.
[2] Director, Oceanographic Institute, Nha Trang, Vietnam.

37

A NOTE ON FISHERIES EMPLOYER-EMPLOYEE RELATIONS IN NHA-TRANG, VIETNAM

by

Tran Van Tri*

and

Nguyen Chau**

Some simple forms of subsistence fisheries require only limited craft, gear and crew which may be supplied by individual fishermen and their families. However, the larger types of gear may require a numerous crew for their operation and fishermen are then obliged to associate themselves together for this purpose. In Vietnam, the organization of these groups varies with the different types of gear.

This communication deals with the organization of a group of men fishing by means of a pocket net in the region of Nha-Trang, Vietnam, including (a) preparative work, equipment provided by the employer, the agreement between employer and operatives and the duties of the latter; (b) actual fishing operations; (c) distribution of benefits after the season is over.

This type of organization has existed in Vietnam for many years and is here presented as it is thought that it may be useful when studying new forms of cooperatives for the improvement of the social conditions of the fishermen.

* Chief, Bureau of Fisheries of the Oceanographical Institute.
** Oceanographical Institute, Nha-Trang, Vietnam.

38

LA PECHE AU DAY DANS LE TONLE-SAP

par

M. Sao-Leang*

et

M. Dom-Saveun**

INTRODUCTION

Le régime des eaux du Cambodge a ceci de particulier qu'il est influencé, d'une part, par la fonte des neiges en été sur le Tibet ou le Mékong prend sa source et, d'autre part, par la Mousson du Sud qui arrose le pays, de Juin à Septembre, de pluies abondantes dont les effects se prolongent jusqu'en Novembre. A cette époque, le Mékong se gonfle à tel point qu'il déborde et inonde toutes les terres basses des arrière-berges ainsi qu'une partie des forêts de plaines.

Ce débordement serait désastreux pour le pays si le Mékong ne rencontrait pas à Phnom-Penh, Capitale du Cambodge, un fleuve secondaire, le Tonlé-Sap, qui le communique aux Grands-Lacs; ceux-ci constituent un véritable réservoir naturel qui reçoit annuellement le trop plein du Mékong quand celui-ci est gonflé et qui lui restitue ses eaux quand son niveau commence à baisser.

Ce phénomène de pulsations périodiques crée dans le Tonlé-Sap deux sens de courant : de Juin à Octobre, l'eau coule du Mékong vers les Lacs et, de Novembre à Mai, des Lacs vers le Mékong. C'est ce phénomène qui, simple par sa nature, constitue une des sources de richesses du pays dont une nous intéresse particulièrement ici : la pêche.

Quand les eaux remontent le Tonlé-Sap vers les Grands-Lacs, une grande quantité de poissons échappés d'une pêche active durant la moitié de l'année et gonflés d'oeufs, suivent ces eaux pour aller se réfugier dans ces lacs, particulièrement dans les forêts inondées qui les bordent; la reproduction y est admirablement favorisée par la grande couverture de ces forêts et par les nourritures abondantes charriées de différentes sources, sans compter le zooplancton et lephytoplancton qui s'y développent à profusion. Après un séjour de six mois dans ces viviers naturels, les poissons sont devenus gros et gras et, quand les eaux du Tonlé-Sap se renversent vers le Mékong, ils y immigrent eux aussi. phénomène secondaire précipite encore cette mig tion : quand les crues se retirent, les Grands-L se vident et se rétrécissent de jour en jour pour garder finalement qu'à peine le tiers de sa supe cie; leur profondeur diminue considérablement leurs eaux deviennent chaudes et inhabitables p une grande majorité d'espèces qui se hâtent alors regagner les eaux profondes, c'est-à-dire le l kong. C'est à partir de ce moment c'est-à-dire Novembre, qu'on peut voir une multitude d'eng de pêche jalonner le Tonlé-Sap pour capturer bancs de poissons en exode.

Parmi les méthodes de pêche pratiquées dans fleuve à cette époque, la pêche au *Day* mé d'être étudiée en détail en raison de l'importa de sa production annuelle (10.000 tonnes enviro Cette production permet d'alimenter plusie saumureries des environs de la ville, favorise l'é age des *Pangasius* qui est en voie d'expansi D'autre part, elle approvisionne la capitale pend quatre mois de l'année et fournit du poisson p la fabrication du *Prahoc* (pâte de poisson) à grande partie d'habitants de Kandal et de K pong-Speu. Une bonne partie de cette product est également exportée à l'état frais sur la Coc chine.

PREPARATIFS D'UNE CAMPAGNE DE PECHE AU *DAY*

La plupart des fermiers des *Days* du Tonlé-S travaillent dans ce métier depuis des dizai d'années. Le matériel employé provient donc, grande partie, des travaux des années précédent Les préparatifs annuels consistent à réparer matériel et à remplacer les éléments détériorés.

Pendant la saison séche, on procéde au calfata des embarcations. En Novembre, c'est la répa tion ou la confection des filets. Après les adju

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cations des *Days*, on achète les bambous, les perches, les rotins et les matières tannantes, on confectionne les flotteurs, les ancres et les paniers.

Il importe de présenter ici tout le matériel nécessaire pour la pêche au *Day*.

(*a*) Le filet *Day*

Il a une forme tronconique dont la grande base mesure de 20 à 25 mètres de diamètre, et le sommet, de 30 à 40 centimètres. Sa longueur atteint 60 à 100 mètres. Ses mailles sont larges à la base et se rétrécissent vers le sommet, allant de 4 à 1 centimètres. La grosseur des mailles dépend des espèces de poissons à capturer et de la force du courant du fleuve.

Les fibres employées pour la confection du filet ont une grosseur de 5/10 à 10/10 de millimètre. La grande base du filet est renforcée d'une ralingue également en chanvre de 15 à 25 millimètres, avec laquelle on fixe l'engin pour sa mise en exploitation.. Sa 'queue' ou sa petite base est munie d'un anneau en bois, auquel se fixe le panier *Day* (ou *Duc*) au moment de la pêche.

L'exploitation d'un *Day* nécessite au moins deux filets de mailles différentes et de différentes longueurs. On utilise, par exemple, un filet de 100 mètres à grosses mailles quand le courant du Tonlé-Sap est très fort, et un filet de 60 mètres à mailles plus petites lorsque les courants sont faibles.

Les fibres, avant d'être maillées, sont bouillies pendant une journée dans du lait de chaux, puis lavées à l'eau froide jusqu'a ce qu'elles deviennent bien blanches. Cette préparation a pour but de rendre les fibres souples, résistantes et perméables au tannin. La confection se fait à la main et le plus souvent par les pêcheurs eux-mêmes et les membres de leur famille.

Le filet est ensuite teinté, pendant trois ou quatre jours, avec de l'écorce du 'Smach' *(Melaleuca leucadendron)*. Puis il est passé dans un bain d'huile de bois décanté. A noter que la teinture au 'Smach' ne se fait seulement que quelques jours avant l'emploi du filet, car, après être tanné, ce dernier ne peut rester longtemps à sec sans que ses fibres deviennent cassantes. Le trempage dans l'huile de bois décanté est très nécessaire pour ce genre de filet qui, durant toute la campagne de pêche, doit rester souvent plusieurs jours successifs dans l'eau. L'huile de bois rend les fibres imperméables et unies et les protège contre la pourriture. On reteint plusieurs fois le filet durant chaque campagne de pêche, surtout entre les périodes de descente de poissons.

(*b*) Le radeau

Le radeau est fait de deux flotteurs de bambou placés de chaque côté d'une pirogue de 12 à 13 mètres de long (ou *ghe-cui*) et réunis entre eux par de fortes traverses en bois maintenues sur cette pirogue. Souvent ces traverses sont jumelées pour assurer un bon assemblage. La longueur du radeau, c'est-à-dire la distance entre les deux flotteurs est de 20 à 25 mètres ; cette distance dépend de l'ouverture des filets employés. La longueur du radeau est de 15 à 18 mètres.

Chaque flotteur se compose de 60 à 80 tiges de bambous réparties en trois couches intercalées par des traverses en rondins de bois. La dernière couche du fond est plus longue d'un mètre que les deux autres de surface. Les bambous ainsi répartis sont ligaturés à l'aide de robustes noeuds en rotin. Le flotteur doit être très léger afin qu'il ne fasse pas grand obstacle au courant, et facilite l'ancrage du radeau (voir fig. 1).

(*c*) Les ancres

Les ancres employés pour retenir le radeau au milieu du courant sont entièrement en bois ; ils sont rudimentaires, mais s'accrochent bien avec leur longue lame au fond du Tonlé-Sap constitué d'alluvions.

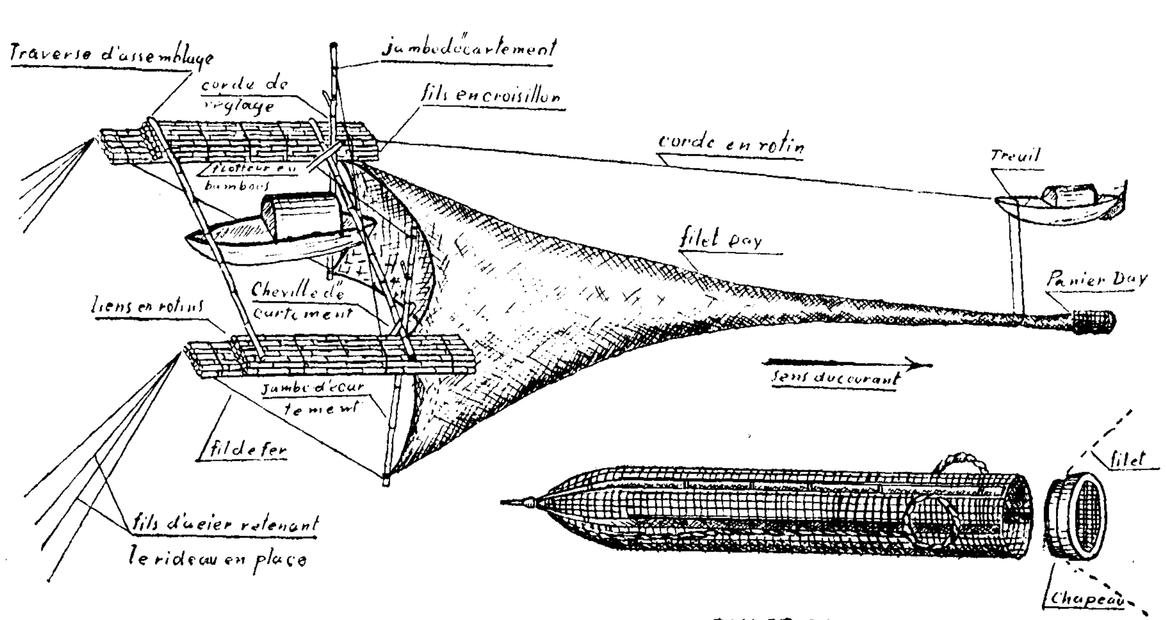
Un ancre se compose d'une lame en bois demi cylindrique d'un mètre de long dont l'un des bouts est bien effilé,et d'une manche en croix de 6 à 8 mètres de long, faite de deux perches de bois de Om15 de diamètre; la manche est réunie à la lame par une mortaise renforcée de noeuds de rotin. On attache à la lame deux ou trois morceaux de pierre pesant chacun 15 à 20 kilogrammes pour lui donner plus de poids, tandis qu'à l'extrémité de la manche on attache un ou deux autres morceaux de pierre qui jouent le rôle de contrepoids pour maintenir la lame oblique au fond du fleuve.

Il existe des ancres simples dont nous parlions plus haut et des ancres doubles qui sont faits de deux ancres simples réunis.

(*d*) Lepanier *Day* (ou *Duc*).

Le panier *Day* est en forme de cigare de Om50 de diamètre, ouvert au grand bout et fermé à la queue en forme d'ogive. Il est fait de lamelles de

VUE GENERAL DE L'INSTALLATION D'UN DAY



PANIER DAY
OU DUC

bambou tressées sur une série d'anneaux, et comporte deux anses en rotin pour faciliter sa manipulation, ainsi qu'un jeu de loquets destinés à le fixer au filet.

OPERATIONS DE PECHE AU *DAY*

(*a*) Installation du radeau

Dans la deuxième quinzaine de Novembre, une fois qu'on a obtenu par adjudication un lot de *Day*, on amène, sur les lieux, les flotteurs, ancres, pirogues et autres matériaux necessaires pour former le radeau. Les ancres, d'abord au nombre de deux, confectionnés sur place, sont attachés au bout des câbles d'acier de 8 à 10 millimètres de diamètre, puis jetés dans l'eau aux emplacements préalablement choisis, en tenant compte du courant de migration des bancs de poissons très connus des pêcheurs et de la largeur d'ouverture du filet. C'est à chacun de ces ancres que sera amarré chacun des flotteurs. Une fois ceux-ci installés à leur emplacement respectif, on place entre eux une pirogue (ou *ghe cui*) puis on les assemble au moyen de deux fortes traverses de bois qui enjambent cette pirogue pour former ainsi un radeau de 20 à 25 mètres de large sur 15 à 18 mètres de long. Après cette opération, on doit s'assurer de la solidité des amarres; si les ancres déjà posés ne résistent pas suffisamment au courant, on en ajoutei une autre paire et ainsi de suite jusqu'à ce qu'c ait la certitude que cet ancrage pourra résister à l traction exercée par le courant et le filet *Day* mis l'eau. Il est à noter ici un détail très important les câbles d'acier du système d'ancrage se trouvar dans l'eau près de l'ouverture du filet, vibrent sou l'effet du courant et émettent un bruit assourdis sant qui peut faire fuire les poissons à l'approch du filet. Aussi fait-on attention à ce que ces câble soient bien écartés et éloignés le plus possible d l'ouverture du *Day*.

On laisse aux ancres temps d'être bien pris dan le fond du fleuve avant de commencer la pose di filet. Ce temps dure deux ou trois jours, parfoi même une semaine.

Le radeau décrit ci-dessus est du type 'ordinaire que la majorité des fermiers utilisent dans le Tonlé Sap, D'autres fermiers qui se livrent à une pêche de moindre importance, emploient des radeaux plus simples. Pour les former, ils jettent deux ancres sur un écartement supérieur d'une dizaine de mètres à l'ouverture du filet employé. A chaque ancre, ils attachent deux fils d'acier dont les bouts libres sont fixés aux deux extrémités d'une perche maintenue verticale et à fleur d'eau par un flotteur ou une pirogue (voir fig. 6).

(*b*) Pose du filet.

Sur la traverse qui réunit, du côté aval, les extrémites des deux flotteurs et á quelques dizaines de centimètres de ceux-ci, on dispose deux rondins de bois formant chevilles. On pose d'abord horizontalement le long de chaque flotteur, entre ceux-ci et la cheville, une perche en bois de 7 mètres de long environ, graduée pour reconnaître la profondeur de pose du filet, et munie à son sommet d'une fourche. Au plus gros bout de chacune de ces perches situé du côté aval, est attaché un fil d'acier destiné à maintenir cette perche verticale, en position d'exploitation, tandis que leur petit bout est attaché à un autre fil d'acier qui le relie au flotteur opposé. On attache ensuite à la fourche de chaque perche une corde qui, passant sous la traverse du radeau entre la cheville et le flotteur et repassant sur la fourche, permet de règler la profondeur de pose du filet.

Une fois tous ces dispositifs mis en place, on n'attend que l'occasion favorable pour poser le filet et pêcher.

La pose du filet nécessite un quart d'heure de travail de cinq hommes. Un coolie amène sur place le filet entassé en accordéon sur une pirogue et attache la ralingue de son ouverture á quatre endroits du radeau, dont deux au gros bout de chacune des perches ci-dessus décrites et deux autres, à fleur d'eau, à l'extrémité aval de chaque flotteur. Il déroule ensuite le filet sur l'eau en ayant soin de faire passer sa 'queue' dans une corde pliée en deux dont les extrémités sont liées à un treuil installé sur une pirogue, Celle-ci est amarrée en aval du radeau au bout d'une longue corde en rotin et sert aux opérations de pêche proprement dite. Par un système de loquet, on fixe le panier *Day* à l'anneau de la queue du filet et on le jette dans l'eau tout en procédant à l'ouverture de la 'bouche' du filet.

Pour cela, deux ouvriers glissent dans l'eau les deux perches dont il était question plus haut, posées sur les flotteurs. Une fois dans l'eau, ces deux perches se dressent verticalement, car la force du courant, qui tire sur le filet ouvert, maintient ces perches fermement appuyées sur les deux chevilles de bois et tend fortement les fils d'acier fixés en croisillon à leur sommet.

Pendant ce temps, deux autres ouvriers tirent sur les cordes de règlage qui font descendre les deux perches à une profondeur voulue. Quand la position du filet est ainsi bien règlée, on attache la corde de règlage et on attend de pouvoir relever de temps en temps le panier *Day* pour vider la capture.

(*c*) La releve.

La relève du *Day* est un travail facile qui, en temps normal, ne nécessite que deux coolies. L'un d'eux manoeuvre le petit treuil dont la corde serre alors l'extrémité du filet et emprisonne les poissons dans le panier. Il bloque ce treuil lorsque la queue du filet arrive à la surface de l'eau; pendant que son compagnon, à l'aide d'un bâton de bambou en forme de levier, soulève le filet hors de l'eau, il l'aide avec ses mains à accrocher ce filet à une cheville de bois fixée sur le bord de la pirogue. Tous les deux coolies unissent ensuite leurs efforts pour hisser le panier sur le bateau et le vider. Après, ils le referment, le rejettent à l'eau, et la pêche recommence.

La capture est triée sur place et les poissons susceptibles d'être conservés vivants sont jetés dans une jonque-vivier ancrée à proximité du lieu de pêche.

Ce système de relève change complètement au moment de la 'grande descente des poissons' (Janvier). On utilise alors deux pirogues de pêche. Le petit treuil est remplacé par un grand trépied enjambant les deux pirogues et muni d'un palan. Le panier *Day* fait place également à un large manchon de filet dont chaque extrémité est munie d'un anneau en fer. Lors de la pose du filet, on serre le bout libre du manchon avec une ficelle.

Pour vider la capture, on manoeuvre le palan qui soulève à la hauteur des pirogues, la masse de poissons emprisonnés dans le manchon. Un ouvrier saisit cette poche et l'appuie sur le bord d'une pirogue de transport, tandis qu'un autre ouvrier délie le noeud de ficelle pour laisser échapper les poissons. Ce travail de relève se fait ainsi nuit et jour, toutes les 5 ou 10 minutes, et devient très fatigant, car les masses de poisons qui sont précipitées dans le filet par la force des courants risqueraient d'arracher tout l'engin si on ne vidait pas à temps la capture.

Pour obvier à cet inconvénient, un des pêcheurs a mis en service une initiative ingénieuse. Il a remplacé le panier *Day* par une caisse en bambou de 2m50 de profondeur sur 3 mètres de long et 0m50 de large, laquelle est maintenue flottante à fleur d'eau par deux pirogues. La queue du filet débouche cette fois dans cette caisse dont la paroi opposée au courant est en claire-voie; ce procédé ne retient donc que les grands poissons tandis que les petits qui n'atteignent pas encore la taille exploitable sont épargnés et passent à travers cette claire-voie.

Par ailleurs, dans ce dernier système, on ne relève pas le filet comme décrit ci-dessus; un coolie manoeuvre d'aval en amont une épuisette munie d'une poche très profonde, en bien râclant le fond de la caisse, puis l'appuie sur le bord d'une pirogue amarrée à côté, tandis qu'un de ses compagnons, tirant sur la corde fixée au fond de l'épuisette, en renverse le contenu dans la pirogue.

(*d*) Surveillance et entretien du filet pendant la peche.

Une branche d'arbre entraînée par le courant, une pirogue coulée en amont, une petite déchirure dans le filet etc . . . peuvent devenir une catastrophe pour un filet qui coûte de 15 à 20.000 piastres. Aussi les pêcheurs doivent-ils veiller constamment sur son engin. Cette tâche n'est pas difficile pour un pêcheur exercé. Il suffit, pour la bien faire, de jeter de temps en temps un coup d'oeil sur le radeau. Si par exemple celui-ci s'enfonce trop en aval, c'est le signe que le filet est alourdi soit par un branchage, soit par une grande capture, soit par une multitude de petits poissons qui en ont bouché les mailles. Si les perches qui tiennent ouverte la bouche du filet se penchent à droite ou à gauche c'est encore le signe qu'il y a une déchirure sur le côté gauche ou sur le côté droit de l'engin. On arrive ainsi à faire à temps les réparations nécessaires avant que les dégâts ne soient grâves.

Tous les jours, avant le coucher du soleil, des ouvriers soulèvent le filet hors de l'eau et le tapotent avec des bâtons en rotin pour le débarrasser de toutes sortes de débris (feuillage, brindilles, petits poissons, algues etc...) qui bouchent les mailles. Quelquefois, en période creuse, on change de filet pour le sécher au soleil ou pour le reteindre.

RENDEMENT ET UTILIZATION DU POISSON

Un *Day* d'importance moyenne nécessite une mise de fonds d'environ 50.000 piastres dont 30.000 piastres pour le matériel et 20.000 piastres pour le personnel. L'importance de ses recettes pour les quatre mois de pêche s'élève á environ 100.000 piastres. Le pêcheur doit gagner ainsi environ 50.000 piastres par campagne de pêche.

Après chaque relève du Day, les pêcheurs trient leurs poissons; ceux qui sont susceptibles d'être conservés vivants sont jetés dans une jonque-vivier. Ce sont le Trey-Pruol (*Cirrhinus auratus*), le Trey-Prâloung (*Leptobarbus haeveni*), le Trey-Kroum (*Osteochilus melanopleura*), le Trey-Châkeng (*Puntiplites proctozysron*). Ils sont destinés à être exportés à l'état frais vers la Cochinchine, ou vendus sur les marchés locaux lorsqu'ils auront les meilleurs cours, surtout à la fin de chaque période de descente. Les autres poissons de bonne qualité, comme les Trey-Kès (*Cryptopterus apogon*), Trey-Khlaing-Hay (*Belodon tichthys dinema*), Trey-Khbâk (*Clupea chibandeani*) et un certain nombre de gros Trey-Lenh (*Thynnichthys thynnoïdes*) et Trey-Réal (*Cirrhinus julliéni*), sont vendus soit sur place, soit aux marchés de Phnom-Penh pour la consommation de la ville. Les Trey-Changvar (variété de petits poissons) sont vendus ou échangés contre du paddy pour la fabrication du 'Prahoc' Les poissons invendus sont mis de côté par le fermier pour la fabrication de l'huile. Comme la plupart des acheteurs fabriquent leur 'Prahoc' à la pêcherie même du fermier, ce dernier peut encore récupérer les déchets de cette fabrication pour en extraire de l'huile.

Le cours du poisson des *Days* est très variable: il change d'heure en heure et d'un endroit à l'autre. Seuls les poissons conservés vivants en vivier ont un cours assez régulier.

Les recettes sont réparties comme suit:

— Poissons conservés en jonque-vivier	... 13·400kg	...40·200$00
— Poissons vendus pour la consommation à l'état frais	... 15·200kg	...30·400$00
— Poissons á 'Prahoc'	... 61·400kg	...30·700$00
— Poissons á huile	... 6·400kg	... 3·400$00
Total ...		104·700$00

En fin de campagne, le bilan du fermier s'établit donc ainsi:

— Recettes	... 104·700$00
— Dépenses	... 52·085$00
— Bénéfices	... 52·615$00

CONSIDERATION SUR LES DESCENTES DE POISSONS

La pêche commence chaque année à partir du 15 Novembre. Le 17 Novembre, nous avons relevé:

— 60kg de Trey-Prâloung (*Leptobarbus hoeveni*).
— 23kg de Trey-Kahè (*Puntius altus*).
— 30kg de Trey-Kântrâng-Préng (*Ambassis wolffi* Blkr).

113kg

Le 29 du même mois, la capture réalisée était de:

— 10kg de Bangkâng (Crevettes).
— 20kg de Trey-Prâloung (*Leptobarbus hoeveni*).
— 3kg de Trey-Bandaul-Pot (*Clupeoïdes, bornesus*).

33kg

A partir de cette date, la pêche ne se faisait que pendant la nuit. Le 6 Décembre, on recommençait à poser le filet jour et nuit. Ce jour (12ème jour de la lune décroissante) était caractérisé par une prise de:

— 50kg de Trey-Prâloung (*Leptobarbus hoeveni*)
— 40kg de Trey-Chakèng (*Puntiplites proctozysron*)
— 28kg de Tre-Kaèk (*Labeo chrysophekadion*)
— 10kg de Trey-Kahè (*Puntius altus*)
— 24kg de Trey-Chhmar (*Lycothryssa crocodilus*)
— 4kg de Trey-Slek-Russey (*Oxygaster oxygastroïde*)
— 4kg de Trey-Pra (*Pangasius nodon sutchi*)
— 10kg de Trey-Khbâk (*Clupea chibandeani*)
— 15kg de Trey-Kroum (*Osteochilus melanopleura*)
— 10kg de Trey-Chhkok (*Cyclocheilichthys enoplus*)
— 10kg de Trey-Khlaing-Hay (*Belodon tichthys dinema*)
— 4kg de Trey-Kantrâng-Préng (*Ambassis wolffi Blkr*)
— 2kg de Trey-Chhvéat (*Pangasius macronemus*)
— 42kg de Trey-Bandaul-Pot (*Clupeoide bornesus*)

253kg

La descente continuait chaque jour de plus en plus intense pour donner le 19 Décembre (10ème jour de la lune croissante), une prise totale de:

— 700kg de Trey-Pruol (*Cirrhinus auratus*)
— 40kg de Trey-Prâloung (*Leptobarbus hoeveni*)
— 40kg de Trey-Khlaing-Hay (*Belodon tichthys dinema*)
— 10kg de Trey-Khbâk (*Clupea chibandeani*)
— 82kg de Trey-Dângkhteng (*Macrochirichthys macrochirus*)
— 12kg de Trey-Kaék (*Labeo chrysophekadion*)
— 34kg de Trey-Kroum (*Osteochilus melanopleura*)
— 8kg de Trey-Pra (*Pangasius nodon sutchi*)
— 1.710kg de Trey-Changvar (variété de petits poissons)
— 202kg de Trey-Kanhchrouk (*Cobitidae*)
— 1.010kg de Trey-Lenh réal (*Thynnichthys thynnoïdes*)
— 20kg de Trey-Kahè (*Puntius altus*)
— 300kg de Trey-Lenh (*Thynnichthys thynnoïdes*)
— 252kg de Trey-Slek-Russey (*Oxygaster oxygastroïde*)
— 8kg de Trey-Dangkhteng (*Macrochirichthys macrochirus*)
— 8kg de Trey-Châkéng (*Puntiplites proctozysron*)

4.436kgrs.

Cette production baisssait ensuite à partir du 25 Décembre (ler jour de la lune décroissante). On ne mettait plus alors le filet que pendant la nuit. La prise journalière suffisait à peine à compenser les frais de nourriture du personnel. Cette période creuse durait du 26 Décembre au 7 Janvier. Le 8 Janvier (le jour de la lune croissante) était donc le commencement de la deuxième descente de poissons, la plus importante de l'année pour les *Days*. Cette deuxième période est aussi appelée " période de poissons à 'Prahoc' " par suite de la production en quantité énorme d'espèces servant habituellement à la fabrication de la pâte de poisson.

Le 13 Janvier (6ème jour de la lune croissante) a donné la prise suivante:

— 900kg de Trey-Pruol (*Cirrhinus auratus*)
— 57kg de Trey-Kroum (*Osteochilus melanopleura*)
— 84kg de Trey-Praloung (*Leptobarbus hoeveni*)
— 80kg de Trey-Kbâk (*Clupea chibandeani*)
— 120kg de Trey-Dangkhteng (*Macrochirichthys macrochirus*)
— 1080kg de Trey-Changvar (*variété de petits poissons*)
— 1.000kg de Trey-Lenh réal (*Thynnichthys thynnoïdes*)
— 900kg de Trey-Slek-Russey (*Oxygaster oxygastroïdes*)
— 500kg de Trey-Lenh (*Thynnichthys thynnoides*)

4.721kg

Ces chiffres augmentaient chaque jour pour atteindre le 21 Janvier (14 ème jour de la lune croissante) les limites suivantes :

— 147kg de Trey-Pruol *(Cirrihnus auratus)*
— 2.800kg de Trey-Lenh *(Thynnichthys thynnoïdes)*
— 6.500kg de Trey-Lenh-Réal *(Thynnichthys thynnoïdes)*
— 8.500kg de Trey-Changvar *(variêté de petits poissons)*
— 1.400kg de Trey-Slek-Russey *(Oxygaster oxygastroïdes)*
— 300kg de Trey-Kanhchrouk *(Cobitidae)*
— 78kg de Trey-Dângkhteng *(Macrochirichthys macrochirus)*
— 150kg de Trey-Kroum *(Osteochilus melanopleura)*
— 40kg de Trey-Khlaing-Hay *(Belodontichthys dinema)*
— 40kg de Trey-Prâloung *(Leptobarbus hoeveni)*
— 20kg de Trey-Chhmar *(Lycothrissa crocodilus)*
— 50kg de Trey-Kaèk *(Labeo chrysophekadion)*
— 30kg de Trey-Chakèng *(Puntiplites proctozysron)*

20.055kg

A partir du 21 Janvier, la production baissait insensiblement jusqu'au 26 Janvier (4ème jour de la lune décroissante) pour devenir nulle le 29 Janvier (7ème jour de la lune décroissante) qui clôturait la 2ème période de descente.

Durant la 3ème période de migration (12 au 21 Février), le *Day* considéré ne pêchait que pendant la nuit et avec beaucoup de relâchement, car le courant, devenant à cette époque trop faible, permet aux poissons déjà engagés dans le filet de rebrousser chemin et d'en sortir.

Le 12 Février (5ème jour de la lune croissante), la prise était de :

— 50kg de Trey-Kanhchanh-Chras *(Ambassis ranga)*
— 10kg de Trey-Chhmar *(Lycothrissa crocodilus)*
— 60kg de Trey-Bandaul-Pot *(Clupeoïde bornesus)*
— 30kg de Trey-Slek-Russey *(Oxygaster oxygastroïdes)*
— 10kg de Trey-Changvar *(variêté de petits poissons)*

160kg

Le 20 du même mois (13ème jour de la lune croissante) cette prise augmentait nettement encore pour la dernière fois :

— 80kg de Trey-Kanhchanh-Chras *(Ambassis ranga)*
— 25kg de Trey-Chhmar *(Lycothrissa crocodilus)*
— 100kg de Trey-Bandaul-Pot *(Clupeoïde bornesus)*
— 50kg de Trey-Slek-Russey *(Oxygaster oxygastroïdes)*
— 30kg de Trey-Changvar *(variêté de petits poissons)*

285kg

Enfin, on voit bientôt pris dans le Day une énorme quantité de petits poissons blancs *(Ambassis ranga* H.B.) qui n'ont aucune valeur de consommation et qui ne sont bons que pour l'extraction de l'huile. Cette dernière migration annonce la fin de la campagne de pêche au *Day*. En effect, à partir du 20 Février, la production tombait nettement de jour en jour jusqu'à devenir nulle vers le 28 Février.

Si nous portons les captures considérées en abcisse et les dates correspondantes en ordonnée et si nous joignons entre elles les coordonnées, nous obtenons un graphique qui représente les pulsations de sortie de nos poissons des Grands-Lacs le Mékong.

CONCLUSION

A l'état actuel de notre règlementation, le *Day* est considéré comme un engin très destructeur et prohibé sur toutes les voies de migration des poissons. Cependant, par mesure exceptionnelle, il est autorisé pendant seulement quatre mois de l'année sur le Tonlé-Sap pour les raisons suivantes :

(1°) Ce fleuve est l'unique voie de migration des poissons des Grands-Lacs vers le Mékong. Or, à cette époque de l'année ces poissons ont atteint leur âge d'exploitabilité et peuvent être capturés sans inconvénient. Par ailleurs, la grande largeur du Tonlé-Sap laisse aux bancs de poissons de forte chance de passer à côté de ces barrages de filets et de gagner le Mékong.

(2°) Le courant du Tonlé-Sap, au moment des fortes descentes, est trop fort pour permettre l'installation d'autres engins que le *Day*.

(3°) Enfin, ces quatre mois de l'année correspondent à la saison de ravitaillement en *Prahoc* (pâte de poisson) des provinces déshéritées des arrière-berges. Seule, la pêche au *Day* dans le

Tonlé-Sap permet de fournir aux habitants à bon marché, la quantité de poissons frais nécessaires pour la fabrication de cet aliment national.

On voit donc que c'est là une industrie de pêche á la fois familiale parce qu'elle est la seule source d'alimentation de nombreuses familles, artisanale parce qu'elle permet à toute une collectivité riverine de vivre aux dépens de cette activité, enfin industrielle parce qu'elle procure d'énormes quantités de poissons tant pour la fabrication d'huile que pour l'exportation à l'état frais.

Nos études sur ce mode de pêche sont encore loin d'être complètes, et nous travaillons encore à les approfondir. Cependant, elles permettent d'ores et déjà de donner à notre Gouvernement une idée exacte du rendement de cet engin important qu'est le *Day*, pour pouvoir le classer dans la catégorie des taxes correspondantes à son importance.

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CONTRIBUTION A LA CONNAISSANCE DES ENGINS DE PECHE DU VIETNAM

par

Tran-Van-Tri[1] et R Serene[2]

Divers ouvrages contiennent des descriptions d' engins utilisés pour les plus importantes pêches pratiquées par les Viêtnamiens. Le dépouillement de ces documents montrant que l'inventaire descriptif des engins de pêche du Viêt-Nam restait á faire, le bureau d'études des pêches de l'Institut Océanographique de Nhatrang s'est attaché à ce travail; il a déjá publié en 1952 quelques monographies et en prépare d'autres pour paraître en 1953. Sans attendre la fin de ce travail, qui sera long, un examen de l'ensemble des documents recueillis permet déjá de reconnaitre les difficultés que rencontrera la classification des engins Viêtnamiens ; difficultés qui sont sans doute plus ou moins les mêmes pour les engins des autres pays.

Un exemple limité aux filets de pêche des Viêtnamiens montre bien ces difficultés. Il donne aussi l'occasion de faire quelques remarques de méthodologie á propos des enquêtes que l'on conduit pour préparer les manuels des pêches.

La distinction des différentes espèces de filets maillants de dimensions différentes et de mailles de taille différente constitue la principale difficulté ; si l'on remarque qu'il faut distinguer si les filets maillants sont utilisés fixes ou dérivants, et que d'autres filets servent de barrière, les poissons ne s'y maillant pas. La distinction des différentes espèces de filet à poche est plus facile.

Si l'état actuel de nos fiches d'enquête donne une idée d'ensemble des filets maillants utilisés par les Viêtnamiens, il ne permet pas toujours de définir avec précision à laquelle des diverses catégories de filets indiquées ci-dessus l'engin appartient. La constitution d'une collection musèographique des engins de pêche faciliterait le travail sans le resoudre entiérement ; elle ne retient pas le modè d'emploi ; elle nécessite des moyens dont on ne dispose généralement pas; certains filets coûtent jusqu'á 40 á50.000$ et le moindre coûte un millier de piastres. Il faut par ailleurs un local et du personnel pour organiser et entretenir un tel musée, dont l'utilité du point de vue Technologique et au stade actuel de nos recherches, ne s'impose pas. Les enquêteurs relèvent en détail toutes les caractèristiques des engins et leurs dimensions. Ils font des dessins, prennent des photographies, s'informent sur le mode d'emploi, la saison de son utilisation, les espèces de poissons qu'il sert à pêcher, le mode de fabrication, le prix, etc. . .

L'établissement d'un lexique des noms Viêtnamiens de filets, qui ne va pas sans difficultès dont les principales sont indiquées ci-desscus, peut, à défaut d'un catalogue des figures des engins encore à faire, servir comme un dictionnaire. Un tel lexique rèvèle, si on le rapproche de nos fiches d'enquête, que même des filets de la région de Nhatrang, oú nous travaillons spécialement, sont encore insuffisamment connus et la dècouverte de ces lacunes oriente nos enquêtes. Les noms Viêtnamiens des engins, même si on essaie de les traduire en français, et c'est souvent impossible, ne sont pas suffisamment précis et connus pour qu'en donnant un nom, le Viêtnamien puisse se rendre compte exactement de l'objet dont il s'agit. Le nom doit alors être accompagné d'une explication, souvent d'une description, parfois il faut aller jusqu'au dessin.

Les Viêtnamiens dèsignent par le terme général de *Luoi*, les filets qu'ils utilisent pour la pêche. La nom de *luoi* est souvent suivi de celui du nom d'un poisson ou de la dimension de la maille du filet ainsi *luoi goc* pour la pêche au *ca goc*, *luoi be* pour le *ca be* (Pellona), etc. . . , de même *luoi hai* pour le filet de 2 doigts de mailles, *luoi ba* de 3 doigts, etc. . . La traduction littérale des noms Viêtnamiens de filet permet donc parfois de reconnaitre soit l'espèce de poisson qu'il sert à pêcher, soit la dimension de ses mailles, soit la manière dont il est utilisé. Ces noms ne sont malheureusement pas toujours uniformes tout au long du littoral Viêtnamien : un filet porte dans le Nord un nom different de celui du filet identique du Sud, (par exemple : le *Xich* du Sud (push net) est appelé *te* au Centre, le *day* du Sud est appelé le *luoi xam* au Nord, etc. . .) Le terme *Mânh* plus restrictif que celui de *Luoi* désigne les filets à poche. Un fichier général des Engins de pêche a été etabli par le dépouillement des documents recueillis par M. M. PIETRI, HILLY, LEMASSON, TRAN VAN TRI, NGUYEN LUONG KHUONG, TRAN LE CHAT, GRUVEL, COTTE ET VAN GAVER, LE NESTOUR, SERENE et par les enquêteurs de l'Institut Océanographique de Nhatrang, au Bureau d'Etudes des Pêches de l'Institut Océanographique de Nhatrang selon la classification de Mr. BURDON (IPFC/51/TECH 24).

Certaines divisions de la classification de Mr. Burdon ne sont pas suffisamment détaillées pour couvrir de nombreuses différenciations surtout dans les modes de capture très variés des engins de pêche du Viêt-Nam et sans doute de tout le Sud Est Asiatique. Cette lacune n'est pas très importante et une étude sérieuse doit permettre de la compléter pour obtenir une classification Standard. Mais c'est dans la classification des filets maillants que réside la principale difficulté. Mr. Burdon classe les filets maillants des Etats malais par la grandeur de leurs mailles et par le nombre de ces mailles compté dans le sens de la hauteur du filet. Cette methode parait difficilement utilisable dans la pratique.

1°/ Le nombre des mailles d'un filet varie plus ou moins dans un même type de filet suivant la profondeur des eaux à laquelle on l'utilise.

2°/Mr. Burdon mesure la largeur d'une maille par la distance entre ses 2 noeuds adjacents, d'autres auteurs et les pêcheurs principalement la mesurent entre les 2 noeuds opposés. Il faut pour appliquer la classification de Mr. Burdon arriver à uniformiser le mode de mesure des mailles : travail très difficile, sinon impossible dans l'état actuel des documents dont on dispose sur les filets du Sud Est Asiatique. D'autre part, la classification de Mr. Burdon se rapporte à la largeur des mailles en unité de mesure arithmétique; les pêcheurs la mesurent par la largeur de leurs doigts, ce qui donne des résultats variables. On pourrait bien proposer une mesure standard du doigt ; ce n'est guère possible actuellement dans la pratique. Je proposerais plutôt pour cette partie de la classification en me basant sur mes observations sur les filets Viêtnamiens de classer les filets maillant en séparant les filets pêchant :

— en surface
— entre deux eaux
— sur le fond

et en précisant

— pourvus ou non de plomb
— dérivants ou fixes.

Si la grandeur de mailles est très importante, elle ne me parait pas actuellement une base utilisable dans le Sud Est Asiatique pour une classification internationale.

Les technologistes abordent généralement la connaissance des engins de pêche de leur pays sous les aspects suivants :

1°/ lexique
2°/ description
3°/ figure
4°/mode et saison d'utilisation
5°/ poissons pêchés.

Les documents ainsi publiés sont souvent trop incomplets pour être utilisables ; ou bien le mode d'utilisation est mal défini ; plus souvent les caractéristiques des engins avec toutes leurs dimensions sont insuffisantes (on ne peut pas s'en servir pour fabriquer un engin). La détermination des engins (leur diagnose pour employer une terminologie en usage chez les systématiciens de zoologie) étant insuffisante, on comprend les difficultés qu'on éprouve à les classer.

C'est sans doute en considération de cette difficulté que le C.I.P.P. avait pensé que l'adoption par tous les pays membres d'une même classification apporterait une assistance au technologiste. Quelle que soit cette classification, et donc sans mettre en cause celle de Mr. Burdon, elle ne résoud qu'en partie le problème. Il faudrait arriver en même temps à uniformiser les fiches de description (diagnose) des engins. Cette fiche type doit être faite par un technologiste des pêches et les catalogues de certaines firmes commerciales peuvent lui servir de guide. Ce sont surtout des ethnographes qui se sont jusqu'à maintenant intéresses a la question et les descriptions des engins dans les ouvrages sont très souvent faites de ce point de vue. Il y a une confusion à supprimer entre le technologiste ethnographe et le technologiste des pêches ; c'est surtout le travail de ce dernier que réclame le développement de la pêche. Des échanges d'information sur les engins de pêche des divers pays établis sur ces bases sont seuls susceptibles d'apporter des modifications aux engins actuellement utilisés. La documentation de tout chapitre de technologie des engins d'un manuel des pêches devrait pouvoir être utilisable non seulement par les nationaux (auquel le lexique suffit souvent) mais par les étrangers. Ce n'est pas souvent le cas actuellement. Dans la plupart des pays du Sud Est Asiatique, les engins sont fabriqués par les autochtones qui s'en transmettent traditionnellement les caractéristiques, ils n'ont pas besoin de technologistes ; mais le jour où ils voudront acheter leurs engins à un fabricant, et pour beaucoup de pays ce jour est venu, ils seront obligés de donner les caractéristiques des engins qu'ils voudront commander. S'ils reçoivent des engins provenant d'autres pays, tels qu'ils existent sur le marché commercial de ces pays, la pratique montre que souvent ils ne peuvent que difficilement les utiliser en les adaptant à leur mode de pêche propre.

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NOTE
SUR LES RELATIONS ENTRE EMPLOYÉS ET PATRON PÊCHEURS Â NHATRANG (VIÊTNAM)

par

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et. Nguyen-Chau[2]

Dés qu'ils dépassent le stade de pêche individuelle avec des équipements réduits : un sampan, une ligne à main, un carrelet, etc. . . les pêcheurs sont obligés de travailler en groupe. L'utilisation des engins de pêche d'une certaine importance exige un nombreux personnel et donc un travail ensemble. Cette coopération s'inscrit dans des organisations sociales qui ont toutes le même principe général de travail en communauté, mais qui diffèrent plus ou moins les unes des autres dans leur forme administrative. A Nhatrang (Centre Viêtnam) chaque type d'engin de pêche différent a son organisation propre. Cette étude porte sur celle d'un *mành*, filet à poche dont la forme rappelle celle d'un chalut, mais dont la ralingue inférieure est trés avancée par rapport à la supérieure. C'est un des plus importants engins de pêche de la province destiné à prendre de petits poissons : les *cá nuc* (*Decapterus* sp.), *cá sôn* (*Holocentrum* sp.), *cá trích* (*Clupea* sp.).

PREMIERE PARTIE

Préparation de la campagne de pêche.—

Le propriétaire fournit tous les équipements :

(*a*) un *mành chà* (filet poche)	...	25.000$00
(*b*) un *mành côm* (filet poche plus grand)	... ...	35.000.00
(*c*) 2 barques	... ...	52.000.00
		112.000$00

L'équipage comprend de 10 à 12 employés :

— un *Thó* (maitre pêcheur, maitre de la lère barque)
— un *Thô lái phu* (aide du maitre pêcheur)
— un *Lái lui* (maitre de la 2ème barque)
— 2 *nâm ghe* (gardiens de barque, un dans chaque barque)
— un *Câm chéo phăch, thô lâng* (plongeur)
— 4 *ban* (coolies pêcheurs).

Chaque organisation de pêche traite avec un mareyeur pour la vente de ses produits et loue un secrétaire tenant la comptabilité qui est réduite à sa plus simple expression.

Engagement et recrutement du personnel.—

Le propriétaire donne au *Thô phu* (maitre pêcheur) une somme forfaitaire appelée *Tiên không* qui constitue son engagement à travailler avec lui pendant toute la durée de la prochaine campagne de pêche. Cette somme varie suivant l'accord intervenu entre le patron et le *Thô phu*. L'engagement qui lie le maitre pêcheur au propriétaire est signé par lui et par sa femme 4 mois avant la pêche ou souvent aussitôt aprés la dernière campagne. Durant la période précédant la saison de pêche si le *Thô phu* a encore besoin d'argent, le propriétaire lui en fournit suivant accord verbal et sans intérêts. Le propriétaire marque la somme prêtée dans son carnet de caisse, et elle lui sera remboursée à la fin de la saison de pêche.

La possession d'un bon *Thô phu* facilite le recrutement des autres membres de l'équipage, qui souvent viennent alors poser eux-mêmes leur candidature, Le *Thô phu* recrute le *Thò phu lái* (son aide) ; les conditions de recrutement sont très simples ; il n'y a pas de versement de *Tiên không*. Cependant le *Thô phu lái* peut aussi profiter du prêt sans intérêt accordé par le propriétaire moyennant une reconnaissance de dette timbrée signée par lui et sa femme.

Tous les autres pêcheurs peuvent emprunter de l'argent au propriétaire dans les mêmes conditions que le *Thò phu lái*.

Fonction de chaque membre de l'équipage.—

Le *Thô phu* (maitre pêcheur) :

— représentant du propriétaire
— responsable des bateaux de pêche et de la sécurité des équipages
— responsable de toutes les opérations de pêche, en particulier reconnaissance des bancs de poisson, des fonds, des fonds de coraux
— choix de l'emplacement pour la pose des *chà*.

Le *Thô phu lái* (l'aide du maitre pêcheur) :

— remplace le *Thô phu*, si ce dernier est malade
— dirige les barques pendant l'aller et le retour, cherche les *chà*, qui portent chacun un nom différent
— transmet les ordres du *Thô phu* aux pêcheurs, en particulier appelle les pêcheurs à la pêche.

Le *Lái lui* (maitre de la 2ème barque)

— même fonction que le *Thô phu* et assure la sécurité du *ghe lui*

Le *nâm ghe* (gardien de barque) :

— garde les barques de pêche et responsable des objets installés dedans
— prépare la cuisine pour tous les pêcheurs
— assure la propreté, l'entretien des barques.

Le *câm chéo phăch* (plongeur) :

— dirige la manoeuvre des voiles
— plonge pour décrocher les *chà* des flotteurs et décrocher les filets des coraux le cas échéant.

Les *ban* (coolies pêcheurs) :

— rament, relèvent le filet.

Le travail de séchage et raccommodage des filets est fait par tous les pêcheurs, sauf les dêux gardiens. Deux mois avant la saison de pêche, tous les pêcheurs se mettent au travail de préparation des équipements tels que coupage des lianes pour la ligature des pierres, récolte des écorces teintoriales, feuilles de latanier etc. . . Durant cette période, le propriétaire paie la nourriture de tous ; ces frais, mentionnés dans la colonne des frais généraux de la campagne, seront déduits en fin de campagne des recettes totales avant de procéder au partage des bénéfices. Avant le départ pour la pêche, on célèbre un culte aux déesses de la mer ; le propriétaire arrête alors le compte des dépenses les 2 mois de travail de préparation y compris celles du culte des déesses et le fait connaitre à tous les employés.

DEUXIEME PARTIE

Campagne de pêche.—

— Pendant la campagne de pêche, le propriétaire distribue une ration de riz suffisante à tous lsa pêcheurs ; cette ration sera retenue à la fin de le saison sur les recettes de chaque pêcheur.

— A la fin de chaque mois, le patron arrête le compte des dépenses qu'il a payées comme frais généraux et le tient à la disposition de tous les pêcheurs.

— Aprés chaque vente, une petite quantité de poisson est toujours laissée pour le compte des 2 gardiens de barque qui, avec ces produits, ont la charge de payer le bois de chauffage, l'eau potable, les condiments, etc. . . Cette laisse varie suivant la prise ; si la pêche est rémunératrice, les 2 gardiens auront une part plus large. A remarquer qu'avec cette part, les gardiens couvrent largement les dépenses ménagères de la barque.

— Le mareyeur est spécialement chargé de l'écoulement des produits de la pêche et de la collecte pour le propriétaire de l'argent chez les divers acheteurs, travail dont il est seul responsable. Il touche toujours 2% sur le prix de vente des poissons, même au cas où la vente se fait directement entre pêcheurs et consommateurs.

— Le secrétaire est très souvent un membre de la famille du propriétaire.

TROISIEME PARTIE

Fin de campagne et partage des bénéfices.—

Après avoir ramené les barques à terre, séché, retanné le filet et célébré un culte de remerciement à tous les dieux et déesses qui les ont protégés pendant la pêche, les pêcheurs procèdent au partage des benéfices. Supposons qu'en fin de la saison, une installation de *mành* ait rapporté 50.000$, cette somme sera repartie comme suit :

Frais généraux

— Culte	... ...	3.000$00
— Frais de nourriture pendant 2 mois de préparation	...	6.000.00
— Taxes	... ...	2.000.00
		11.000$00

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Ces dépenses sont déduites des recettes, il reste donc :

50.000$ — 11.000$ = 39.000$, à repartir entre les pêcheurs :

maitre pêcheur son aide gardiens des barques	} 10% ...	3.900$00
forfait pour le plongeur	...	500.00
2% pour le mareyeur	...	780.00
1½% pour le secrétaire	...	585.00
		5.765$00

39.000$00 — 5.765$00 = 33.235$00

On partage 33.235$00 en deux parts égales, une revenant au propriétaire, une autre aux pêcheurs :

$$\frac{33.235\$}{2} = 16.617\$50$$

Le maitre pêcheur du *ghe lui* (le *lai lui*) touche 2% sur la part revenant aux pêcheurs, c'est à dire :

$$\frac{16.617\$50 \times 2}{100} = 332\$35$$

Le reste est à partager à parts égales entre le nombre total des pêcheurs plus une part supplémentaire pour le propriétaire, part qui lui revient comme propriétaire du *ghe lui* :

$$\frac{16.617\$50 - 332\$35}{11} = 1.480\$46$$

En principe, chaque pêcheur devra donc gagner 1.480$46 ; en fait il ne touche sa part que suivant le travail qu'il a fourni pendant la pêche ; celui qui travaille bien gagne davantage que les autres ; le droit de décider la part réelle revenant à chaque pêcheur appartient à un comité composé du *Thô phu, Thô phu lâi* et du *lâi lui*. Les pêcheurs sur leur part remboursent alors les rations de riz que le propriétaire leur a fournies pendant la campagne de pêche et les emprunts qu'ils ont pu lui faire. Très souvent ils arrivent à peine à les couvrir.

Pour les 10% du maitre pêcheur, son aide et des 2 gardiens, ils les divisent en 2 parts égales, une revenant aux 2 gardiens (qui touchent chacun une part égale) et une autre au maitre pêcheur et son aide. Sur cette 2ème moitié, la maitre pêcheur touche ⅔ et ⅓ revenant à son aide.

L'organisation ci-dessus est celle d'avant guerre. L'evolution politique a amené avec elle des modifications dont les principales sont :

1°/ Le propriétaire n'est plus la seule personne ayant droit de décider de la vente des produits de pêche. La vente s'effectue maintenant en accord entre le propriétaire et les pêcheurs ; si pour une certaine part de produits, ils n'arrivent pas à se mettre d'accord pour la vente, ils la partagent en 2 parts égales, une pour le propriétaire, une pour les pêcheurs.

2°/ Le maitre pêcheur du *ghe lui* n'a plus sa part (2%) sur la part des pêcheurs, mais sur la somme totale aprés déduction des premiers frais généraux, c'est á dire sur 39.000$ dans l'exemple ci-dessus.

3°/ Les pêcheurs préfèrent payer **1/2%** de plus au secrétaire, (2% pour lui), et 1% de plus au mareyeur (3%), mais que ces 2 derniers leur présentent clairement leur registre de comptabilité et non á moitié triché comme c'était souvent le cas avant guerre.

4°/ La part revenant au patron à titre du *ghe lui* est supprimée. On partage dorénavant les recettes des pêcheurs (si l'équipage comprend 10 personnes) en 10 parts égales au lieu de **11**.

* * *

Il résulte de ce qui précéde que pour une part de bènéfice de 16.617$50, le propriétaire investit en début de campagne.

(*a*) un équipement matériel de 112.000$00,

(*b*) des dépenses diverses suivantes :

1.200$—gratification au maitre pêcheur.
15.000—prêt à l'équipage avant la saison de pêche.
6.000—prêt à l'équipage pendant la campagne de pêche. Cette somme varie suivant la fluctuation de la production de la pêche.
20.000—frais généraux occasionnés pendant la campagne de pêche.
27.000—riz, tabac, bétel (15$ par jour et par tëte).

89.200$

Le propriétaire investit donc pendant 6 mois :

112.000$ + 89.200$ = 201.200$.

Son bénéfice etant de 16.617$50, ses capitaux lui rapportent du 16,51% par an.

C'est une forme de contrat 'capital—travail' honnête si l'on considère que le propriétaire partage plus que son équipage les risques de la non productivité et celles des accidents qui peuvent endommager son matériel. Ces organisations qui existen depuis fort longtemps dans le milieu pêcheur Viêtnamien doivent être étudiées, soit pour être modifiées, soit pour servir de base à l'élaboration d formes nouvelles de cooperatives. Dans ces cooperatives le propriétaire disparaitrait, le capital étai fourni par le pêcheur (travail).