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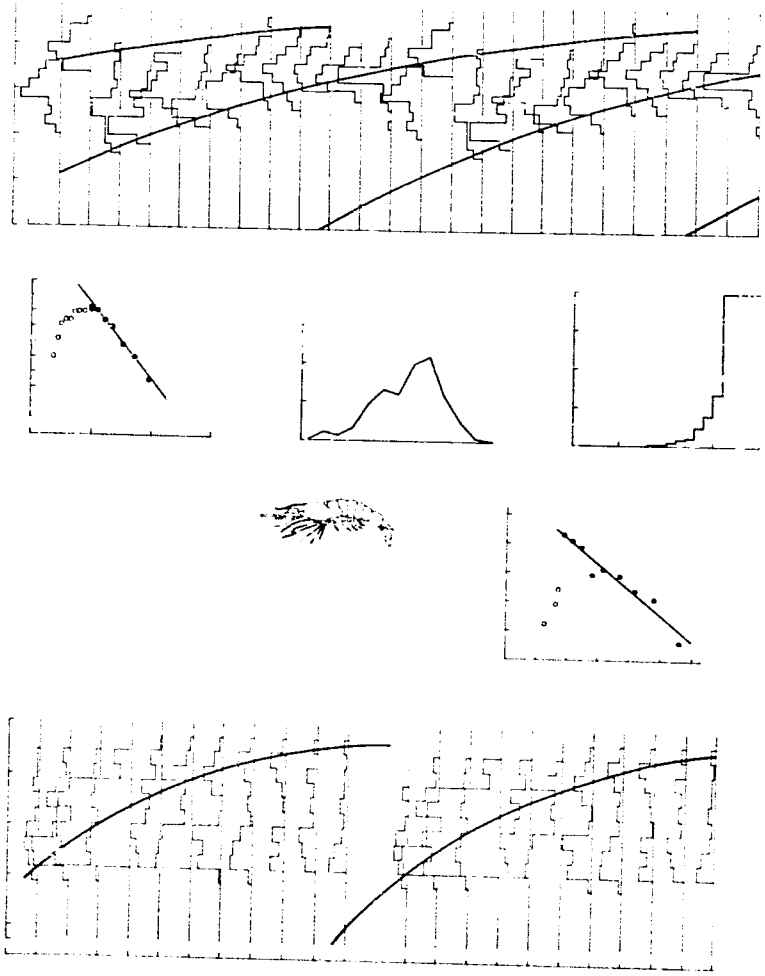

Growth, Mortality and Recruitment of Commercially Important Fishes and Penaeid Shrimps in Indonesian Waters

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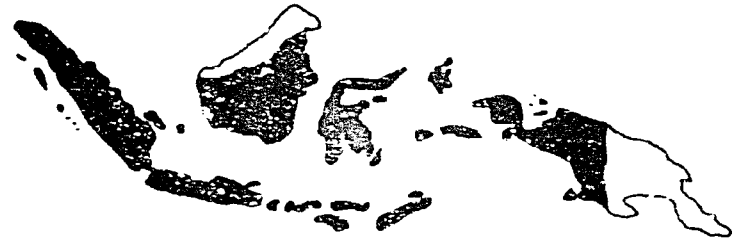

RESEARCH INSTITUTE FOR MARINE FISHERIES
JAKARTA, INDONESIA
INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
MANILA, PHILIPPINES

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Abstract

Estimates of von Bertalanffy growth parameters (L_∞ and K) were derived through application of the ELEFAN I program to length-frequency data from 52 stocks and 36 species of commercially important bony fishes from Indonesian waters, and to 9 different cohorts of a stock of penaeid shrimp *(Penaeus merguiensis)* from the Arafura Sea. Derived quantities such as total, natural and fishing mortality estimates, as well as selection and recruitment patterns were then obtained by application of the ELEFAN II program to these same length-frequency data. Some generalizations on the status of the stocks included are presented, notably on the demersal fishes off the north coast of Java, and on *P. merguiensis* in the Arafura Sea.

Introduction

Indonesia, as a large archipelagic country spanning the Sunda and Sahul shelves, has considerable fishery resources. Most of them are presently exploited, but there are some which could support increased fishing effort, notably in the eastern part of the country (Sujastani 1981; Dwiponggo 1982).

The vastness of Indonesian waters and the diversity of her fish and fisheries are both a blessing and a curse, however. Assessing the status of the various fisheries such as to eventually ensure that each exploits its stocks in optimal fashion is particularly difficult in view of the distances that must be covered, the logistical problems that must be solved when a given sampling scheme is to be applied and, last but not least, in view of the dearth of Indonesian personnel trained in fish population dynamics and stock assessment.

In this context, the application of the length-based method, such as the ELEFAN package of programs seems particularly useful, as it allows for preliminary assessments on the basis of a minimum of information, i.e., reasonably well-sampled length-frequency data.

This document presents results obtained by the systematic application of the ELEFAN approach to those length-frequency data that became available to the authors from 1983 to 1985. These data cover fishes ranging in size from 10 in *Secutor ruconius* to 80 cm in *Katsuwonus pelamis* and from areas as far apart as Jakarta Bay and the Arafura Sea (see Fig. 1). Altogether, 52 stocks of fish are covered, distributed in 36 species, 21 genera and 15 families of bony fishes, as well as 9 annual cohorts from the Arafura Sea stock of banana prawn *Penaeus semisulcatus*.

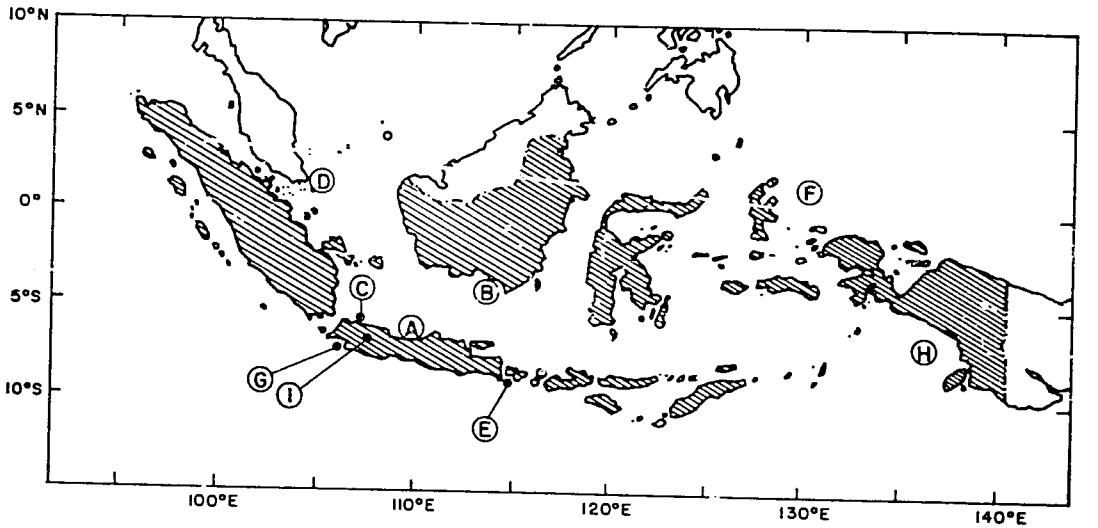

Fig. 1. Geographic distribution of stocks for which data were analyzed for this atlas.

A	Central and East Java (Tegal, Pekalongan)	33 stocks
B	South coast of Kalimantan	4
C	Jakarta Bay	3
D	Bintan/Riau Archipelago	4
E	Bali Strait	4
F	Sorong/West Pacific	2
G	Pelabuhan Ratu/Indian Ocean	2
H	Arafura Sea (shrimp stocks)	9
I	Jatiluhur Lake/West Java	1

Project Background, Materials and Methods

NARRATIVE OF PROJECT

The work leading to this document started in early 1983, after an agreement formalizing the project was signed by the late M. Unar, Director of the Marine Fisheries Research Institute (now Research Institute for Marine Fisheries, or RIMF), Jakarta and then ICLARM Director General Dr. Richard Neal, which outlined how both institutions were to cooperate on a joint project for the analysis of length-frequency and abundance data on commercially important fish and invertebrate stocks in Indonesian waters. The agreement further included ICLARM supplying a microcomputer, line printer and appropriate software (notably the ELEFAN programs) to the project staff in Jakarta, and regular visit by ICLARM staff to the project site. The project as a whole was to be the "Indonesian Module" of ICLARM's "Management-Oriented Fisheries Research Project" and its progress has been reported upon in ICLARM's annual reports from 1983 onwards. Since the start of the active phase of this project

the last author of this document visited the project site thrice, while the first author came twice to ICLARM headquarters in Manila. These exchanges made it possible to pattern our work after a similar undertaking, conducted simultaneously in the Philippines and which led to an "Atlas of the growth, mortality and recruitment of Philippine fishes" (Ingles and Pauly 1984), and yet to include a more detailed analysis of some of the results presented here, notably as concerns the shrimp *Penaeus merguiensis* (see below). With completion of the project phase involving length-frequency data acquisition, standardization and analysis using ELEFAN I and II (end of 1984), ICLARM donated the microcomputer, line printer and software supplied to its counterpart organization, and Mr. M. Saleh (RIMF) began drafting the plates for presentation of the results.

Simultaneously, a number of preliminary papers presenting selected project results were prepared by the first author (Dwiponggo 1984), by Sadhotomo et al. (1983) and by Drs. Nurzali Naamin and Purwito Martosubroto, who based parts of their dissertation (Martosubroto 1982; Naamin 1984) on analyses by the project staff of size-frequency data obtained by them and by staff of the Directorate General of Fisheries from vessels fishing in the Java Sea, and in the Arafura Sea for *P. merguiensis*, respectively.

In November 1983, ICLARM received a generous grant from the L.J. and Mary C. Skaggs Foundation, of Oakland, California, USA, which offset some of ICLARM's costs for supporting this project, notably the printing of the present document.

Project results pertaining to abundance (i.e., catch/effort) data will be presented in a subsequent contribution.

MATERIALS

The size-frequency data used here were all length-frequency data, except in the cases of the shrimp *P. merguiensis* which were expressed in tails per pound. The source of the size-frequency data used here are given for each data set in the legends of Plates 1 to 61, while the size frequency themselves are given in Appendix A as Tables A1 to A61.

METHODS (This section is adapted from Pauly and David 1981, Pauly et al. 1980 and Ingles and Pauly 1984)

The ELEFAN I program, run on a Radio Shack microcomputer (Model III, 48K) was used to estimate, for each set of length-frequency data, the value of the parameters L_∞ and K of a growth equation of the form

$$L_t = L_\infty (1 - e^{-K(t - t_o)})$$

that is, of the VBGF (von Bertalanffy 1938), where

- L_t is the mean length at age t,
- L_∞ is the asymptotic length, that is the mean length the fish of a given stock would reach if they were to grow indefinitely,
- K is a growth constant which may be conceived as a "stress factor",
- t_o is the "age of the fish at zero length" if they had always grown in the manner described by the equation (note that t_o is generally negative).

No attempt was made to estimate the values of the parameter t_o, because it cannot be estimated from the length-frequency data alone, and because it is not needed for most assessments (see below). With t_o remaining unknown, all growth curves shown refer to *chronological* time: they indicate what size the fish of a given cohort had at a certain *time* but do not indicate the *absolute ages* of the fish, i.e., they do not give the *age* corresponding to a given *size*.

No attempt was made to investigate seasonal growth oscillation, although such oscillations occur in tropical waters and ELEFAN I could have picked them up. The quantity and quality of the data processed were too high and too low, respectively, to justify this effort.

To estimate the set of growth prameters which best "fits" a set of growth parameters, ELEFAN I does the following:

1. "restructures" the length-frequency sample(s) that have been entered, such that small but clearly identifiable peaks are attributed a number of "points" similar to peaks based on a larger number of fishes. The procedure used here essentially consists of calculating running average frequencies (over five length classes), dividing each length-frequency value by the corresponding running average frequency, then subtracting 1 from the quotient. A few other minor adjustments are then made to prevent certain types of samples from generating biases;
2. calculates the maximum sum of points "available" in a (set of) length-frequency sample(s), where "available points" refer to points which can possibly be "accumulated" by one single growth curve (see below). This sum is termed "available sum of peaks" (ASP);
3. "traces" through the (set of) length-frequency sample(s) sequentially arranged in time, for any arbitrary "seed" input of L_∞ and K, a series of growth curves started from the base of each of the peaks, and projected backward and forward in time to meet all other samples of the sample set and/or the same sample repeated again and again;
4. accumulates the "points" obtained by each growth curve when passing through peaks (positive points) or through the troughs separating peaks (negative points);
5. selects the curve which, by passing through most peaks and avoiding most troughs best "explains" the peaks in the (set of) sample(s) and, therefore, accumulates the largest number of points. This new sum is called "explained sum of peaks" (ESP);
6. increases or decreases the "seeded" values of L_∞ and K until the ratio ESP/ASP reaches a maximum, and outputs the growth parameters corresponding to this optimum ratio.

The validity of the procedure outlined here rests on the following assumptions:

1. that the sample(s) used represents the population investigated;
2. that the growth pattern in the population is the same from year to year;
3. that the VBGF describes the average growth of the investigated stock;
4. that all fishes in the (set of) sample(s) have the same length at the same age, and that, therefore, differences in length can be attributed to differences in age.

Of these four assumptions, the first is a sampling problem and need not be discussed here. Assumptions 2 and 3 appear to be realistic, and they are in fact made, explicitly or not, every time the growth parameters of fish are calculated on the basis of annual markings on skeletal parts.

The last of these assumptions does not strictly apply, since it is known that fishes having the same age may have different lengths. Simulations show, however, that this assumption, which is essential to the operation of the program, does not generate a marked bias.

The reader is reminded that the growth curve which has been superimposed on the length-frequency data is the single growth curve which gave the best fit, not the only one that could have been fitted. Thus in most cases, or more precisely, in all cases where two cohorts recruit annually to the stocks, a second growth curve could have been fitted to the data by shifting the original growth curve by about five to seven months.

Some of the growth curves may generate *ages* that appear too high due to the values of L_∞ being too low because the samples were not representative of the stock (e.g., from migration out of the sampling area). In most cases, however, growth curves and parameter values appear reasonable and generally compare well with values available in the literature.

The length-converted catch curves are generally straight, justifying the computation of a single value of Z for all sizes (ages) in the exploited phase.

The ELEFAN I program used to fit the growth curves presented here has been modified since the bulk of the work in this atlas was completed. It is expected, therefore, that any reader attempting to reproduce the results using length-frequency data in this document and a recent version of ELEFAN I would find slightly different growth parameter

values to give the best fit. These small differences should not detract from the overall usefulness of this atlas, however.

The ELEFAN II program has four main subroutines, all of which require growth parameter estimates (as generated by ELEFAN I) and the same length-frequency data used for growth parameter estimation. These routines are:

1. The estimation of total mortality (Z) from the straight right arm of a length-converted catch curve (Pauly 1984);
2. The estimation of natural mortality (M) from the built-in empirical relationship (Pauly 1980):
   $\log_{10} M = -0.0066 - 0.279 \log_{10} L_\infty + 0.6543 \log_{10} K + 0.4634 \log_{10} T$;
3. The derivation of a "selection pattern", i.e., of a graph giving probabilities of capture by length, based on the method described in Pauly (1984);
4. The derivation of a "recruitment pattern", i.e., of a graph showing the seasonality of recruitment into the stock investigated.

The first of these routines usually provides estimates of Z that are very close to the true values when the length-frequency data used are representative of the population investigated (Pauly 1984). As with the latest version of this program, the version of ELEFAN II used pooled the various samples of a data set into one single sample, such that the effect of seasonal recruitment pulses on the length-converted catch curves was evened out as far as possible. However, the early version of ELEFAN II differed from the latest versions in that each sample of a data set was given the same weight before pooling (through re-expression in percentages); in newer versions, several weighting modes are offered, including weighting of the percentage samples by the square root of their original sample sizes.

The estimates of M, obtained from equation (4) using a mean water temperature set at T = 27°C throughout, were subtracted from the values of Z obtained from the length-converted catch curves to obtain approximate values of fishing mortality (F = Z − M), which were used to compute exploitation rates (E = F/Z). The latter may be used to assess stocks, in the absence of catch and effort data, if the generalization of Gulland (1971) is accepted that the optimum fishing mortality in an exploited stock should be approximately equal to natural mortality or $E_{opt} \approx 0.5$.

Because of the uncertainties inherent in the various estimates used to compute the values of E, no attempt should be made to assess a *single* stock using the technique outlined here. On the other hand, a predominance of estimates of values of $E > 0.5$, in a *number of stocks* should be suggestive of overexploitation.

The selection patterns presented were obtained from the left, ascending arm of the length-converted catch curves, using the analytical method described in Pauly (1984), which is run automatically every time a length-converted catch curve is derived by ELEFAN II (Pauly et al. 1981). Throughout, the computations were run with a straight, backward projection of the descending right arm of the curve. This leads to estimates of mean size at first capture very close to those that would have been obtained, had a more elaborate computational method been used to estimate the probabilities of capture (see Pauly 1984). However, it should be noted that the estimates of mean size at first capture (L_c) presented in this atlas are usually higher than would have been obtained based on mesh selection experiments, because the method used here cannot account for the masking effect of incomplete recruitment.

The method by which recruitment patterns are derived from a set of length-frequency data and growth parameter values has been described in Pauly and Navaluna (1983); it is also part of the user's instruction for ELEFAN II (Pauly et al. 1981). Recruitment patterns are generated by a backward projection, using the growth parameter at hand, of the available length-frequency data.

Typically, recruitment patterns have the bell-shape of a normal distribution when recruitment occurs as a single annual event. When annual recruitment occurs as two major events (more than two are unlikely, see Pauly and Navaluna 1983), this usually results in a single asymmetric structure, or in a bimodal pattern. Recruitment patterns as obtained by ELEFAN II can then be decomposed into their component distributions and inferences can then be drawn on the seasonality of the recruitment and on the relative strength of dif-

ferent recruitment pulses (see Pauly and Navaluna 1983 for an example).

The set of methods outlined above were applied to the fish data in Plates 1-52. In the case of shrimp (Plates 53 to 61), the nature of the available raw data (commercial tail counts) required application of some modifications, while precluding application of some methods.

Shrimp tail counts are actually weight-frequency distributions with unequal class intervals. They were here transformed into length-frequency distribution based on the following steps:

1. The shrimp tail counts (i.e., number of shrimp tails per pound) were converted to shrimp tail weight-frequency data.
2. The shrimp tail weights were converted to shrimp total weights through multiplication by a factor of 1.6.
3. The total weight-frequency data were converted to total length-frequency data through application of the appropriate length-weight relationships (Naamin 1984), based on the assumption of even distribution of shrimps within each weight class.

This procedure provides "length"-frequency data which will reflect the gross features of the actual length-frequency distribution of the catch and hence allow estimation of growth and mortality but which are too crude to allow estimation of parameter requiring detailed information on the distribution of the smaller animals such as the recruitment and selection patterns. For this reason, these two types of graphs are omitted in Plates 53 to 61 pertaining to *Penaeus merguiensis.*

The availability of time series of data on the shrimp *Penaeus merguiensis* in the Arafura Sea (Table 1) on the other hand, allowed application of various stock assessment models, of which we have selected here the following:

- plot of Z on effort to estimate natural mortality (M) and catchability coefficient (q) as intercept and slope, respectively, of the regression line;
- parabolic surplus production model (Schaefer 1957) to estimate Maximum Sustainable Yield (MSY) and optimum effort (f_{opt});
- "logarithmic" surplus production model (Fox 1970), to obtain a second set of estimates of MSY and f_{opt}, and
- surplus production model of Csirke and Caddy (1983), to show that estimates of total mortality (Z) obtained from length-converted catch curves can indeed replace effort in production modelling.

EXPLANATION OF THE GRAPHS ON PLATES 1 TO 61

Graphs of length-frequency data with superimposed growth curves, length-converted catch curves, recruitment pattern and selection pattern, are given for each fish "stock" recognized here in Plates 1 to 52. An index to these stocks, which are arranged by families, themselves arranged according to Greenwood et al. (1966), is provided on p. 12 and 13.

The upper graph in each plate referring to fish gives length-frequency histograms, which are shown as percentages rather than absolute numbers, for months in which data were available. The number of fish in each monthly sample is shown beside each histogram. The sequence of histograms is repeated to show how ELEFAN I uses the data repetitively. Best-fit lines of growth resulting from ELEFAN's analysis are shown for *one* cohort only (two cohorts are recruited each year in the majority of fish species investigated). Note that the projection back to zero of the growth curve *does not* necessarily provide the time at hatching of the fish, because t_o cannot usually be assumed equal to zero (see above).

In plates referring to fish, the lower left graph is a length-converted catch curve. Relative age is given since the growth curves provide only relative, not absolute, age (t_o is not known). Black dots are those used in calculating the parameters of the straight line, the slope of which (with sign changed) is an estimate of Z. Open dots represent fish not fully selected by the gear used in the fishery and/or not used in mortality estimates.

The central lower graph in each plate referring to fish is the pattern of annual recruitment into the fishery as obtained

from ELEFAN II. The data are expressed as percentage of annual recruitment by month.

In most fish stocks the graphs suggest that two annual pulses of recruitment have occurred; fewer species show one (bell-shaped curve); the remainder are somewhat ambiguous, the result of insufficient data.

The lower right graph presents the probability of capture of fish by length class as estimated from ELEFAN II. Mean length at first capture (L_c) was estimated, using a cumulative method, as the length at which P = 0.5.

Parameters determined from these graphs (L_∞, K, L_c, Z, M and E) are provided beneath each plate referring to fish, together with a reference to literature on the species concerned.

The plates referring to shrimp (Plates 53 to 61) differ from those referring to fish in that they include neither recruitment nor selection patterns (see above) and by being arranged differently. The upper part of each plate referring to shrimp presents an outline drawing of the shrimp species in question—as in the case of the fish—along with details on the sampling data and location and, to the right, a length-converted catch curve. The original length-frequency data with superimposed growth curve and legend form, as in the case of the fish, the lower part of each graph.

Results and Discussion

Plates 1 to 62 present the key results of our project, and readers are encouraged to look at each plate separately, then to assess our overall interpretation of the available data.

The astute reader will not fail to notice that the quality of the data analyzed here is, for most stocks, such that one would not (and in fact should not) put a great amount of trust in a given isolated set of growth and mortality estimates. However, when our results are grouped, general trends emerge which will tend to reflect the underlying reality.

Two of these data groupings will be presented and discussed in some detail here, the demersal fishes of the northern coast of Central Java and the population dynamics of banana prawn in the Arafura Sea. These accounts are followed by a more general discussion of our results.

STATUS OF DEMERSAL FISHES OF THE NORTH JAVA COAST PRIOR TO THE TRAWLING BAN OF 1980

The analyses of length-frequency data of fishes of the north coast of Central Java (see Fig. 1) allows an assessment of the status of these resources in the late 1970s, when these data were collected.

Fig. 2 presents (on its left side) a frequency distribution of values of the exploitation rate (E = F/Z) for 24 stocks of fishes

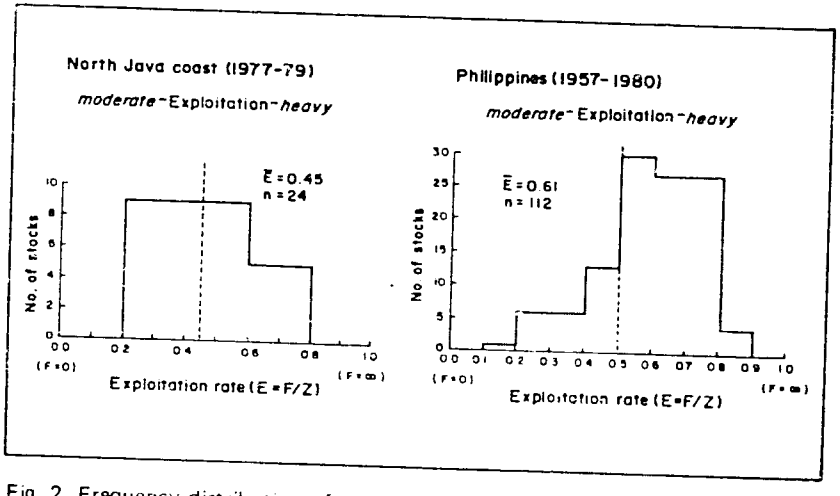

Fig. 2. Frequency distribution of exploitation rates (E = F/Z) in demersal fishes of the north Java coast, and in Philippine fishes, as based on the same analytic approach (application of ELEFAN I and II) (see text for interpretation).

exploited by demersal trawlers from 1977 to 1979. As might be seen, this frequency distribution has a mean of $\bar{E} = 0.45$ suggesting that the majority of species were exploited more or less optimally.

This finding confirms the contention of Martosubroto (1984) that the demersal stocks of the Java Sea were, at the time trawling was banned (Sarjono 1980), in a lesser state of exploitation than those of some neighboring countries, e.g., Thailand (see Pauly 1979) or the Philippines (see Fig. 2, right side). This does not imply that the trawl ban was unjustified. Rather it puts the trawl ban where it belongs, into the political sphere, as a measure to alleviate the plight of the small-scale fishermen who—especially along the North Java coast—had a minuscule share of the "optimally" exploited stocks.

POPULATION DYNAMICS OF *PENAEUS MERGUIENSIS* IN THE ARAFURA SEA, 1969-1981 (This section is based on Naamin 1984 and Pauly and Neal 1985)

The analysis of the size-frequency data of *Penaeus merguiensis* from the Arafura Sea area of Indonesia yielded particularly interesting results because these data, covering the period from 1969 to 1981 encompass a wide range of catch levels, extracted with a wide range of effort (Table 1).

Hence it was possible to use, in conjunction with the available catch and effort data, and with the total mortality estimates, a number of population models, all showing that the banana prawn population in the Arafura Sea tend to behave very much as predicted by the Theory of Fishing.

Thus, the plot of Z on effort in Fig. 3 shows a highly linear response of Z to fishing effort, leading to an estimate of natural mortality (M) extremely close to values estimated using different approaches and/or elsewhere (Table 2).

This is confirmed here by Fig. 4, i.e., an application of the model of Csirke and Caddy (1983)—the first ever to shrimp—which, besides producing a value of M extremely close to that provided by Fig. 3, also provides a value of maximum sustainable yield that is very close to those produced by conventional surplus-production models (Fig. 5).

Table 1. Catch, effort and total mortality of *Penaeus merguiensis* in the Arafura Sea, Indonesia (Subarea IV).[a]

Year	Annual catch (t)	Effort (vessel days) (Z) standard	Total mortality	Data in plate number
1969	873	857	2.71	53
1970	1,056	1,542	3.05	n.a.[b]
1974	5,777	12,247	8.62	54
1975	4,177	11,124	8.56	55
1976	5,328	15,701	10.96	56
1977	4,049	11,215	8.79	57
1978	4,508	10,436	8.41	58
1979	3,845	10,040	7.47	59
1980	3,940	9,795	8.01	60
1981	4,038	10,132	7.93	61

[a]From Tables 10b and 21 in Naamin (1984).
[b]The length-frequency data for 1970, and used by Naamin (1984) for his dissertation were not available at the time this atlas was completed.

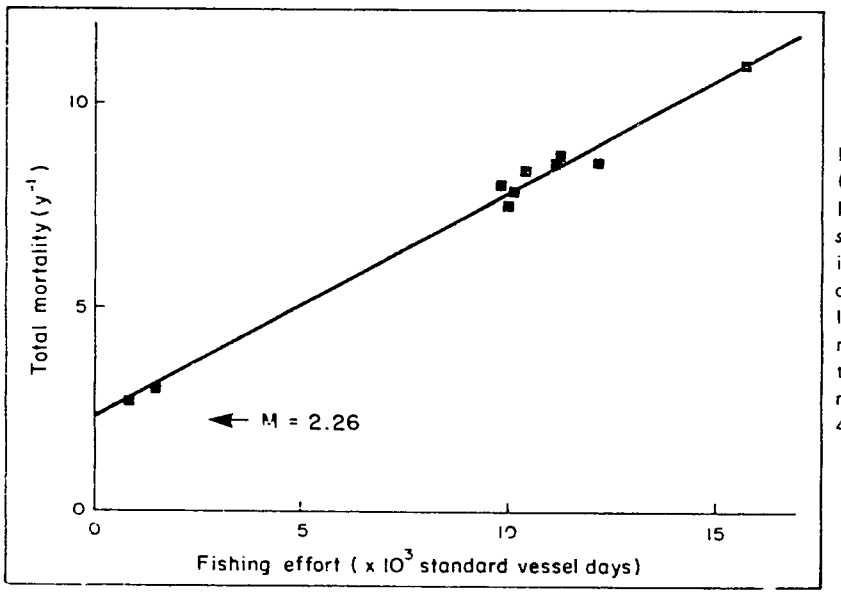

Fig. 3. Plot of total mortality (Z, as estimated using ELEFAN II) on effort in *Penaeus merguiensis*, Arafura Sea (based on data in Table 1); note very close fit of data points to regression line and estimate of natural mortality (M) very close to that obtained using alternative methods (see also Table 2, Fig. 4 and text).

GENERAL DISCUSSION

As noted in numerous publications dealing with the theory and applications of the ELEFAN programs, the reliability of

Table 2. Estimates of natural mortality (M) in *Penaeus merguiensis*, as obtained by various authors and methods.

Method	M (1/year)	Area, source and remarks
Plot of Z on effort	2.26	Arafura Sea, see Fig. 2
Parabolic plot of catch on Z	2.22	Arafura Sea, see Fig. 3
Empirical equation	2.06	Arafura Sea (Naamin 1984, based on Pauly 1980)[a]
M = Z in a little-exploited stock	2.60	Gulf of Carpentaria (Lucas et al. 1979); authors noted that their M is an overestimate
M = Z − M, with F estimated from area swept by trawlers	2.70	Gulf of Papua (Gwyther 1982) see original paper for problems within estimation of Z and F

[a]Note that this independent estimate is within 15% of the other two estimates of M for the Arafura Sea stock.

results obtained will depend largely on the quality (i.e., representativeness) of the size-frequency data upon which the analyses are based.

In the case of the data analyzed here, representativeness is certainly a problem, as the data used have been sampled rather haphazardly, for purposes other than detailed analysis with the ELEFAN programs (which in fact was not available at the time the data were collected).

Thus, as mentioned above, results based on any single data set must be viewed with caution. Generalizations based on aggregated results, on the other hand tend to confirm inferences drawn from independent sources, as shown above with references to Java Sea fishes and the banana prawns of the Arafura Sea.

This suggests that continued analyses of length-frequency data, using the ELEFAN programs and/or related computer-based approaches deserve to be encouraged.

Fig. 4. Application to the Arafura Sea stock of *Penaeus merguiensis* of Csirke and Caddy's yield model (based on data in Table 1); note relatively good fit of this first application of the model to a shrimp stock, and estimate of M close to those obtained using different methods (Fig. 3, Table 2 and text).

Fig. 5. Application of Schaefer and Fox's production models to the Arafura Sea stock of banana prawn *(Penaeus merguiensis)*. Note that estimate of MSY (4.0-4.5 x 10^3 t/year) are similar to the MSY estimate obtained using the model of Csirke and Caddy (see Fig. 4 and text; based on data in Table 1).

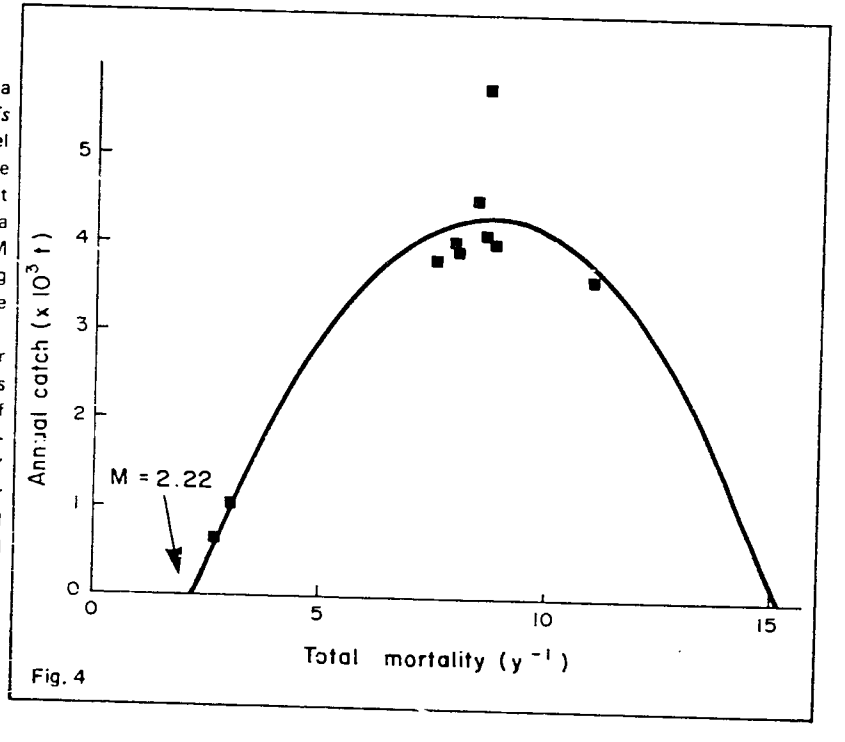

Fig. 4

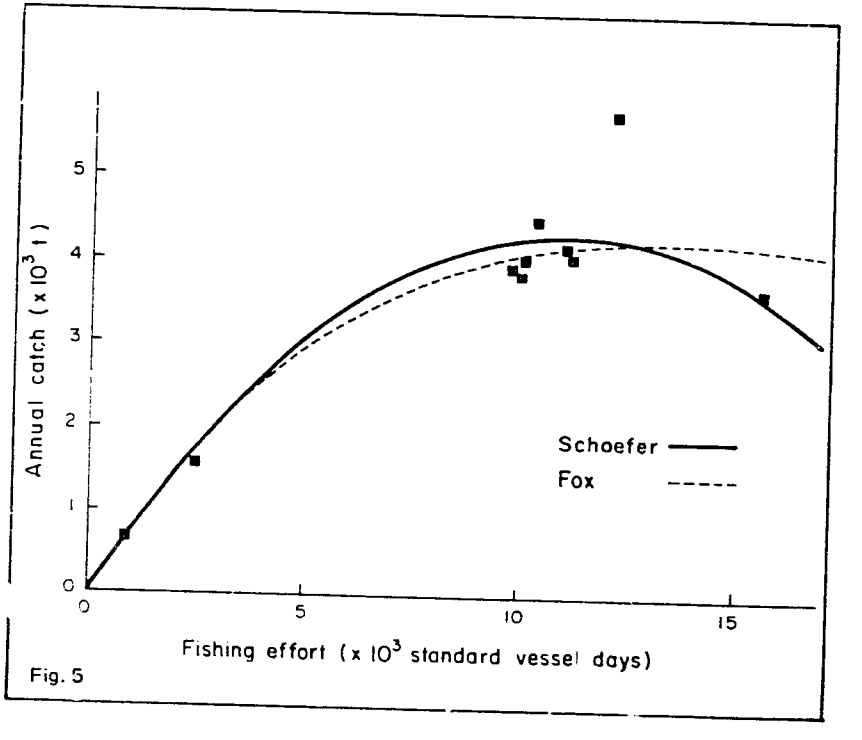

Fig. 5

The results presented here were obtained using some of the earliest versions of the ELEFAN programs. Following a fire at the printer's shop(!) which destroyed an earlier, camera-ready layout of this contribution (inclusive of all hand-drafted graphs prepared by Mr. M. Saleh), the present document was recreated at ICLARM by Ms. M.L. Palomares and Mr. O. Espiritu, Jr. based on raw data and (small) photocopied versions of Mr. Saleh's graphs, as well as on more recent, faster versions of the ELEFAN programs, which also generate HIRES graphics output.

Readers interested in these versions, which run on Apple II (CP/M) and IBM PC and their compatibles may write to the Director, Resource Assessment and Management Program, ICLARM, MC P.O. Box 1501, Makati, Metro Manila, Philippines.

Acknowledgments

The authors' sincere thanks are due to the late Mr. M. Unar, former Director of Research, Institute for Marine Fisheries, and Dr. N. Naamin, present Director, for their encouragement. The cooperation of the scientist and staff of the Research Institute for Marine Fisheries, the Ocean Research Institute (LON), Directorate General for Fisheries (DGF), in providing length-frequency data, is highly appreciated. Authors and colleagues who contributed length-frequency data for use in this atlas are acknowledged on the corresponding plates. We wish here, however, to state our appreciation to Messrs. M. Badrudin, U. Beck, Djamali, P. Martosubroto, S. Nurhakim, Purwanto, R. Rustam, B. Sadhotomo, Setiadi, Subroto, A. Sudradjat, G. Tampubolon and J.C.B. Uktolseya.

The assistance given to the authors by Mrs. Maria Wahiono at the early stage of the project, by Ms. M.L. Palomares when results were assembled, and by Messrs. M. Saleh and O. Espiritu, Jr. for drafting graphs, is gratefully acknowledged along with, last but not least, the generous support of the L.J. and Mary C. Skaggs Foundation.

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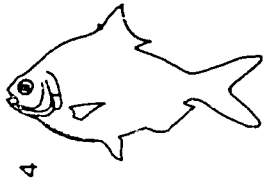
Index to families, genera, species and stocks

Plate No.	Family	Species	Fishing ground	Location on Fig. 1	Year(s)	N	Page
1	Clupeidae	*Anadontostoma chacunda*	Riau waters (Bintan)	D	1982/1983	2,371	15
2		*Sardinella gibbosa*	Riau waters (Bintan)	D	1982	2,708	16
3		*Sardinella longiceps*	Bali Strait	E	1977	2,845	17
4		*Sardinella longiceps*	Bali Strait	E	1979	943	18
5		*Sardinella longiceps*	Bali Strait	E	1980	1,619	19
6		*Sardinella longiceps*	Bali Strait	E	1981	1,656	20
7		*Sardinella sirm*	Java Sea (Pekalongan)	A	1982/1983	6,276	21
8	Synodontidae	*Saurida longimanus*	Java Sea (Central Java)	A	1977/1978	7,495	22
9		*Saurida micropectoralis*	Java Sea (Central Java)	A	1978/1979	470	23
10		*Saurida undosquamis*	Java Sea (Central Java)	A	1977/1978	263	24
11	Cyprinidae	*Hampala macrolepidota*	Jatiluhur Lake (West Java)	I	1983/1984	275	25
12	Ariidae	*Arius maculatus*	Java Sea (Tegal)	A	1978	495	26
13		*Arius thalassinus*	Java Sea (So. Kalimantan)	B	1976	325	27
14	Priacanthidae	*Priacanthus macracantus*	Java Sea (Central Java)	A	1977/1978	2,537	28
15		*Priacanthus macracantus*	Java Sea (Central Java)	A	1978/1979	649	29
16	Carangidae	*Decapterus macrosoma*	Java Sea (Pekalongan)	A	1982/1983	5,692	30
17		*Decapterus maruadsi*	Java Sea (Tegal)	A	1981/1982	765	31
18		*Decapterus maruadsi*	Java Sea (Tegal)	A	1982/1983	1,238	32
19		*Decapterus maruadsi*	Java Sea (Pekalongan)	A	1981/1982	4,265	33
20		*Decapterus maruadsi*	Java Sea (Pekalongan)	A	1982/1983	7,910	34
21		*Decapterus russelli*	Java Sea (Seribu Is.)	C	1973	525	35
22		*Decapterus russelli*	Java Sea (Seribu Is.)	C	1974	1,044	36
23		*Decapterus russelli*	Java Sea (Seribu Is.)	C	1975	885	37
24		*Selar crumenopthalmus*	Java Sea (Pekalongan)	A	1982/1983	5,540	38
25		*Selaroides leptolepis*	Java Sea (Tegal)	A	1978/1979	884	39
26		*Selaroides leptolepis*	Java Sea (Bintan)	D	1982/1983	2,456	40
27	Formionidae	*Formio niger*	Java Sea (Central Java)	A	1979	392	41
28	Leiognathidae	*Leiognathus bindus*	Java Sea (Tegal)	A	1977/1978	6,824	42
29		*Leiognathus brevirostris*	Java Sea (Central Java)	A	1979	364	43
30		*Leiognathus equulus*	Java Sea	A	1977	434	44
31		*Leiognathus decorus*	Java Sea	A	1977/1978	918	45
32		*Leiognathus leuciscus*	Java Sea (Central Java)	A	1982/1983	728	46
33		*Leiognathus splendens*	Riau Waters (Bintan)	D	1982	2,142	47
34		*Leiognathus splendens*	Java Sea	A	1977/1978	4,227	48
35		*Leiognathus splendens*	Java Sea (So. Kalimantan and Central Java)	A, B	1979	4,453	49

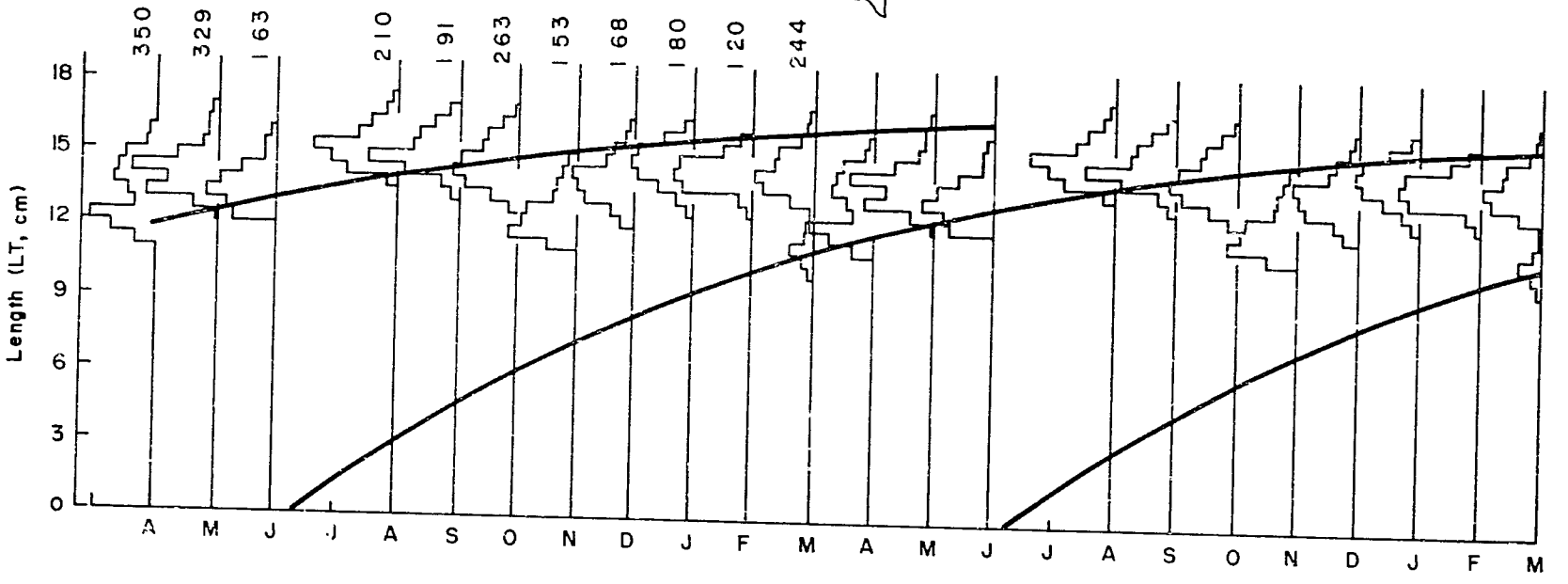
Continued

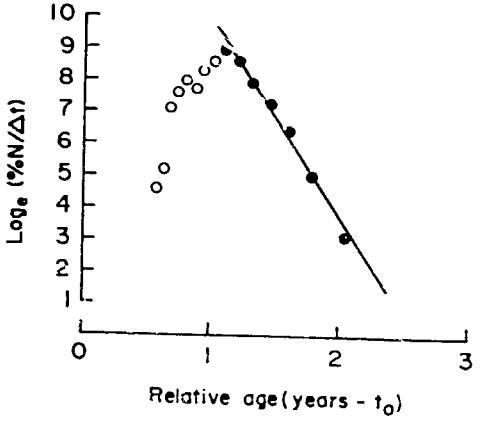
Plate No.	Family	Species	Fishing ground	Location on Fig. 1	Year(s)	N	Page
36		*Secutor ruronius*	Java Sea (Tegal)	A	1977/1978	688	50
37		*Secutor r onius*	Java Sea (Central Java)	A	1977/1978	680	51
38	Nemipteridae	*Nemipterus hexodon*	Java Sea (Central and East Java)	A	1979	1,568	52
39		*Nemipterus japonicus*	Java Sea (Central Java)	A	1977	296	53
40		*Nemipterus mesoprion*	Java Sea (Central Java)	A	1978/1979	570	54
41	Gerridae	*Pentaprion longimanus*	Java Sea (Semarang)	A	1978/1979	5,685	55
42	Pomadasyidae	*Pomadasys hasta*	Java Sea (Tanjung, Selatan, So. Kalimantan)	B	1977/1978	425	56
43	Mullidae	*Upeneus sulphureus*	Java Sea	A	1977/1978	5,356	57
44		*Upeneus sulphureus*	Java Sea	A	1978/1979	1,313	58
45	Drepanidae	*Drepane punctata*	Java Sea (So. Kalimantan)	B	1977	820	59
46	Scombridae	*Auxis thazard*	Indian Ocean (Pelabuhan Ratu, West Java)	G	1980	1,016	60
47		*Auxis thazard*	Indian Ocean (Pelabuhan Ratu, West Java)	G	1981	1,769	61
48		*Katsuwonus pelamis*	West Pacific (Sorong, Irian)	F	1978	2,013	62
49		*Katsuwonus pelamis*	W. Pacific (Sorong, Irian)	F	1979	3,543	63
50		*Rastrelliger brachysoma*	Java Sea (Central Java)	A	1979	403	64
51		*Rastrelliger kanagurta*	Java Sea (Pekalongan)	A	1982/1983	5,267	65
52	Stromateidae	*Pampus argenteus*	Java Sea (Central Java)	A	1978/1979	486	66
53	Penaeidae	*Penaeus merguiensis*	Arafura Sea	H	1969	9,678	67
54		*Penaeus merguiensis*	Arafura Sea	H	1974	19,340	68
55		*Penaeus merguiensis*	Arafura Sea	H	1975	12,110	69
56		*Penaeus merguiensis*	Arafura Sea	H	1976	51,610	70
57		*Penaeus merguiensis*	Arafura Sea	H	1977	12,192	71
58		*Penaeus merguiensis*	Arafura Sea	H	1978	12,136	72
59		*Penaeus merguiensis*	Arafura Sea	H	1979	28,483	73
60		*Penaeus merguiensis*	Arafura Sea	H	1980	12,398	74
61		*Penaeus merguiensis*	Arafura Sea	H	1981	10,476	75

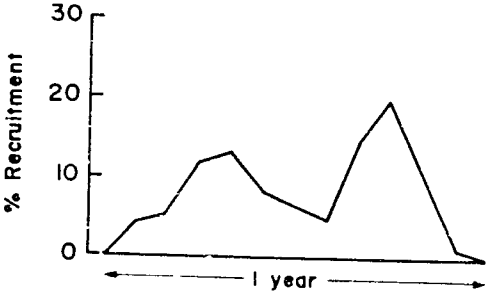
Fam. Clupeidae
Anadontostoma chacunda

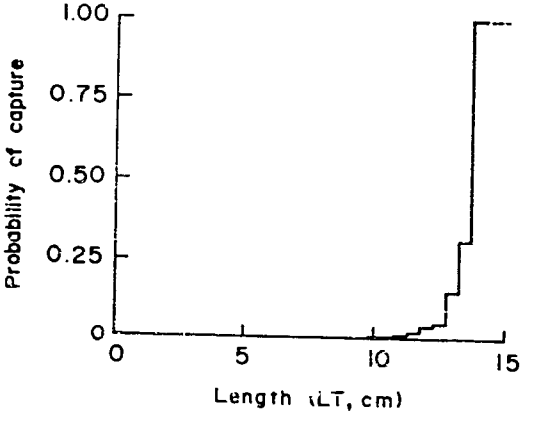


Riau Waters (Bintan), 1982-1983







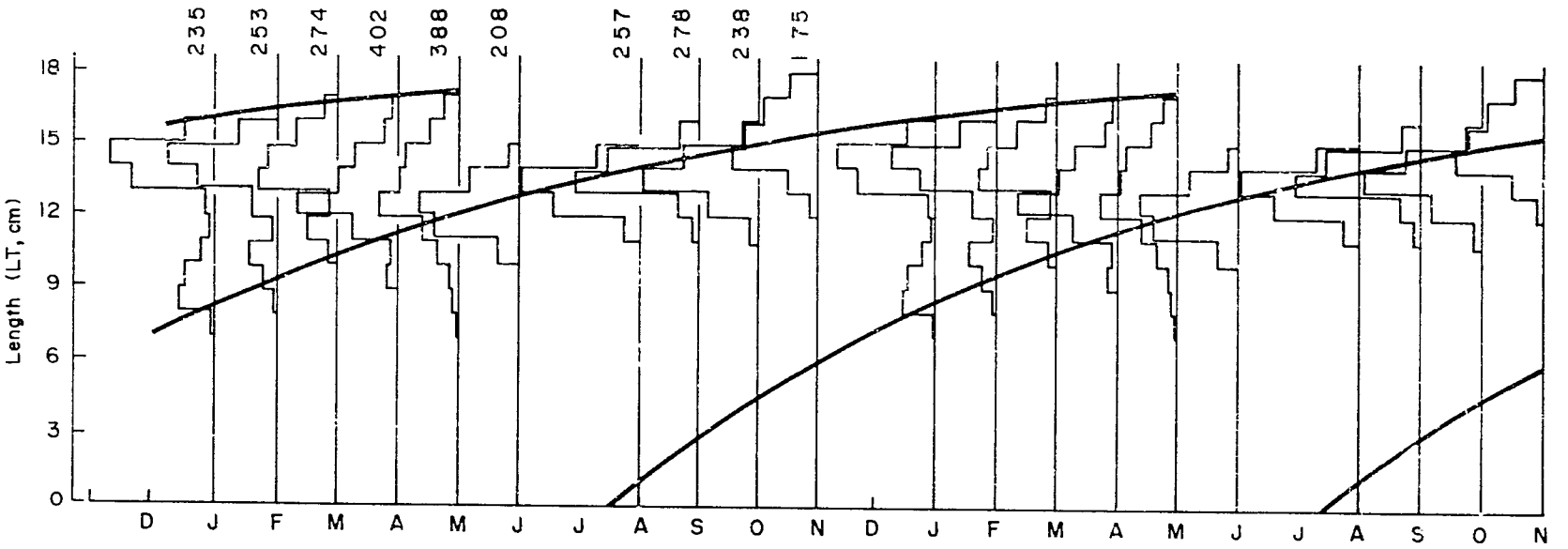


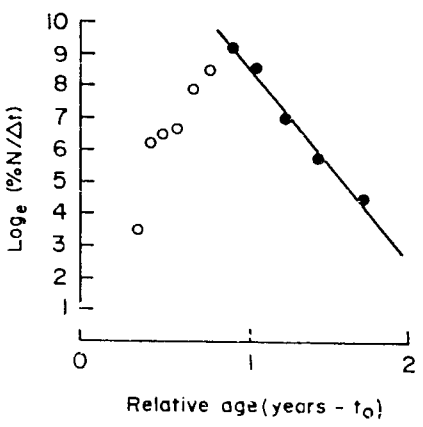
These length-frequency data originate from Mr. Sudrajat (1982-1983). The following parameter values were estimated: L_∞ = 18.10 cm, K = 1.30, L_c = 13.60 cm, Z = 6.18, M = 2.47, F = 3.72, E = 0.60. Annual recruitment consists of two well-separated pulses. Information on the biological aspect of gizzard shad may be found in Babu Rao, M. 1965. Biological studies on the gizzard shad, *Anadontostoma chacunda* Hamilton (Family Clupeidae) J. Mar. Biol. Assoc. Ind. 7(1): 89-101.

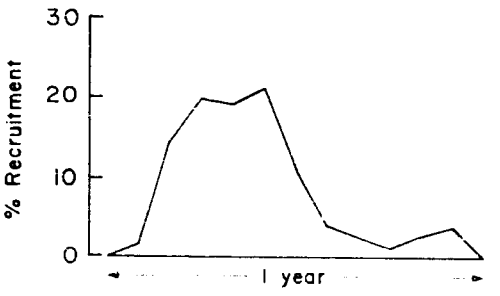
Plate 2

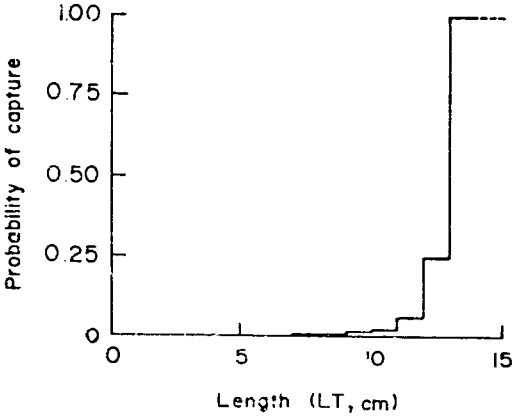
Fam. Clupeidae
Sardinella gibbosa

Riau Waters (Bintan), 1982







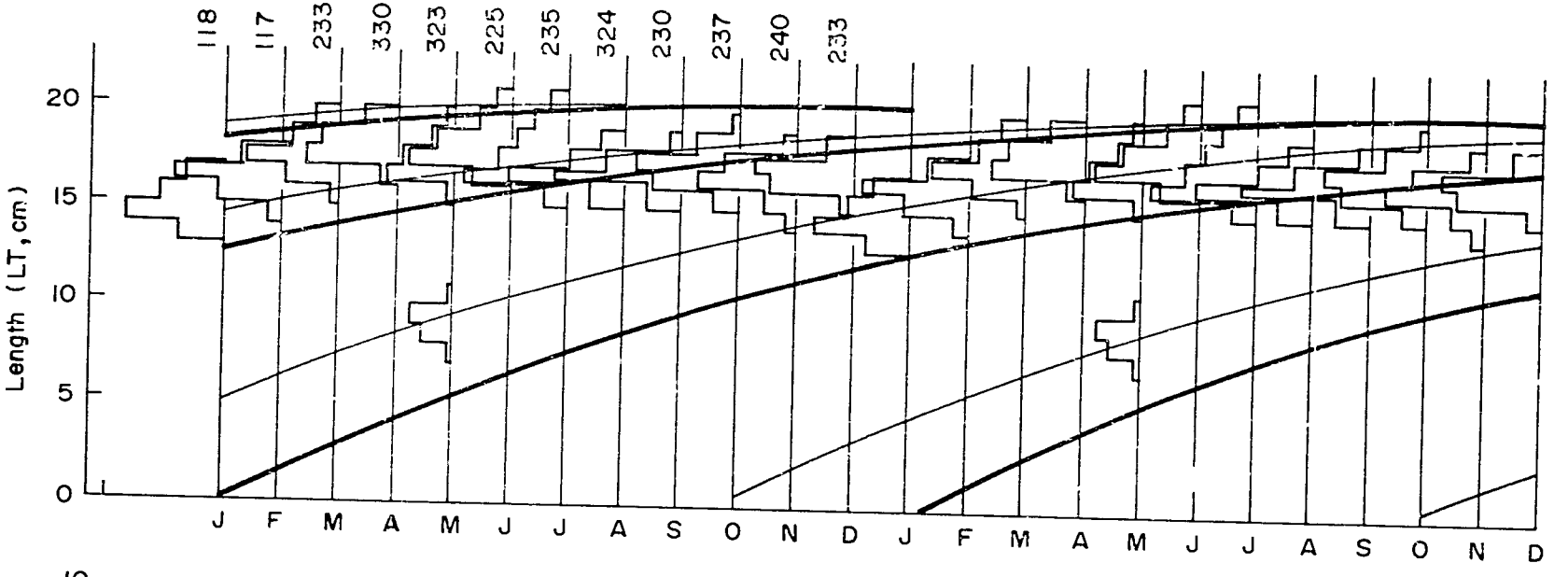


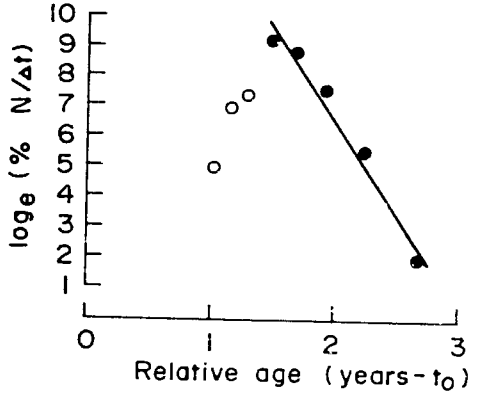
The set of length-frequency data on *Sardinella gibbosa* presented here was collected by Mr. Sudrajat from the Riau Archipelago waters. The estimated statistics are: L_∞ = 19.50 cm, K = 1.20, L_c = 12.85 cm, Z = 6.24, M = 2.29, F = 3.95, E = 0.63. The recruitment pattern, although somewhat jagged, suggests that annual recruitment occurred in two pulses of unequal duration and strength. The food and feeding habit of *S. gibbosa* have been discussed in Sekharan, K.V. 1966. On the food of the sardines, *Sardinella albella* (Valenciennes) and *S. gibbosa* (Bleeker) of the Mandapan area. Indian J. Fish. 13(1&2): 96-141.

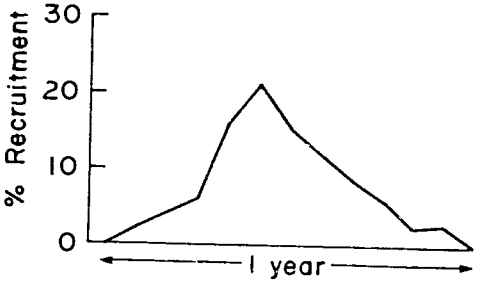
Plate 3

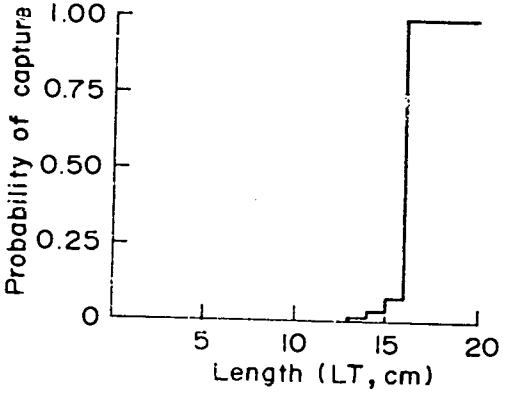
Fam. Clupeidae
Sardinella longiceps

Bali Strait, 1977



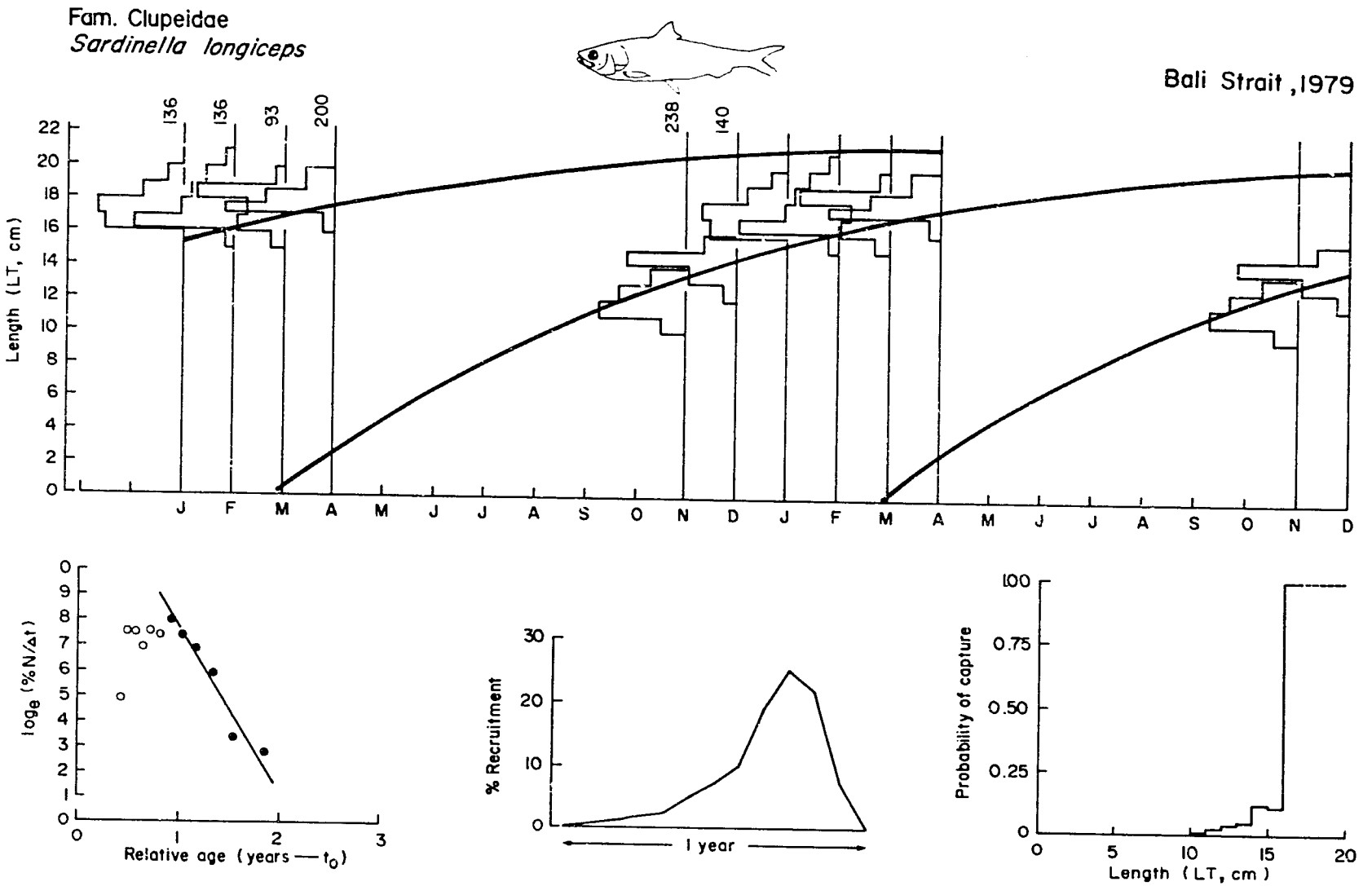






The Indian oil sardine *(Sardinella longiceps)* is represented here by length-frequency data from the Research Institute for Marine Fisheries, Jakarta which, unfortunately cover a small range of sizes and hence lead to a less credible "best estimate" (thick line) and a more credible growth curve (thin line) with lower ESP/ASP ratio. The thin line leads to the estimation of the following parameter values: L_∞ = 22.30 cm, K = 0.85, L_c = 15.98 cm, Z = 6.28, M = 1.76, F = 4.53, E = 0.72. The recruitment pattern appeared to consist of two pulses of unequal strength. The taxonomic status and other information on *S. longiceps* are reviewed in Soerjodinoto, R. 1960. Synopsis of the biological data on lemuru *Sardinella longiceps*. FAO Fish. Synopsis (15): 313-328 and in Dwiponggo, A. 1974. The fishery for and preliminary study on the growth rate of "lemuru" (oil sardine) at Muncar, Bali Strait. Symposium on Coastal and High Seas Pelagic Resources, Wellington, New Zealand, 18-27 October 1972. Proc. Indo-Pac. Fish. Counc. 15(3): 221-240.

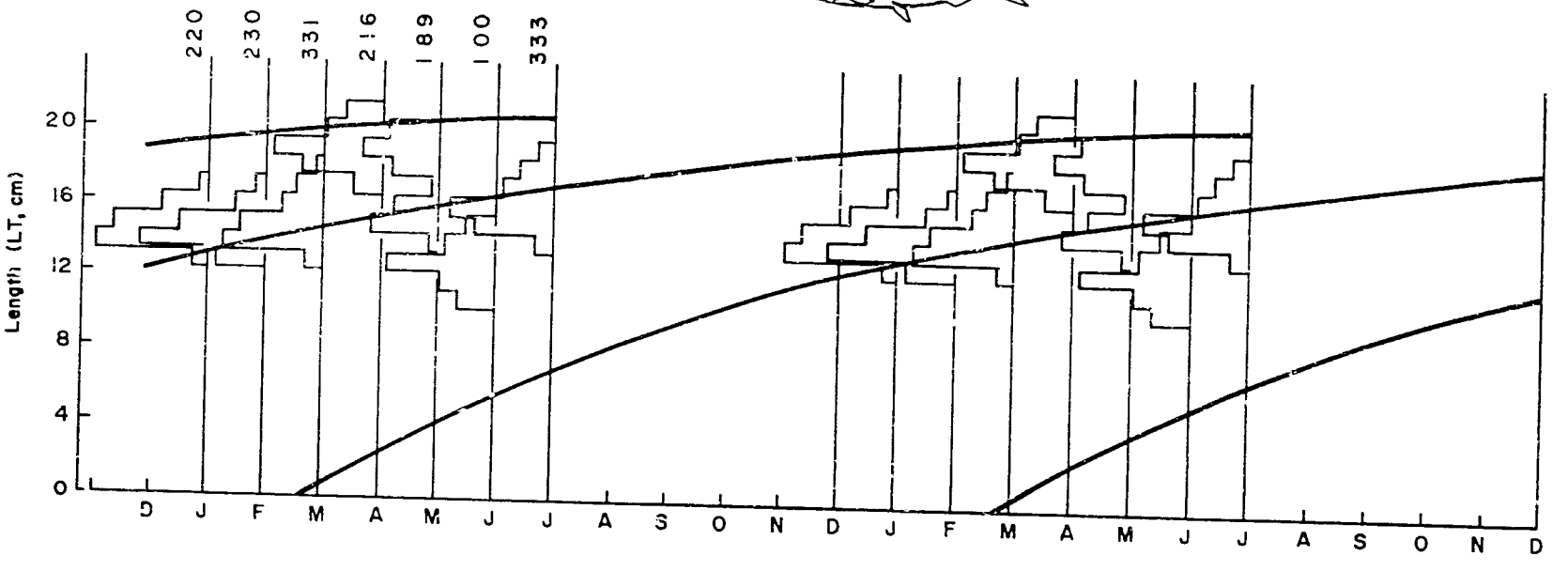
Plate 4

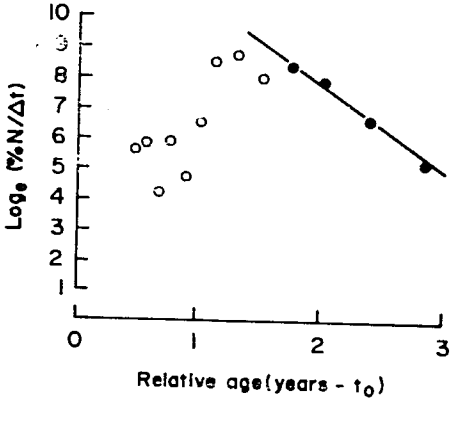


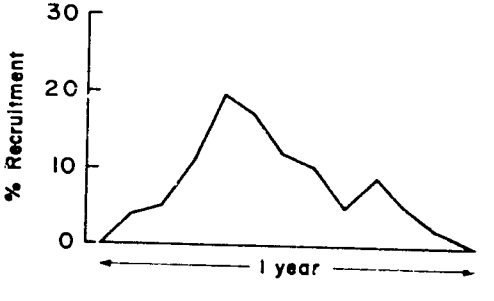
This set of length-frequency data on *Sardinella longiceps* was collected in 1979 from the Bali Strait and led to the following parameters: L_∞ = 23.20 cm, K = 1.28, L_c = 15.00 cm, Z = 6.57, M = 2.25, F = 4.32, E = 0.66. Annual recruitment probably occurred in two irregular pulses. Further data on *S. longiceps* may be found in Ritterbush, S. 1975. An assessment of the population biology of the Bali Strait lemuru fishery. Mar. Fish. Res. Inst. Res. Rep. 1/1975: 1-38.

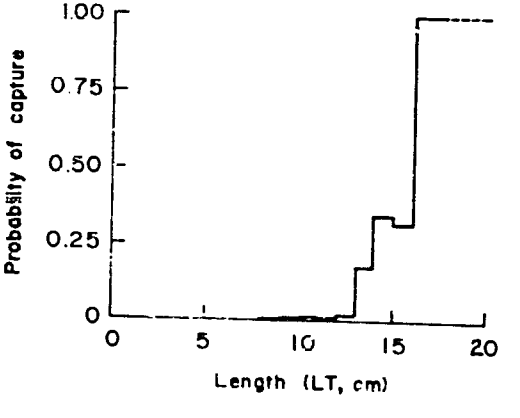
Fam. Clupeidae
Sardinella longiceps

Bali Strait, 1980







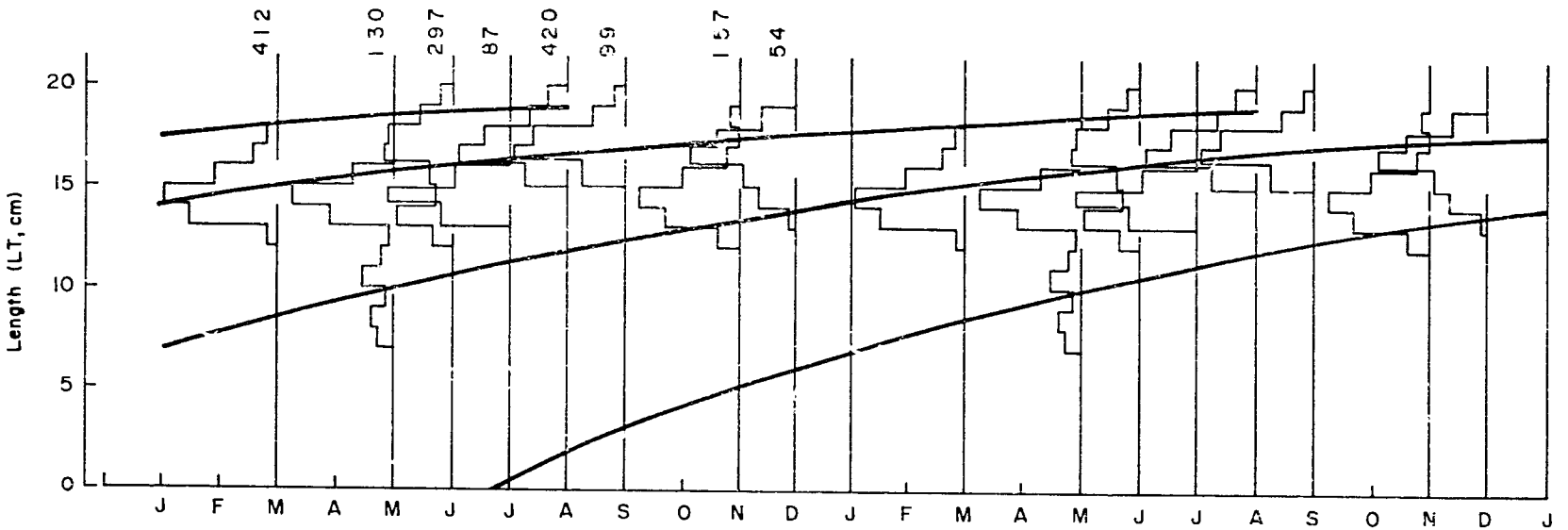


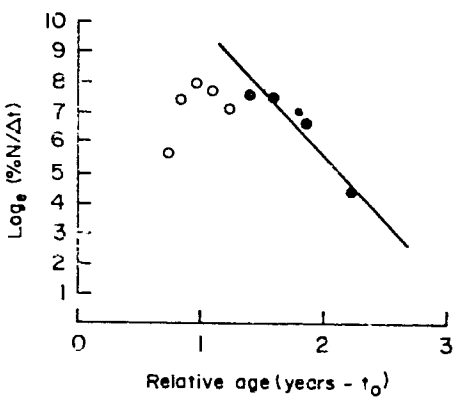
This set of length-frequency data on oil sardine was obtained from the Research Institute for Marine Fisheries, 1980. It led to the following estimates: L_∞ = 22.50 cm, K = 1.00, L_c = 16.75 cm, Z = 4.39, M = 1.95, F = 2.44, E = 0.56. Annual recruitment pattern appeared to consist of two pulses of irregular strength. Stock assessment studies may be found in Sujastani, T. and S. Nurhakim. 1982. The stock assessment of lemuru (oil sardines), *Sardinella longiceps* in Bali Strait. CRIFI Proc. No. 2/SPL/82: 1-11. (In Indonesian with English abstract).

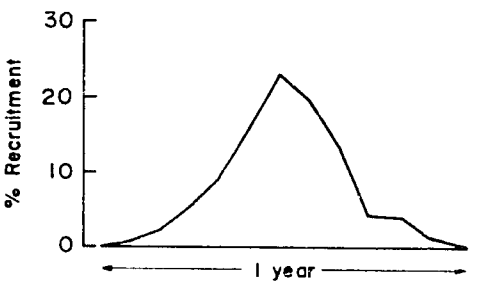
Fam. Clupeidae
Sardinella longiceps

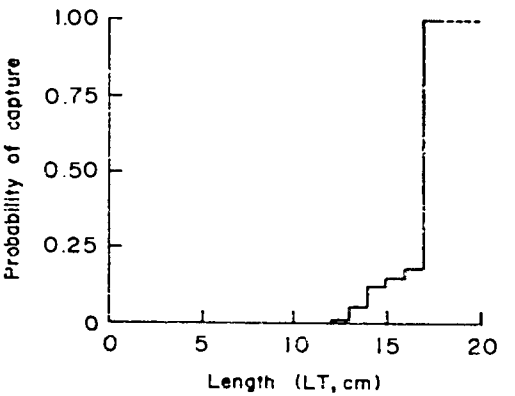
Bali Strait, 1981

Plate 6

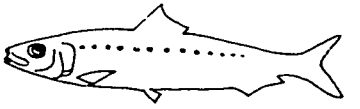






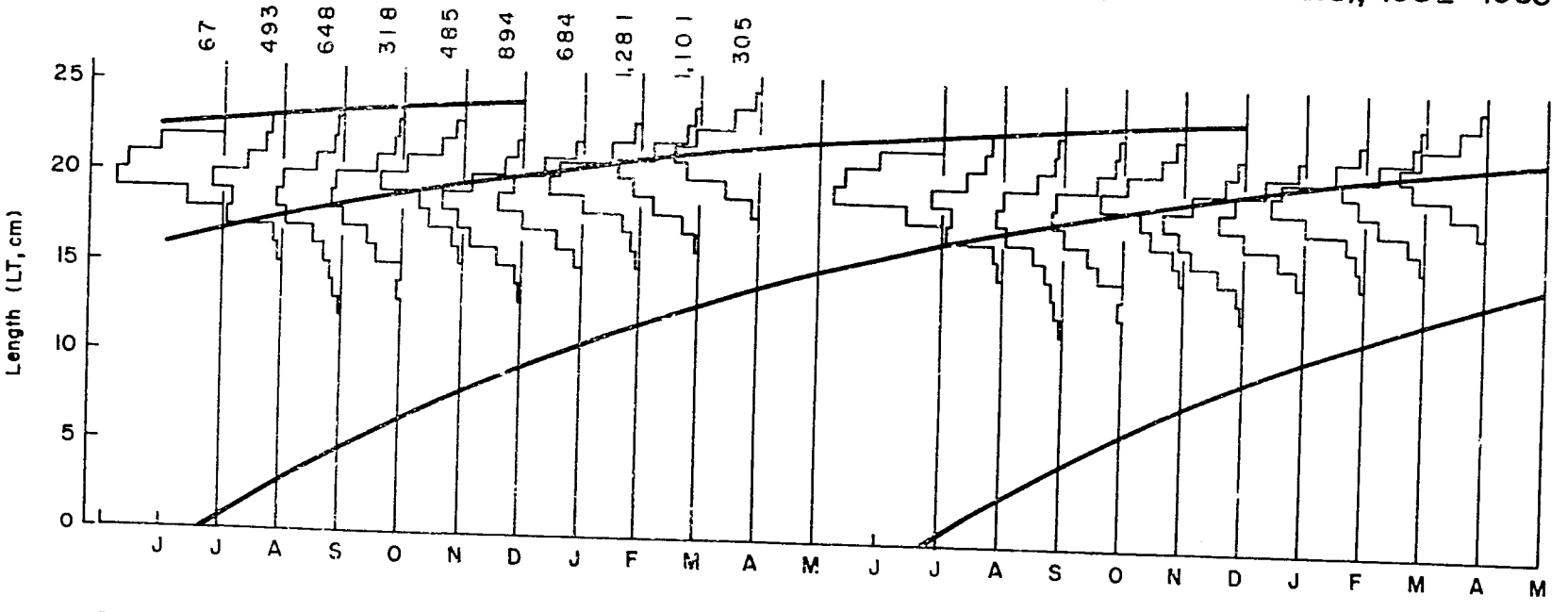


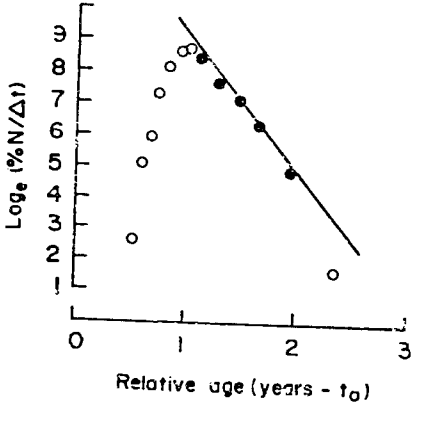
The length-frequency data analyzed here stem from the files of the Research Institute for Marine Fisheries. They allowed the estimation of the following parameter values: L_∞ = 21.10 cm, K = 0.80, L_c = 13.47 cm, Z = 2.24, M = 1.72, F = 0.52, E = 0.23. The recruitment pattern suggests that recruitment occurred as a single protracted event and one much smaller pulse. Miscellaneous biological data and other information on oil sardine in Bali Strait can be found in Anon. 1982. Proceedings of a seminar on lemuru (sardine) fishery, Banyuwangi, 18-21 January 1982. Central Institute for Fisheries Research, Jakarta. 312 p. (In Indonesian)

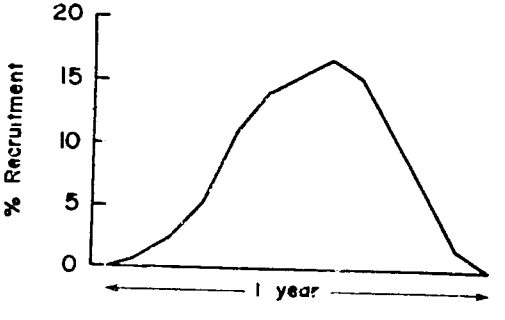


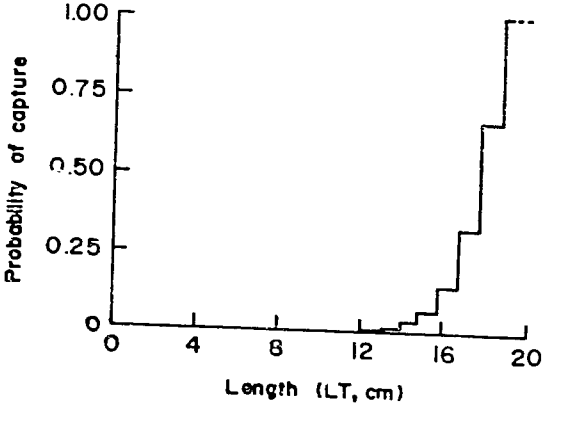
Fam. Clupeidae
Sardinella sirm

Java Sea (Pekalongan Central Java), 1982 - 1983







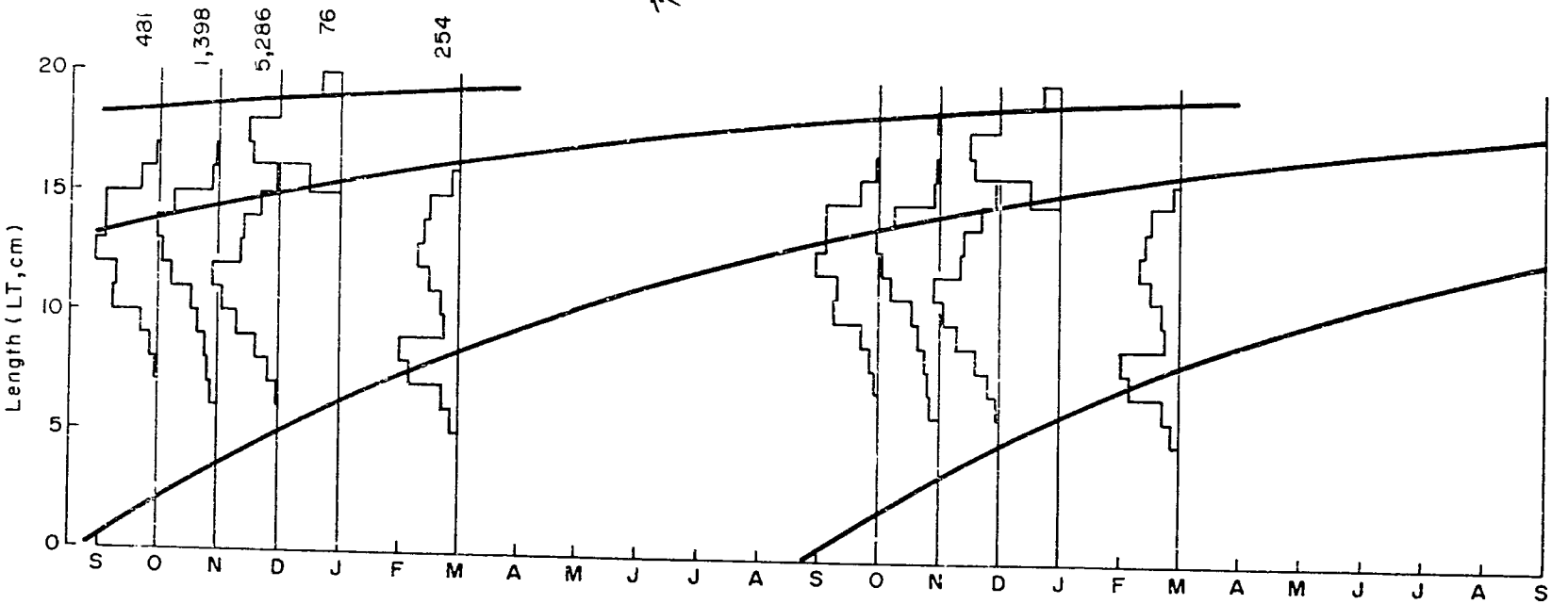


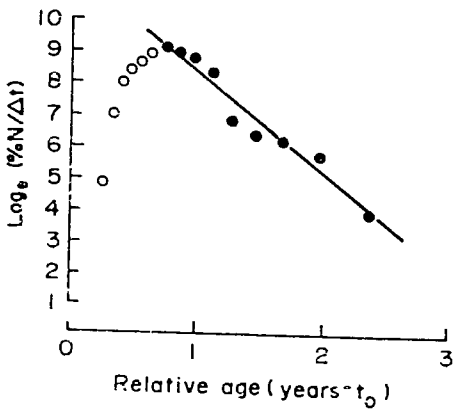
The set of length-frequency data analyzed here was collected by G. Tampubolon from the north coast of Java in 1982-1983. The following parameter values were estimated: L_∞ = 25.80 cm, K = 1.15, L_c = 18.75 cm, Z = 5.80, M = 2.06, F = 3.74, E = 0.65. Annual recruitment probably occurred in the form of one pulse. Data on biological aspect of *Sardinella sirm* may be found in Burhanuddin, M. Hutomo, S. Martosewojo and A. Djamali. 1974. Some biological aspects of lemuru, *Sardinella sirm* (Waldbaum) around Panggang (Island). Oseanologi di Indonesia 2: 17-25. (In Indonesian with English abstract).

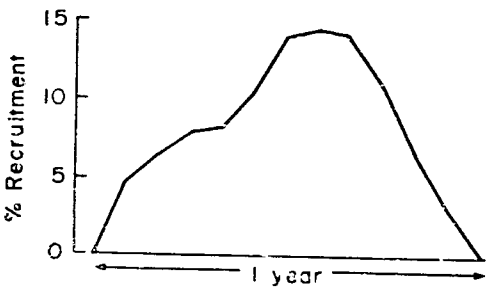
Plate 8

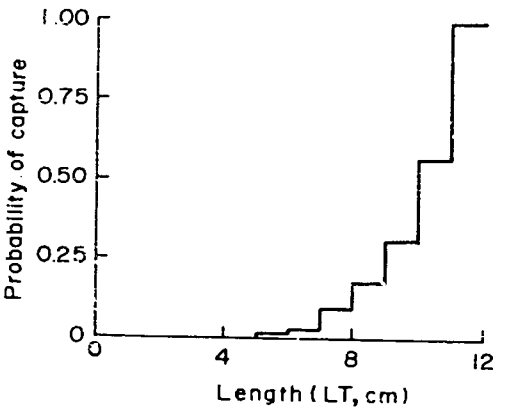
Fam. Synodontidae
Saurida longimanus

Java Sea (Central Java), 1977-1978

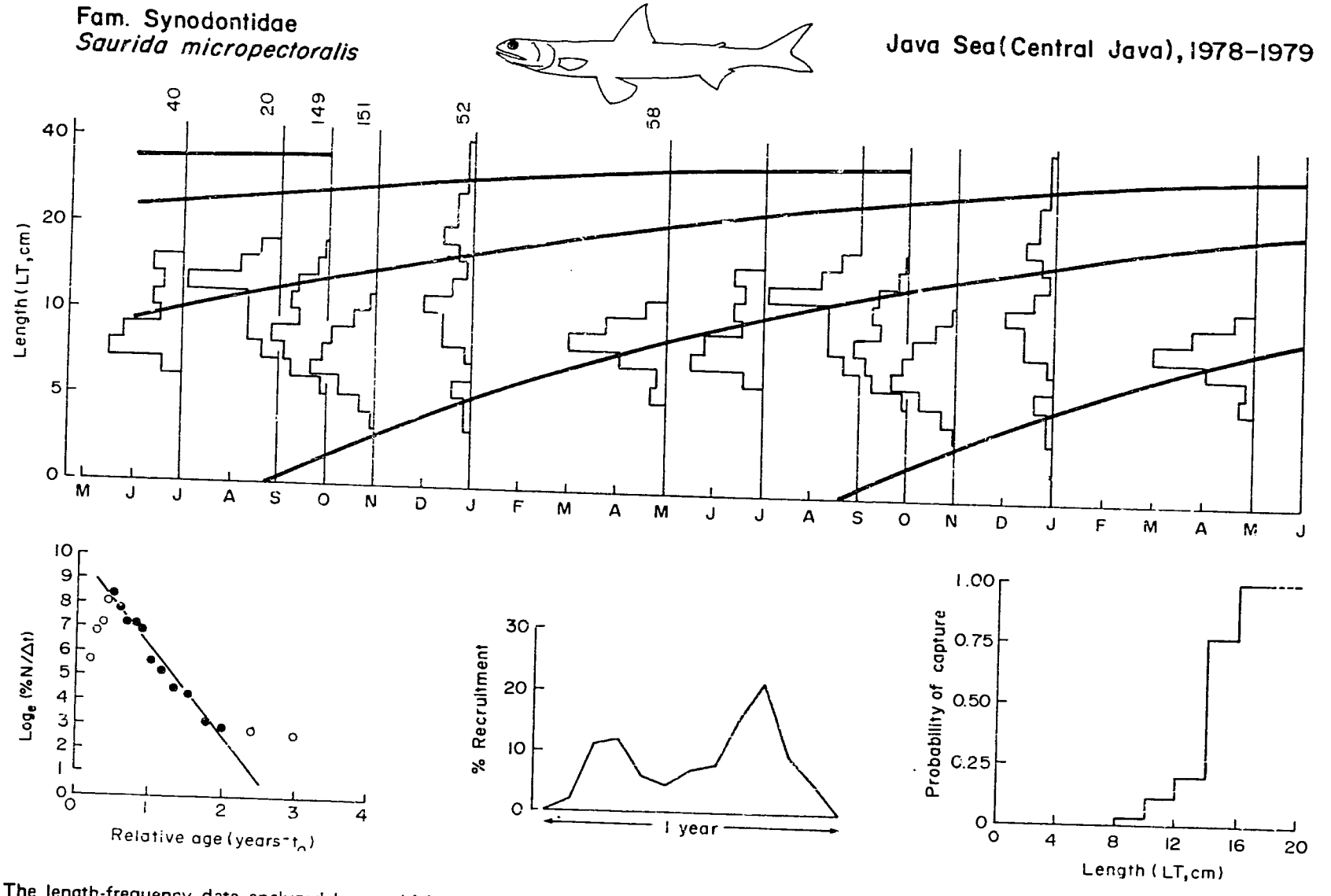








The length-data analyzed here originated from the survey data files of R/V Mutiara-IV (1977-1978). They allowed the estimation of the following parameter values: L_∞ = 21.25 cm, K = 0.95 L_c = 10.35 cm, Z = 3.21, M = 1.92, F = 1.29, E = 0.40. Annual recruitment seems to consist of two pulses of unequal strength. Additional information on *Saurida longimanus* has been presented by Sriyono. 1982. Potential reproduction, growth and stock density of ikan beloso, *Saurida* spp. in the east coast of Sumatra and South China Sea. University of Diponegoro. 70 p. M.Sc. thesis. (Unpublished) (In Indonesian).

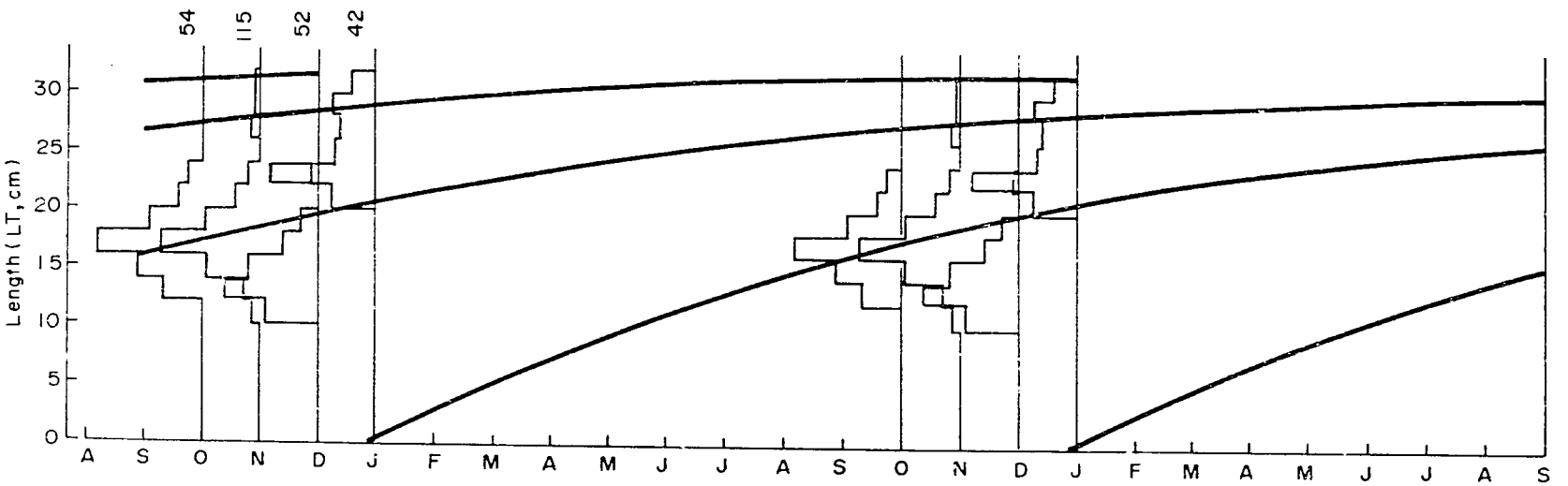


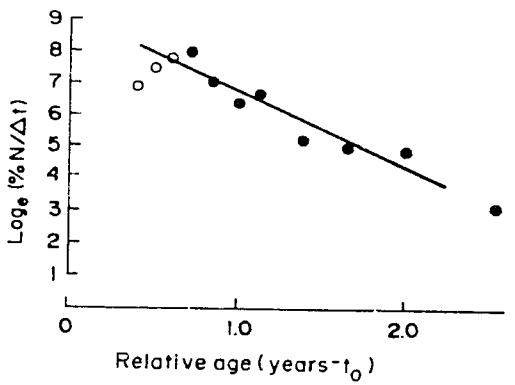
The length-frequency data analyzed here, which originated from the data files of R/V Mutiara-IV (1978-1979), led to the following parameter estimates: L_∞ = 42 cm, K = 0.88, L_c = 13.84 cm, Z = 3.73, M = 1.5, F = 2.22, E = 0.60. Annual recruitment consisted of two well-separated pulses. A detailed description of lizard fish is given in Widodo, J. 1977. Stock distribution and preliminary investigation of some biological aspect of lizard fish. Paper presented to the National Seminar of Biology, Malang, 7-9 July 1977. (In Indonesian).

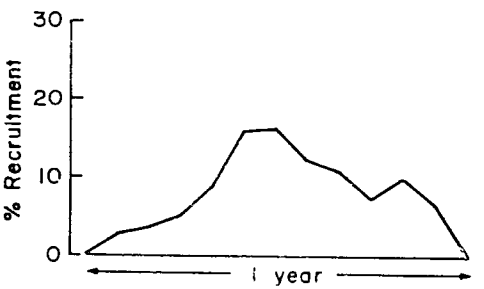
Plate 10

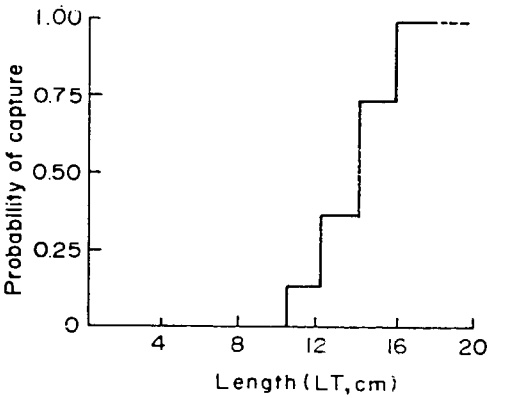
Fam. Synodontidae
Saurida undosquamis

Java Sea (Central Java), 1977-1978

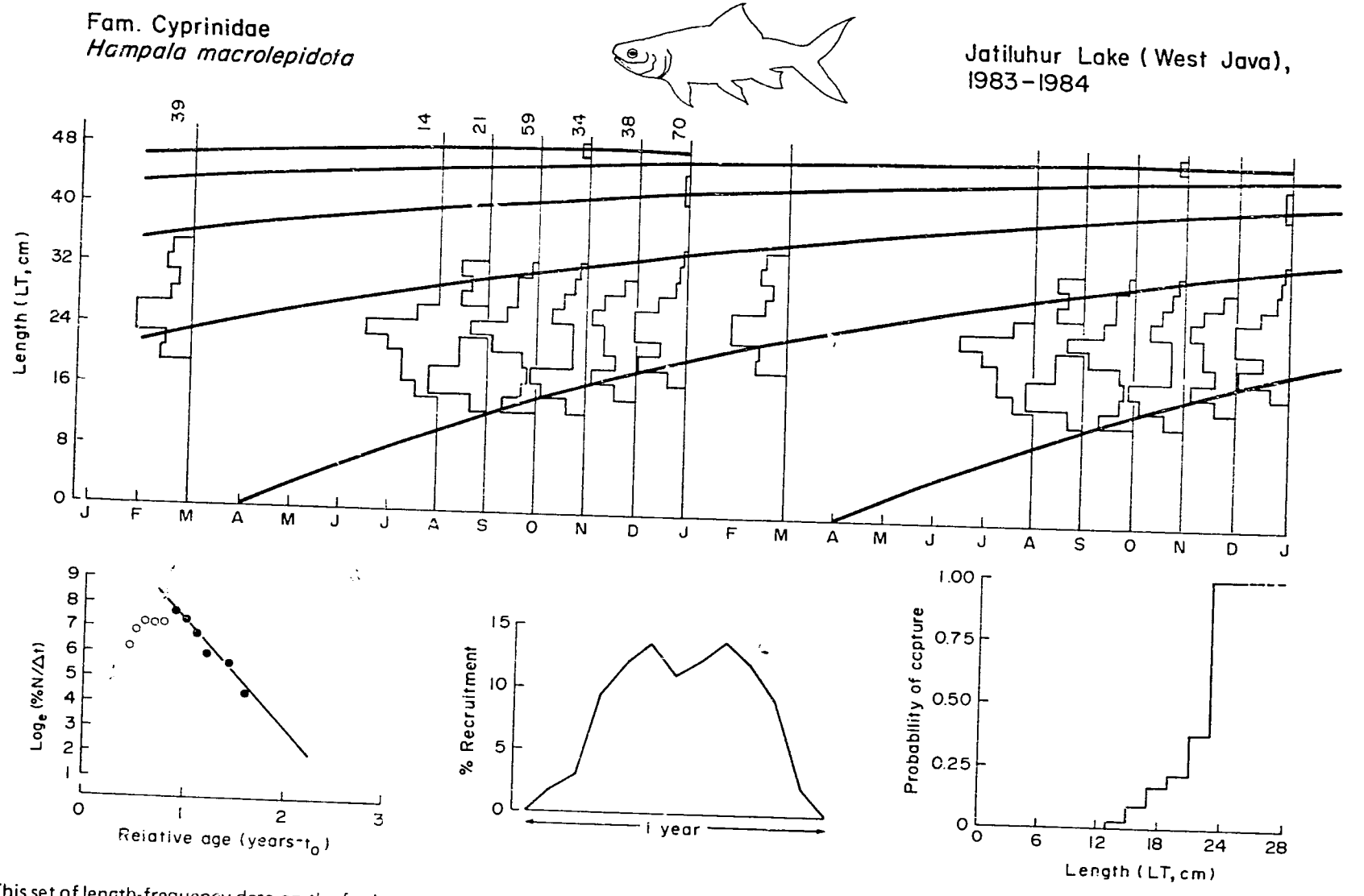








The length-frequency data were collected in the frame of the Indonesian-German Demersal Fisheries Project in 1977-1978. From these data, the following parameter values were estimated: L_∞ = 33.5 cm, K = 0.95, L_c = 13.10 cm, Z = 2.30, M = 1.69, F = 0.61, E = 0.26. Annual recruitment appears to have occurred in two pulses of unequal strength. Information on the growth of lizard fish has been given by Kühlmorgen-Hille, G. 1970. A contribution to the knowledge of the growth of *Saurida undosquamis* Richardson in the Gulf of Thailand, p. 467-470. *In* Marr, J.C. (ed.) The Kuroshio. A symposium of the Japan current. East West Center Press, Honolulu. Also in Martosubroto, P. 1982. Fishery dynamics of the demersal resources of the Java Sea. Dalhousie University, Canada. Ph.D. thesis. (Unpublished).

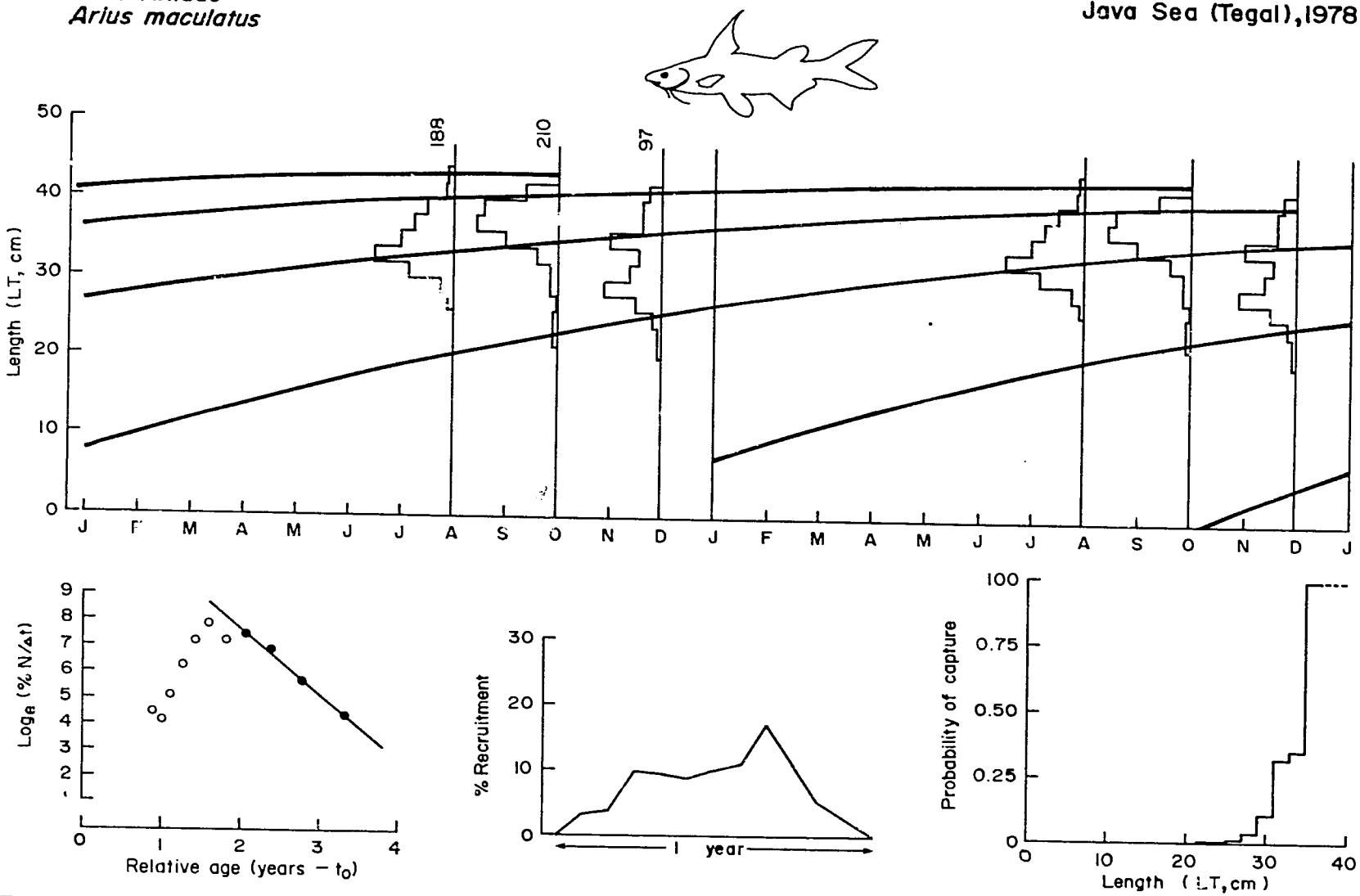


This set of length-frequency data on the freshwater species *Hampala macrolepidota* analyzed here was collected by Mr. Setiadi, Jatiluhur Freshwater Research Station, West Java, 1983. The following parameters were estimated from the data: L_∞ = 50 cm, K = 0.68, L_c = 22.1 cm, Z = 4.44, M = 1.21, F = 3.23, E = 0.73. A description and some details on food and range may be found in Mohammad Mohsin, A.K. and Mhd. Azmi Ambak. 1983. Freshwater fishes of Peninsular Malaysia. Penerbit Universiti Pertanian Malaysia, Kuala Lumpur, 284 p.

Plate 12

Fam. Ariidae
Arius maculatus

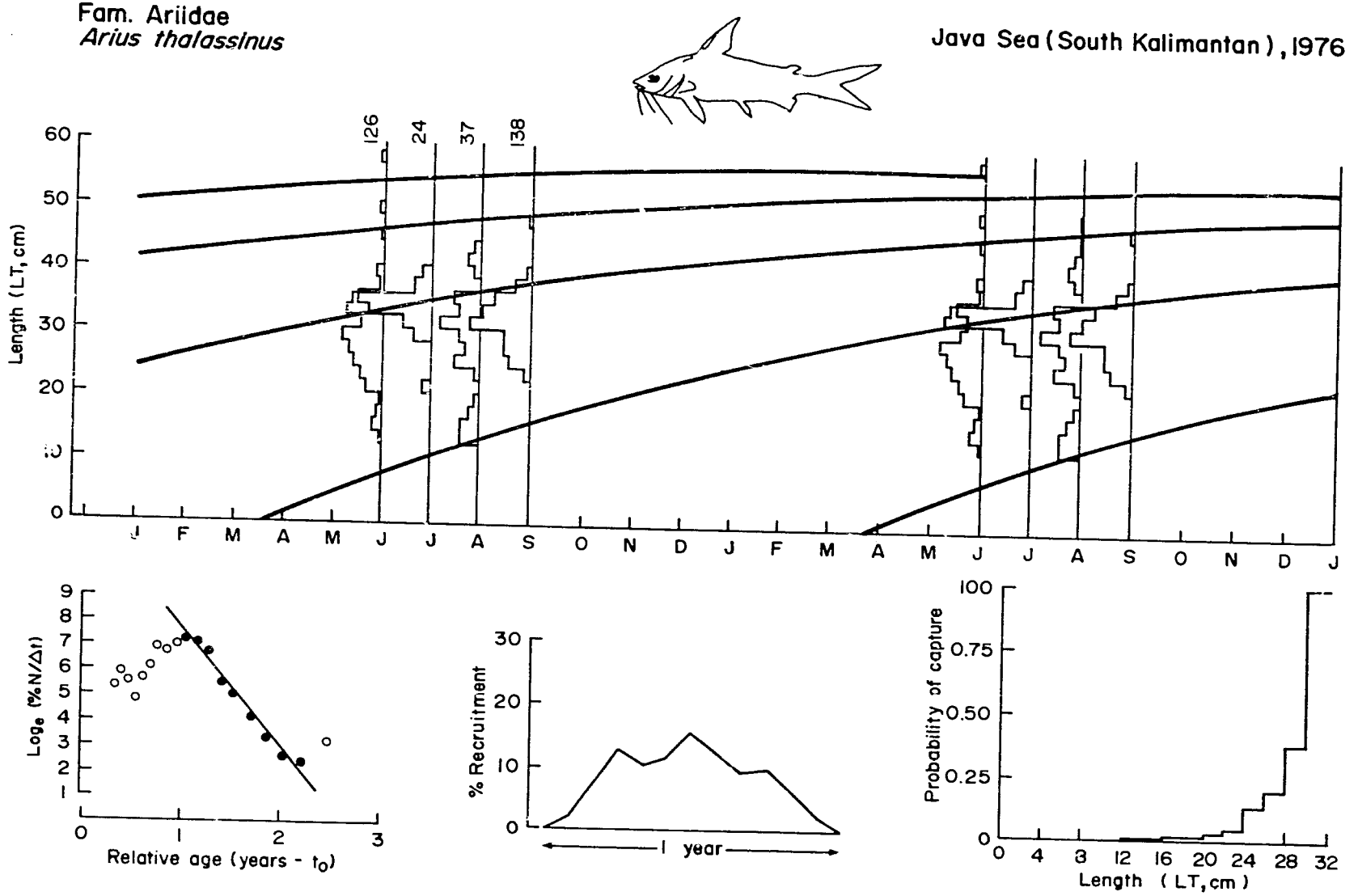
Java Sea (Tegal), 1978



The length-frequencies on *Arius maculatus* presented were obtained from Dwiponggo, A. and M. Badrudin. 1979. Data of trawl survey by RV Mutiara-IV in 1978. Contribution of the Demersal Fisheries. Project No 6A, Marine Fisheries Research Institute (LPPL), Jakarta, 128 p. The parameter estimates are: L_∞ = 45.00 cm, K = 0.73, L_c = 34.20 cm. The straight segment of the length-converted catch curve suggests Z = 2.42, M = 1.30, F = 1.11, E = 0.46 and recruitment pattern denotes two pulses of unequal strength. Additional information on the biological aspects of *Arius maculatus* and its related species can be found in Purwanto. 1980. The stock length-weight relationship and stage of gonad maturity of Ikan Manyung (*Arius* spp.) in the Tanjung Selatan of south coast of Kalimantan waters, based on trawl catches by RV Mutiara-IV in January 1980. University of Diponegoro, Semarang. 59 p. Thesis.

Fam. Ariidae
Arius thalassinus

Java Sea (South Kalimantan), 1976

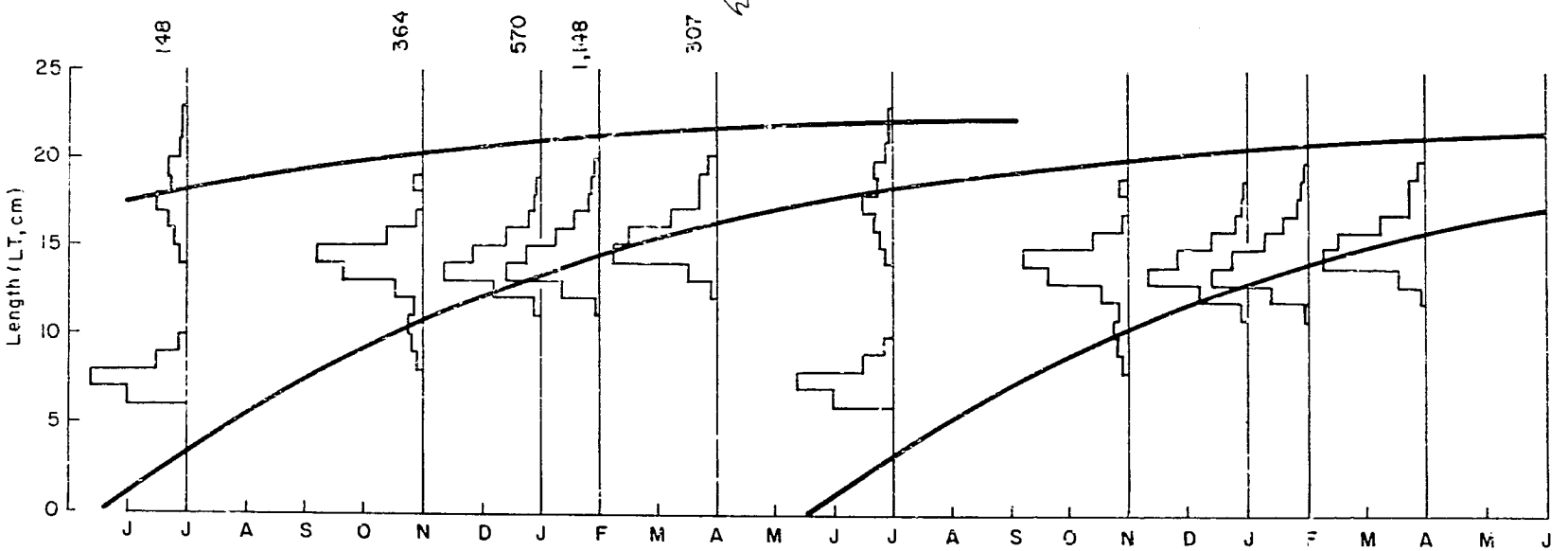


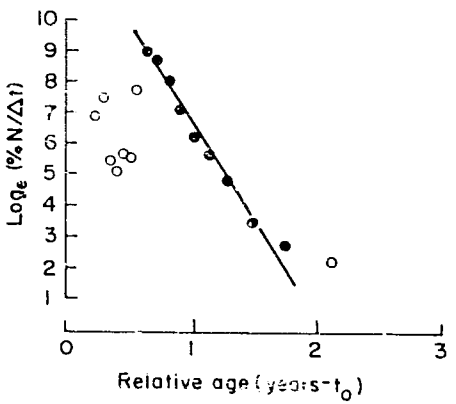
The source of length-frequency data presented here is Martosubroto, P. and D. Pauly. 1976. Mutiara-IV survey data. Spe. Rep. RIMF 4/77. The parameter estimates are: L_∞ = 60.00 cm, K = 0.65, L_c = 29.20 cm, Z = 4.73, M = 1.11, F = 3.59, E = 0.76. Annual recruitment appears to have been irregular. Other information on the variations in catch rates and species composition of this fish may be found in Dwiponggo, A. and M. Badrudin. 1977, 1978, 1980. Result of the Java Sea inshore monitoring survey. Contribution of the demersal fisheries project nos. 5, 6, 7, RIMF, Mar. Res. Report Jakarta. 14 p. 19 p, 31 p.

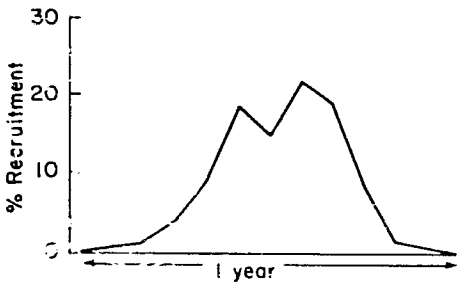
Plate 14

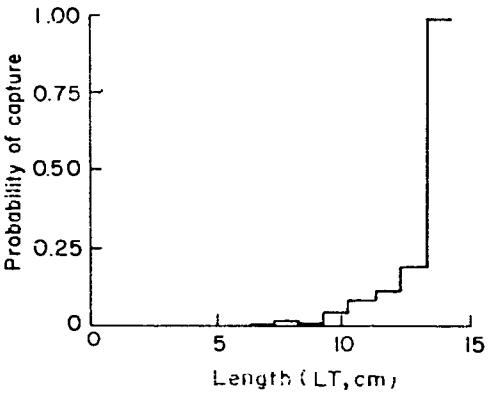
Fam. Priacanthidae
Priacanthus macracanthus

Java Sea (Central Java), 1977-1978





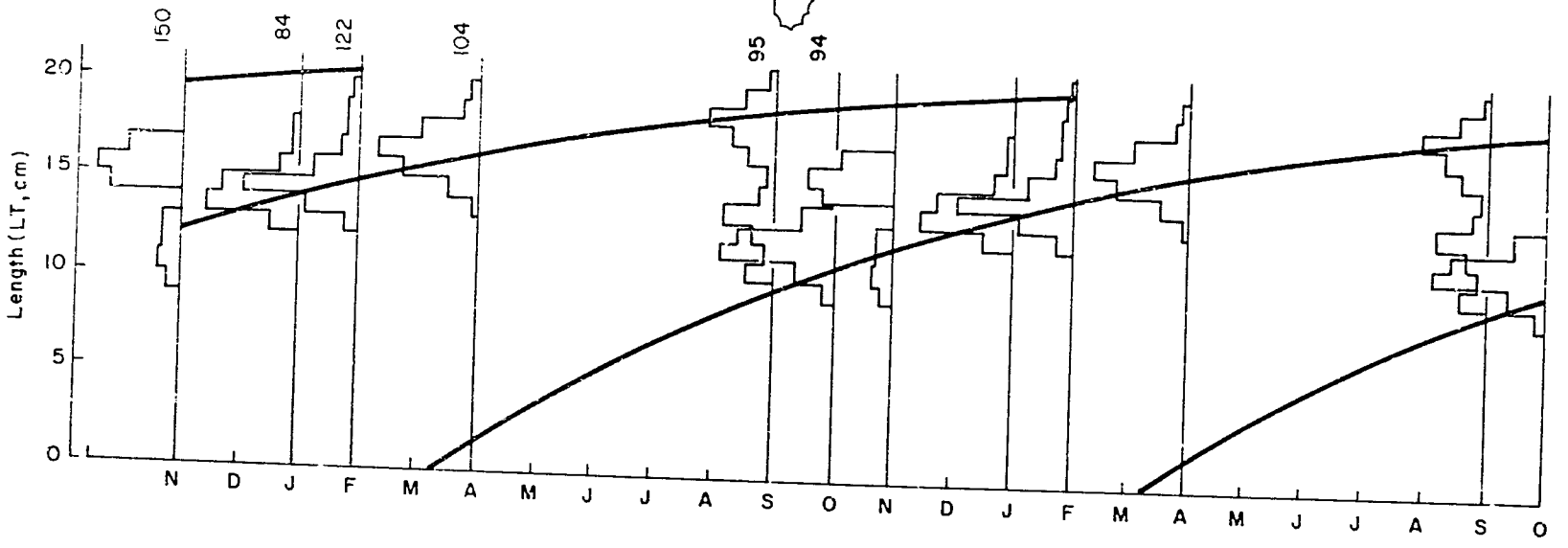


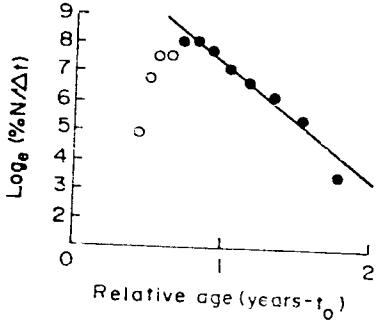


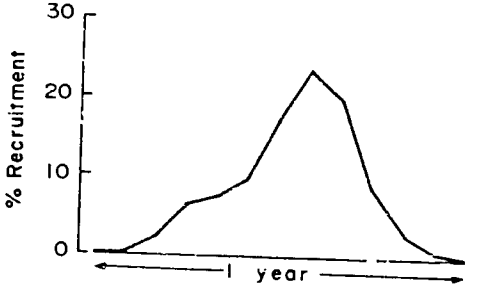
The length-frequency data analyzed here were obtained from R.V. Mutiara-IV data files, 1977-1978. From these the following parameter values were estimated: L_∞ = 23.75 cm, K = 1.30, L_c = 13.11 cm, Z = 6.38, M = 2.28, F = 4.10, E = 0.64. Annual recruitment consisted of two pulses. Additional data on growth and some biological parameters of *Priacanthus macracanthus* may be found in Duto Nugroho and Rusmadji Rustan. 1983. Study on growth and some biological parameters of *Priacanthus macracanthus* in the north coast of Java, Jakarta. Mar. Fish. Res. Rep. No. 27: 9-14. (In Indonesian with English abstract). Also in Martosubroto, P. 1982. Fishery dynamics of the demersal resources of the Java Sea. Dalhousie University, Canada, Ph.D. thesis. (Unpublished).

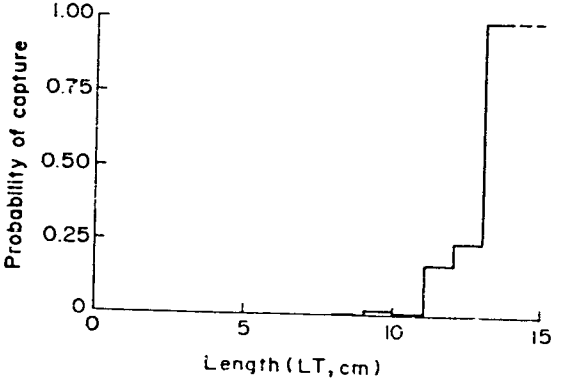
Fam. Priacanthidae
Priacanthus macracanthus

Java Sea (Central Java), 1978-1979







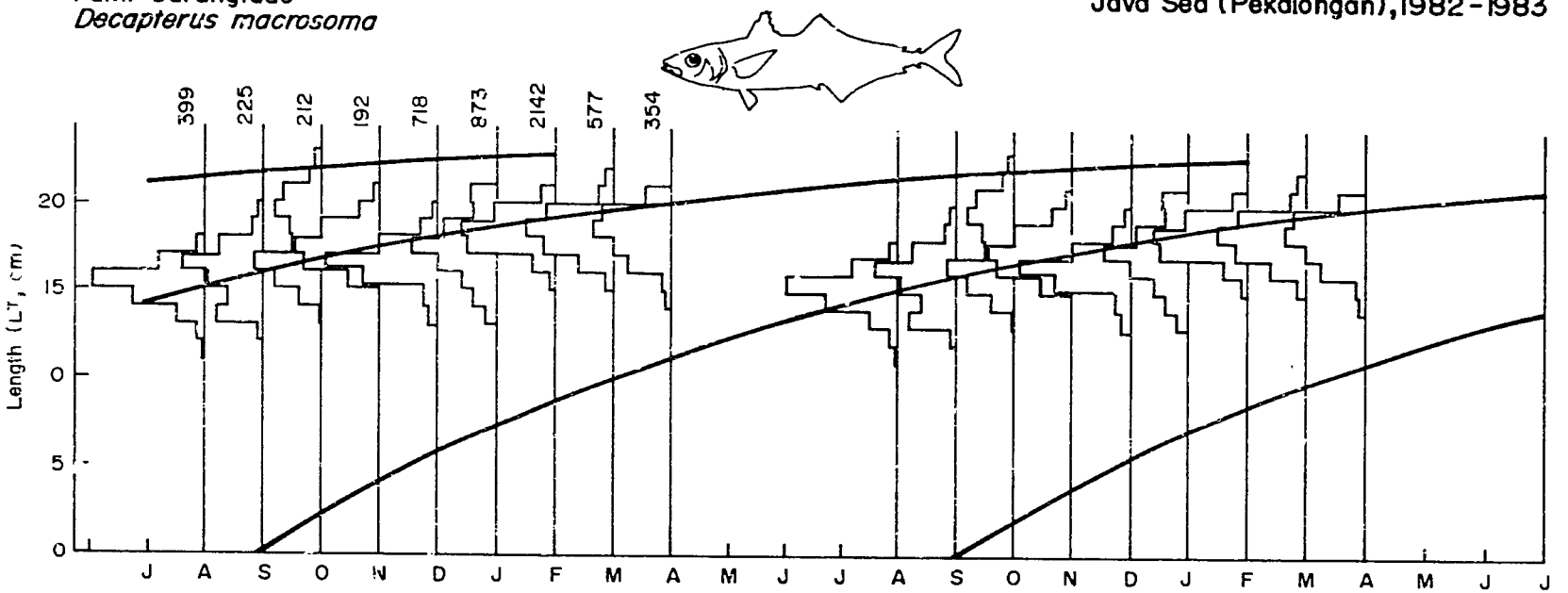


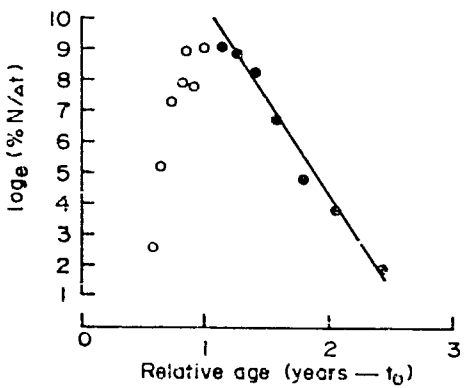
The set of length-frequency data, reported to pertain to big eye bream, were collected by R.V. Mutiara-IV during the demersal trawl survey in 1978/1979 in the north coast of Central Java. From the data the following parameters were obtained: L_∞ = 23.00 cm, K = 1.15, L_c = 2.50 cm, Z = 4.20, M = 2.13, F = 2.07, E = 0.49. Annual recruitment appears to have consisted of two unequal pulses. Additional information on variations in catch rates of *Priacanthus* may be found in Dwiponggo, A. and M. Badrudin. 1979. Variations in catch rates and species composition of trawl surveys in the Java Sea subareas. 1978. MFRI Spec. Rep. 6: 1-19.

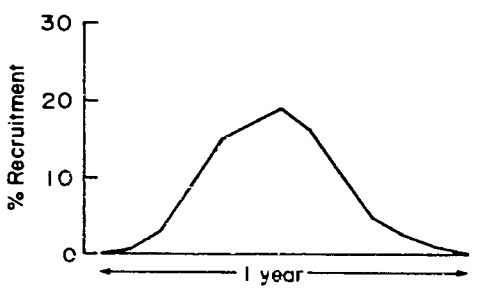
Plate 16

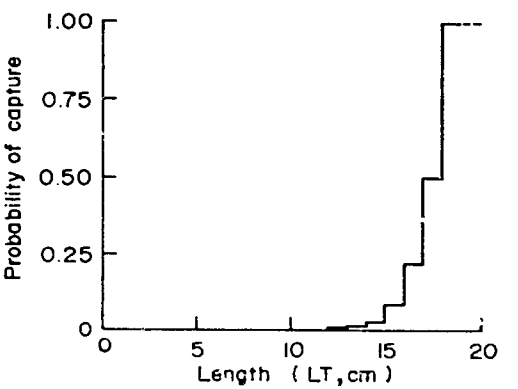
Fam. Carangidae
Decapterus macrosoma

Java Sea (Pekalongan), 1982-1983







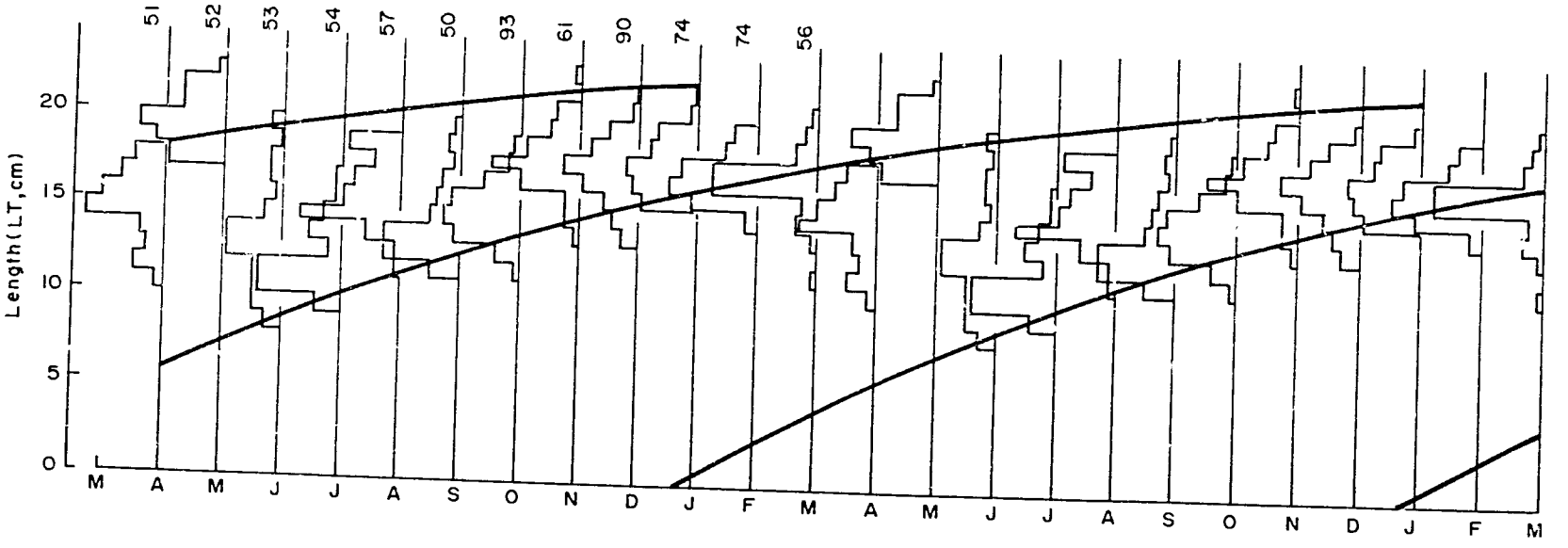


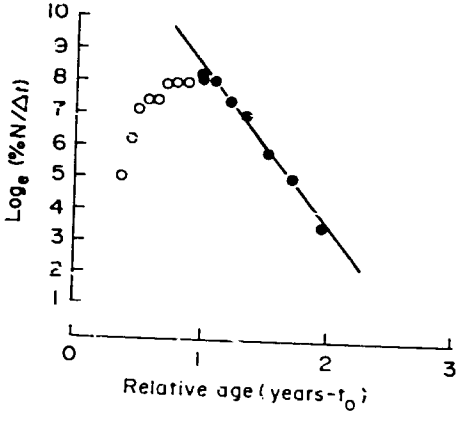
The length-frequency data presented here on scad mackerel *(Decapterus macrosoma)* were obtained from the files of Tampubolon, G. collected at Pekalongan, Central Java. The following parameter estimates were obtained: L_∞ = 25.40 cm, K = 0.98, L_c = 16.60 cm, Z = 6.19, M = 1.86, F = 4.33, E = 0.70. Annual recruitment seems to have been brought about by a single protracted pulse. Information on the biology of this fish may be found in Tiews, K., I.A. Ronquillo and P. Caces-Borja. 1971. On the biology of round scads (*Decapterus*, Bleeker) in Philipp. J. Fish. 9(1/2): 45-71.

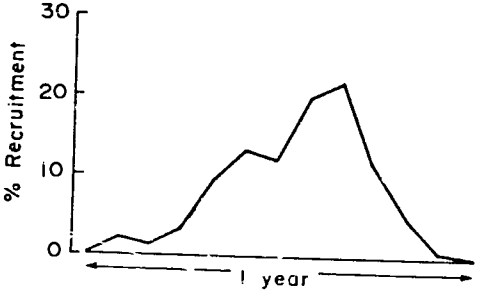
Plate 17

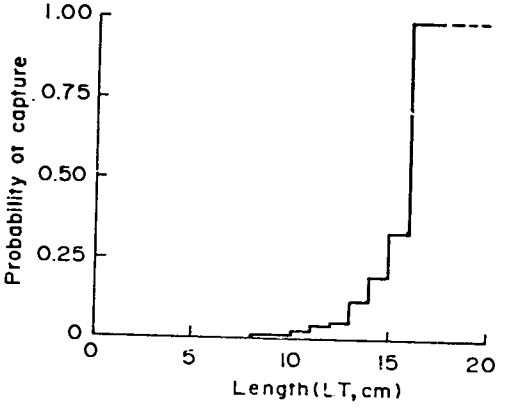
Fam. Carangidae
Decapterus maruadsi

Java Sea (Tegal), 1981-1982







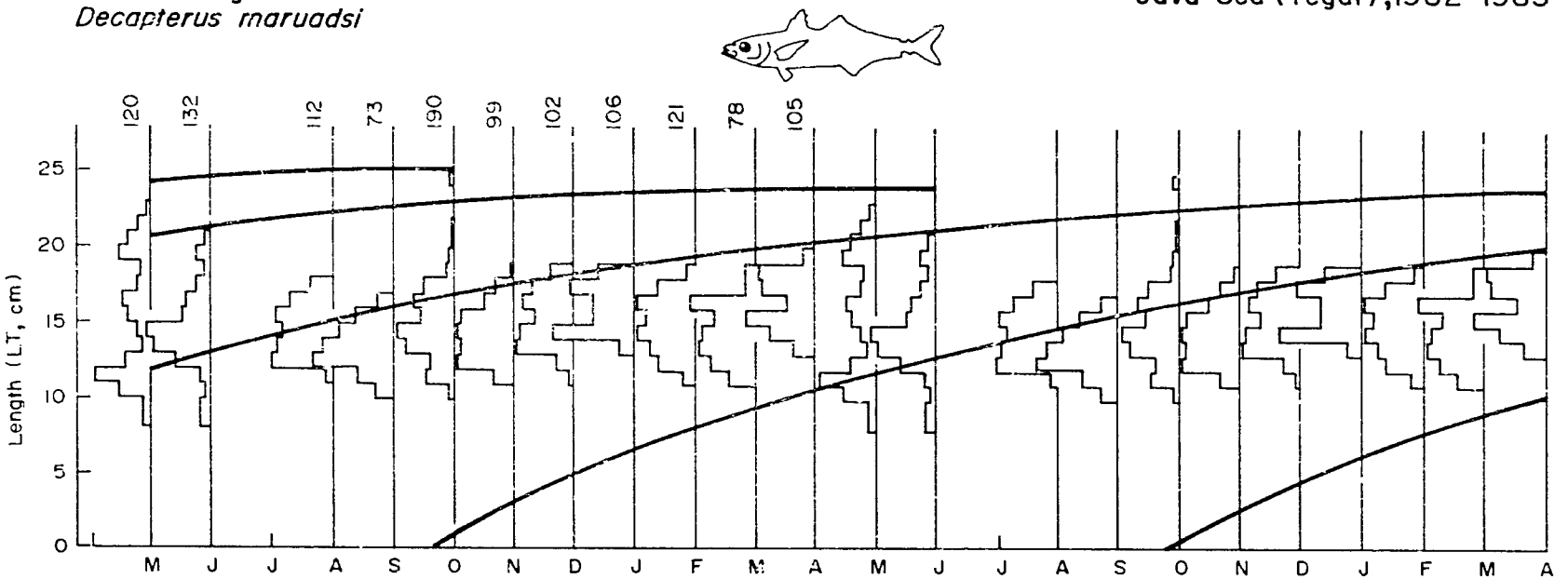


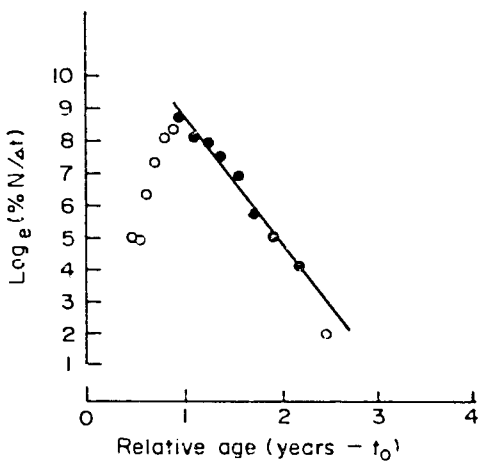
The length-frequency data on round scad, *Decapterus maruadsi* (1981-1982) used here stem from the raw data file of Mr. Subroto (Directorate General of Fisheries) and led to the following parameter estimates: L_∞ = 25.90 cm, K = 0.98, L_c = 15.61 cm, Z = 4.95, M = 1.85, F = 3.10, E = 0.63. Annual recruitment appears to have originated from two pulses of unequal strength. Some biological aspects of round scads are given by Suherman Banon, A., B. Sadhotomo and R. Rustam. 1982. Gonad index and sex ratio of round scad (*Decapterus maruadsi* Temminck and Schlegel) in the Arafura Sea. RIMF. Jakarta Mar. Res. Rep. No. 24: 37-43. (In Indonesian with English abstract).

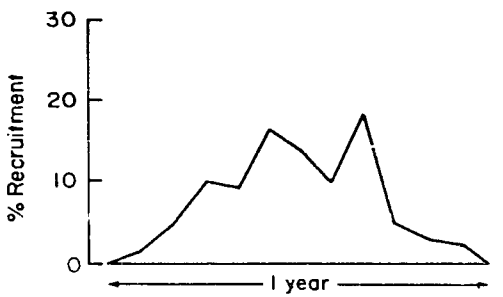
Plate 18

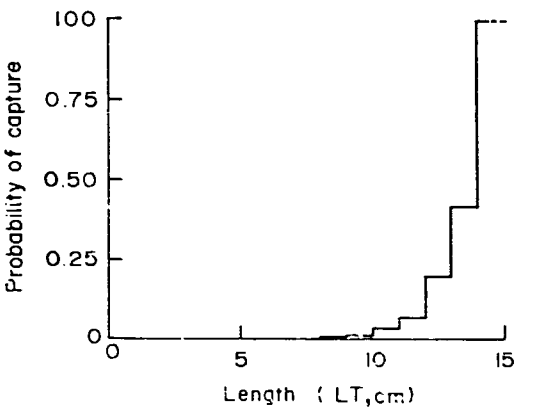
Fam. Carangidae
Decapterus maruadsi

Java Sea (Tegal), 1982-1983







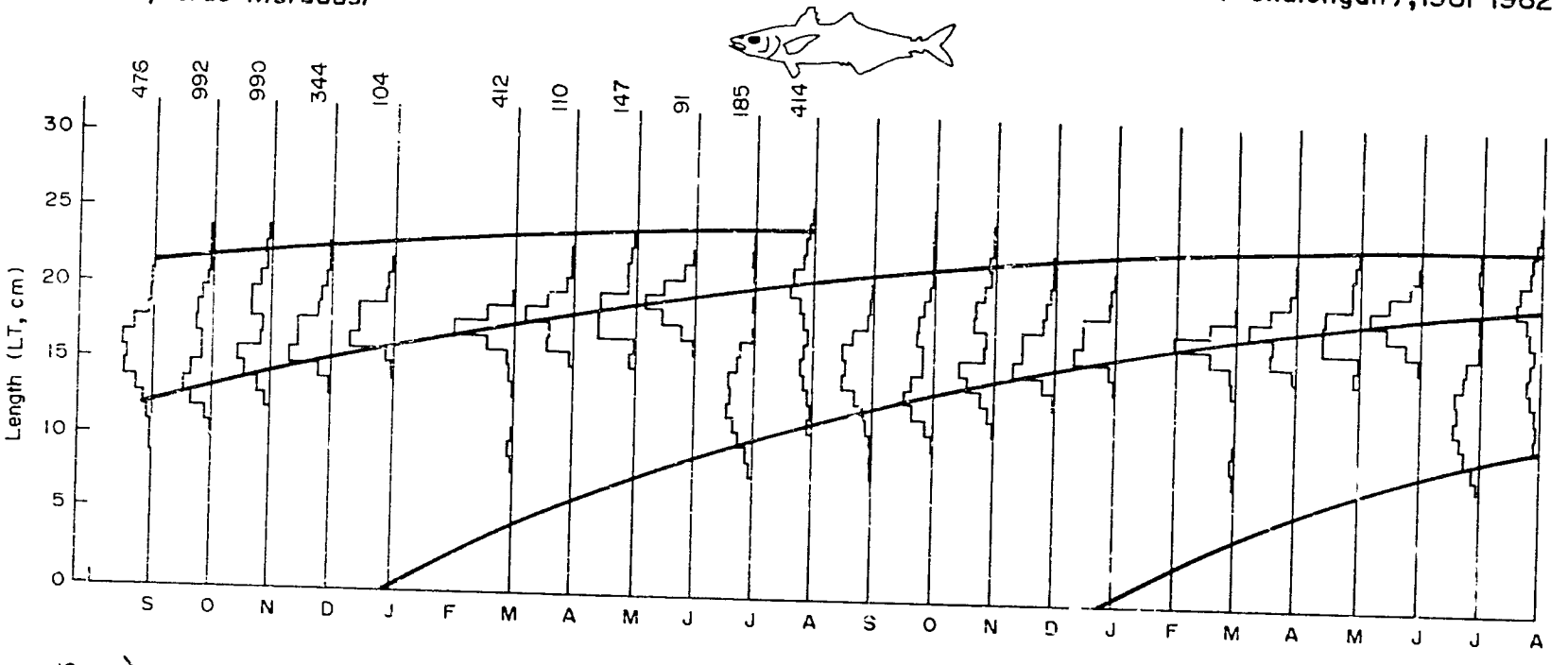


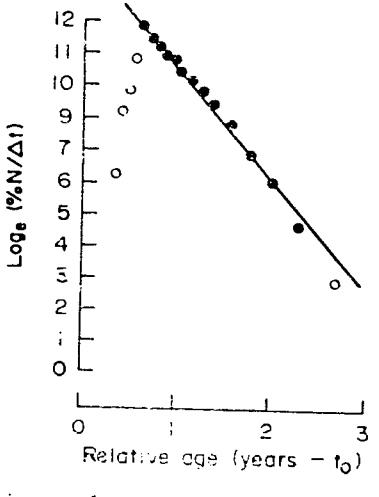
The set of length-frequency data discussed here was obtained from Mr. Suhroto's raw data files (Directorate General of Fisheries). The following parameter estimates were obtained from these data: L_∞ = 26.50 cm, K = 0.95, L_c = 13.64 cm, Z = 5.27, M = 1.80, F = 3.46, E = 0.66. Annual recruitment appears to have been irregular.

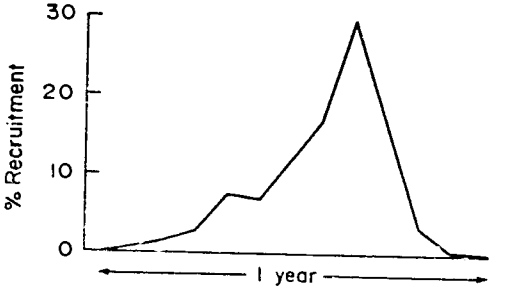
Plate 19

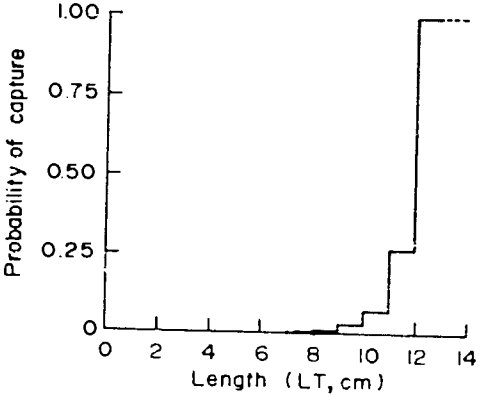
Fam. Carangidae
Decapterus maruadsi

Java Sea (Pekalongan), 1981-1982







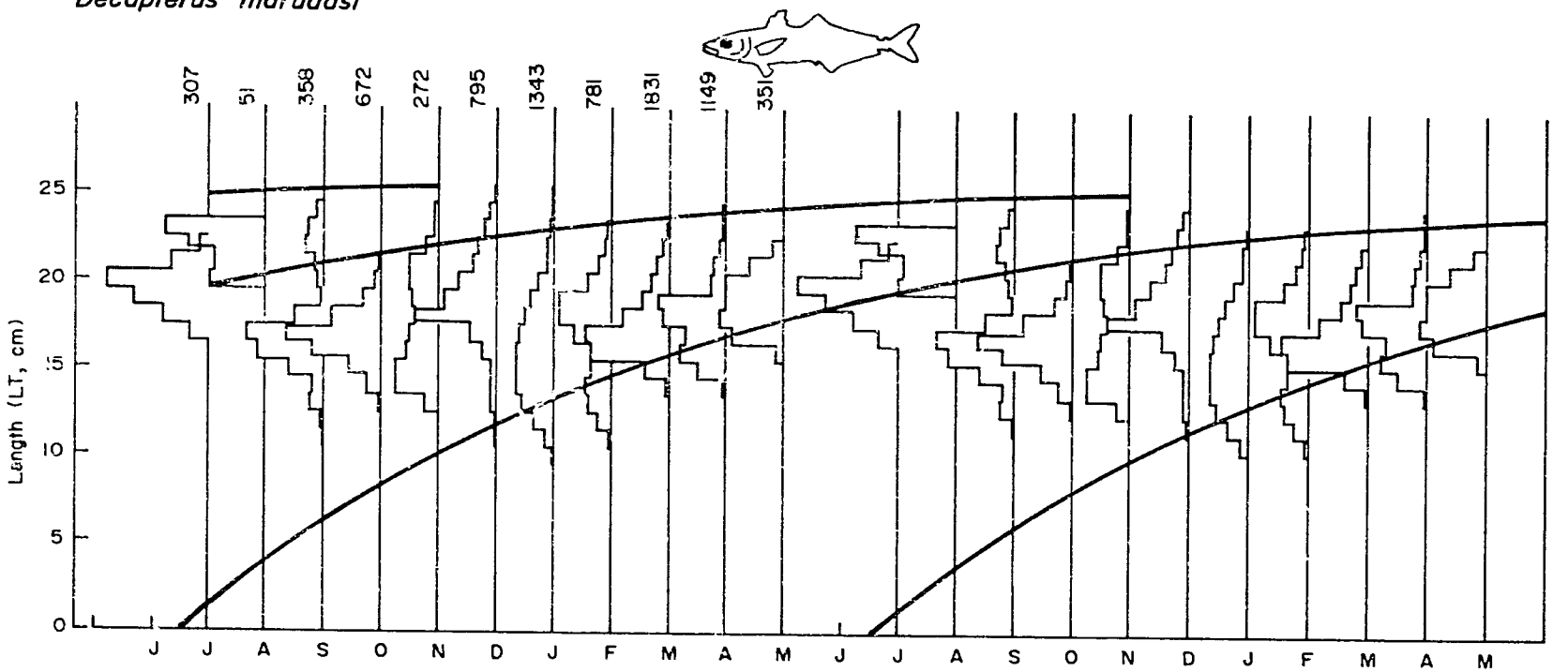


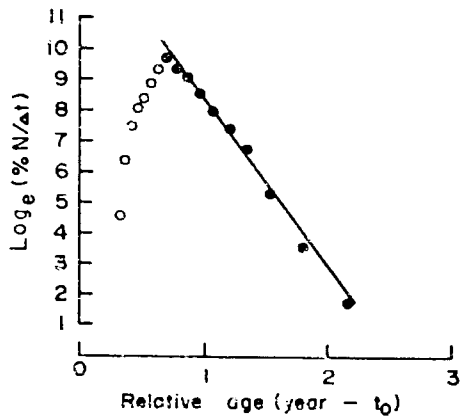
This set of length-frequency data, pertaining to scad mackerel *(Decapterus maruadsi)*, were collected by one of us (Banon Suherman) in 1981-1982. These data led to the estimates: L_∞ = 27.00 cm, K = 0.95, L_c = 11.82 cm, Z = 3.44, M = 1.79, F = 1.65, E = 0.48. Annual recruitment consisted of two well-separated unequal pulses. Aspects of growth and mortality of this fish are given in Bambang Sadhotomo, A. Suherman Banon and Subhat Nurhakim. 1985. Estimates of growth parameters, instantaneous mortality and yield per recruit of round scads, *Decapterus maruadsi* (Temminck and Schlegel) in the Java Sea. RIMF. Jakarta. Mar. Fish. Res. No. 27: 1-8. (In Indonesian with English abstract).

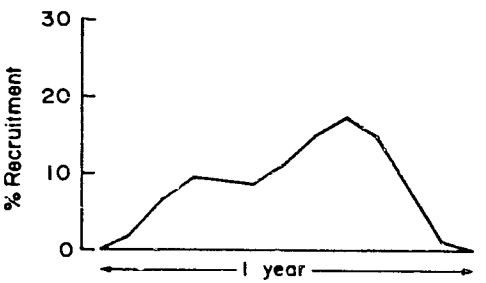
Fam. Carangidae
Decapterus maruadsi

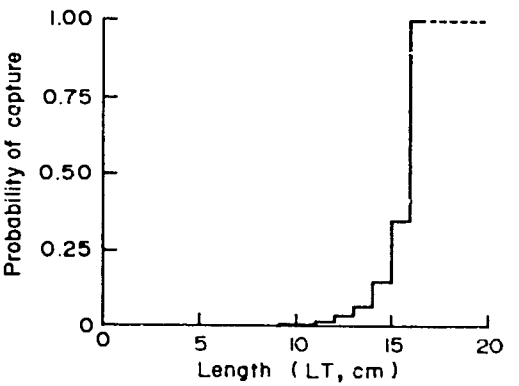
Java Sea (Pekalongan), 1982-1983

Plate 20







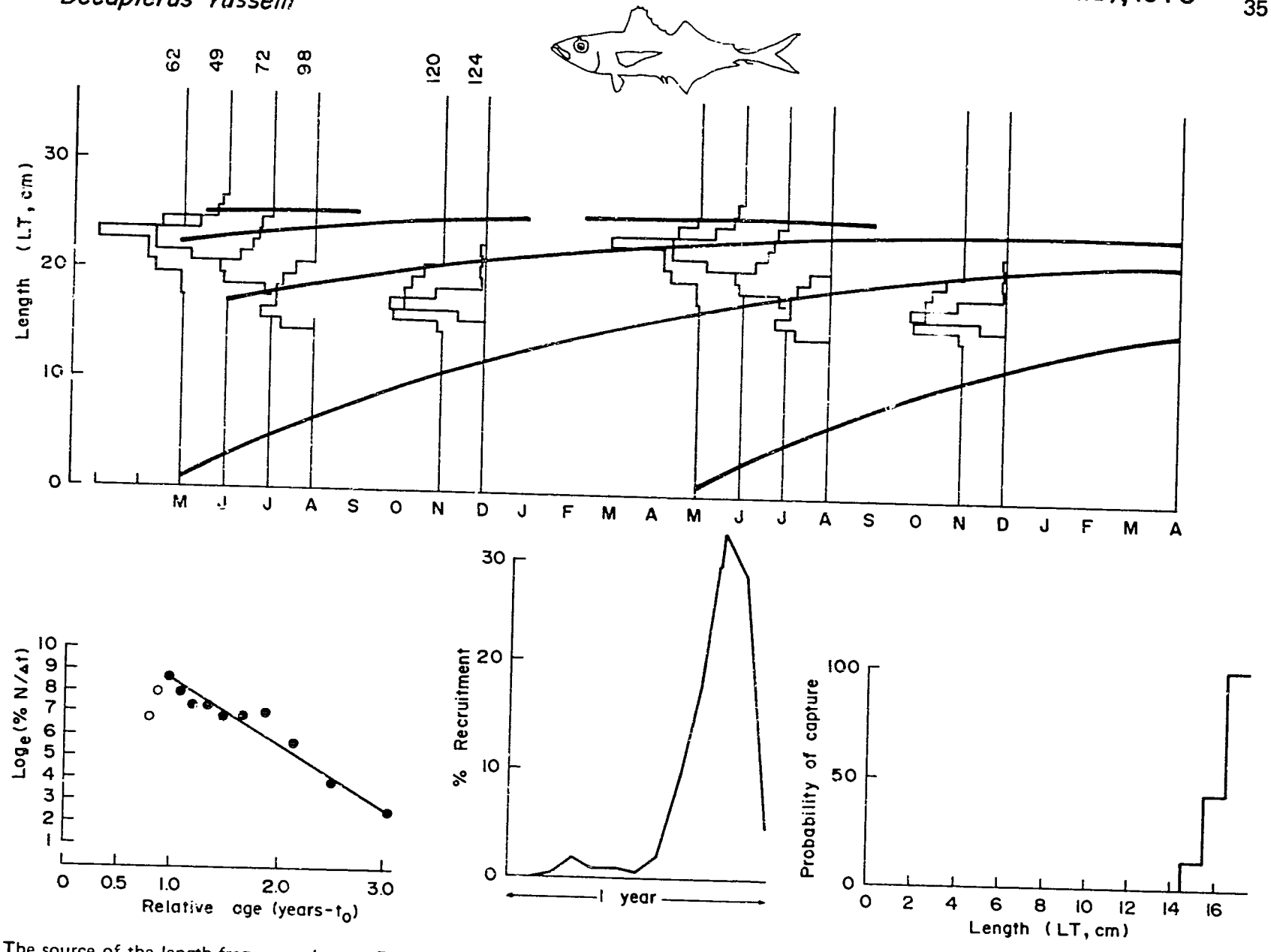


The length-frequency data of scad mackerel *(Decapterus maruadsi)* presented here, which stem from the raw data file of Tampubolon, G. (1982-1983) suggest the following statistics: L_∞ = 26.70 cm, K = 1.28, L_c = 15.68 cm, Z = 5.50, M = 2.18, F = 3.32, E = 0.60. Annual recruitment consisted of two unequal pulses.

Plate 21

Fam. Carangidae
Decapterus russelli

Java Sea (Seribu island), 1973

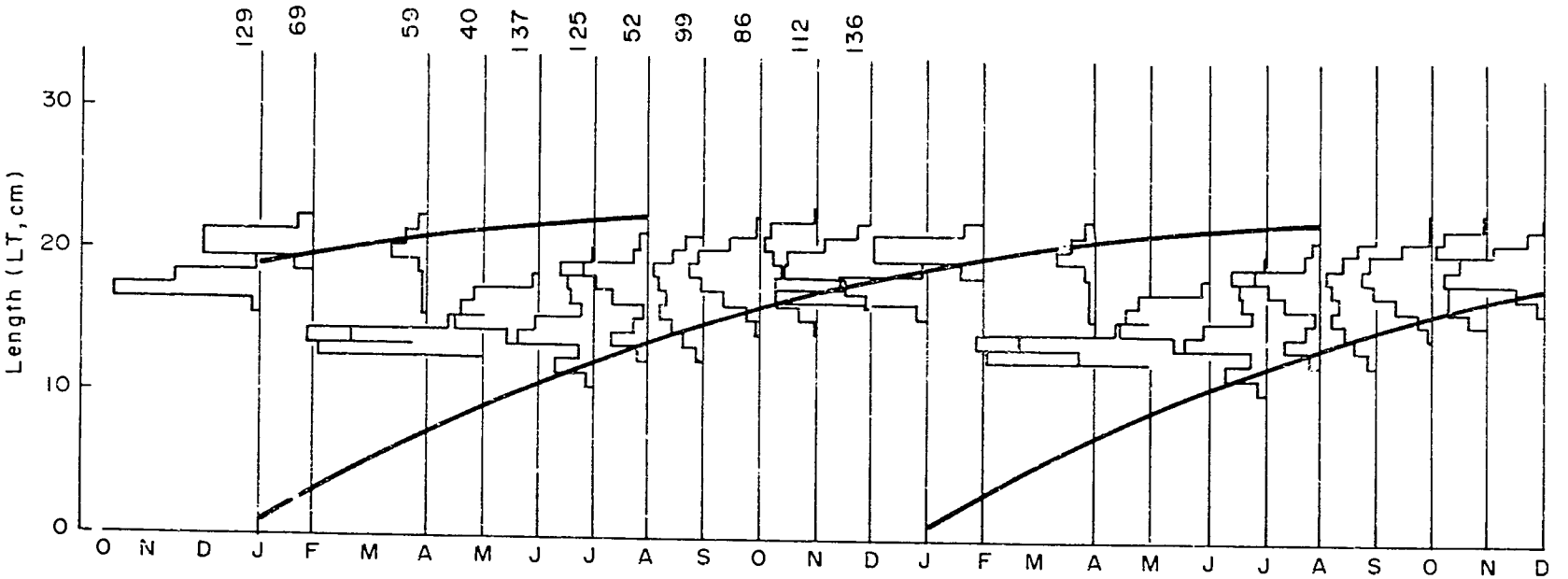


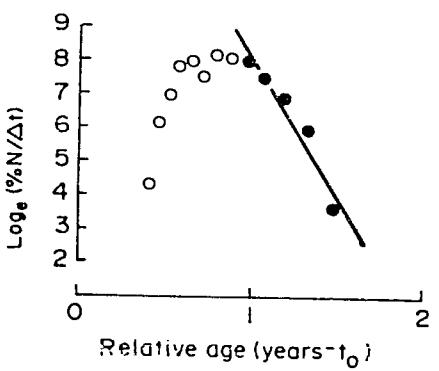
The source of the length-frequency data on *Decapterus russelli* presented here is Mr. Djamali's raw data files, Ocean Research Institute, Jakarta. They led to the following parameter estimates: L_∞ = 26.55 cm, K = 0.95, L_c = 20.72 cm, Z = 3.73, M = 1.80, F = 2.13, E = 0.57. Annual recruitment seems to have occurred in two pulses of very unequal strength. Notes on the biology, migration and behavior of round scad, particularly in relationship to fish lure, have been presented by Soemarto. 1960. Fish behavior with special reference to pelagic shoaling species: lajang (*Decapterus* spp.). Proc. Indo-Pac. Fish. Counc. 8(3): 89-93.

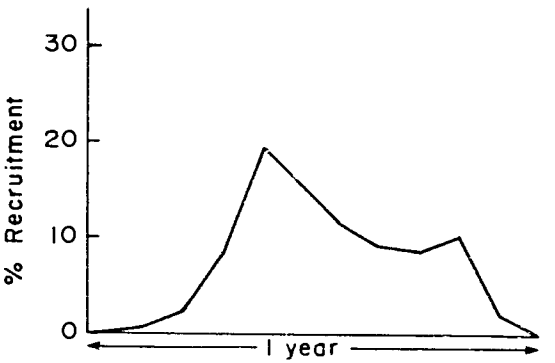
Fam. Carangidae
Decapterus russelli

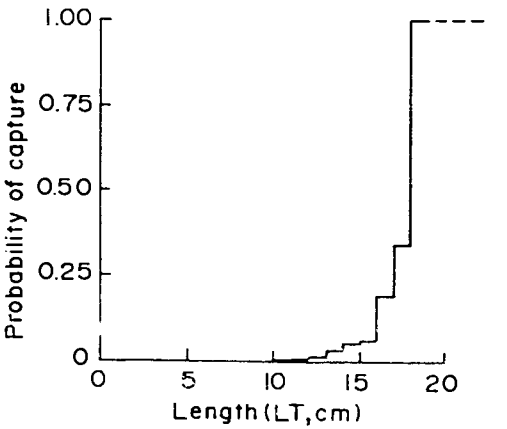
Jakarta Bay (Seribu Island), 1973

Plate 22







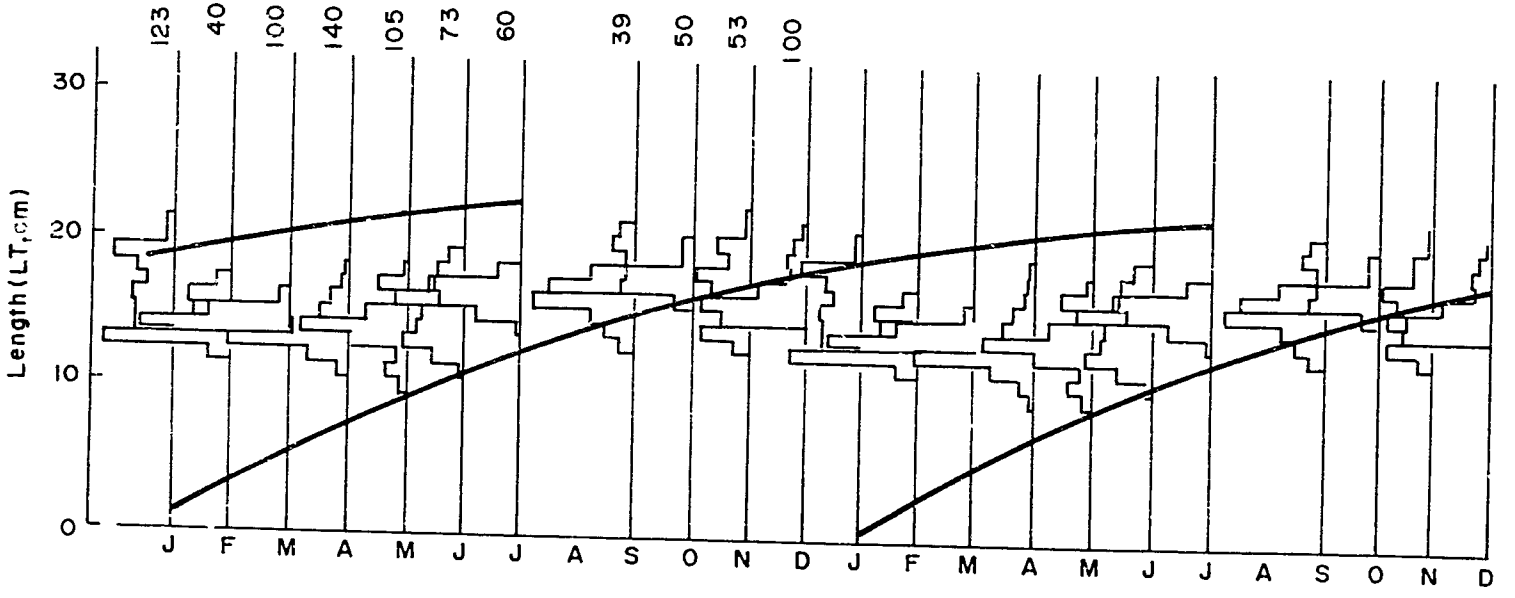


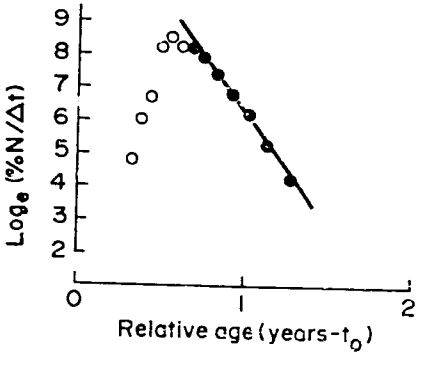
The set of length-frequency data presented here originated from the raw data files of Mr. Djamali, Ocean Research Institute, Jakarta. From these the following parameter values were estimated: L_∞ = 27.00 cm, K = 1.15, L_c = 17.32 cm, Z = 8.21, M = 2.03, F = 6.18, E = 0.75. Annual recruitment probably occurred in the form of two unequal pulses. The hypothetical migration pattern of the lajang *(Decapterus)* has been given by Hardenberg, J.P.E. 1938. Theorie omtrent den trek van layang in de Java Zee. Med. Inst. Zee Visscherij Batavia 4: 124-131. (In Dutch).

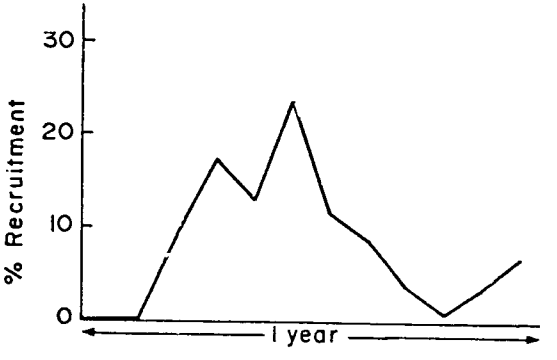
Plate 23

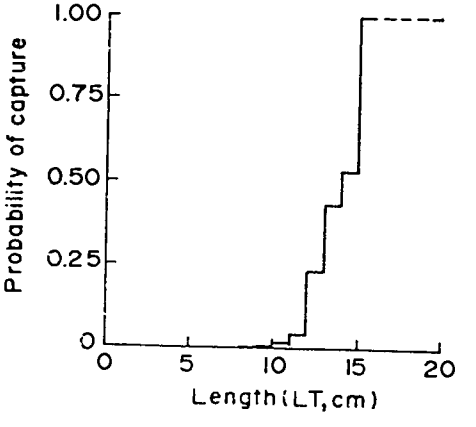
Fam. Carangidae
Decapterus russelli

Jakarta Bay (Seribu Island), 1975







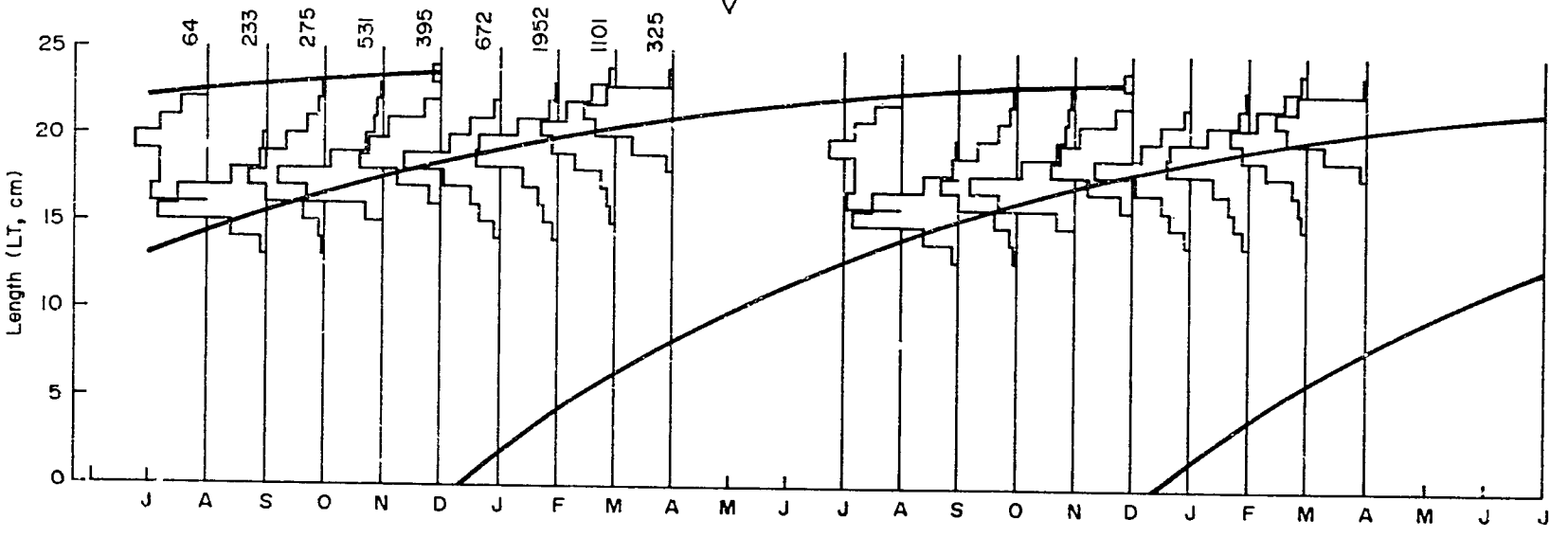


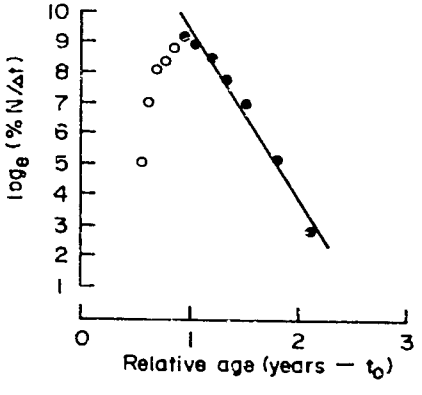
Length-frequency data on *Decapterus russelli* were collected by Mr. Djamali, Ocean Research Institute, Jakarta. The following parameters were estimated from the data: L_∞ = 27.00 cm, K = 1.18, L_c = 13.76 cm, Z = 6.68, M = 2.06, F = 4.62, E = 0.69. Annual recruitment patterns suggest that recruitment occurred in two pulses of unequal strength. A review of catch-and-effort data in the round scad fisheries of Southeast Asia is given in SCSP. 1978. Report of the workshop on the biology and resources of mackerels (*Rastrelliger* spp.) and round scads (*Decapterus* spp.) in the South China Sea. SCS/GEN/78/17. 70 p. South China Sea Fisheries Development and Coordinating Programme, Manila.

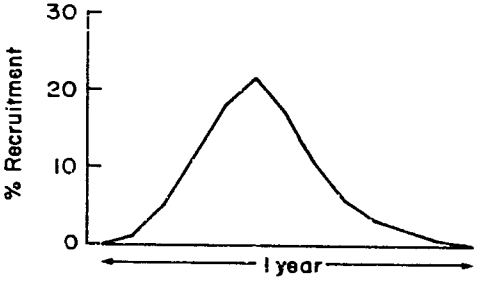
Plate 24

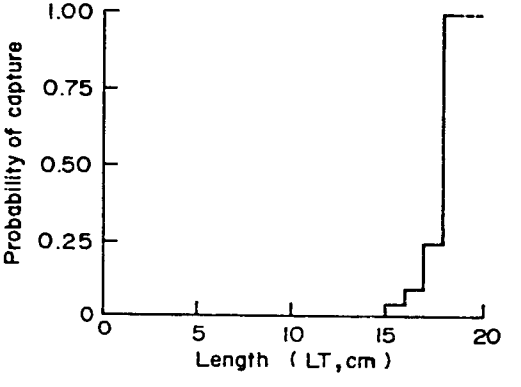
Fam. Carangidae
Selar crumenopthalmus

Java Sea (Pekalongan), 1982-1983





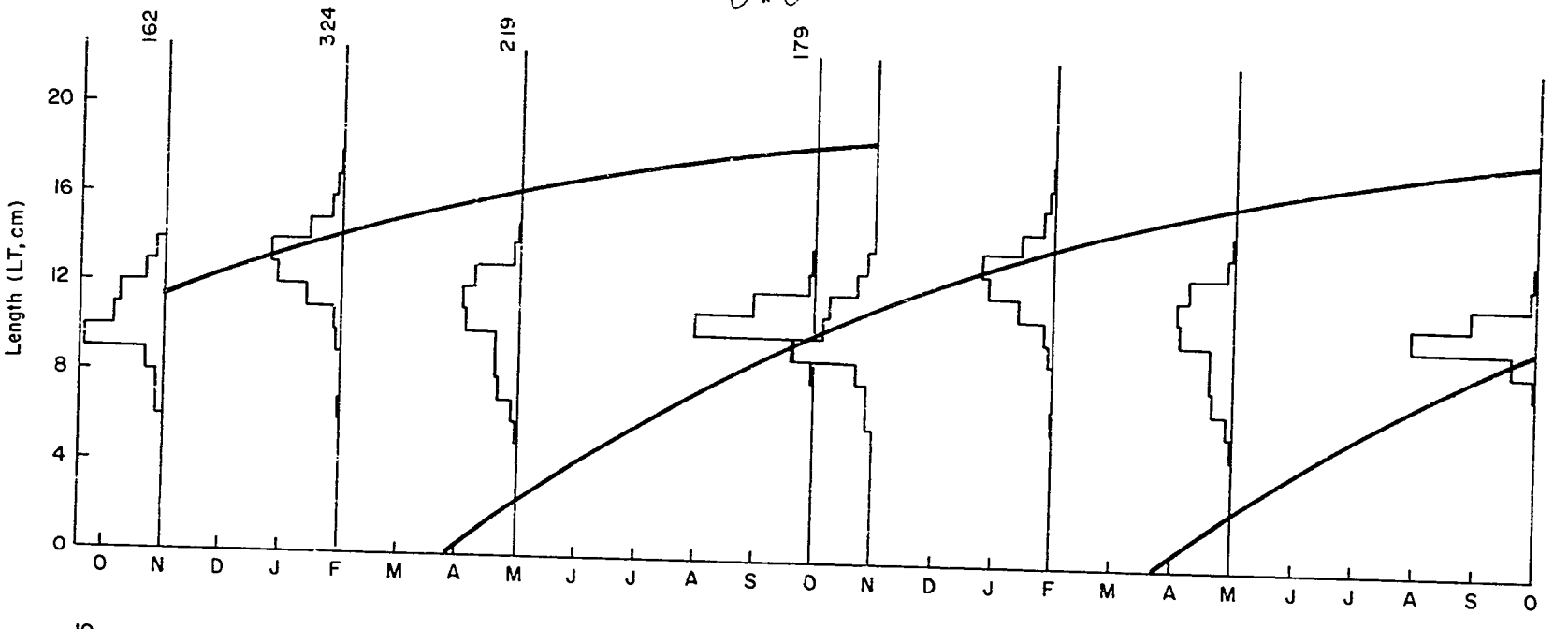


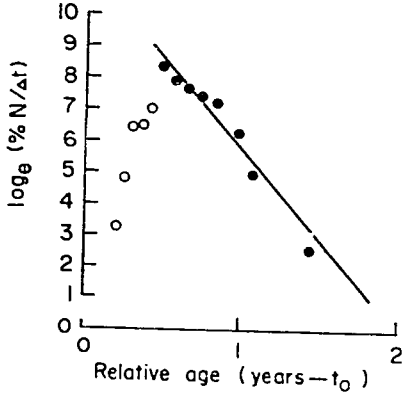


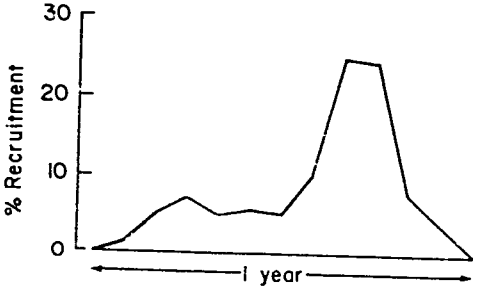
This set of length-frequency data of *Selar crumenopthalmus* was collected by G. Tampubolon from a landing place in Pekalongan in 1982-1983 and led to the estimation of the following parameter values: L_∞ = 25.90 cm, K = 1.25, L_c = 17.80 cm, Z = 5.56, M = 2.17, F = 3.39, E = 0.61. Annual recruitment may have consisted of a single, protracted event. A description of the eggs of *S.* (= *Caranx*) *crumenopthalmus* and allied species is given in Delsman, H.C. 1962. Fish eggs and larvae from the Java Sea 5: *Caranx kurra, C. macrosoma* and *C. crumenopthalmus.* Treubia 8: 199-211 (reprinted in Delsman, H.C. 1972. Fish eggs and larvae from the Java Sea, Linnaeus Press, Amsterdam).

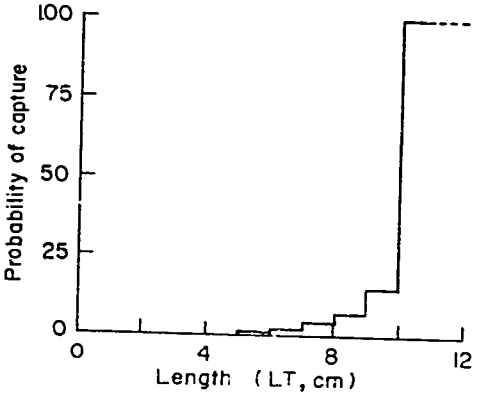
Fam. Carangidae
Selaroides leptolepis

Java Sea (Tegal), 1978-1979







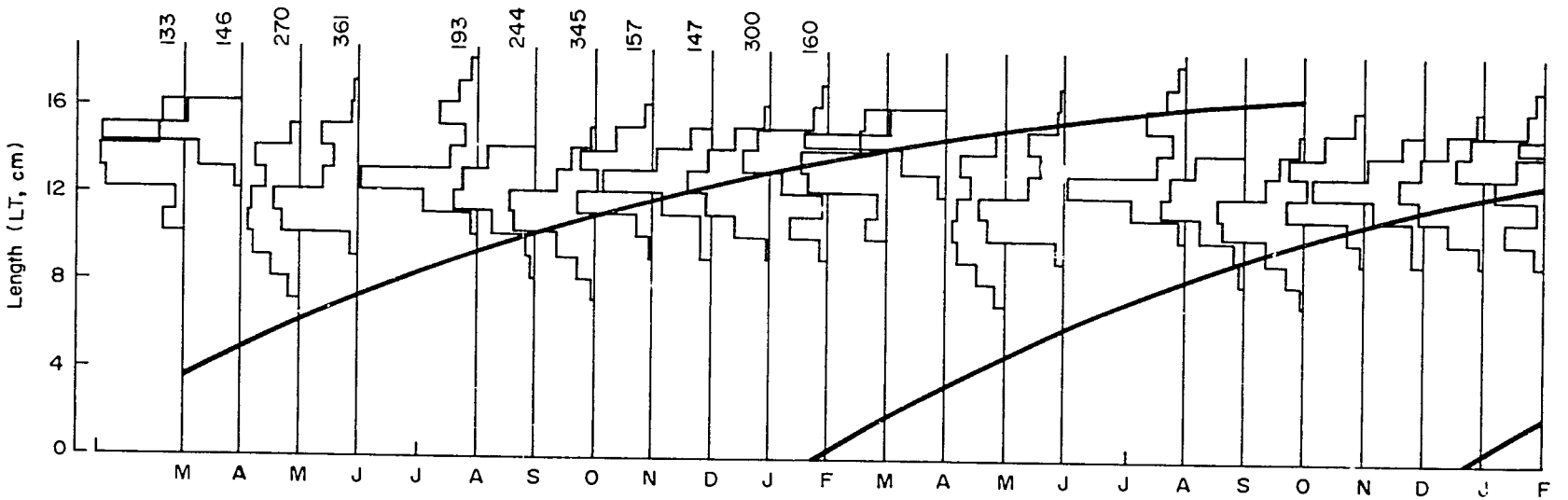


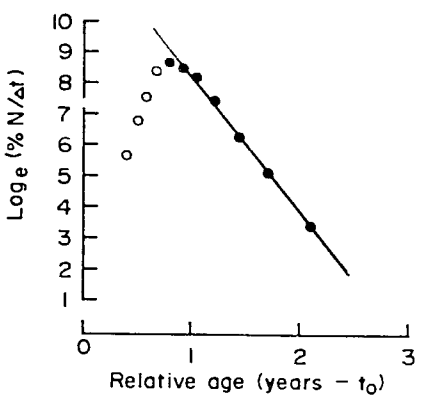
The length-frequency data of *Selaroides leptolepis* presented here were obtained from the raw data files of R.V. Mutiara-IV survey in the Java Sea, 1977. They led to the following estimates: L_∞ = 22.00 cm, K = 1.20, L_c = 9.88 cm, Z = 5.75, M = 2.21, F = 3.54, E = 0.62. Annual recruitment occurred in the form of two well-separated pulses of unequal strength. Information on the biological aspects of slender trevally may be found in Mosuwan, P. 1970. On the biology of slender trevally, *Caranx leptolepis* in the Gulf of Thailand. Marine Fisheries Laboratory, Bangkok, 16 p. (MS). Information on the growth of *Selaroides leptolepis* have been reported by Martosubroto, P. 1982. Fishery dynamics of the demersal resources of the Java Sea, Dalhousie University, Canada. Ph.D. Thesis.

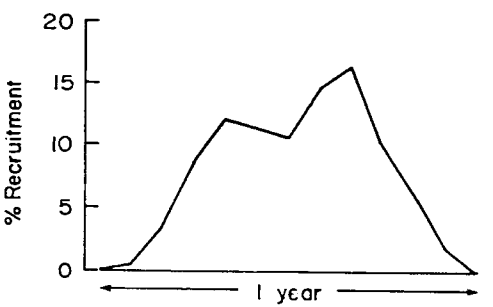
Plate 26

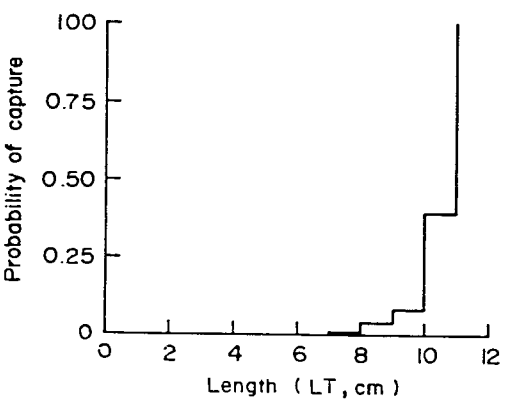
Fam. Carangidae
Selaroides leptolepis

Riau waters (Bintan), 1982-1983

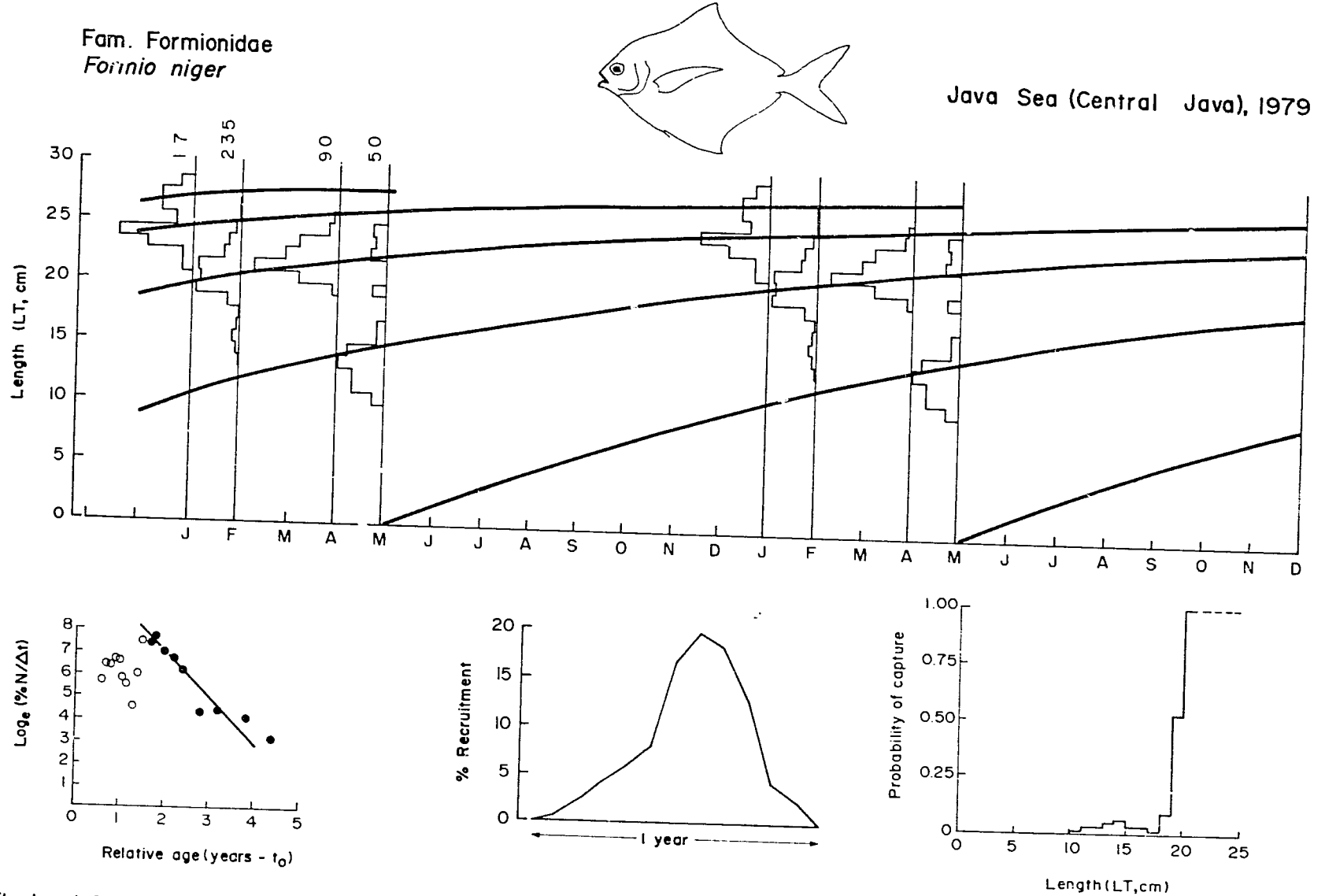








The set of length-frequency data of *Selaroides leptolepis* presented here was culled from the files of Mr. Sudradjat and were collected in Riau waters, 1982-1983. They led to the following estimates: L_∞ = 18.90 cm, K = 1.10, L_c = 10.80 cm, Z = 4.26, M = 2.18, F = 2.08, E = 0.49. Annual recruitment appears to have consisted of two pulses of unequal strength. Data on the biology of *S. leptolepis* are given in Sudradjat, A. and D. Nugroho. 1983. Study on the biology of yellowstriped trevally, *Selaroides leptolepis* (Cuvier and Valenciennes) in the Sunda shelf waters, Jakarta. Mar. Res. Rep. (29): 79-88. (In Indonesian with English abstract).

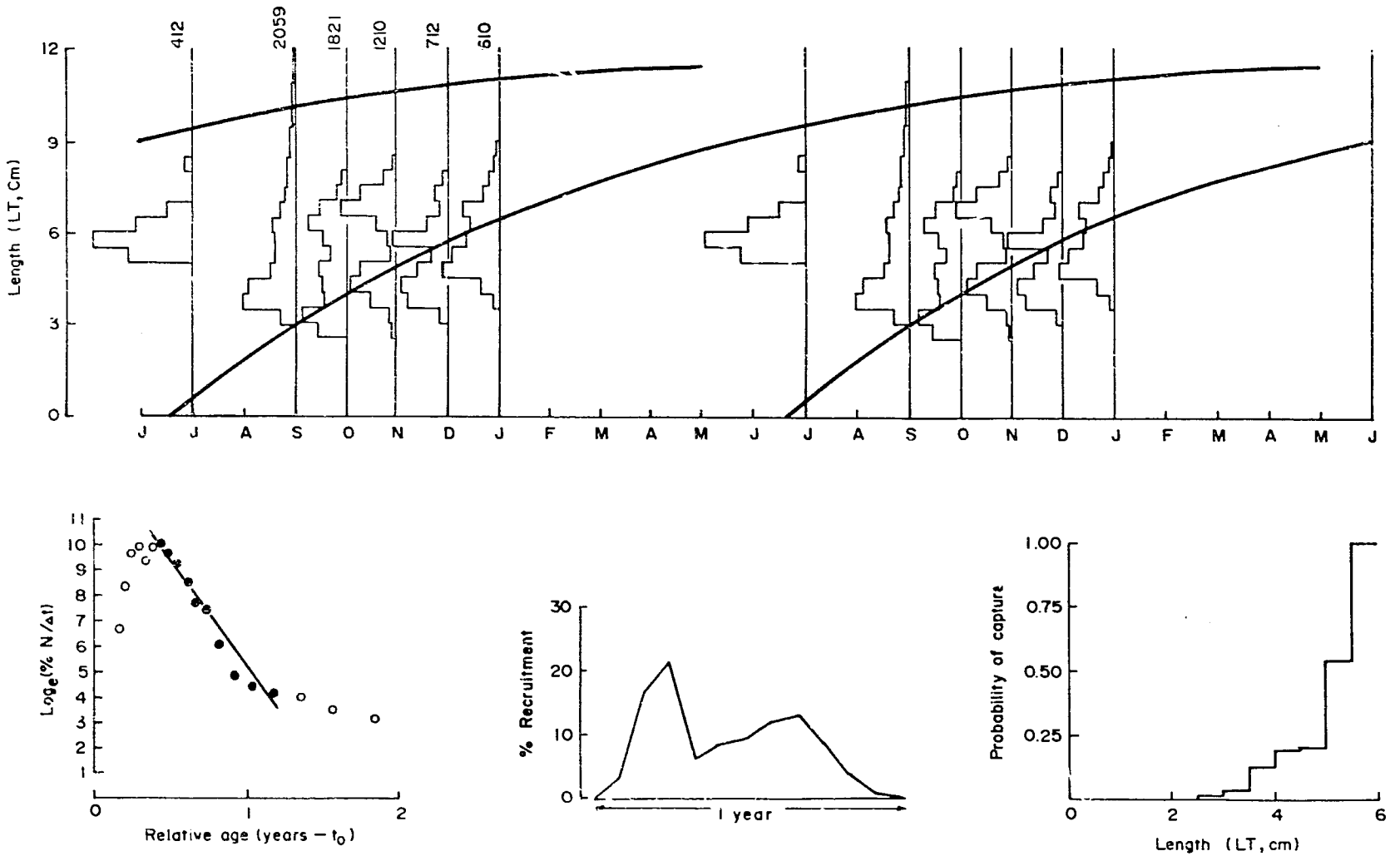


The length-frequency data presented here on *Formio niger*, the black pomfret, were obtained from Dwiponggo, A. and M. Badrudin. 1980. The following parameter estimates were obtained: L_∞ = 29.50 cm, K = 0.66, L_c = 19.12 cm, Z = 2.06, M = 1.40, F = 0.64, E = 0.31. The bulk of the annual recruitment appears to have been produced during one spawning season. Data used stem from the Java Sea inshore monitoring survey by R/V Mutiara-IV in 1979. RIMF. Spec. Rep. (7a): 1-87.

Plate 28

Fam. Leiognathidae
Leiognathus bindus

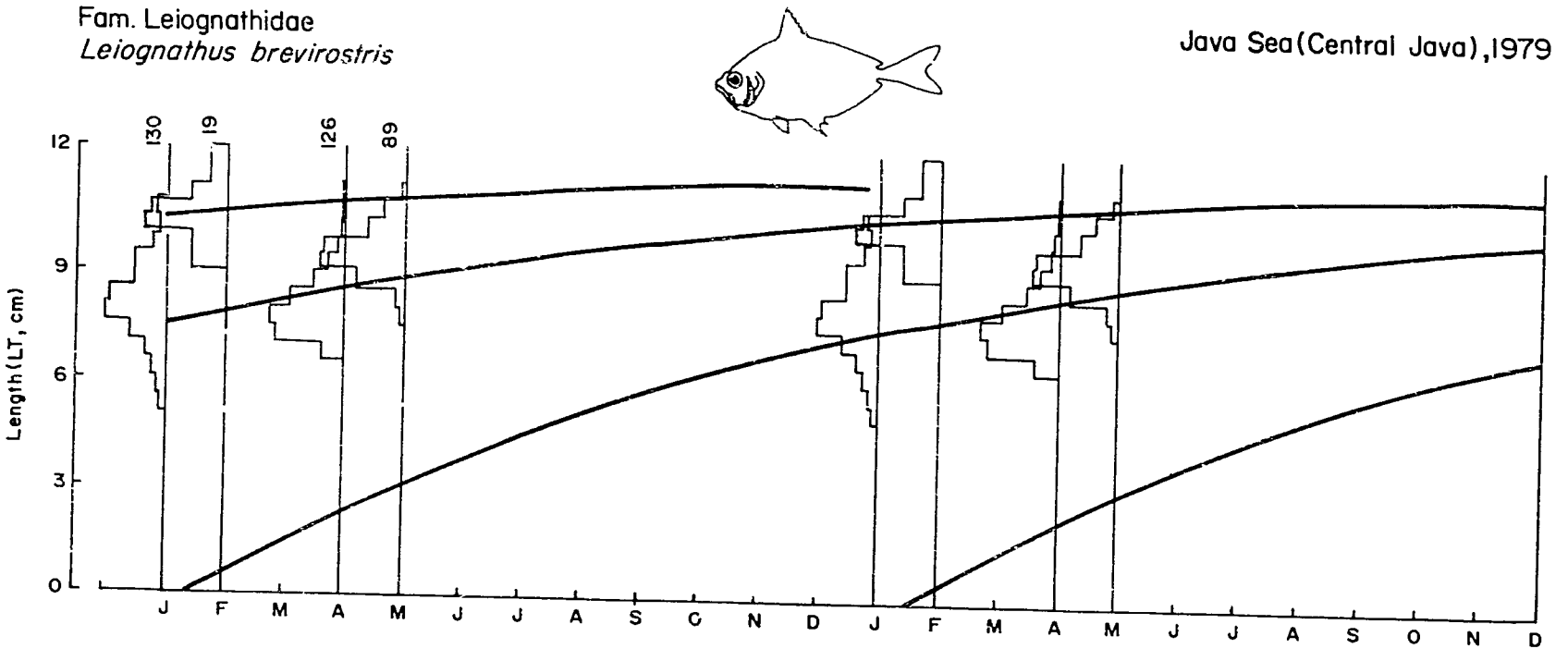
Java Sea (Central Java), 1977-1978

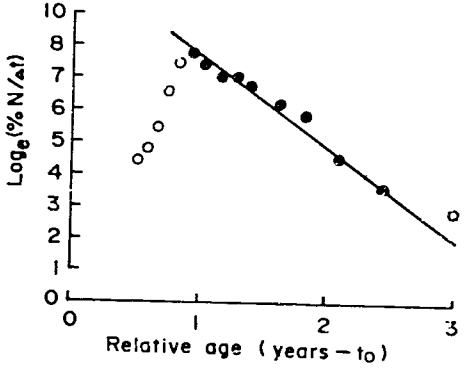


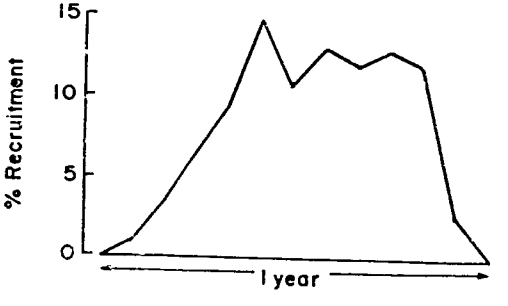
The source of the length-frequency data on slipmouth stems from Dwiponggo, A. and M. Badrudin. 1979. RIMF. Spec. Rep. (6a): 1-128. Data of trawl survey by R.V. Mutiara-IV in the Java Sea subarea in 1978. The following parameter values were estimated from these data: L_∞ = 12.50 cm, K = 1.38, L_c = 5.03 cm, Z = 8.84, M = 2.83, E = 0.68. Annual recruitment appears to have consisted of two pulses of unequal strength. Information on the biological aspects of the silver belly is given by Balan, V. 1967. Biology of the silver belly *Leiognathus bindus* (Val.) of the Calicut coast. Ind. J. Fish. 10(1): 118-134.

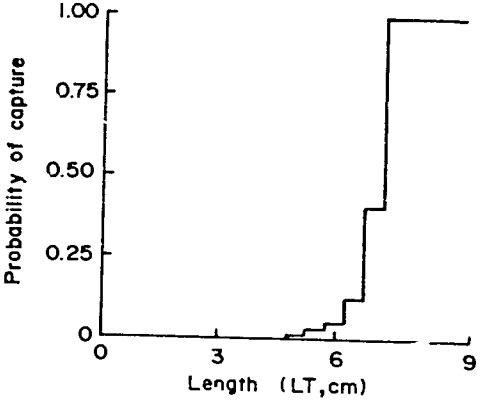
Fam. Leiognathidae
Leiognathus brevirostris

Java Sea (Central Java), 1979





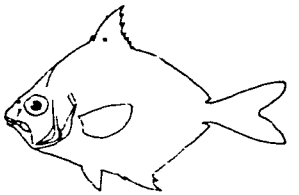




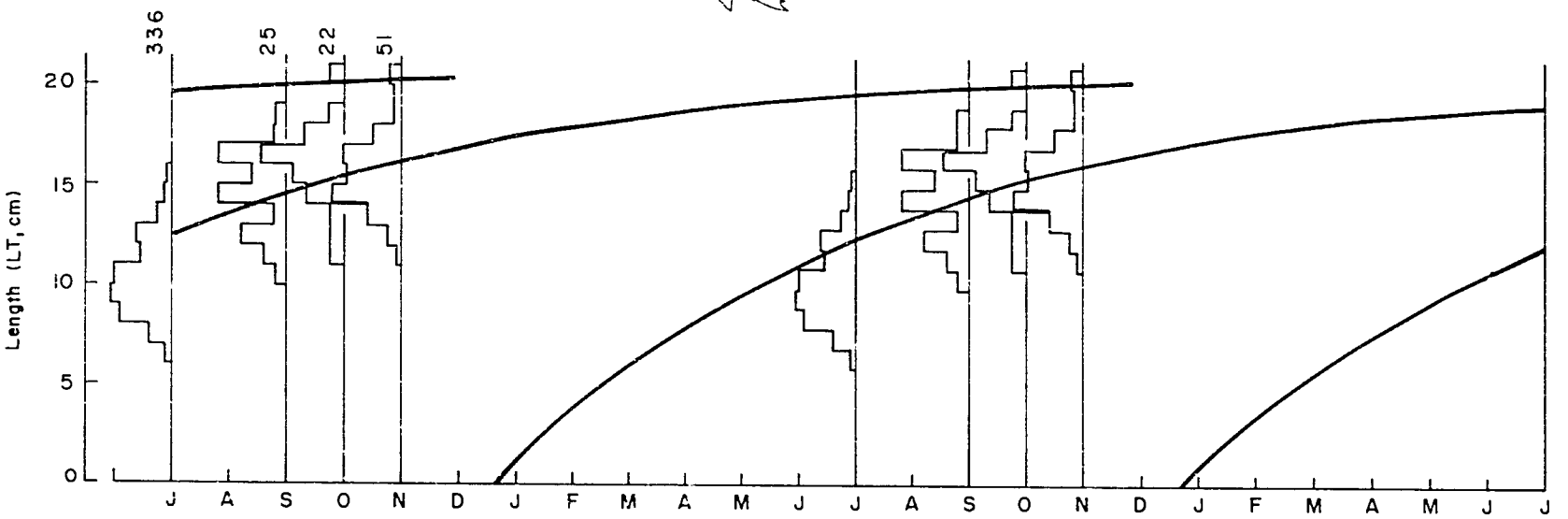
This set of length-frequency data on shortnose ponyfish was obtained from Dwiponggo, A. and M. Badrudin. 1980. Length-frequency measurements of demersal fish species in the Java Sea inshore areas, 1979. RIMF. Spec. Rep. (7b): 1-94. The data allowed the estimation of the following parameter values: L_∞ = 12.00 cm, K = 0.95, L_c = 7.10 cm, Z = 2.79, M = 2.20, F = 0.59, E = 0.21. The shape of the recruitment pattern does not allow for a definite conclusion as to the seasonality of recruitment. A large number of references on leiognathids may be found in Pauly, D. and S. Wade-Pauly. 1981. An annotated bibliography of slipmouths (Pisces: Leiognathidae). ICLARM Bibliographies 2, International Center for Living Aquatic Resources Management, Manila, Philippines. 62 p.

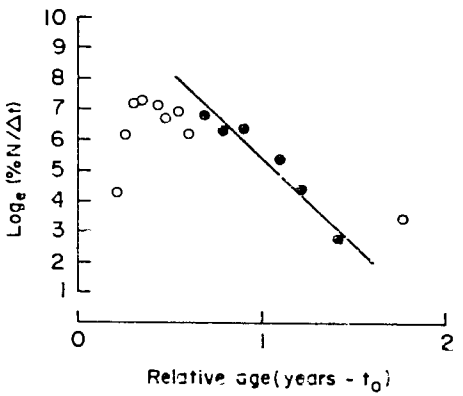
Plate 30

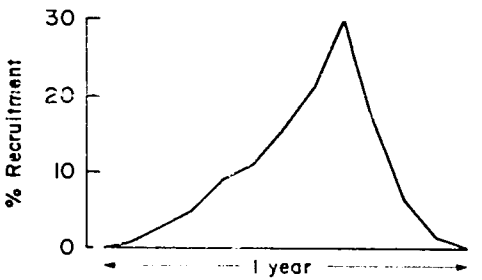
Fam. Leiognathidae
Leiognathus equulus

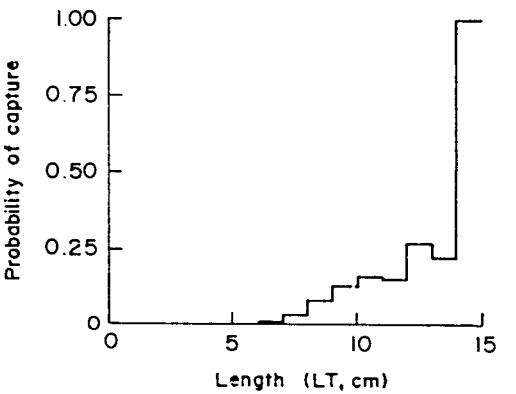


Java Sea (Central Java), 1977

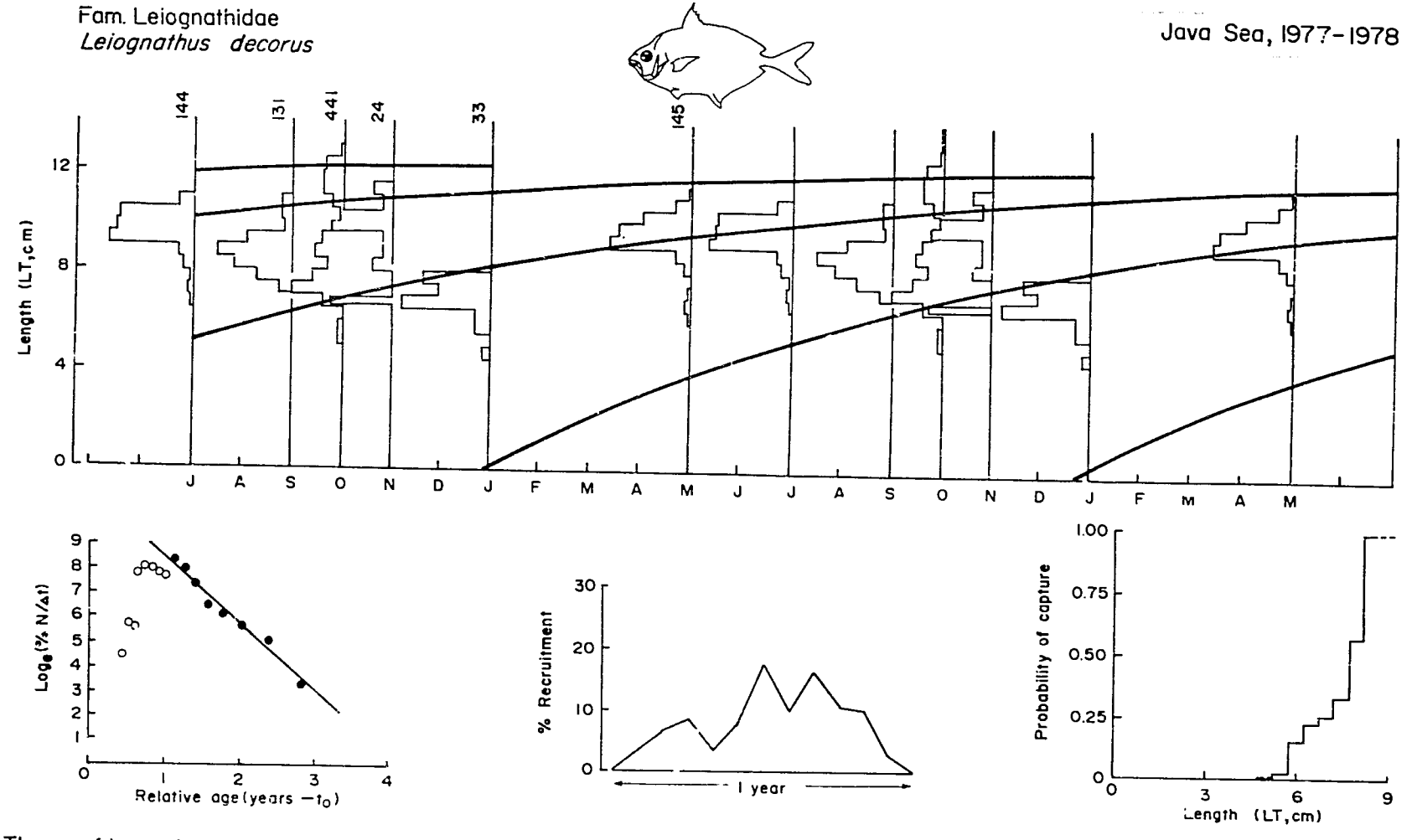








This set of length-frequency data of ponyfish was extracted from Mutiara-IV survey data files (1977). The following parameter values were estimated: L_∞ = 21.50 cm, K = 1.50, L_c = 13.40 cm, Z = 5.68, M = 2.58, F = 3.10, E = 0.55. The bulk of the annual recruitment seems to have originated from one major recruitment event. Other information may be found in Martosubroto, P. 1982. Fishery dynamics of the demersal resources of the Java Sea. Dalhousie University, Canada, Ph.D. Thesis.

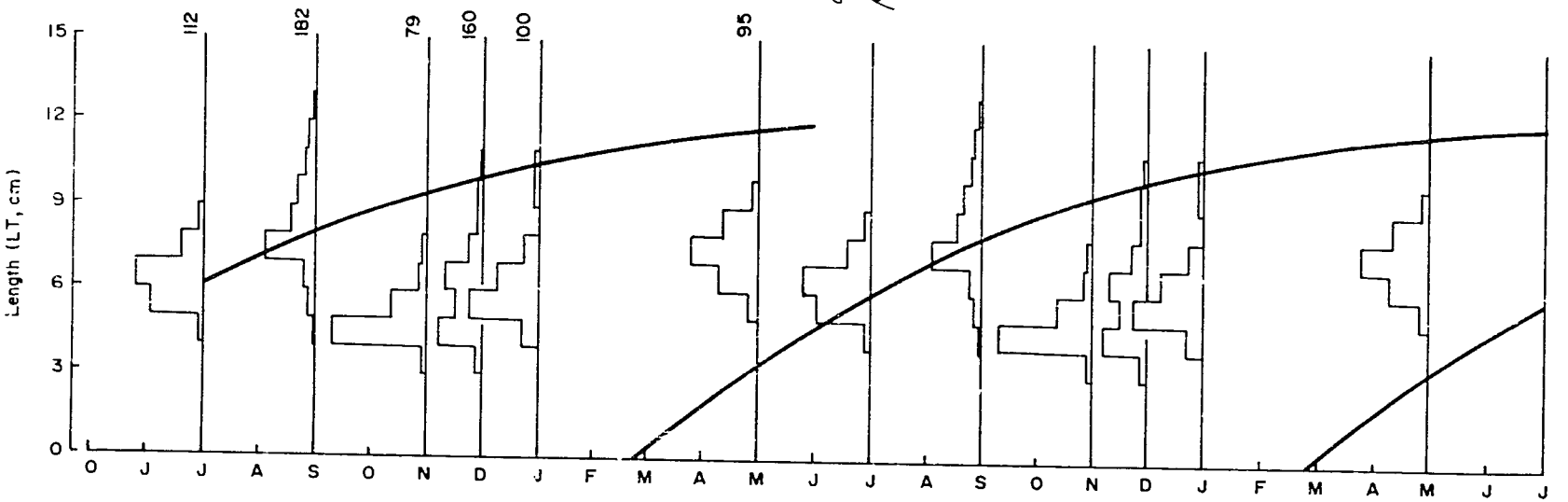


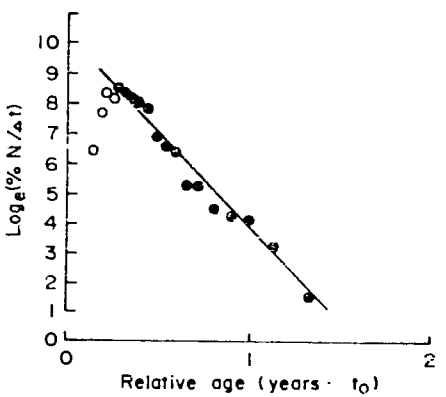
The set of length-frequency data discussed here was obtained from Dwiponggo, A. and M. Badrudin. 1979. Data of trawl survey by R.V. Mutiara-IV in the Java Sea subareas in 1978. Contribution of the Demersal Fisheries Project, No. 6A. From these data, the following parameter values were estimated: L_∞ = 13.00 cm, K = 1.00, L_c = 8.26 cm, Z = 2.69, M = 2.27, F = 0.43, E = 0.16. The available data suggest an irregular pattern of recruitment, probably consisting of two pulses. The species name is based on Jones, G. 1985. Revision of the Australian species of the family Leiognathidae. Aust. J. Mar. Freshwat. Res. 36(4): 559-613.

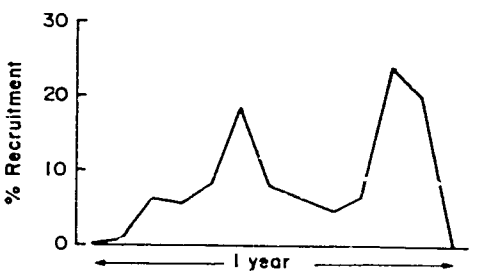
Plate 32

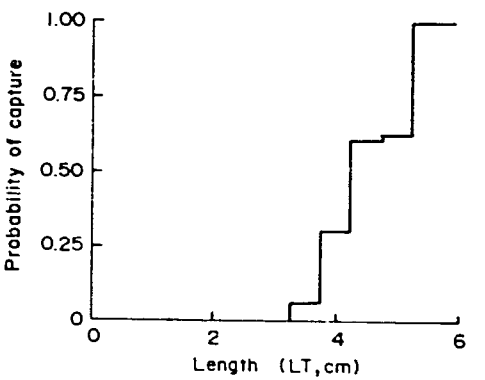
Fam. Leiognathidae
Leiognathus leuciscus

Java Sea (Central Java), 1982-1983





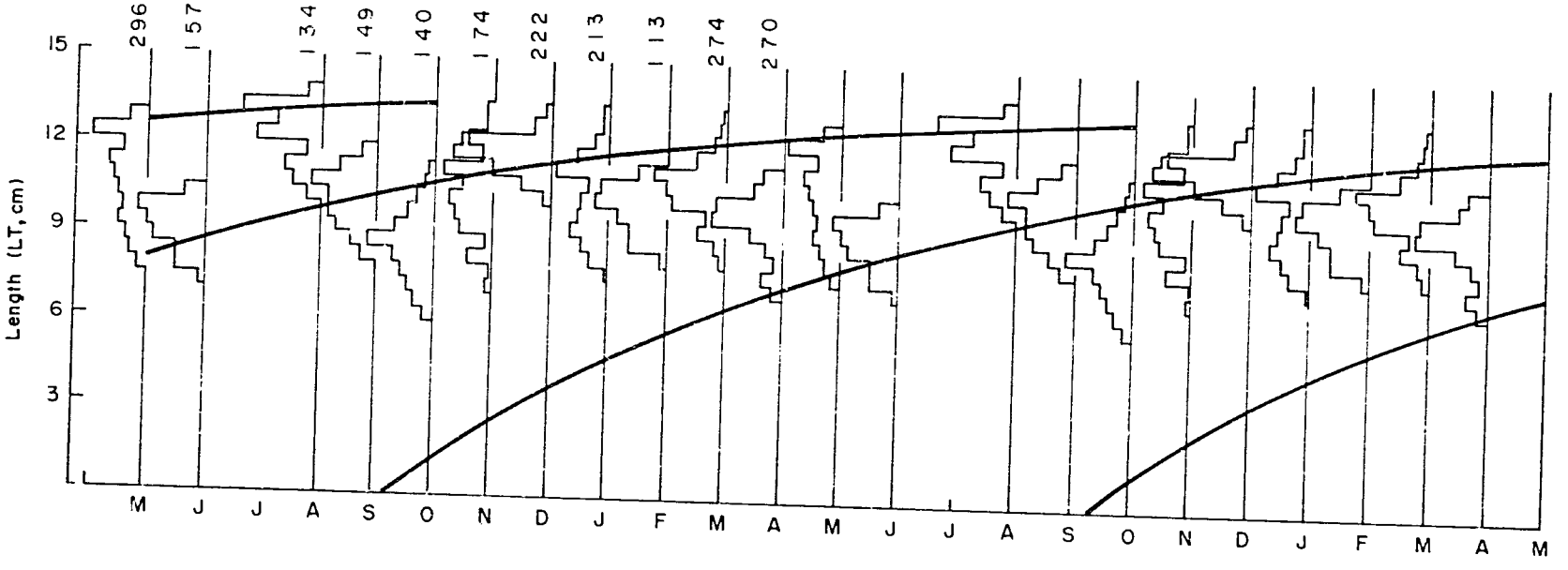


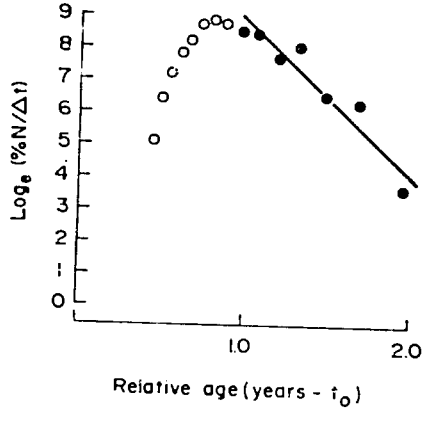


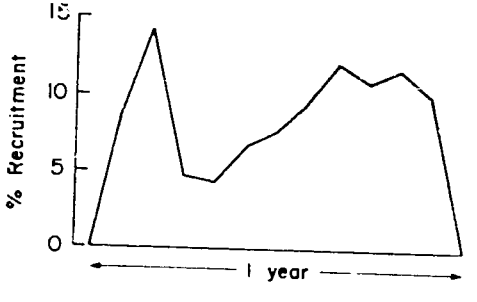
The length-frequency data presented here were derived from the files of the R.V. Mutiara-IV, Research Institute for Marine Fisheries, Jakarta. From these data, the following statistics were estimated: L_∞ = 13.50 cm, K = 1.80, L_c = 4.76 cm, Z = 6.15, M = 3.31, F = 2.84, E = 0.46. Annual recruitment appears to have consisted of two pulses. A detailed description of this fish, whose biology is little known, is given in James, P.S.B.R. 1967. *Leiognathus leuciscus* (Günther) and *L. smithursti* (Ramsey and Ogilby) (Family Leiognathidae: Pisces)—the new records from the Indian Seas. J. Mar. Biol. Assoc. India 9(2): 330-302.

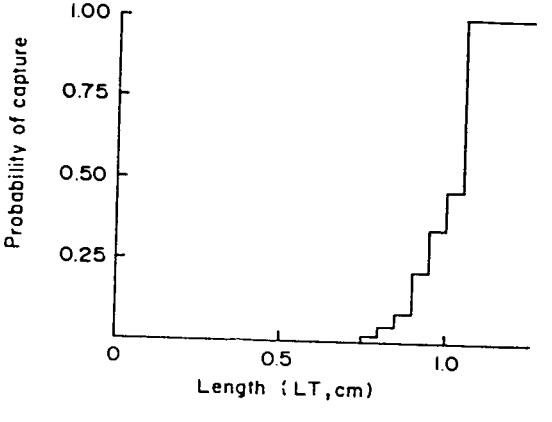
Fam. Leiognathidae
Leiognathus splendens

Riau Waters (Bintan), 1982-1983





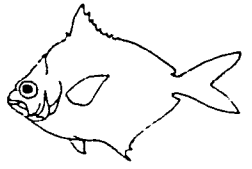




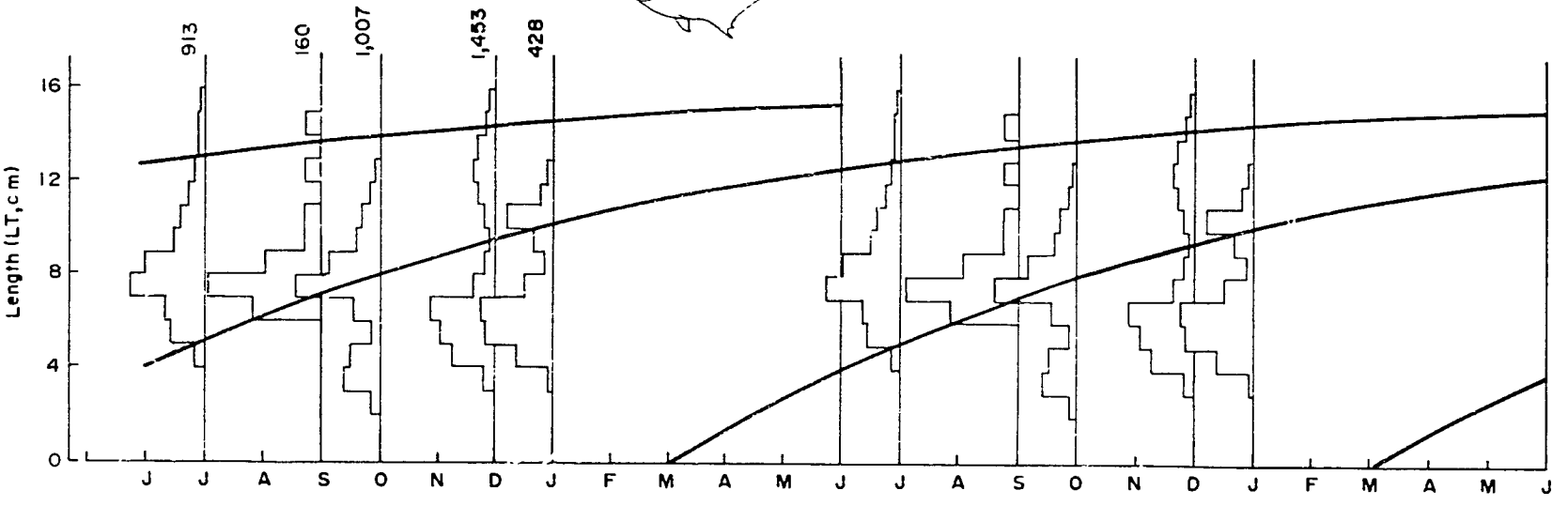
The length-frequency data analyzed here were collected by Sudradjat in Riau Archipelago waters in 1982. The following parameter estimates were derived: L_∞ = 14.50 cm, K = 1.25, L_c = 9.65 cm, Z = 4.64, M = 2.55, F = 2.09, E = 0.45. The recruitment pattern, although jagged, suggests that annual recruitment occurred in two pulses of unequal duration and strength. Some data on the catch rate and distribution of this fish in the Java Sea area may be found in Losse, G.F. and A. Dwiponggo. 1977. Report on the Java Sea southeast monsoon trawl survey, June-December 1976. RIMF. Spec. Rep. Contribution of the Demersal Fisheries Project 3: 1-119 and in A. Sudrajat, U. Rempe and S. Ehrich. 1982. Biometric comparison of the splendid ponyfish, *Leiognathus splendens* (Cuvier) from the Sunda Shelf. CRIFI, Jakarta Bull. Pen. Perikanan 1(2): 17-36.

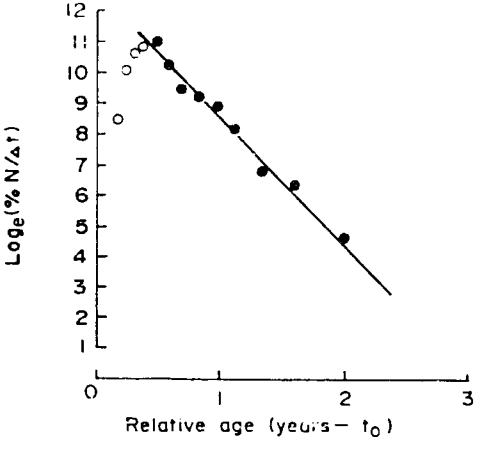
Plate 34

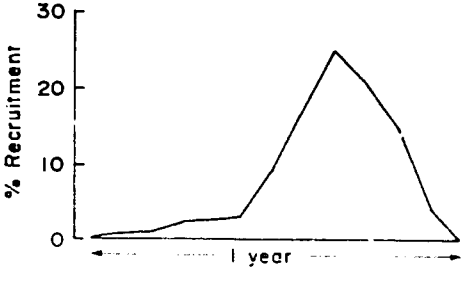
Fam. Leiognathidae
Leiognathus splendens

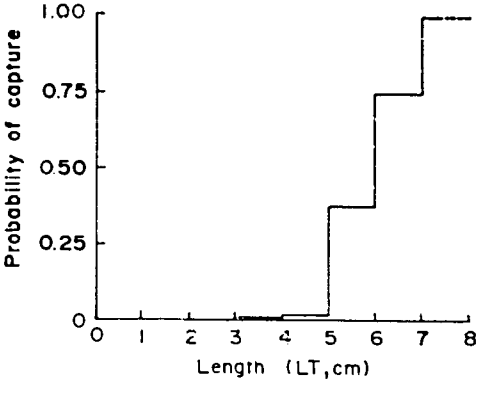


Java Sea (South Kalimantan), 1977-1978





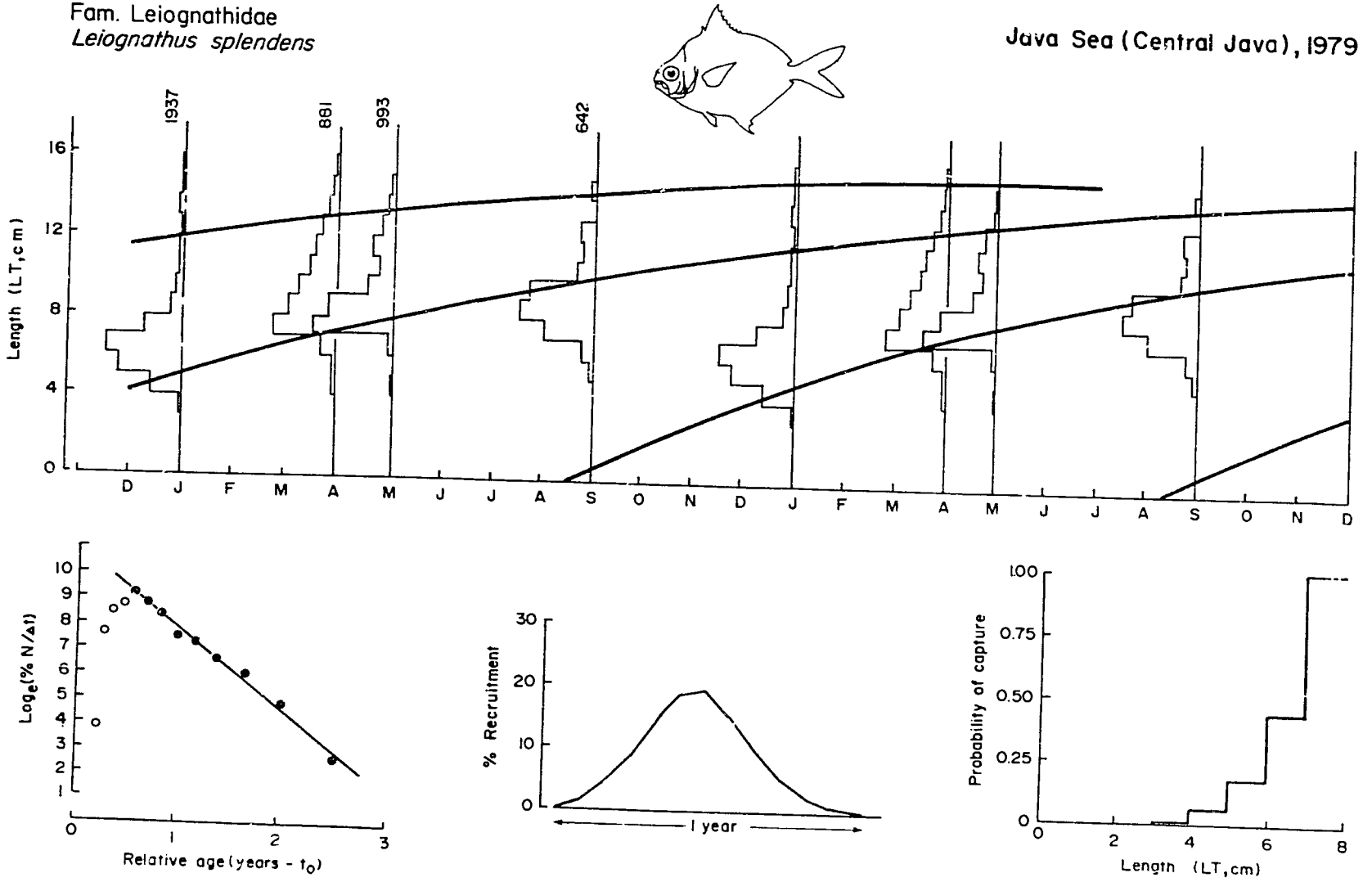




The length-frequency data analyzed here were extracted from R.V. Mutiara survey data (1977-1978) in the Java Sea. The following parameter values were estimated from these data: L_∞ = 16.90 cm, K = 1.10, L_c = 6.23 cm, Z = 4.00, M = 2.25, F = 1.75, E = 0.43. Annual recruitment consisted of two seasonal pulses, one much stronger than the other. Information on the estimation of mortality rates of this fish can be found in Pauly, D. 1980. The use of pseudo catch curves for the estimation of mortality rates in *Leiognathus splendens* (Pisces: Leiognathidae) in Western Indonesian waters. Meeresforsch./Rep. Mar. Res. 28(1): 56-60.

Fam. Leiognathidae
Leiognathus splendens

Java Sea (Central Java), 1979

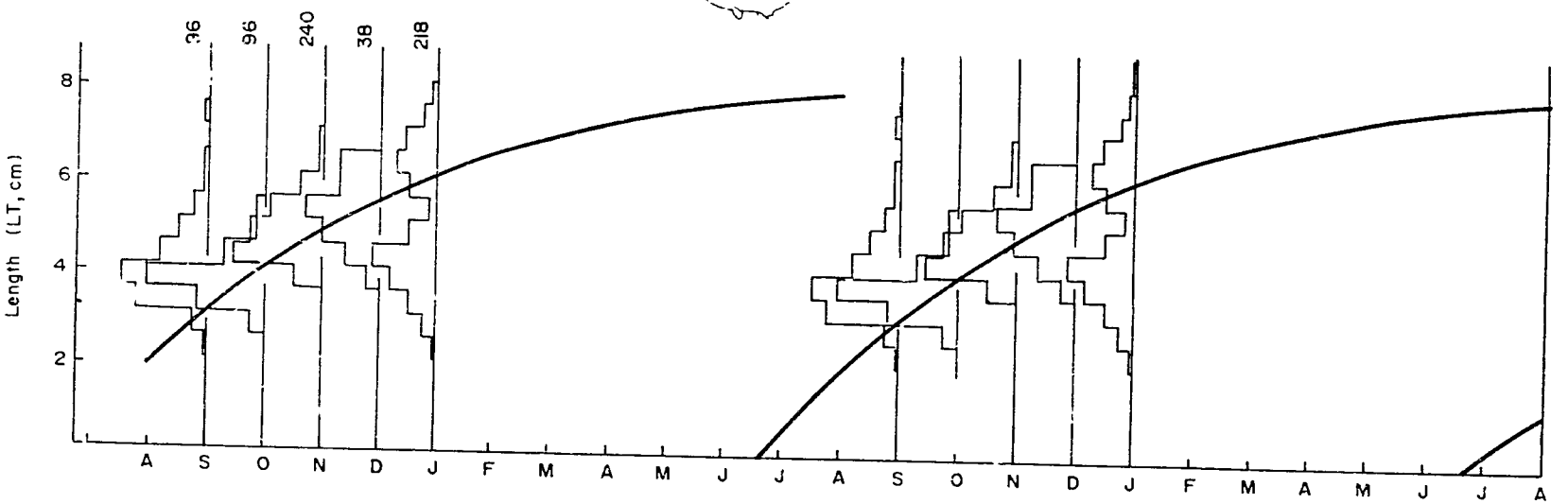


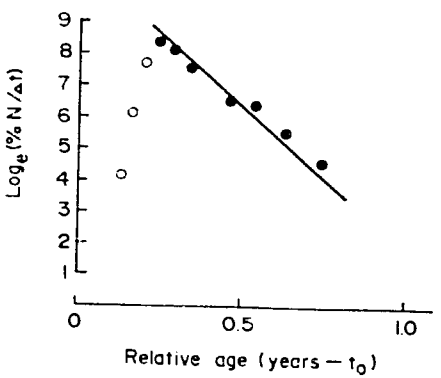
The source of the length-frequency data presented here is the trawl survey data of R.V. Mutiara-IV. From these, the following parameter values were estimated: L_∞ = 16.70 cm, K = 0.90, L_c = 6.23 cm, Z = 3.27, M = 1.98, F = 1.25, E = 0.38. The shape of the recruitment pattern suggests one seasonal pulse. Some biological aspects of this fish and its fishery were discussed in Pauly, D. 1977. The Leiognathidae (Teleostei): their species, stocks and fishery in Indonesia, with notes on the biology of *Leiognathus splendens* (Cuvier). Mar. Res. Indonesia 19: 73-93.

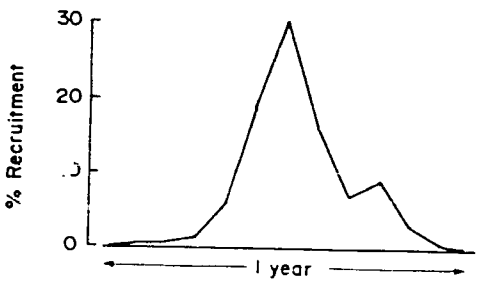
Plate 36

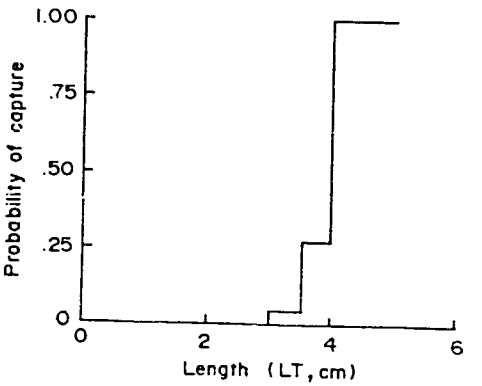
Fam. Leiognathidae
Secutor ruconius

Java Sea (Tegal), 1977-1978



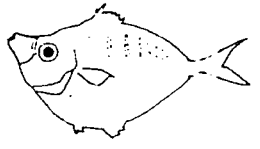




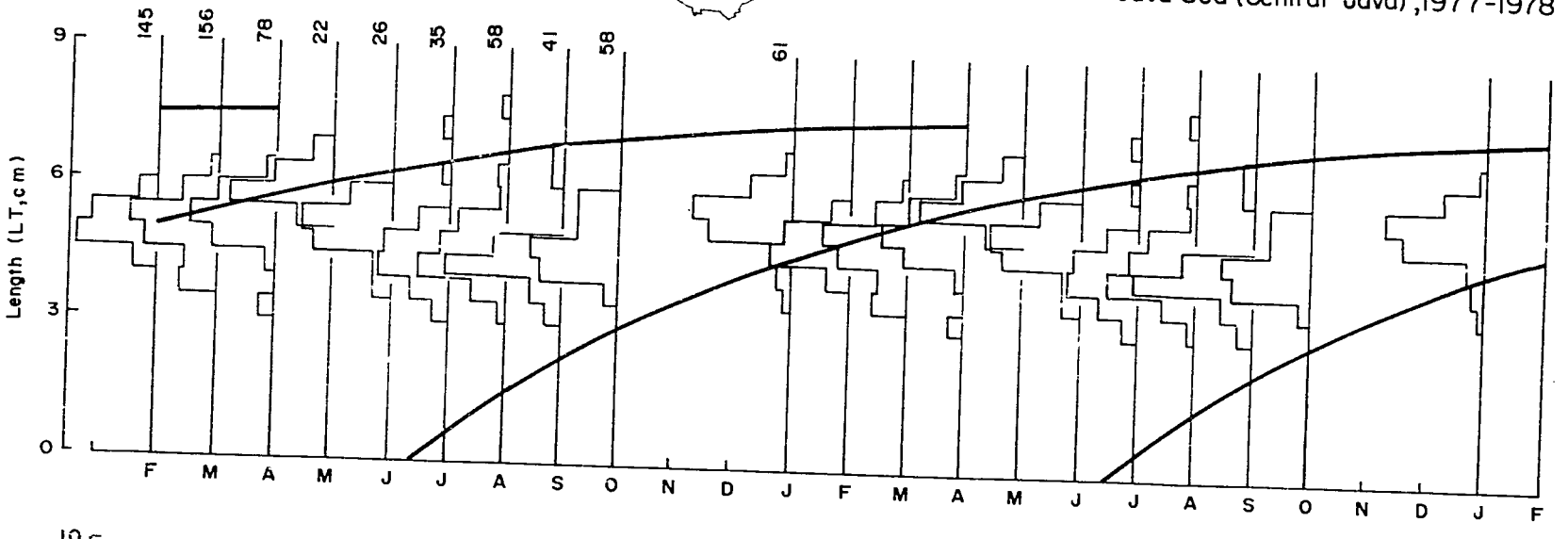


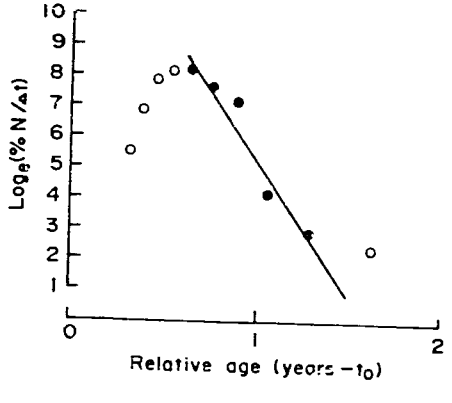
The length-frequency data were collected in the frame of the Indonesian-German Demersal Fishery Project in 1977-1978. The following parameter estimates were obtained: L_∞ = 9.00 cm, K = 2.20, L_c = 3.60 cm, Z = 8.91, M = 4.22, F = 4.69, E = 0.53. Annual recruitment appears to have occurred in the form of two pulses of unequal strength. The depth distribution in relation to light emission of this fish and other leiognathids was discussed in Pauly, D. 1977. The Leiognathidae (Teleostei): a hypothesis relating to their mean depth occurrence and the intensity of their counter-shading bioluminescence. Mar. Res. Indonesia 19: 137-146.

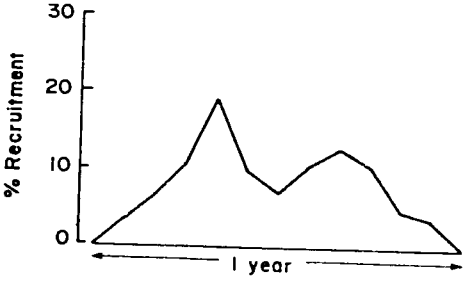
Fam. Leiognathidae
Secutor ruconius

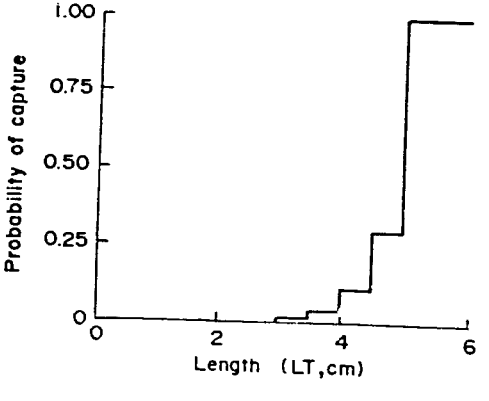


Java Sea (Central Java), 1977-1978







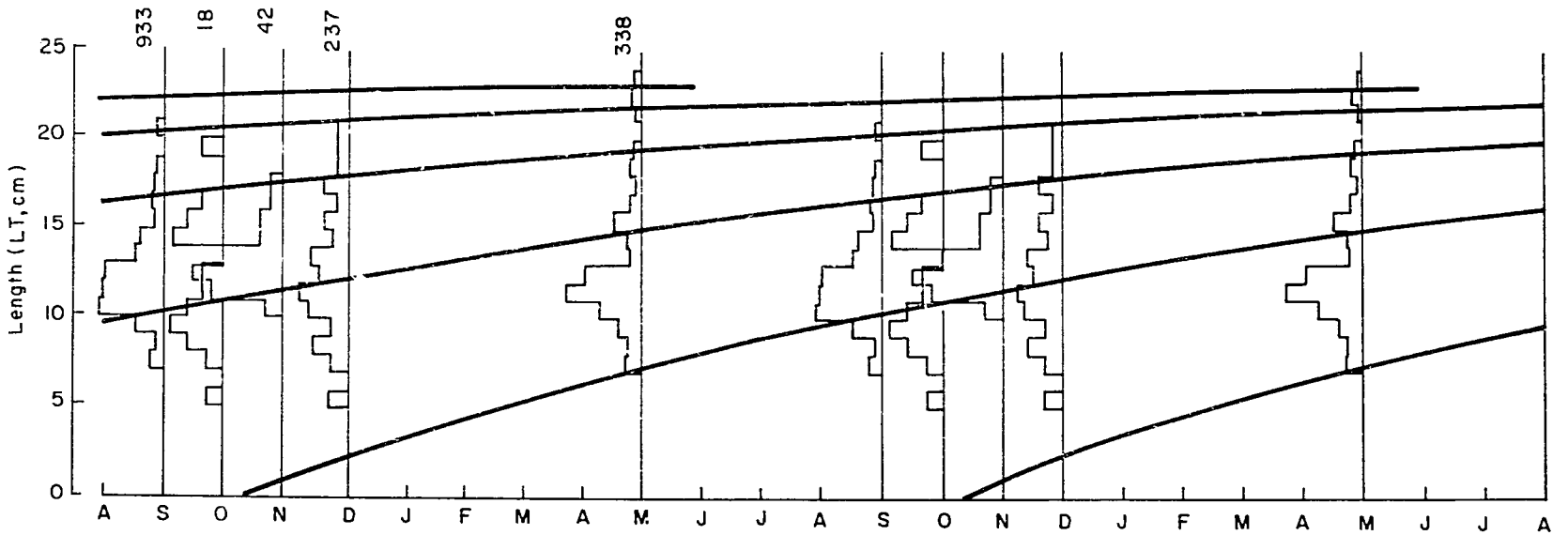


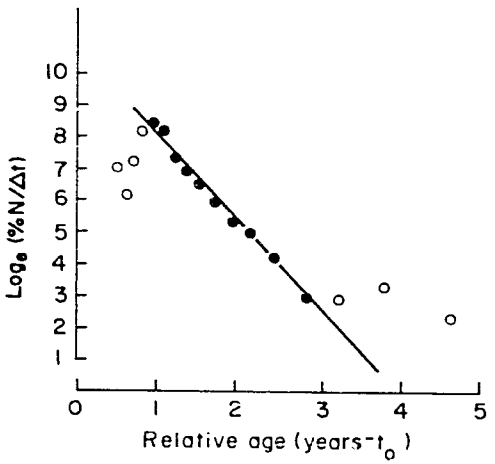
The length-frequency data analyzed here were extracted from R.V. Mutiara-IV survey in the Java Sea. They led to the parameter estimates: L_∞ = 8.30 cm, K = 1.45, L_c = 4.90 cm, Z = 8.86, M = 3.29, F = 5.57, E = 0.63. Annual recruitment probably occurred in the form of two unequal pulses. Data on postlarval stages attributed to this fish have been presented by Nair, R.V. 1952. Studies on some post-larval fishes of Madras plankton. Proc. Indian Acad. Sci. 35B(5): 225-244.

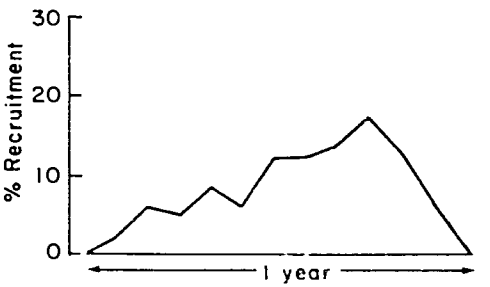
Fam. Nemipteridae
Nemipterus hexodon

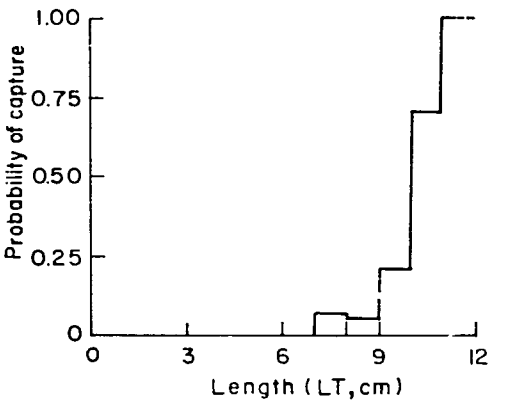
Java Sea (Central and East Java), 1979

Plate 38





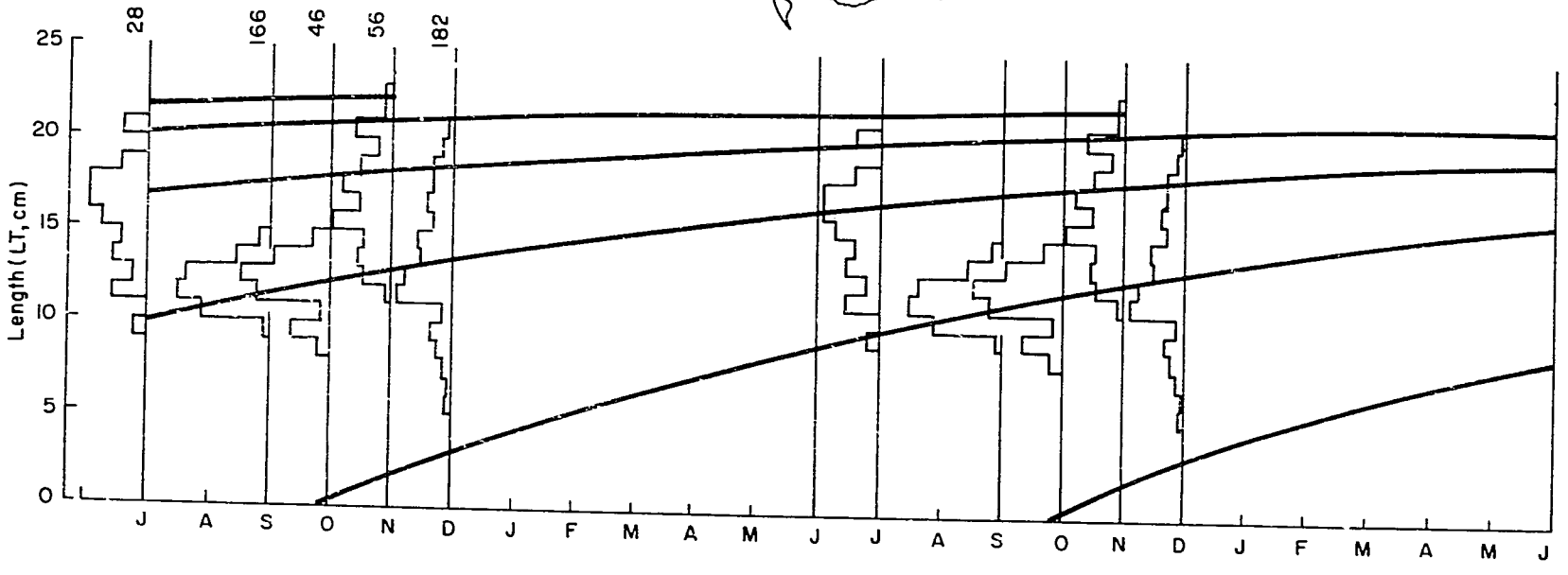


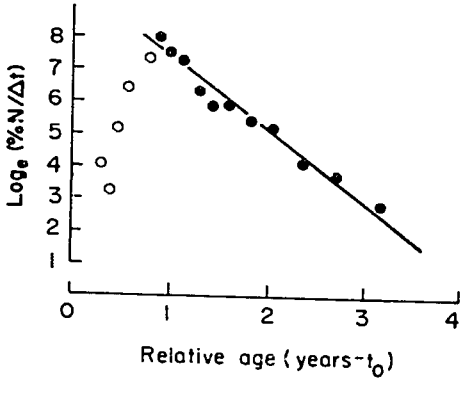


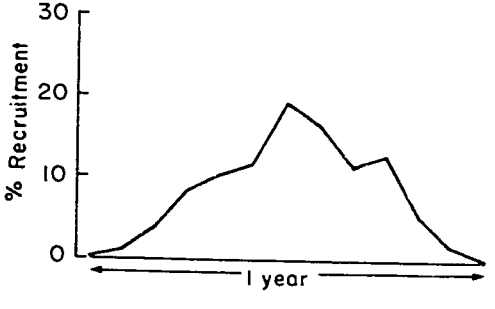
The length-frequency data were collected during the Indonesian-German demersal fisheries projects survey by R.V. Mutiara-IV. The following parameter estimates were obtained: $L_\infty = 24.50$ cm, K = 0.60, $L_c = 10.40$ cm, M = 1.36, F = 1.17, E = 0.46. The available data suggest a very irregular pattern of recruitment, possibly consisting of two events per year. Additional information on this fish can be found in Weber, W. and A.A. Jothy. Undated. Observations on the fish *Nemipterus* spp. (Family: Nemipteridae) in the coastal waters of East Malaysia, 1972. Manuscript with raw data pertaining to paper with same authors and title and published in Arch. FischWiss. 28(2/3): 109-122.

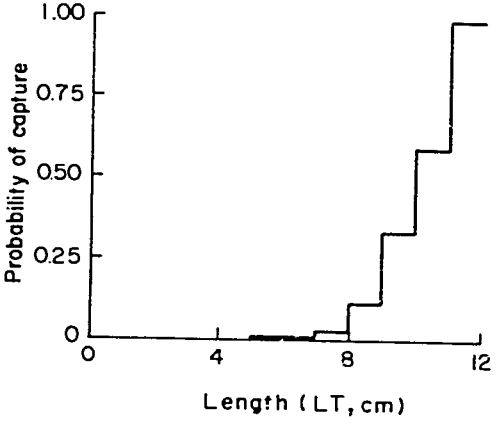
Fam. Nemipteridae
Nemipterus japonicus

Java Sea (Central Java), 1977







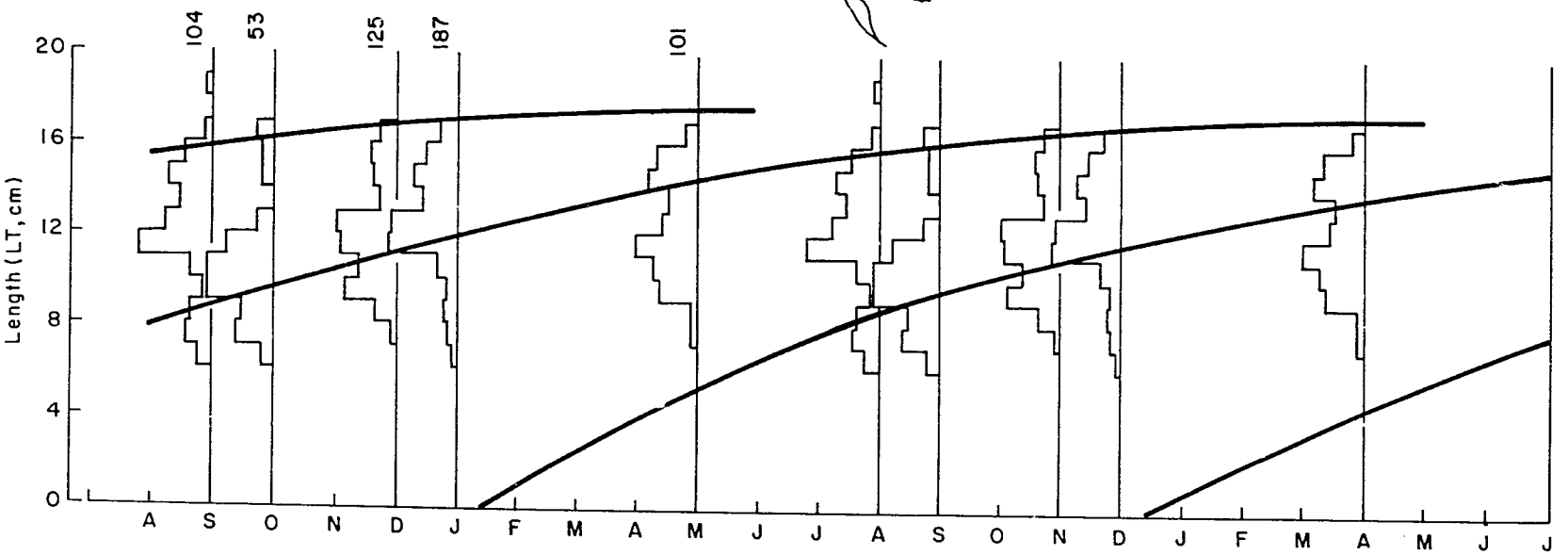


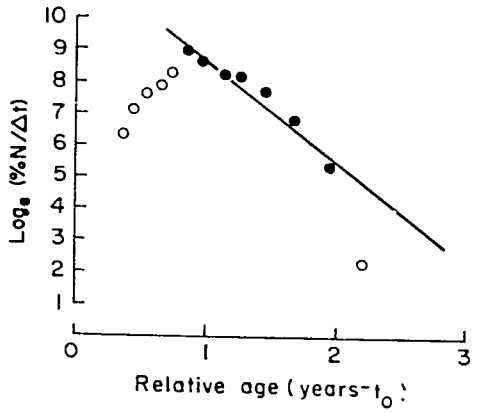
The length-frequency data presented here were extracted from the demersal trawl survey by R.V. Mutiara-IV in 1977. They yielded the following parameter estimates: L_∞ = 23.50 cm, K = 0.70, L_c = 10.43 cm, Z = 2.17, M = 1.53, F = 0.64, E = 0.30. Annual recruitment appears to have consisted of two pulses. The stock of threadfin fish (Fam. Nemipteridae) and some biological aspects of *Nemipterus marginatus* in South China Sea were discussed in the paper of Martusobroto, P. 1977. Paper presented to the National Seminar of Biology, Melang, 7-9 July 1977. Further information on this species may be found in Krishnamoorthi, B. 1971. Biology of the threadfin bream, *Nemipterus japonicus*. Indian J. Fish. 18(1-2): 1-21.

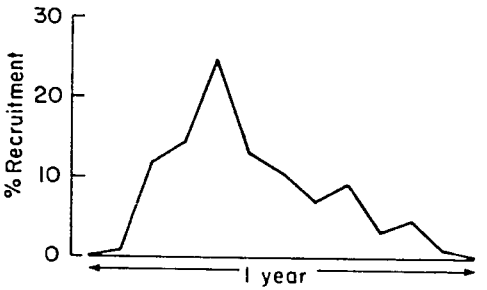
Plate 40

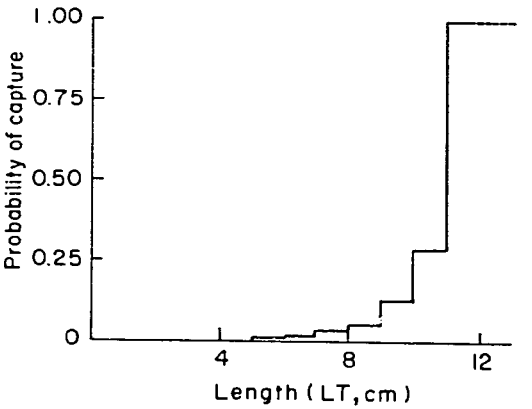
Fam. Nemipteridae
Nemipterus mesoprion

Java Sea (Central Java), 1978-1979







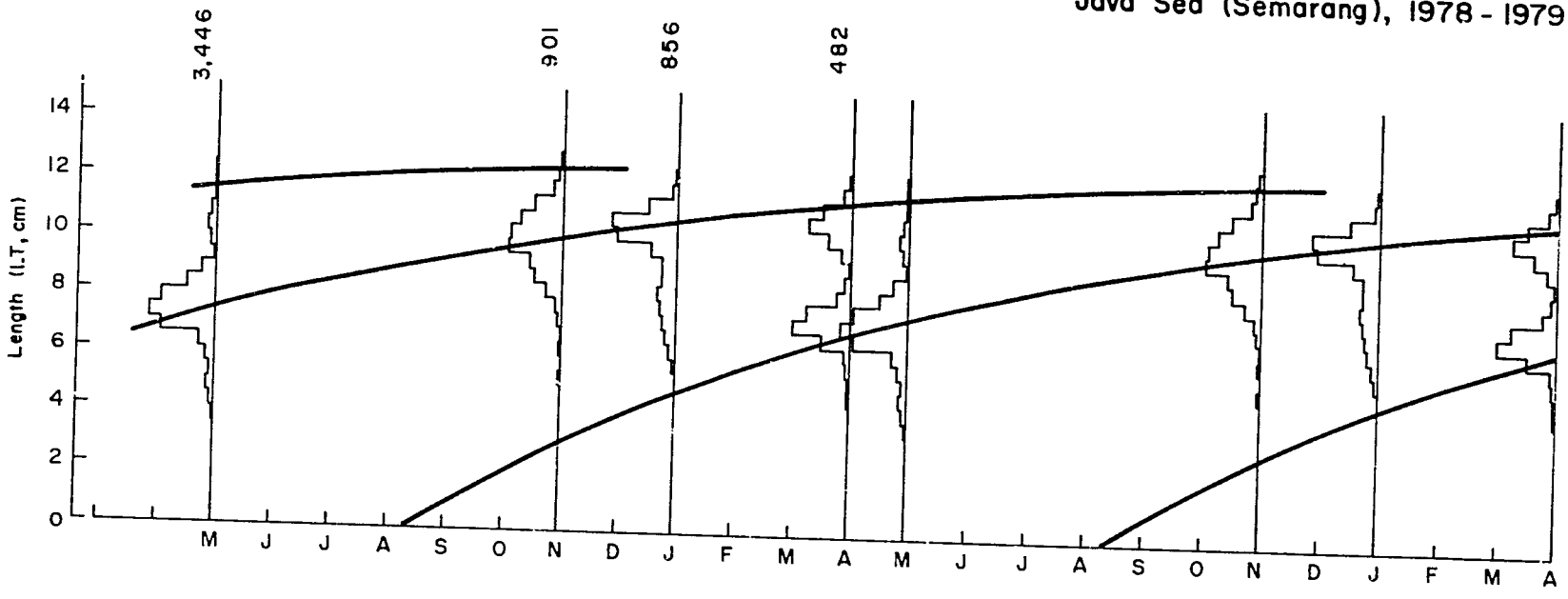


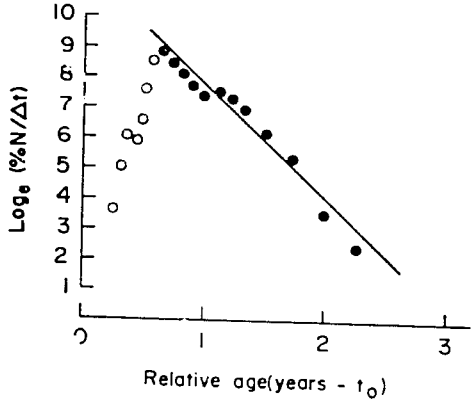
This set of length-frequency data, pertaining to threadfin bream, was obtained from the R.V. Mutiara-IV survey data files (1978). It led to these parameter estimates: L_∞ = 21 5 cm, K = 0.8, L_c = 10.8 cm, Z = 3.25, M = 1.73, F = 1.54, E = 0.47. Recruitment appeared to be irregular. Information on the population dynamics of *Nemipterus marginatus*, a closely related species, can be found in Pauly, D. and P. Martosubroto. 1980. The population dynamics of *Nemipterus marginatus* off Western Kalimantan, South China Sea. J. Fish. Biol. 17: 263-273. Also in Martosubroto, P. 1982. Fishery dynamics of the demersal resources of the Java Sea. Dalhousie University, Canada. Ph.D. thesis (unpublished).

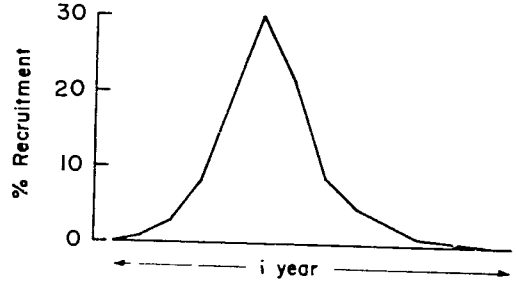
Plate 41

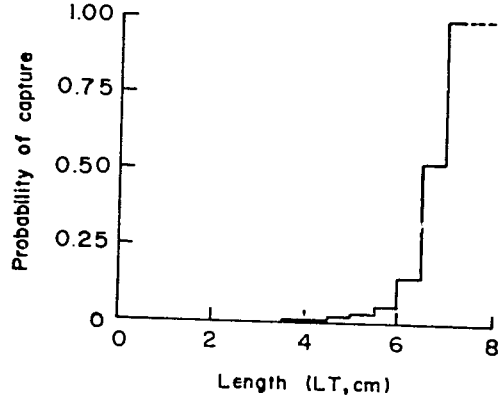
Fam. Gerridae
Pentaprion longimanus

Java Sea (Semarang), 1978 - 1979







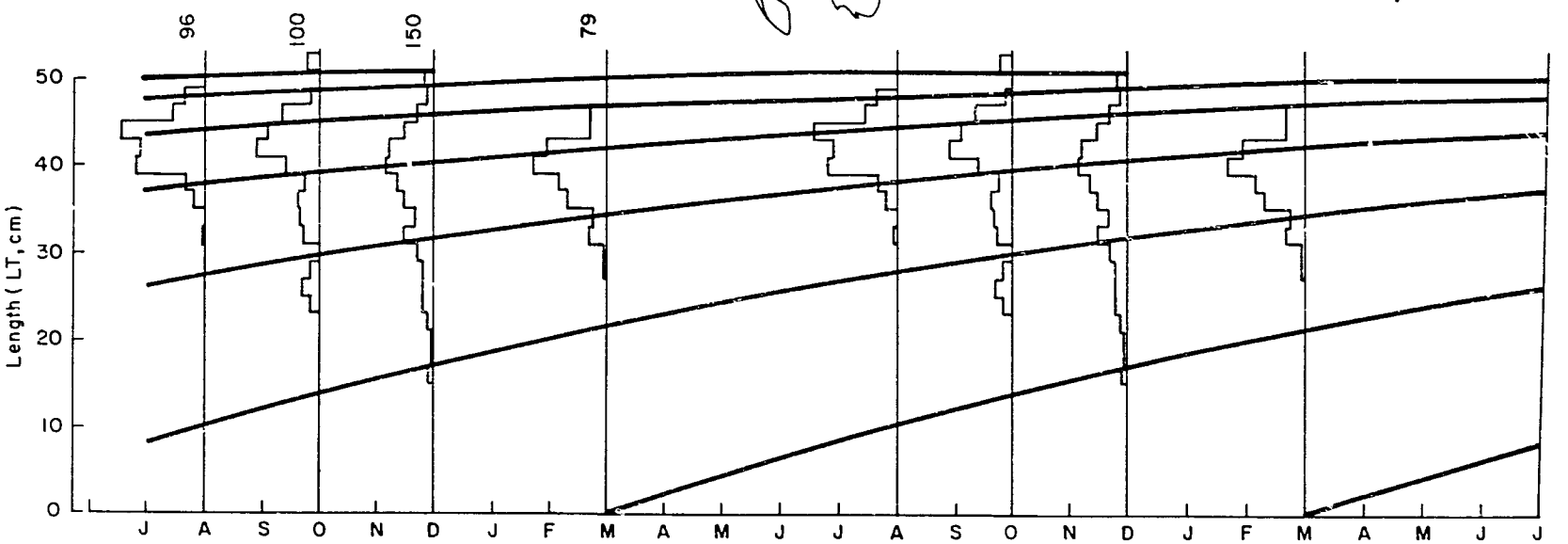


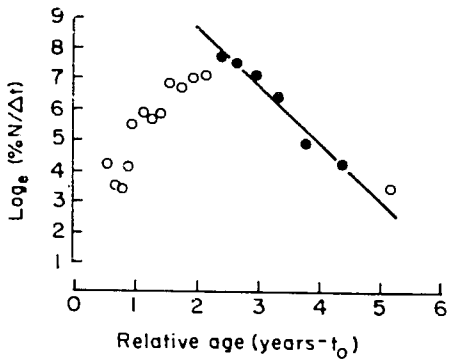
The length-frequency data presented here on silver biddy were obtained from Beck, U. and A. Sudrajat. 1980. Variation in size and composition of demersal trawl catches from the north coast of Java with estimated growth parameters for three important food-fish species. Mar. Fish. Res. Rep. (Spec. Rep.)/Contrib. Demersal Fish. Proj., Jakarta 4: 1-80. They led to parameter estimates: L_∞ = 13.50 cm, K = 1.10, L_c = 6.81 cm, Z = 3.76, M = 2.39, F = 1.36, E = 0.36. Annual recruitment seems to have occurred in a single protracted pulse. Miscellaneous biological data may be found in Badrudin, M. and A. Sudradjat. 1978. On the age, growth and some biological aspects of silver biddy, *Pentaprion longimanus* (Cantor) in the Java Sea. Mar. Fish. Res. Rep. (1): 63-78 and in Bambang Sadhotomo and B. Sumiono. 1983. The dynamics of trevally, *Pentaprion longimanus* at Java Sea, Jakarta. Mar. Res. Rep. (28): 81-88. (In Indonesian with English abstract).

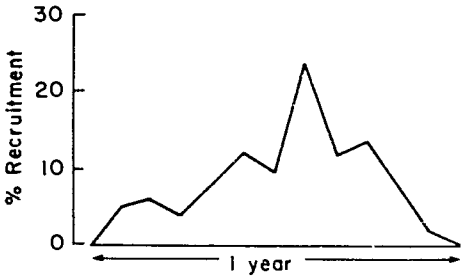
Plate 42

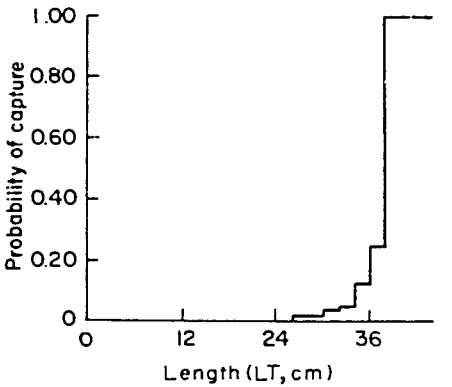
Fam. Pomadasyidae
Pomadasys hasta

Java Sea (Tanjung Selatan, South Kalimantan), 1977-1978





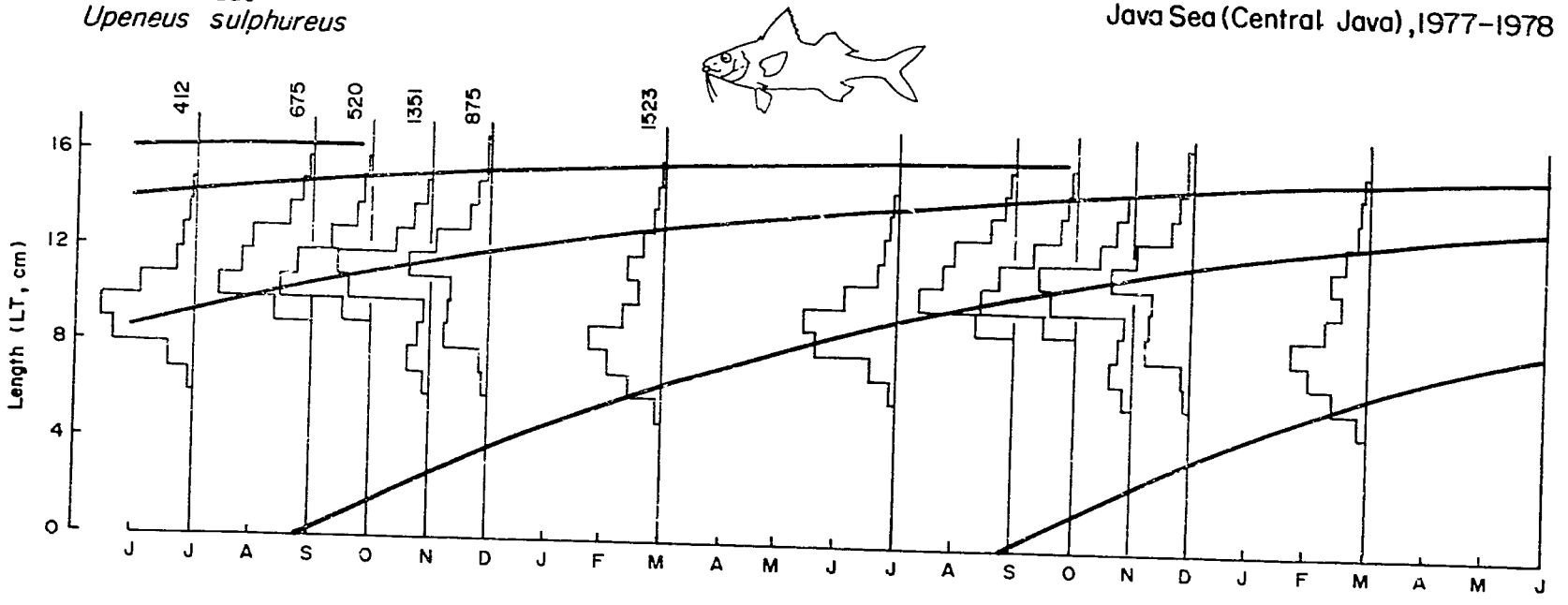


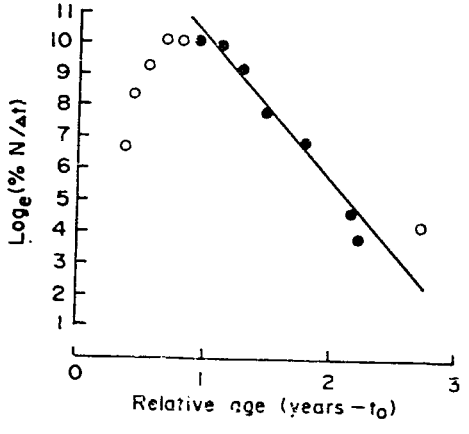


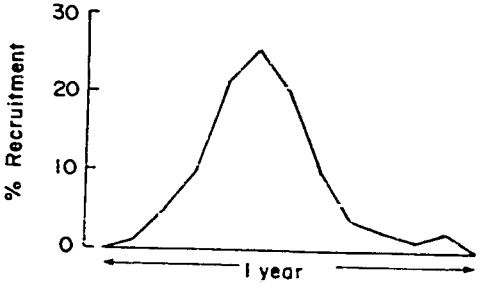
The length-frequency data on silver grunt presented here were extracted from the R.V. Mutiara survey data files, 1977-1978; from these data, the following parameter estimates were obtained: L_∞ = 54.00 cm, K = 0.50, L_c = 37.40 cm, Z = 1.94, M = 0.97, F = 0.97, E = 0.50. Annual recruitment probably consisted of two pulses of unequal strength. Information on the catch rate and species composition of big specimens of *Pcmadasys hasta* in the south coast of Kalimantan waters may be found in Dwiponggo, A. and M. Badrudin. 1978. Demersal resources survey in coastal areas of the Java Sea, 1977. RIMF. Spec. Rep. (5): 1-14.

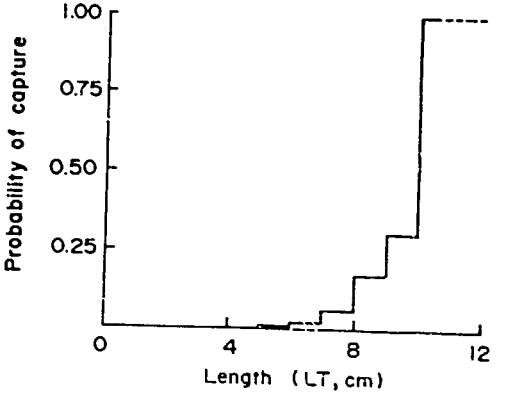
Fam. Mullidae
Upeneus sulphureus

Java Sea (Central Java), 1977–1978







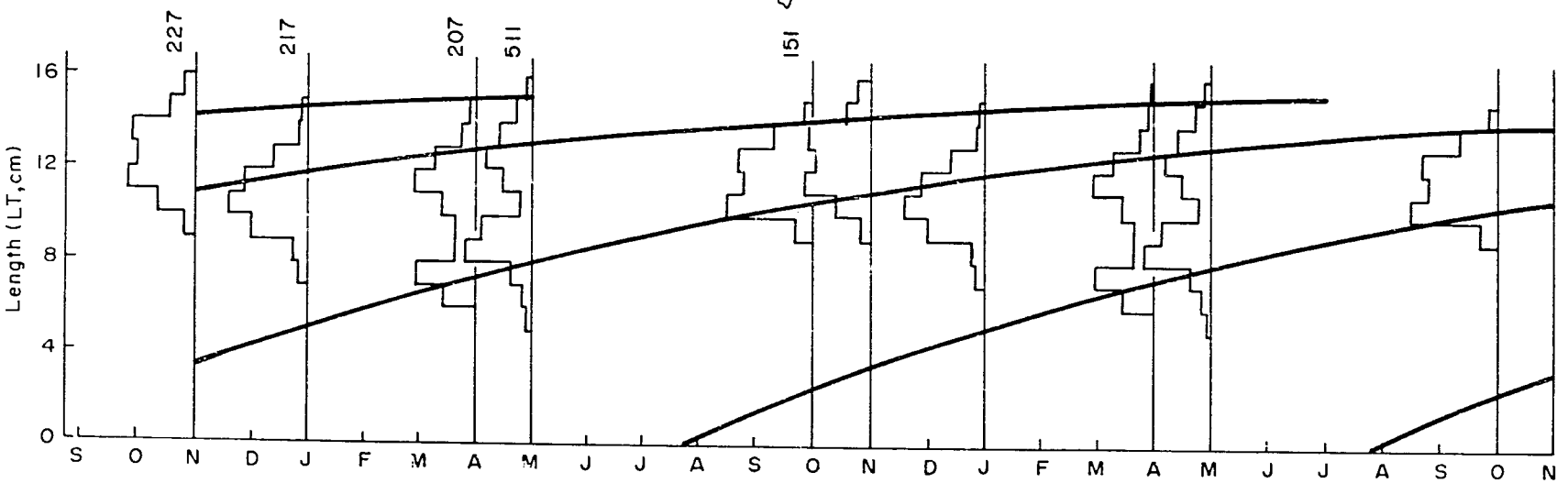


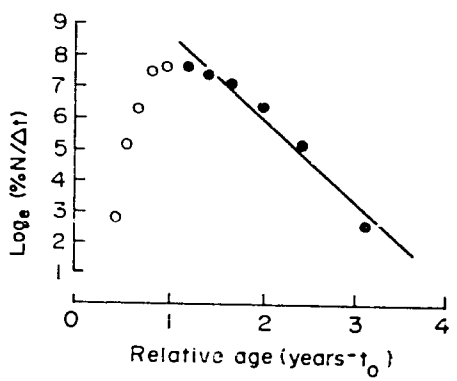
The set of length-frequency data presented here was collected during the R.V. Mutiara-IV survey in the Java Sea in 1977-1978, and led to the following estimates: L_∞ = 17.50 cm, K = 0.90, L_c = 9.72 cm, Z = 4.52, M = 1.95, F = 2.57, E = 0.57. The available data suggest a pattern of recruitment consisting of two unequal events per year. Stock abundance and some biological aspects of goat fish in the offshore waters of Java are given in Badrudin, M. 1978; paper presented to the "Simposium Modernisasi Perikanan Rakyat," held in Jakarta, 27-30 June 1978. Report No. 43. (in Indonesian).

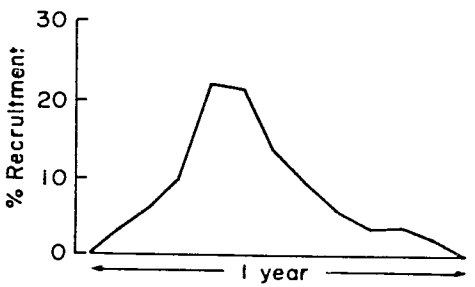
Plate 44

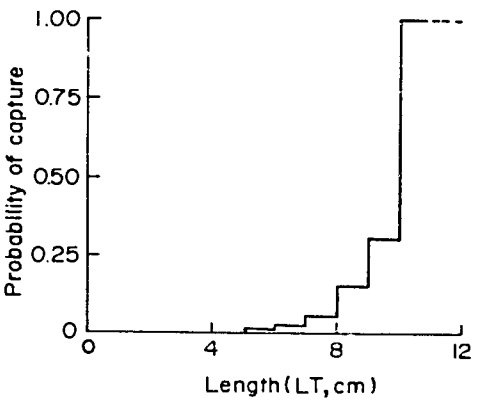
Fam. Mullidae
Upeneus sulphureus

Java Sea (Central Java), 1978-1979



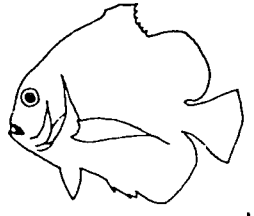




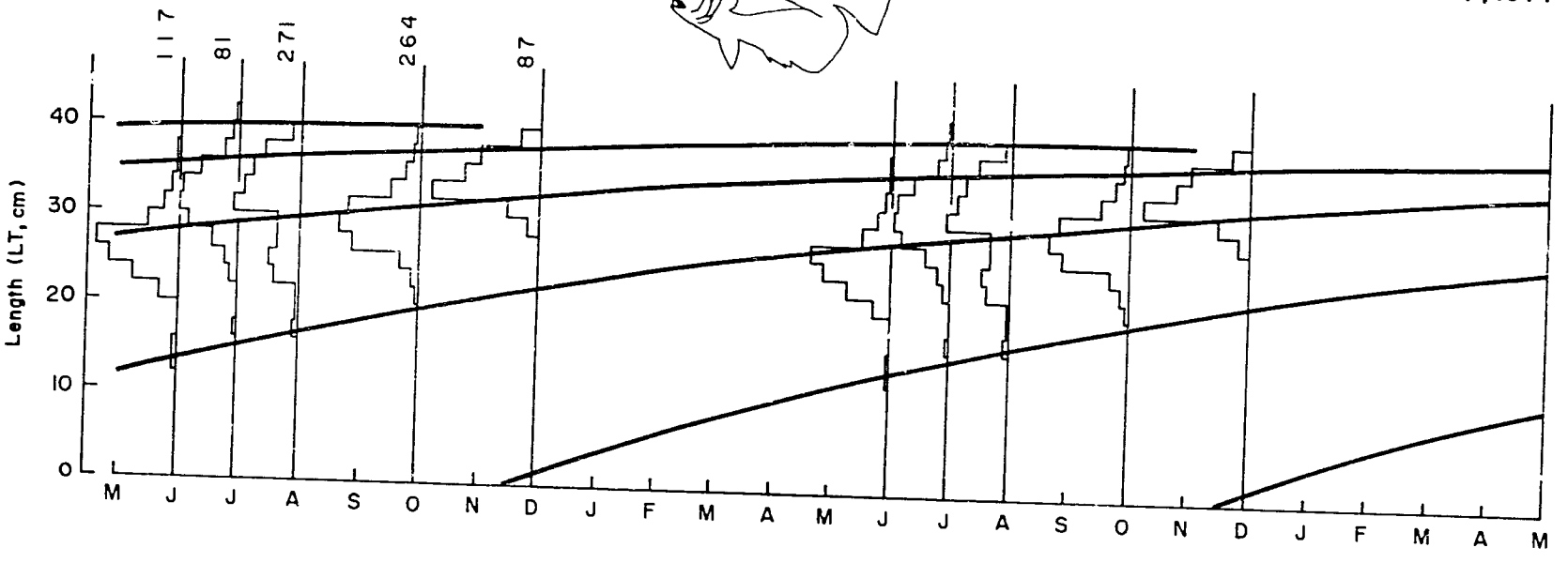


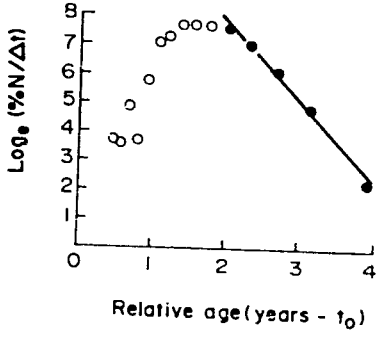
The set of length-frequency data on goat fish used here was obtained from the trawl survey by R.V. Mutiara-IV in the north coast of Central Java. It suggests the statistics: L_∞ = 16.50 cm, K = 0.78, L_c = 9.74 cm, Z = 2.71, M = 1.80, F = 0.91, E = 0.34. Annual recruitment consisted of two seasonal pulses, one stronger than the other. Details may be found in Martosubroto, P. 1972. Fishery dynamics of the demersal resources of the Java Sea. Dalhousie University, Canada. Ph.D. Thesis (unpublished).

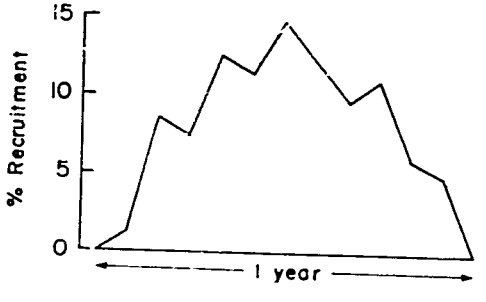
Fam. Drepanidae
Drepane punctata

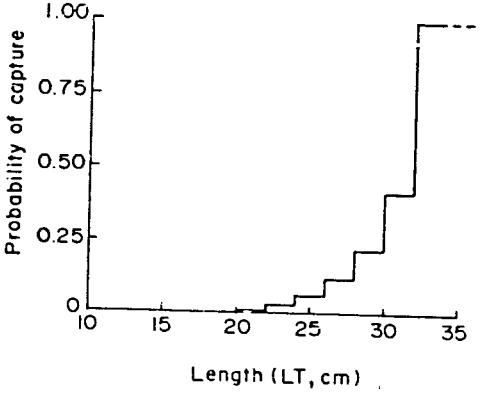


Java Sea (South Kalimantan), 1977





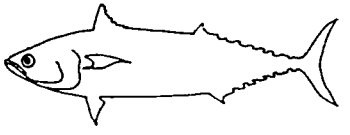




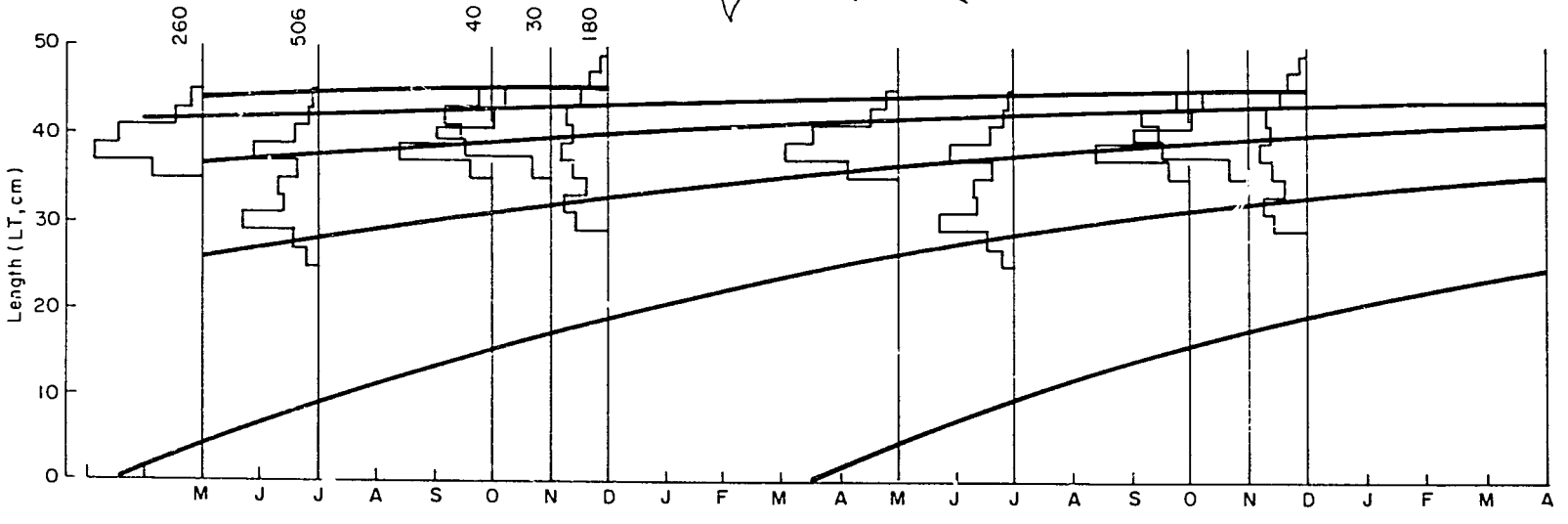
This set of length-frequency data on *Drepane punctata* was extracted from the files of Mutiara-IV survey data (1977). The following parameter values were estimated from these data: L_∞ = 43.00 cm, K = 0.68, L_c = 30.28, Z = 2.68, M = 1.26, F = 1.42, E = 0.53. The shape of recruitment pattern does not allow for definite conclusions to be drawn on the seasonality of recruitment. Additional information on the distribution and seasonal changes of catch rates of spotted sickle fish is given by Dwiponggo, A. and M. Badrudin. 1980. Result of the Java Sea inshore monitoring survey, 1979. RIMF. Spec. Rep. (7): 1-31.

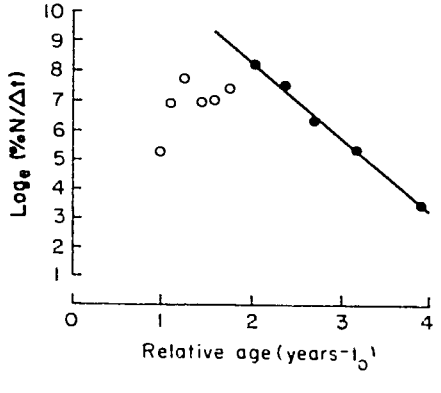
Plate 46

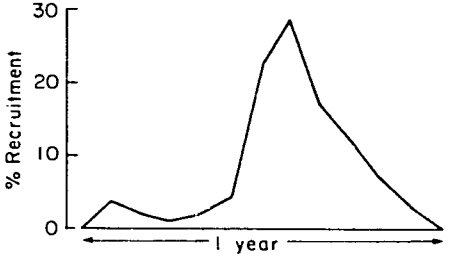
Fam. Scombridae
Auxis thazard

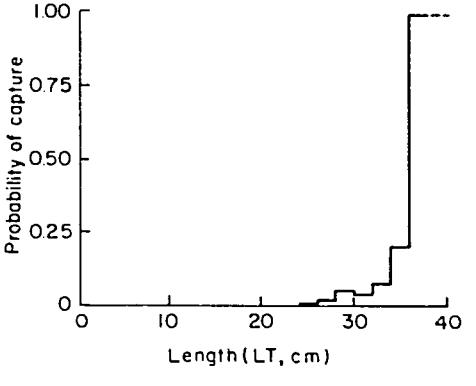


Indian Ocean (Pelabuhan Ratu, West Java), 1980





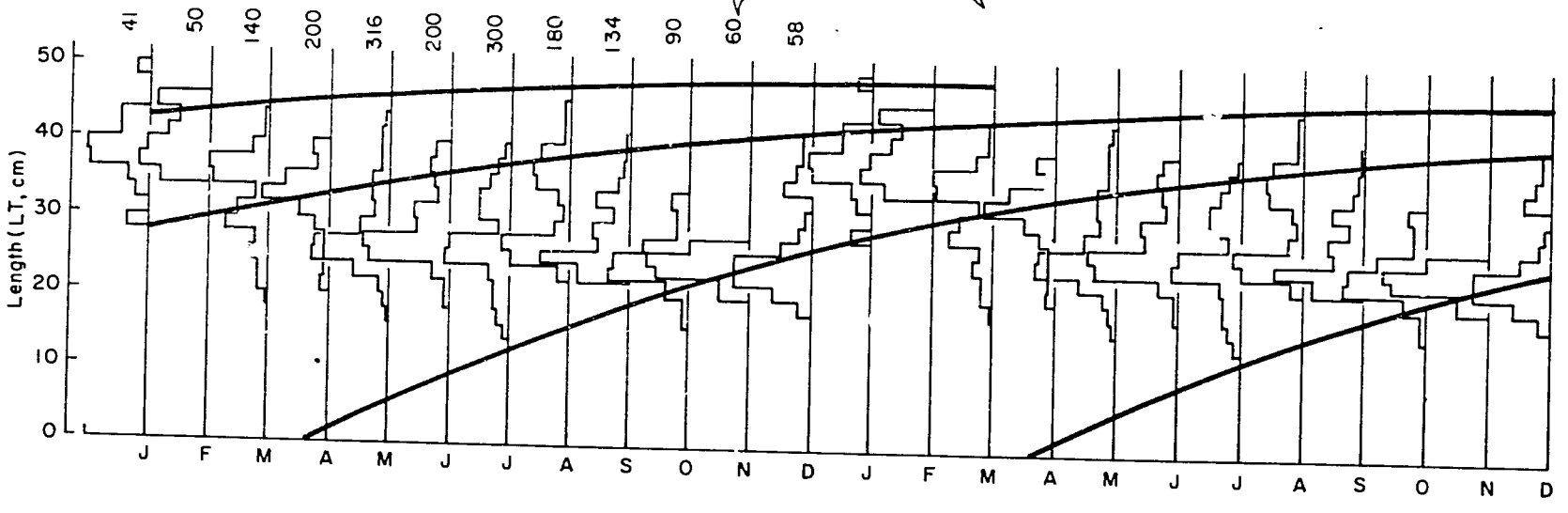


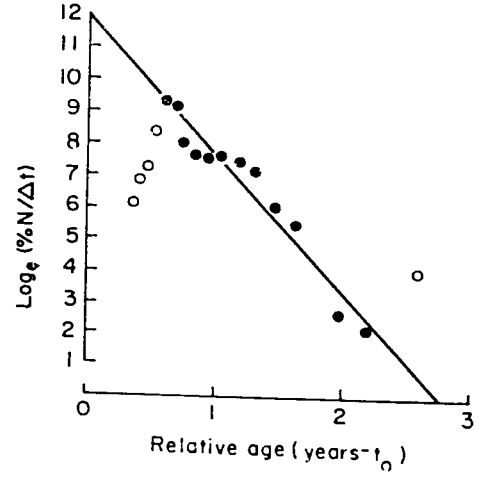


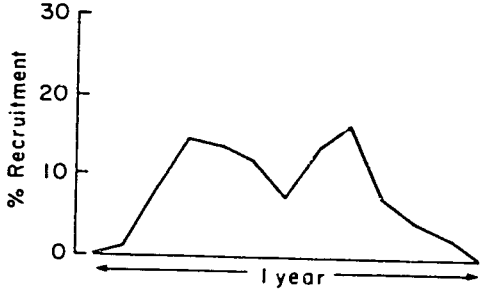
The length-frequency data used here were collected by J.C.B. Uktolseya, 1980. From these, the following parameter estimates were obtained: L_∞ = 47.50 cm, K = 0.70, L_c = 35.59 cm, Z = 2.59, M = 1.25, F = 1.34, E = 0.52. Annual recruitment appears to have consisted of two unequal pulses. Additional information on this fish may be found in Sivasubramaniam, K. 1973. Co-occurrence and relative abundance of narrow and broad corselleted frigate mackerel: *Auxis thazard* (Lacépède) and *Auxis rochei* (Risso) around Ceylon, p. 537-547. *In* Proceedings of the Symposium on Living Resources of Seas around India. Spec. Publ. Cen. Mar. Fish. Res. Inst. Cochin. 784 p.

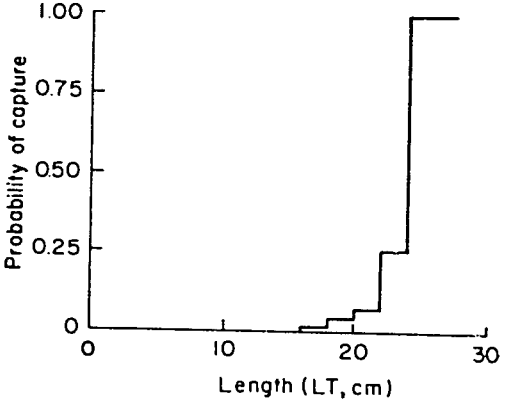
Fam. Scombridae
Auxis thazard

Indian Ocean (Pelabuhan Ratu, West Java), 1981







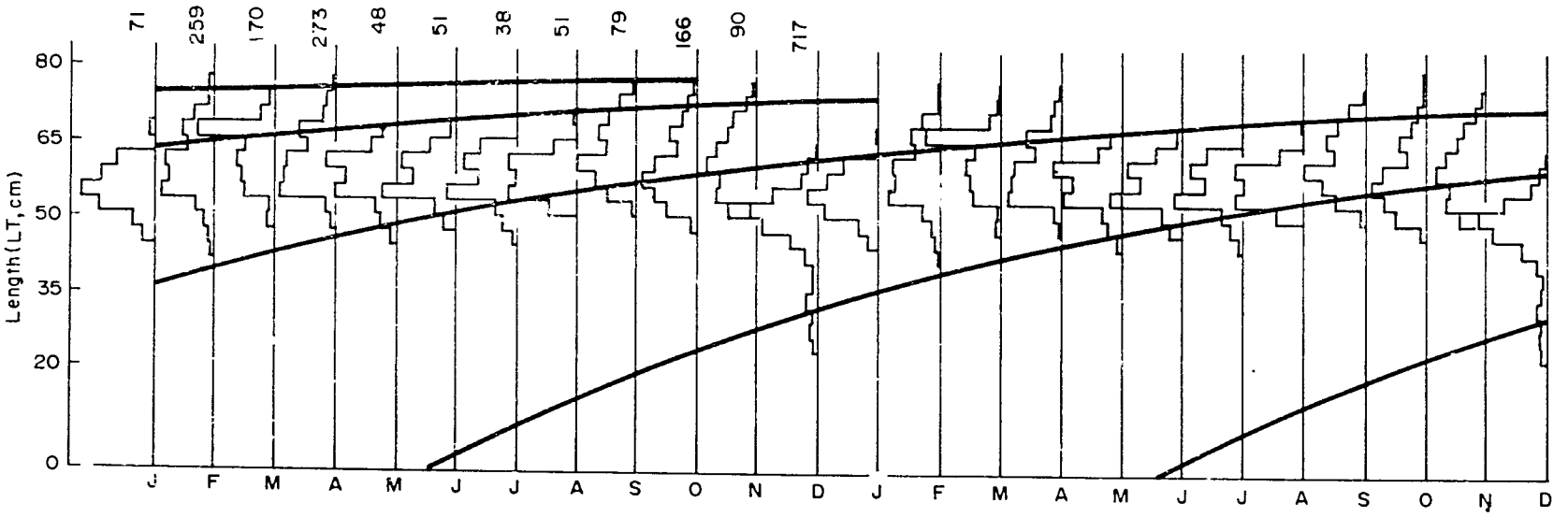


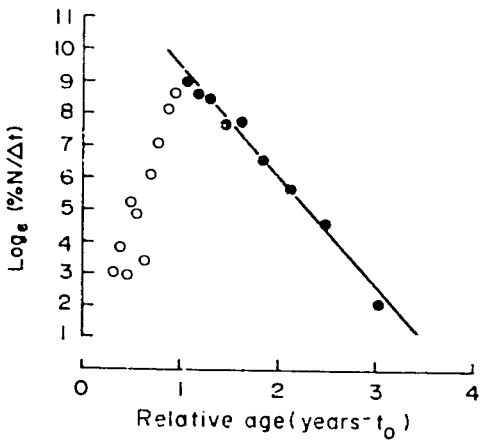
The length-frequency data presented here were compiled by J.C.B. Uktolseya in 1981 in the eastern Indonesian waters. The data yielded the following parameter estimates: L_∞ = 51.50 cm, K = 1.00, L_c = 23.60 cm, Z = 4.03, M = 1.55, F = 2.86, E = 0.71. Annual recruitment occurred in two well-separated pulses. Additional information on the biology of this fish can be found in Haryanto, S. 1980. Length-weight relationship, gonad maturity and fecundity of *Auxis thazard*, caught by gillnets and landed at Bondo, Jepara, in May-July 1980. University of Diponegoro, Semarang. 47 p. M.Sc. thesis. (Unpublished) (In Indonesian).

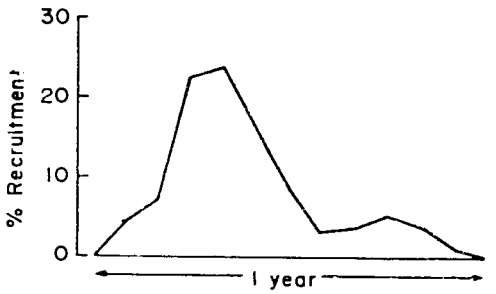
Plate 48

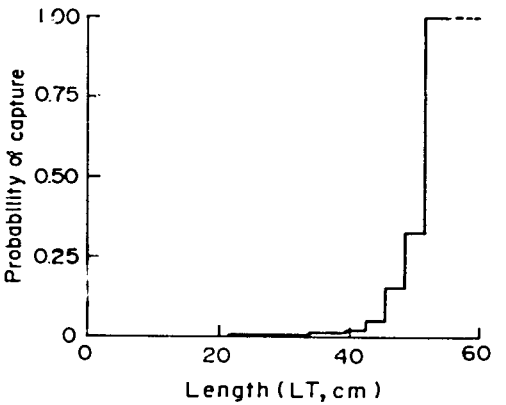
Fam. Scombridae
Katsuwonus pelamis

West Pacific (Sorong, Irian), 1978







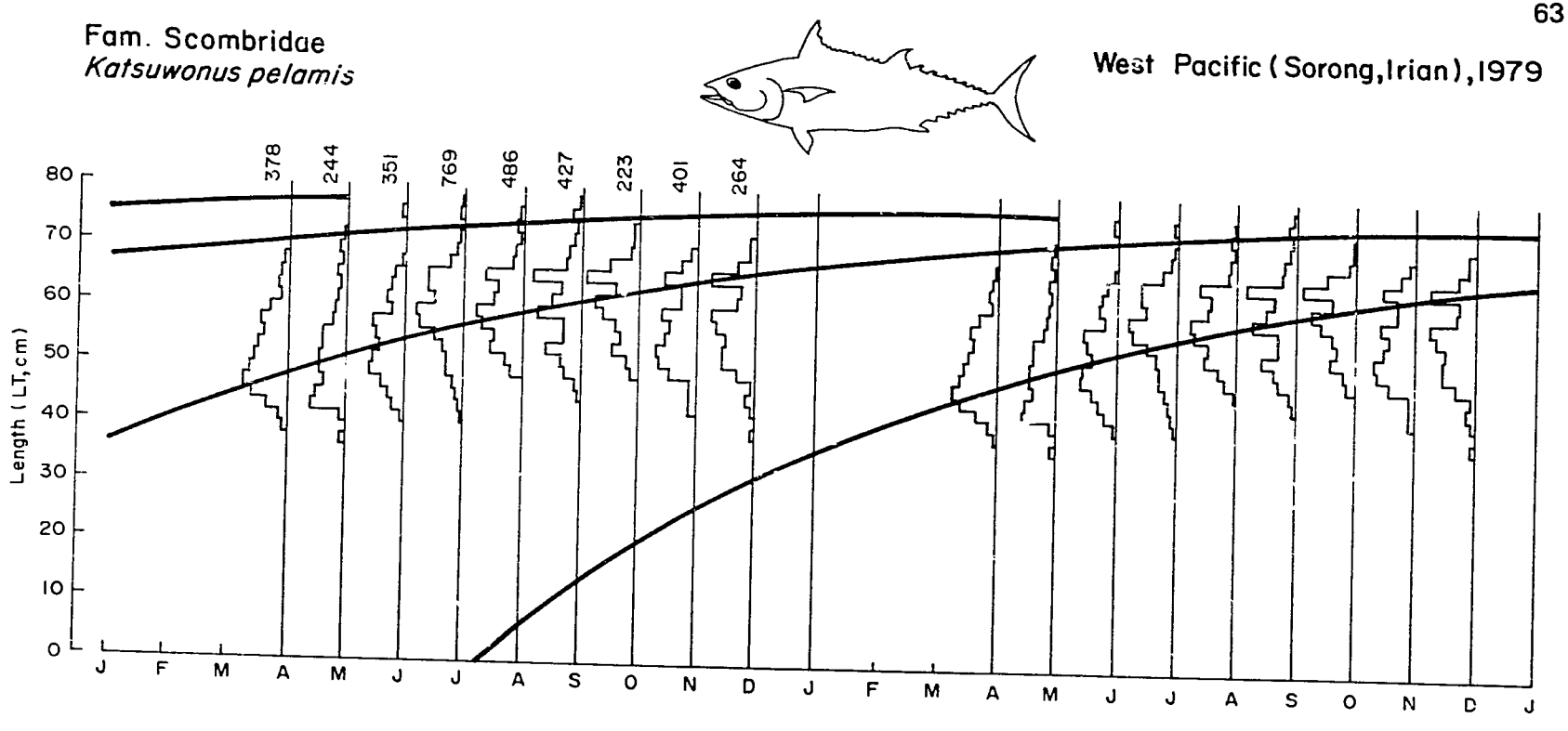


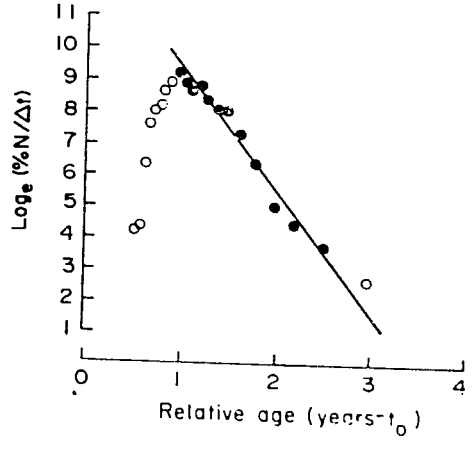
The length-frequency data analyzed here were collected by J.C.B. Uktolseya in the eastern Indonesian waters in 1979. From these the following parameter values were estimated: L_∞ = 80.00 cm, K = 0.95, L_c = 50.68 cm, Z = 3.49, M = 1.32, F = 2.16, E = 0.62. Annual recruitment clearly consisted of two distinct events of unequal magnitude. The present status of tuna fisheries including skipjack fisheries has been presented by Uktolseya, J.C.B. and I.S. Merta. 1984. Recent developments of Indonesian tuna fisheries. Paper presented to the Ad-hoc Workshop on the Stock Assessment of Tuna in the Indo-Pacific Region, Jakarta, 20-22 August 1984. 17 p. (Mimeo).

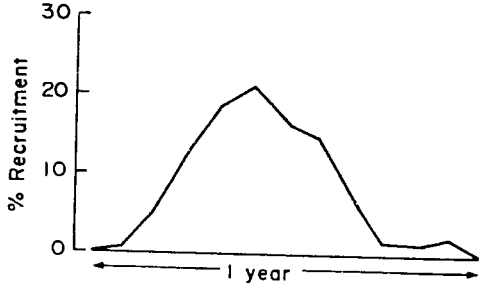
Plate 49

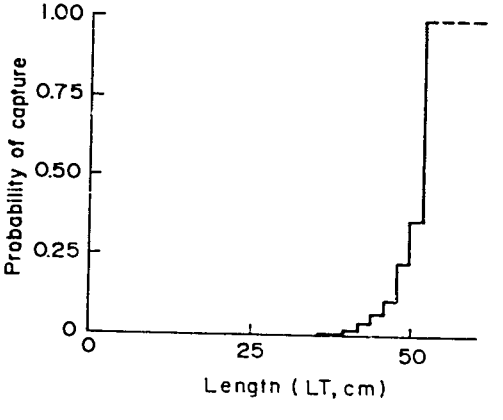
Fam. Scombridae
Katsuwonus pelamis

West Pacific (Sorong, Irian), 1979





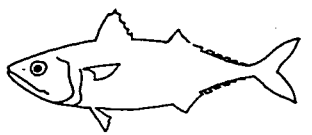




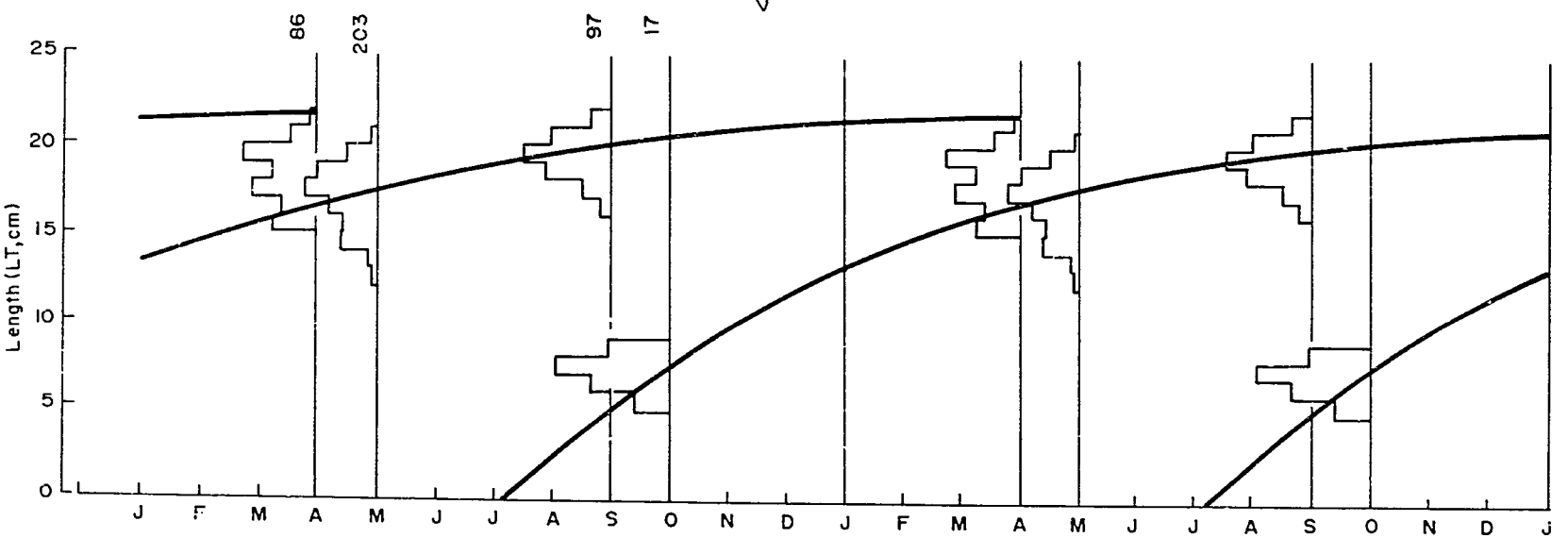
This set of data on skipjack was obtained from Mr. J.C.B. Uktolseya, 1978, raw data files. The following parameter values were estimated: L_∞ = 79.00 cm, K = 1.10, L_c = 51.20 cm, Z = 3.95, M = 1.46, F = 2.52, E = 0.64. Annual recruitment seems to have occurred in the form of two pulses, one much stronger than the other. Some aspects of the biology of *Katsuwonus pelamis* can be found in Merta, I.S. 1983. Preliminary study on food habits and gonad maturity of skipjack, *Katsuwonus pelamis* (Linnaeus 1758), caught off south of Bali and West Sumatra waters. RIMF Jakarta Mar. Res. Rep. 27: 69-74.

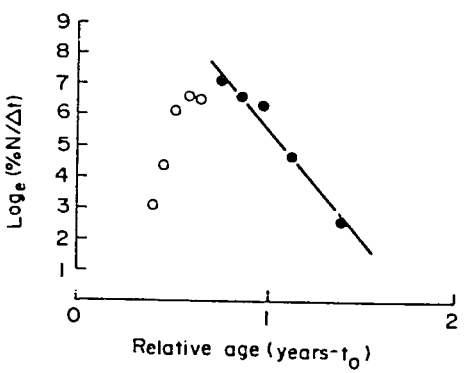
Plate 50

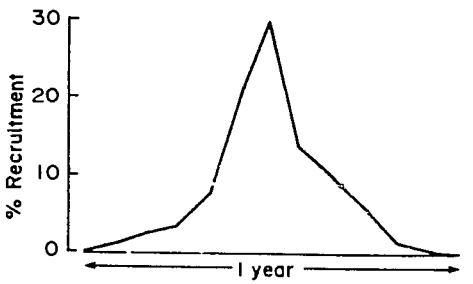
Fam. Scombridae
Rastrelliger brachysoma

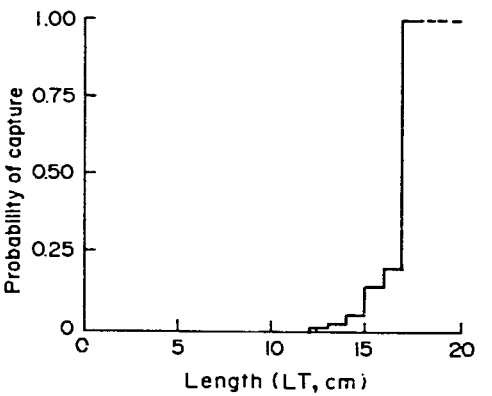


Java Sea (Central Java), 1979





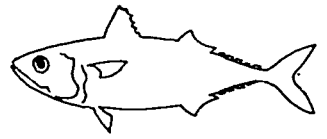




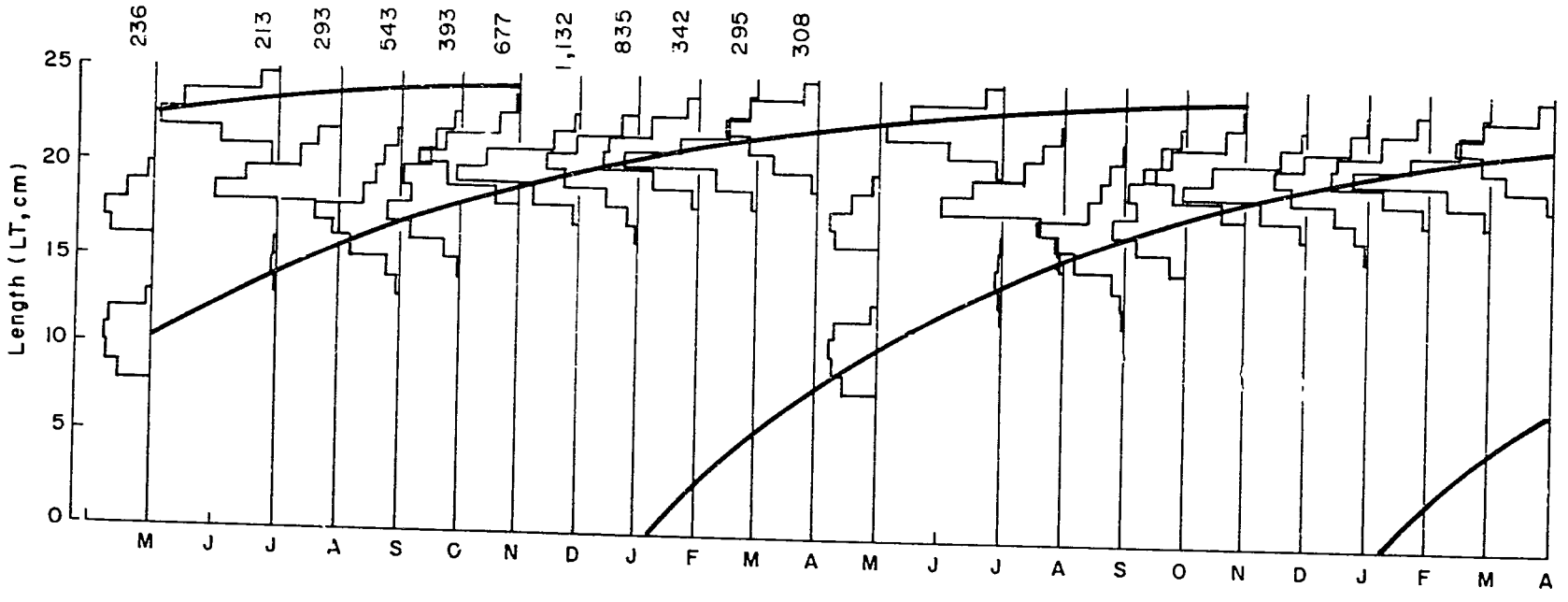
The length-frequency data of chub mackerel used here were obtained from R.V. Mutiara-IV survey data files, 1979. The estimated parameter values obtained were: L_∞ = 22.90 cm, K = 1.80, L_c = 16.80 cm, Z = 7.40, M = 2.93, F = 4.57, E = 0.62. Annual recruitment appears to have consisted of one major pulse. The population dynamics of *R. brachysoma* (= *R. neglectus*) (in the Gulf of Thailand) has been given by Hongskul, V. 1972. Population dynamics of pla-tu *(Rastrelliger neglectus)* in the Gulf of Thailand. Proc. Indo-Pac. Fish. Counc. 15(3): 297-350.

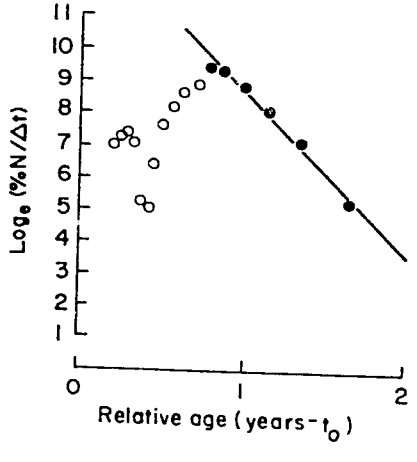
Plate 51

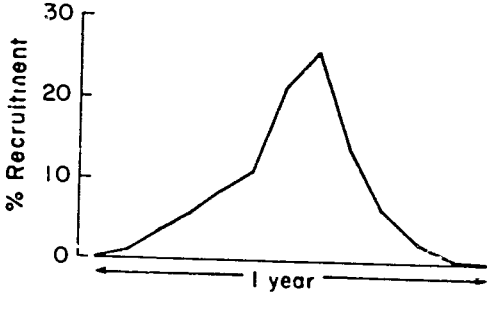
Fam. Scombridae
Rastrelliger kanagurta

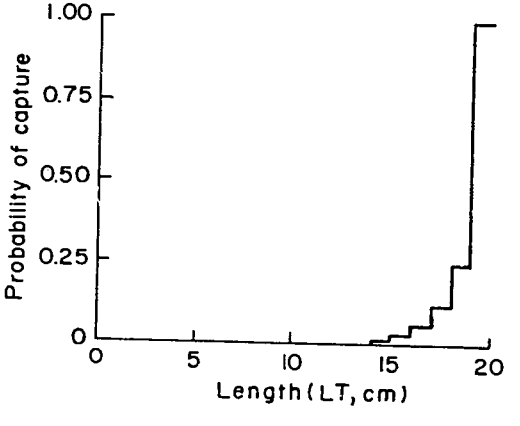


Java Sea (Pekalongan), 1982-1983







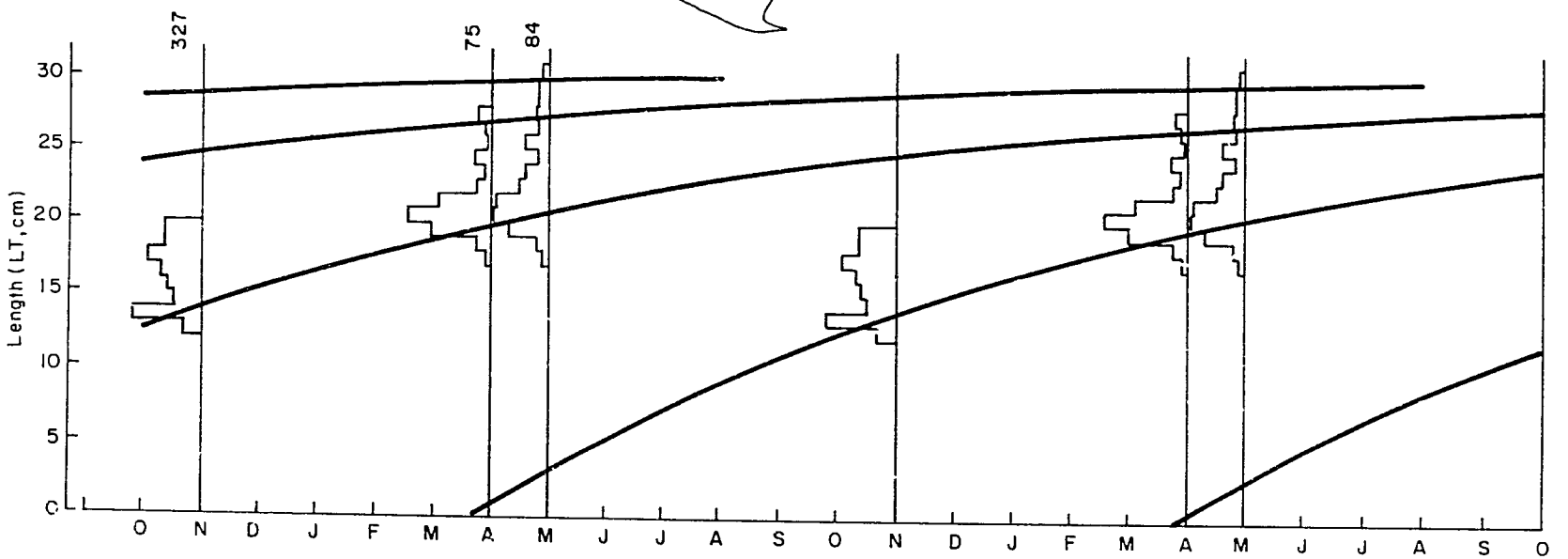


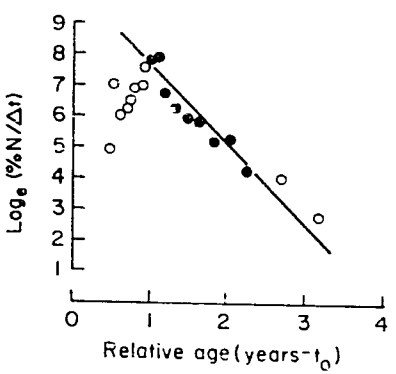
The set of length-frequency data on chub mackerel presented here was collected by G. Tampubolon and B. Suherman in the north coast of Central Java and led to the following parameter estimates: L_∞ = 25.80 cm, K = 1.63, L_c = 18.77 cm, Z = 5.08, M = 2.58, F = 2.50, E = 0.49. Annual recruitment appears to have consisted of a single event. Various aspects of the biology and population dynamics of chub mackerel *(Rastrelliger kanagurta* and *R. brachysoma)* are presented in Sujastani, T. 1974. Population dynamics of chub mackerel in Java Sea. RIMF. Mar. Res. Rep. (7): 30-64. Gafa, B. 1982. Some biological aspects of the "Kembung lelaki" *(Rastrelliger kanagurta)* of the Makasar Strait, RIMF. Mar. Res. Rep. 23: 91-95. (In Indonesian); and Susanto, V. 1961. Some problems of fisheries research with special reference to the *Rastrelliger* fishery. Proc. Indo-Pac. Fish. Counc. 9(3): 71-18.

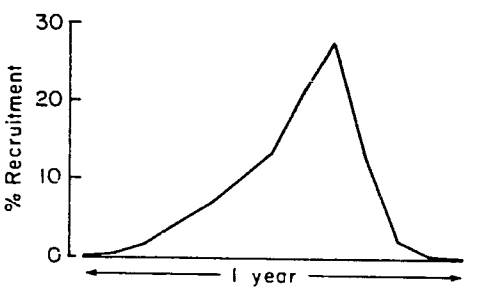
Plate 52

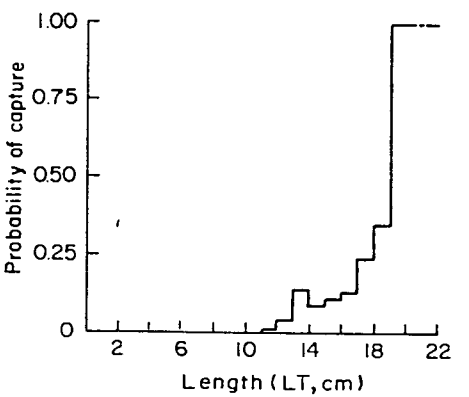
Fam. Stromateidae
Pampus argenteus

Java Sea (Central Java), 1978-1979



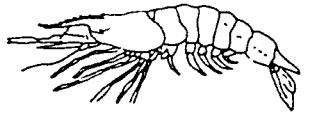


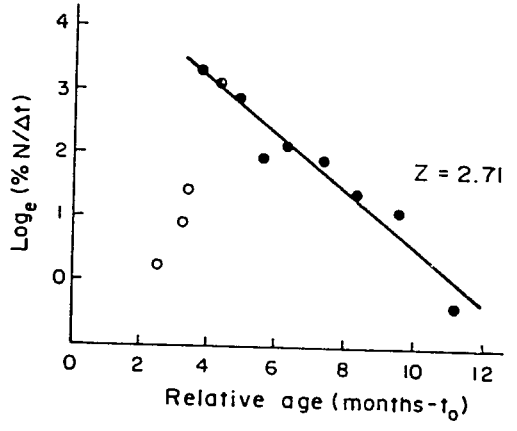


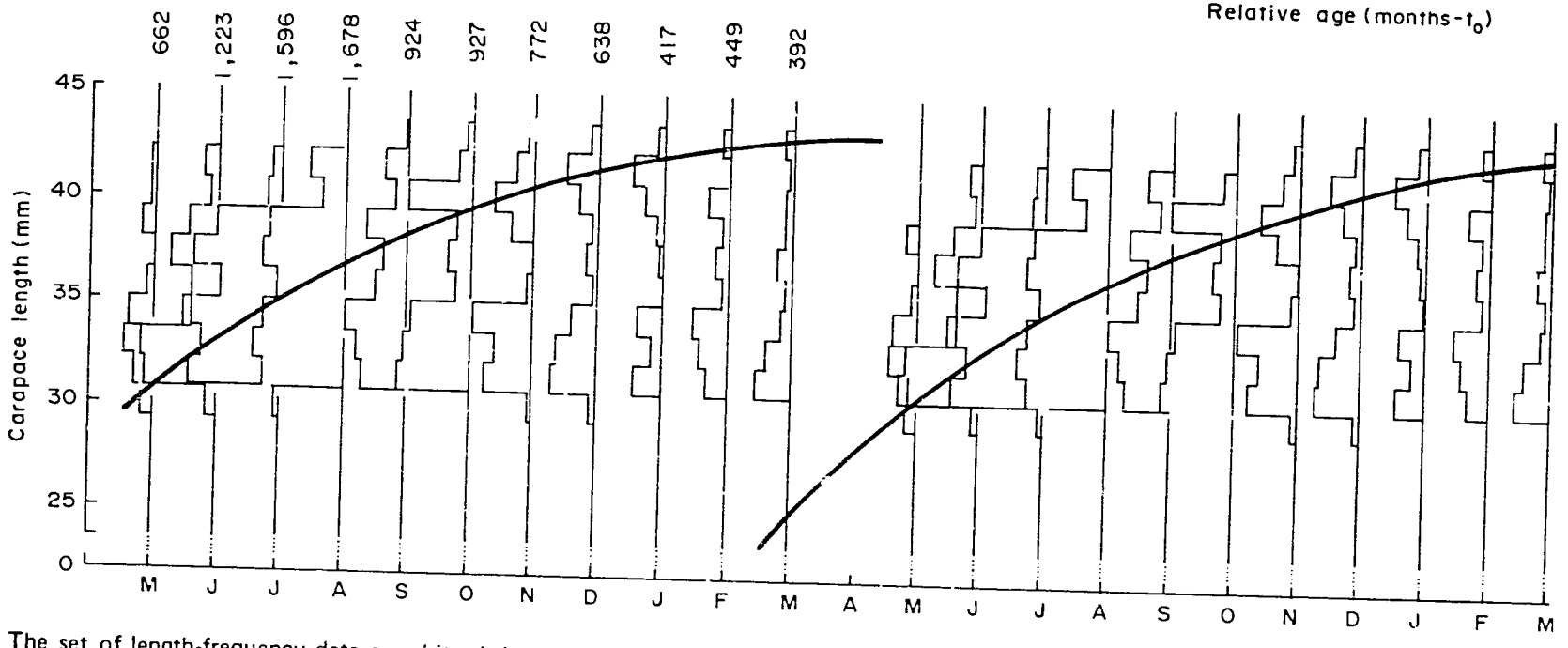


The source of the length-frequency data on silver pomfret *(Pampus argenteus)* presented here is Dwiponggo, A. and M. Badrudin. 1980. Length-frequency measurements of demersal fish. Contribution of the Demersal Fisheries Project, RIMF Spec. Rep. (7b): 1-94. The parameter estimates are: L_∞ = 31.50 cm, K = 0.95, L_c = 19.00 cm, Z = 2.60, M = 1.72, F = 0.88, E = 0.34. Annual recruitment appears to have occurred in the form of a single protracted pulse. Further data on the growth and mortality of this fish may be found in Morgan, G.R. 1985. Stock assessment of the pomfret *(Pampus argenteus)* in Kuwaiti waters. J. Cons. CIEM 4(2): 3-10.

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea , 1969



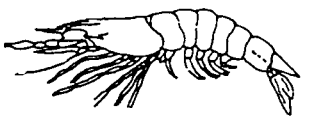


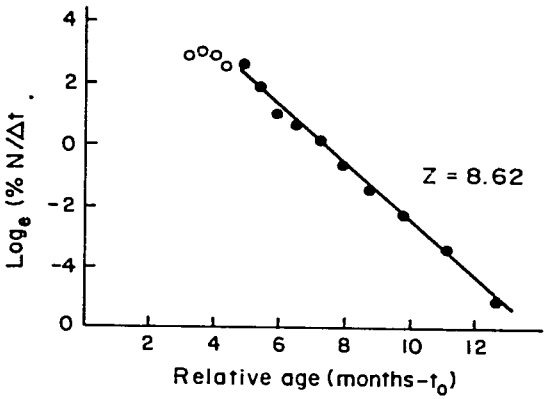


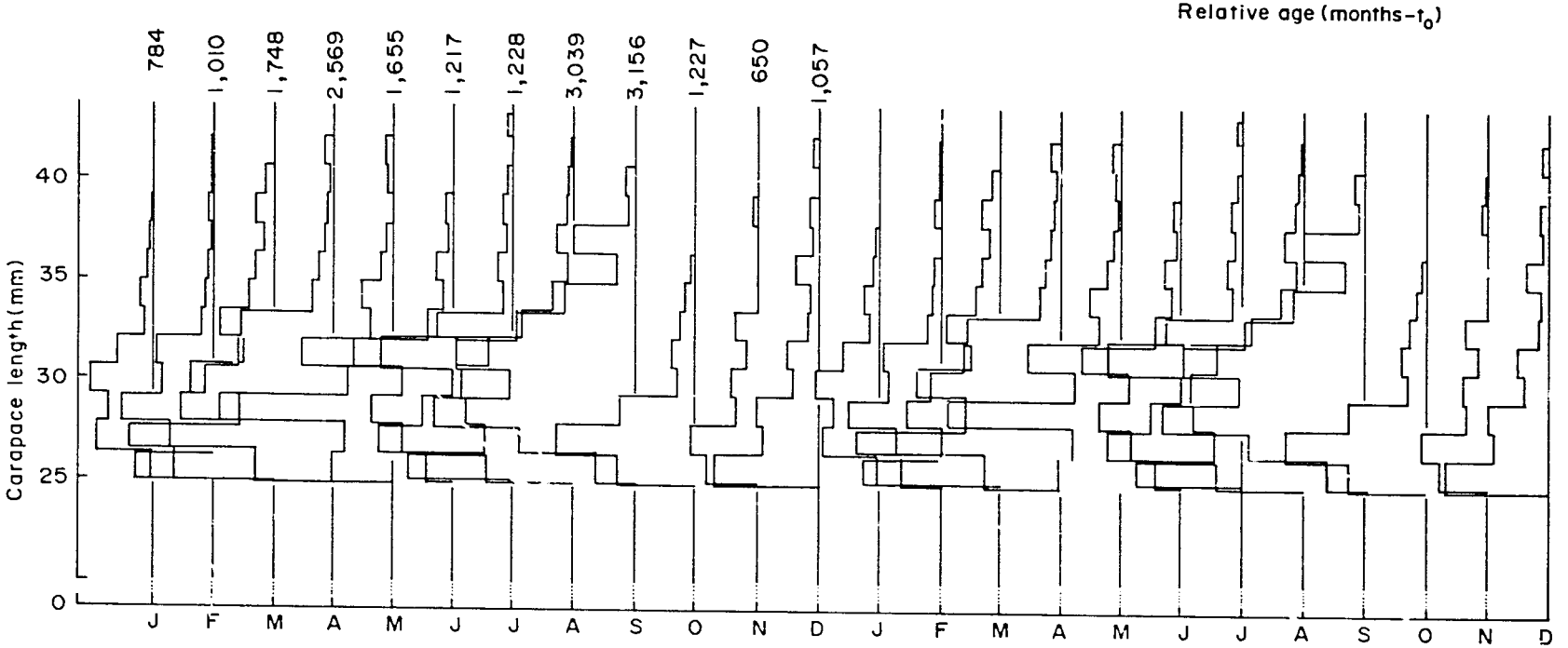
The set of length-frequency data on white shrimp presented here was obtained from Naamin, N. 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures, Bogor Institute for Agriculture. Ph.D. thesis. The estimated statistics are: L_∞ = 49.00 mm, K = 1.625, Z = 2.71, M = 2.16, F = 0.55, E = 0.20. Various recent contributions and an entry into the literature on the biology and population dynamics of white shrimp (= banana prawn) may be found in Rothlisberg, D.C., B.J. Hills and D.J. Staples (eds.) 1985 Second Australian National Prawn Seminar. Cleveland, Australia. 368 p.

Plate 54

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea, 1974

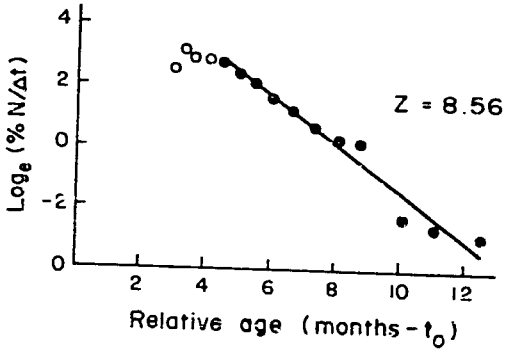


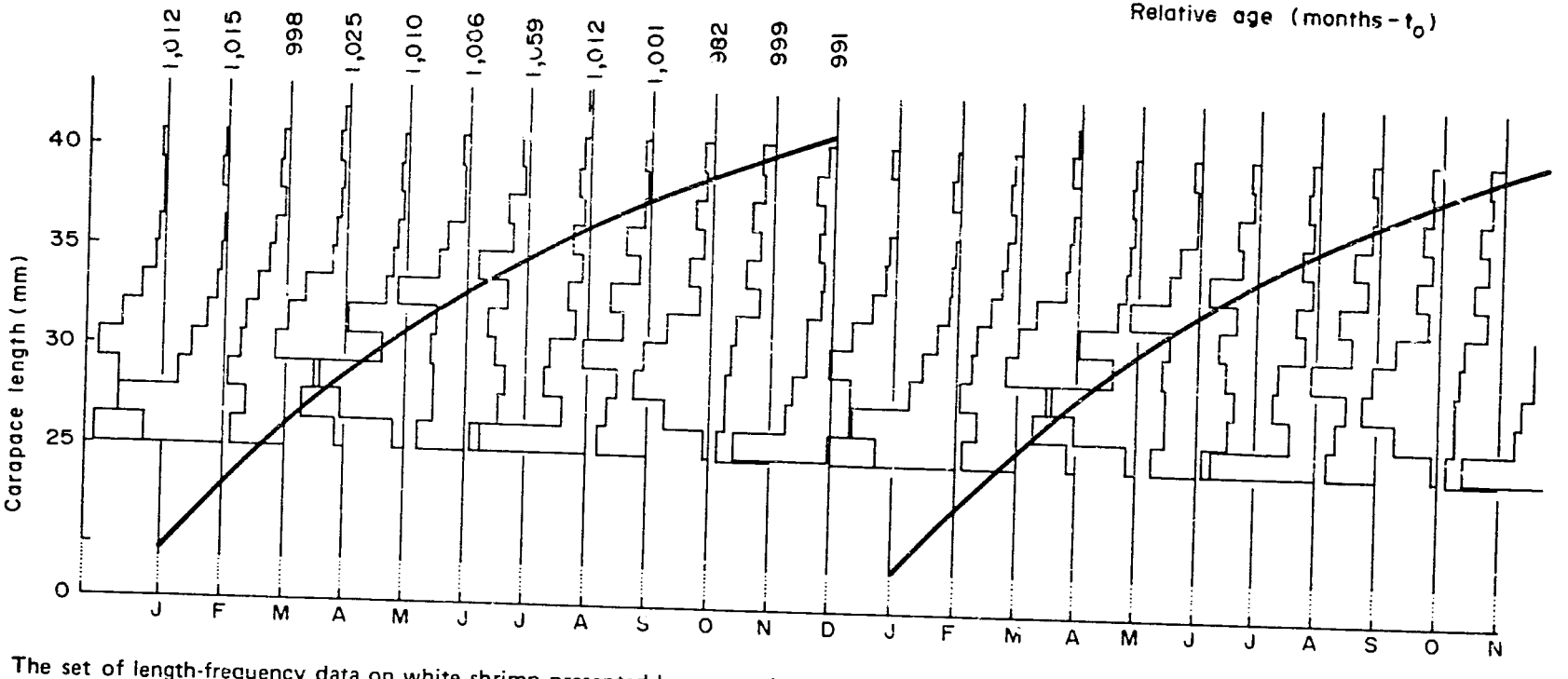




The set of length-frequency data on white shrimp presented here was obtained from Naamin, N. 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures, Bogor Institute for Agriculture. Ph.D. thesis. The estimated statistics are: L_∞ = 52.00 mm, K = 1.75, Z = 8.62, M = 1.81, F = 6.81, E = 0.79. Exploratory shrimp trawling in the Arafura Sea has been reported upon by Martosubroto, P. 1972. Exploratory trawling with R.I. Jalanidhi. Proc. IPFC 13th Session, Brisbane, Australia. 1968: 649-652.

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea, 1975

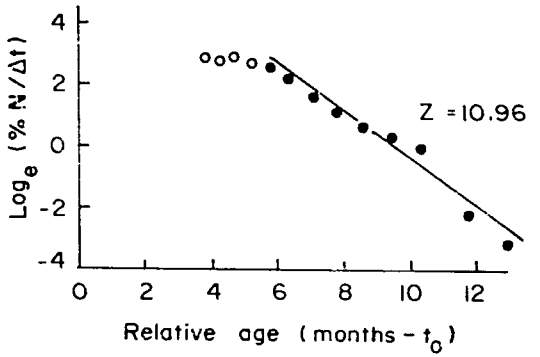


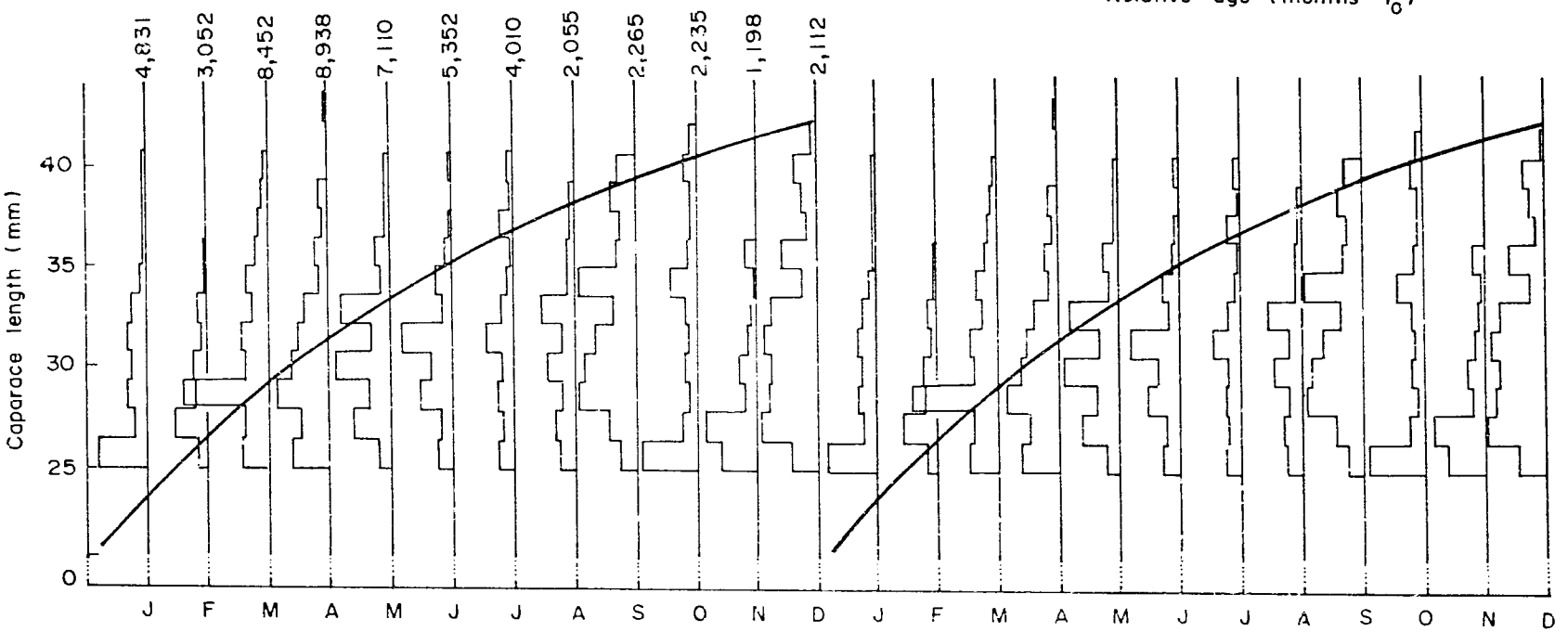


The set of length-frequency data on white shrimp presented here was obtained from Naamin, N. 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures. Bogor Institute for Agriculture. Ph.D. thesis. The estimated parameters are: $L_\infty = 50.20$ mm, $K = 1.65$, $Z = 8.56$, $M = 2.16$, $F = 6.40$. Additional information on the growth of white shrimp may be found in Martosubroto, P. 1977. Spawning season and growth of *Penaeus merguiensis* and *Metapenaeus ensis* in Tanjung Kerawang. Second National Seminar on Shrimp, Jakarta, 15-18 March 1977. 17 p. (In Indonesian).

Plate 56

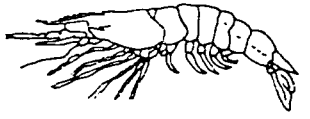
Fam. Penaeidae
Penaeus merguiensis
Arafura Sea, 1976

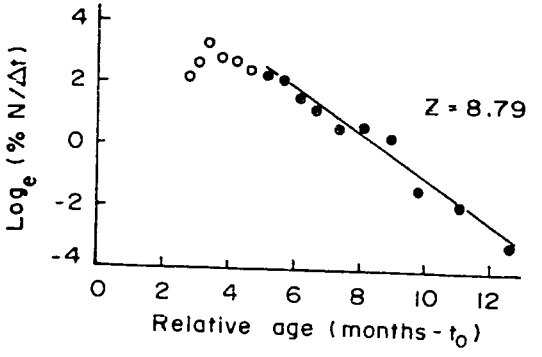


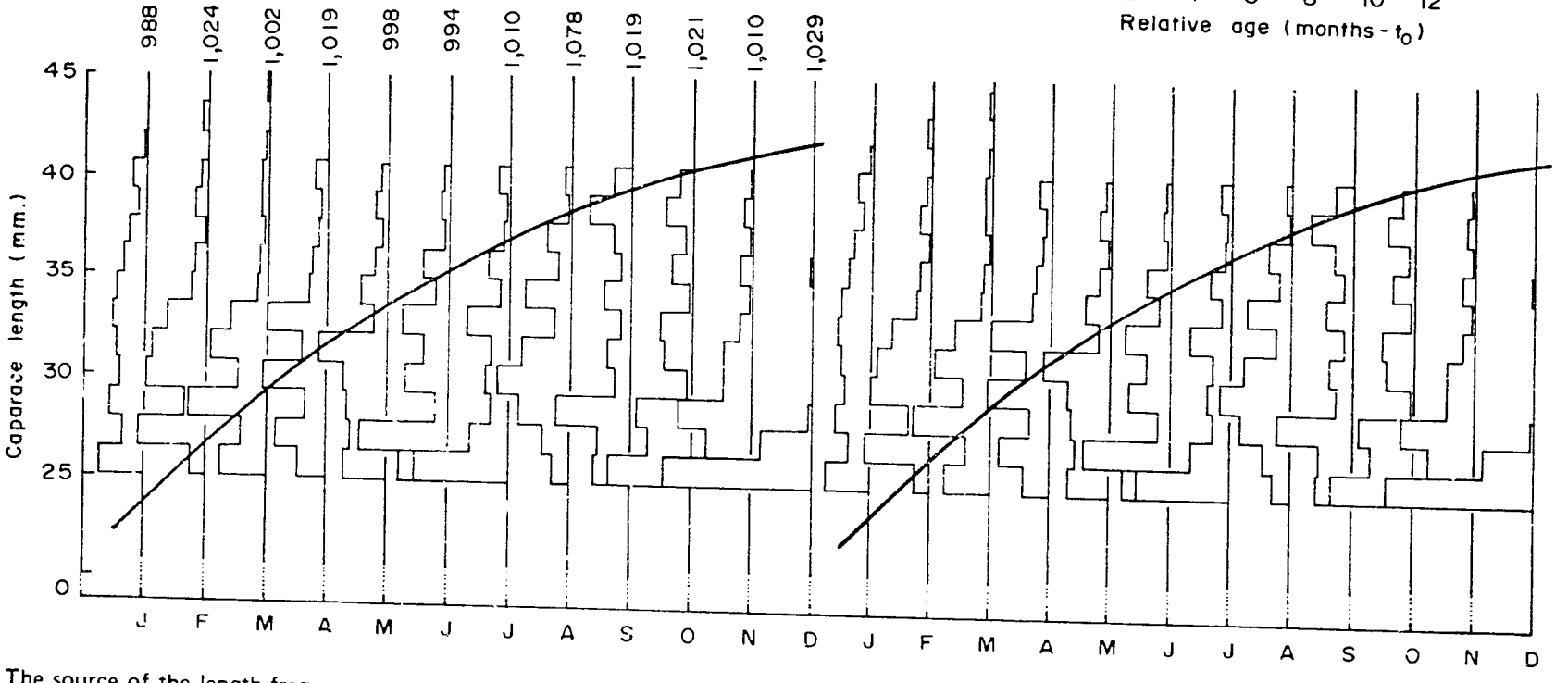


The length-frequency data used here on white shrimp were collected from the Arafura Sea in 1976, and were obtained from Naamin, N. 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures. Bogor Institute for Agriculture. Ph.D. thesis. The following parameters were estimated: L_∞ = 49.90 mm, K = 1.425, Z = 10.96, M = 1.97, F = 8.99, E = 0.82. The conservation of shrimp resources in the West Irian waters have been discussed by Naamin, N. and T. Yamamoto. 1977. Some thoughts on the conservation of shrimp resources in West Irian waters. Second National Seminar on Shrimp, Jakarta, 15-18 March 1977. 44 p. and in Gulland, J.A. 1973. Some notes on the assessment and management of Indonesian fisheries. ISFC/DEV/73/21. Bangkok. Indian Ocean Fish. Comm. FAO. 21 p.

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea , 1977



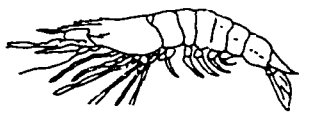


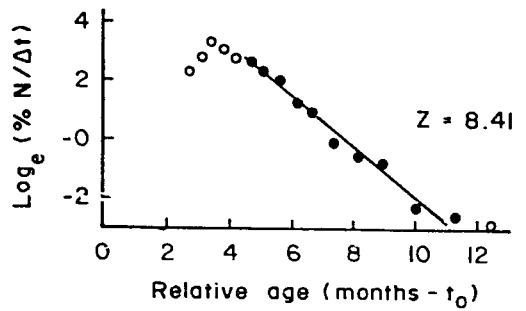


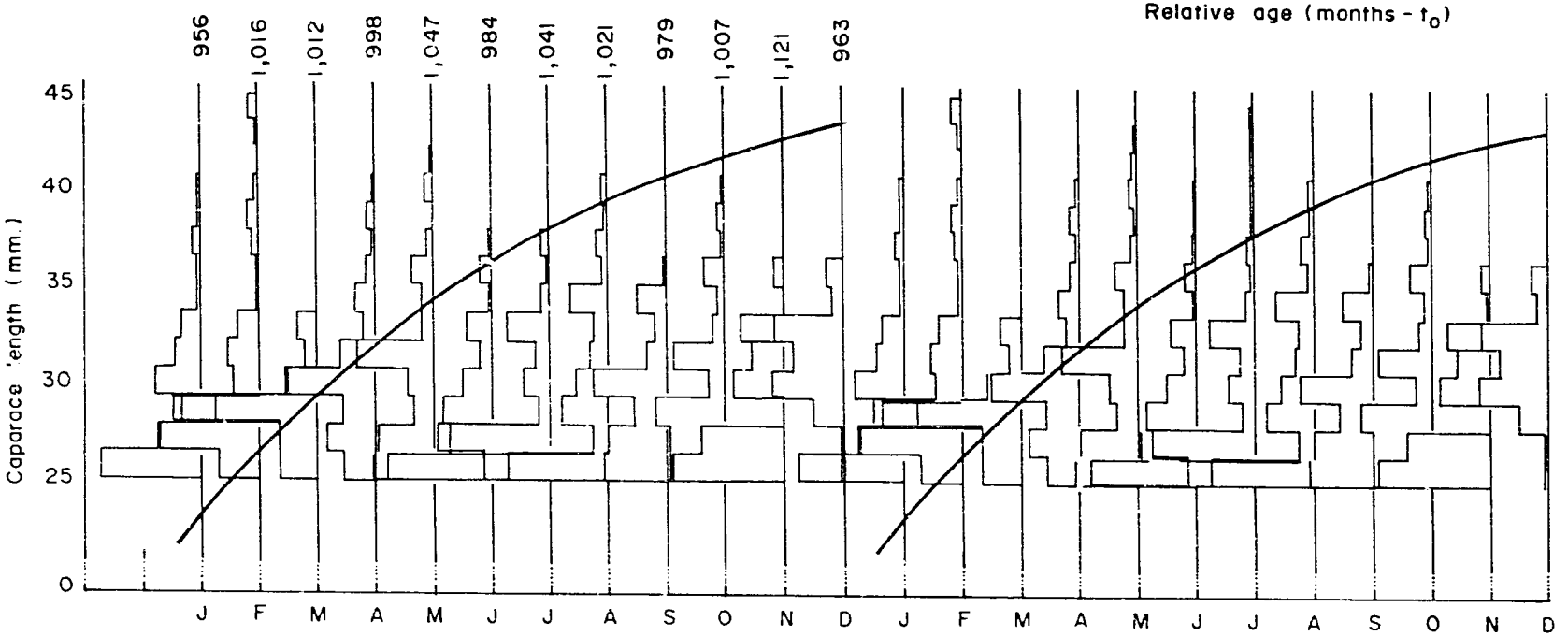
The source of the length-frequency presented here is Naamin, N. 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures. Bogor Institute for Agriculture. Ph.D. thesis. They led to the following parameter estimates: L_∞ = 50.20 mm, K = 1.650, Z = 8.79, M = 2.17, F = 6.62, E = 0.75. A review on the shrimp fishery may be found in Naamin, N. and A. Farid. 1980. A review of the shrimp fishery in Indonesia. Report of the Workshop on the Biology and Resources of Penaeid Shrimps in the South China Sea area Part I. SCS/GEN/80/26. South China Sea Fisheries Development and Coordinating Programme, Manila, p. 13-32.

Plate 58

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea , 1978

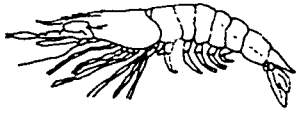


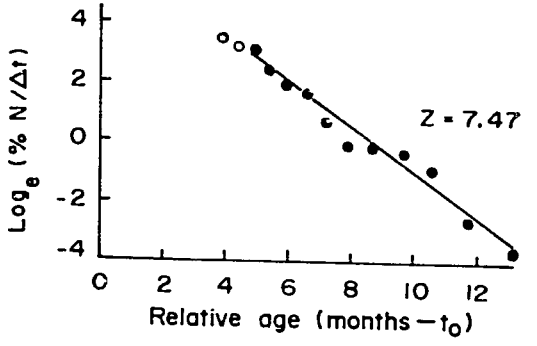


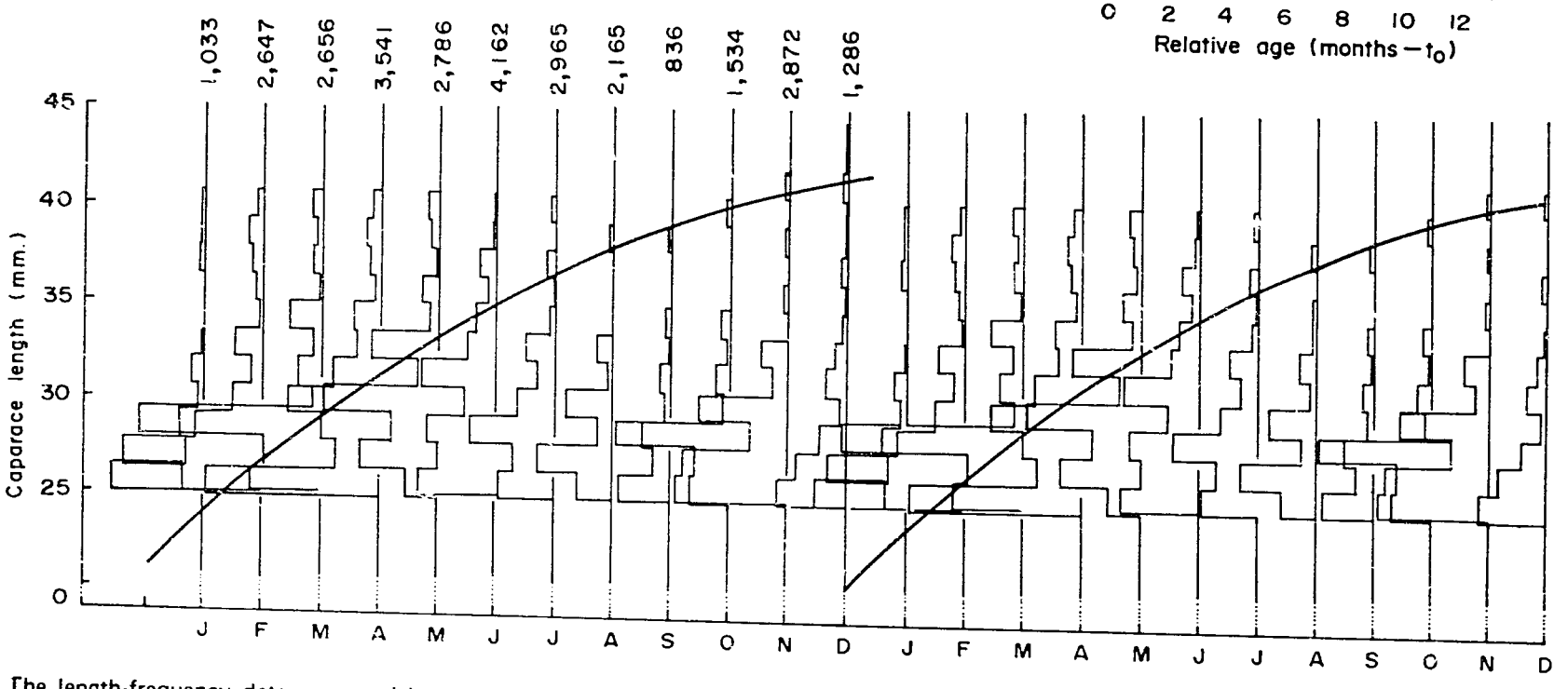


The length-frequency data presented here were obtained from N. Naamin, 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures. Bogor Institute for Agriculture. Ph.D. thesis. The following parameter values were estimated: L_∞ = 50.1mm, K = 1.650, Z = 8.41, M = 2.17, F = 6.24, E = 0.74. Additional information on the fishing grounds of shrimp in the Arafura Sea may be found in Nasution, C. 1977. The new fishing grounds outside the commercial fishing ground—Arafura Sea. Second National Seminar on Shrimp, Jakarta, 15-18 March 1977. 12 p. (In Indonesian).

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea , 1979



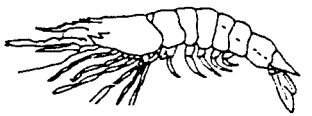


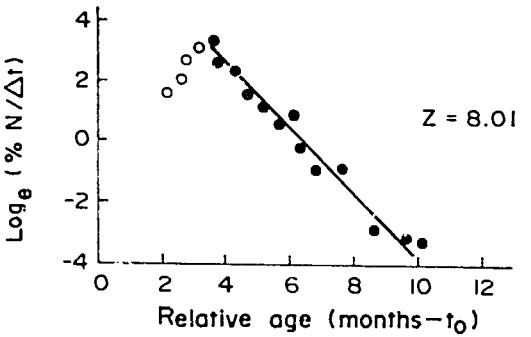


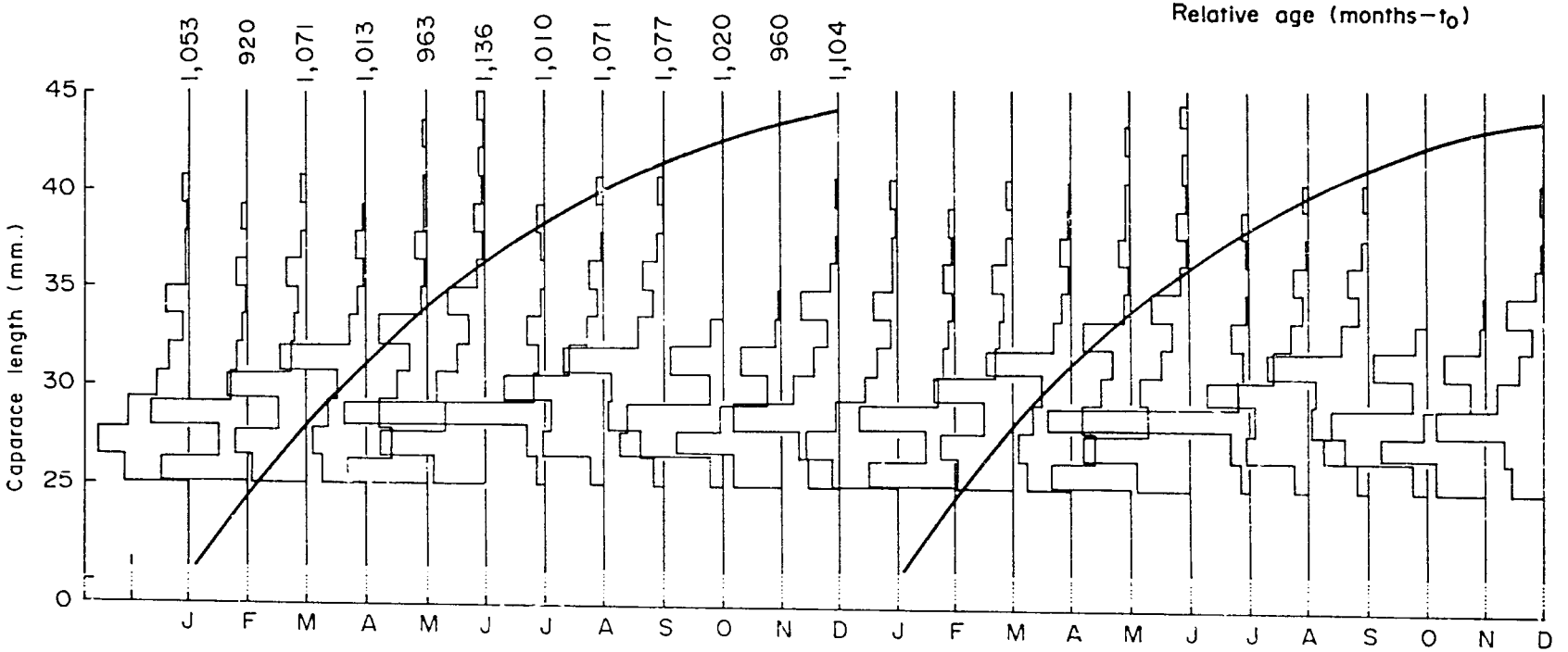
The length-frequency data presented here were extracted from N. Naamin, 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures. Bogor Institute for Agriculture. Ph.D. thesis. The estimated parameter values are: L_∞ = 50.0 mm, K = 1.40, Z = 7.47, M = 1.95, F = 5.52, E = 0.74. Additional information on the biological aspects of this shrimp is given by Sumiono, B. 1983. The length at first maturity stage and sex ratio of *Penaeus merguiensis* De Man, in the Bintuni Bay, Irian.Jaya. RIMF, Jakarta. Mar. Res. Rep. (19): 41-46. (In Indonesian).

Plate 60

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea, 1980

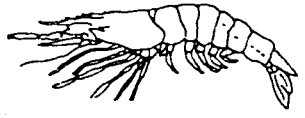


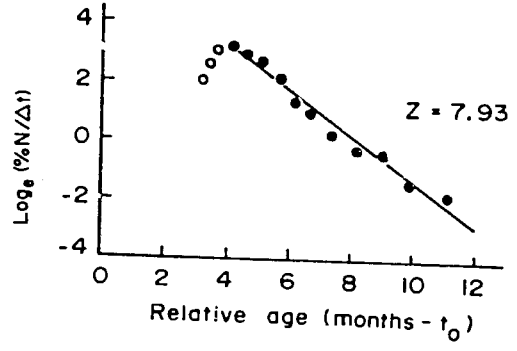


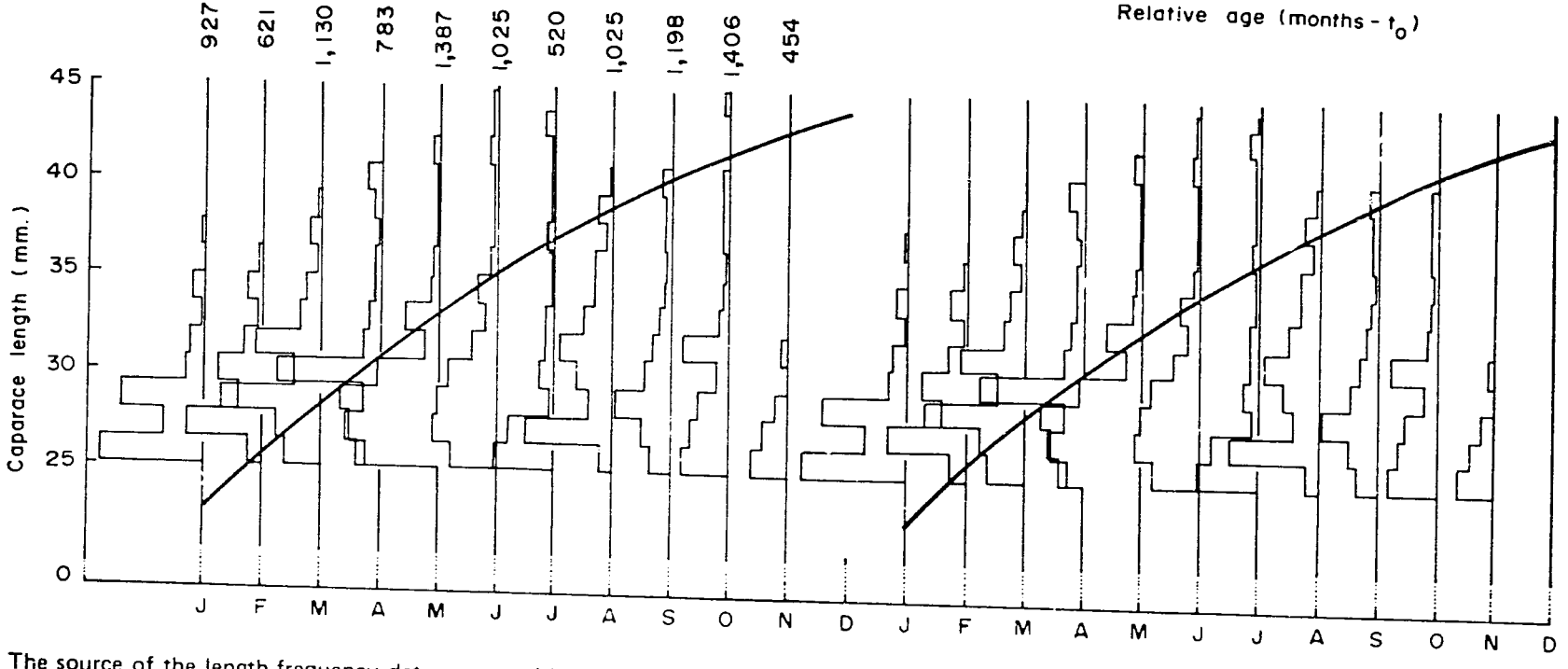


The set of length-frequency data on white shrimp was obtained from N. Naamin, 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures, Bogor Institute for Agriculture. Ph.D. thesis. The following parameter estimates were extracted: L_∞ = 50.4 mm, K = 1.875, Z = 8.01, M = 2.35, F = 5.66, E = 0.71. Information on the size maturity of banana prawn in other are given by Siswanto, A. 1983. A review on size maturity and spawning season of banana prawn (*Penaeus merguiensis* De Man) at Cilacap and adjacent waters. RIMF, Jakarta. Mar. Res. Rep. (29): 97-102. (In Indonesian).

Fam. Penaeidae
Penaeus merguiensis
Arafura Sea, 1981







The source of the length-frequency data presented here was from N. Naamin, 1984. The population dynamics of white shrimp (*Penaeus merguiensis* De Man) in the Arafura Sea and its alternative management measures. Bogor Institute for Agriculture. Ph.D. thesis. The data led to the following parameter estimates: L_∞ = 50.0 mm, K = 1.475, Z = 7.93, M = 2.01, F = 5.92, E = 0.75. In his thesis, Naamin concluded that the shrimp fishery in the Arafura Sea has already put a heavy pressure on the *Penaeus merguiensis* stock and that management measures should be implemented such as close season, size limitations and limitation of fishing effort.

Table A1

Family: Clupeidae
Species: *Anadontostoma chacunda*

Location: Riau Waters (Bintan)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
10.0			4	–									
10.5			8	–									
11.0			20	26							15		
11.5			6	51							37		
12.0			5	78	2	27					36	4	
12.5	2	1	5	23	27	28				6	30	7	
13.0	9	5	19	29	81	42			1	21	12	36	
13.5	23	30	47	51	52	34		8	6	47	11	37	
14.0	40	41	49	46	98	19		36	46	62	8	51	
14.5	42	32	35	35	40	5		49	77	60	4	12	
15.0	41	7	34	8	17	5		63	26	29		9	
15.5	18	4	9	3	5	3		24	20	22		8	
16.0	5		2		5			19	11	13		3	
16.5			1		2			8	4	3		1	
17.0								3					
Σ	180	120	244	350	329	163		210	191	263	153	168	2,371

Table A2

Family: Clupeidae
Species: *Sardinella gibbosa*

Location: Riau Waters (Bintan)
Year: 1982

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
7.5	1	–			1								
8.0	5	–			2								
8.5	21	2			3								
9.0	15	4			2								
9.5	8	5		3	8								
10.0	4	19		1	17	2							
10.5	3	4	3	1	7	4							
11.0	1	1	8	9	24	35		6	1	1			
11.5	0	0	18	61	22	48		3	1	3			
12.0	1	5	1	86	57	65		13	3	11	1		
12.5	4	15	1	63	53	26		47	18	40	2		
13.0	24	33	38	61	65	18		118	75	94	5		
13.5	48	48	85	35	27	9		49	97	41	12		
14.0	74	79	78	49	46	1		18	64	39	30		
14.5	21	22	26	19	29			3	8	5	25		
15.0	5	11	9	8	22				2	4	25		
15.5	–	4	6	4	1				2		29		
16.0	–		1	2	0						25		
16.5	–				1						9		
17.0	–				–						10		
17.5	–				–						2		
Σ	235	253	274	402	388	208		257	278	238	175		2,708

Table A3

Family: Clupeidae
Species: *Sardinella longiceps*

Location: Bali Strait
Year: 1977

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
7.5	–				2								
8.5	–				44								
9.5	–				49								
10.5	–				4								
11.5	–				0								
12.5	–				0								
13.5	9				0								
14.5	62	4	–		19						2		
15.5	36	33	2	–	110		8	21	6	6	17	10	
16.5	11	65	53	4	49	33	156	254	167	134	138	104	
17.5		15	126	180	31	123	52	47	57	84	78	106	
18.5			46	130	15	56	15	2		11	5	13	
19.5			6	16		12	4			2			
20.5			–			1							
Σ	118	117	233	330	323	225	235	324	230	237	240	233	2,845

Table A4

Family: Clupeidae
Species: *Sardinella longiceps*

Location: Bali Strait
Year: 1977

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
10.5	–										20		
11.5	–										98		
12.5	–										96	1	
13.5	–										24	31	
14.5	–											96	
15.5	–	1	2									12	
16.5	51	80	21	3									
17.5	54	26	19	113									
18.5	20	18	36	70									
19.5	8	10	14	14									
20.5	1	1	1										
21.5	2												
Σ	136	136	93	200							238	140	943

Table A5

Family: Clupeidae
Species: *Sardinella longiceps*

Location: Bali Strait
Year: 1980

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
12.5	7	37	18	12	–	–	–						
13.5	105	119	132	63	2	–	20						
14.5	74	60	123	88	53	–	91						
15.5	32	13	32	43	33	10	124						
16.5	2	1	21	10	4	20	46						
17.5			5		38	47	36						
18.5					59	15	16						
19.5						8							
20.5													
Σ	220	230	331	216	189	100	333						1,619

Table A6

Family: Clupeidae
Species: *Sardinella longiceps*

Location: Bali Strait
Year: 1981

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
7.5					7								
8.5					9								
9.5					2								
10.5					12								
11.5					4								
12.5			4		1	16					12		
13.5			118		27	70	31				47	1	
14.5			211		55	13	54				59	0	
15.5			67		13	17	2	70	11		32	6	
16.5			8			80		194	54		4	8	
17.5			4			75		93	27		0	24	
18.5						18		52	6		3	10	
19.5						8		11	1			5	
Σ			412		130	297	87	420	99		157	54	1,656

Table A7

Family: Clupeidae
Species: *Sardinella sirm*

Location: Java Sea (Pekalongan, Central Java)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
12.5	–		–	–			–	–	1	–	–	–	
13.5	–		–	–			–	–	7	2	–	3	
14.5	–		–	–			–	–	14	0	–	19	
15.5	11	8	–	–			–	4	34	24	1	69	
16.5	56	19	3	–			–	49	76	39	13	160	
17.5	136	66	72	–			–	110	144	67	38	219	
18.5	219	255	165	8			3	98	164	84	117	246	
19.5	176	466	261	28			29	159	132	76	206	140	
20.5	77	412	350	77			23	61	55	21	84	33	
21.5	9	54	186	100			12	8	13	4	23	5	
22.5		1	63	70				4	4	1	3		
23.5			1	21									
24.5				1									
Σ	684	1,281	1,101	305			67	493	648	318	465	894	6,276

Table A8

Family: Synodontidae
Species: *Saurida longimanus*

Location: Java Sea (Central Java)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5			4										
6.5			14										
7.5			44								45	14	
8.5			51							3	51	193	
9.5			11							9	62	404	
10.5			12							30	99	741	
11.5			24							74	112	987	
12.5			35							60	229	1,198	
13.5			30							99	271	706	
14.5			24							84	286	694	
15.5	5		5							84	211	323	
16.5	24									28	24	26	
17.5	25									1	4		
18.5	18										0		
19.5	4										4		
Σ	76		254							481	1,398	5,286	7,495

Table A9

Family: Synodontidae
Species: *Saurida micropectoralis*

Location: Java Sea (Central Java)
Year: 1978-1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
8.0	2												
10.0	4				2						4		
12.0	0				1						16		
14.0	1				11		13			7	30		
16.0	6				27		10		2	29	37		
18.0	6				14		3		1	28	46		
20.0	10				3		6		1	29	14		
22.0	4						1		1	15	3		
24.0	1						7		7	24	1		
26.0	2								6	15			
28.0	6								3	1			
30.0	3									1			
32.0	3												
34.0	1												
36.0	1												
38.0	1												
40.0	1												
Σ	52				58		40		20	149	151		470

Table A10

Family: Synodontidae
Species: *Saurida undosquamis*

Location: Java Sea (Central Java)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
11.5													
13.5										–	1	13	
15.5										6	5	19	
17.5										14	25	12	
19.5										22	48	5	
21.5	7									9	22	2	
23.5	17									2	7	0	
25.5	6									1	3	1	
27.5	5										0		
29.5	6										2		
31.5	1										1		
											1		
Σ	42									54	115	52	263

Table A11

Family: Cyprinidae
Species: *Hampala macrolepidota*

Location: Jatiluhur Lake (West Java)
Year: 1983-1984

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
14.0			1					–	4	9	5	1	
16.0			1					2	8	3	4	6	
18.0	3		1					3	1	0	10	4	
20.0	14		4					2	2	12	3	4	
22.0	7		9					5	1	13	1	6	
24.0	15		12					2	0	11	4	7	
26.0	15		6						1	4	1	6	
28.0	8		1						2	3	2	2	
30.0	3		1						0	3	3	2	
32.0	2		3						2	1	–	–	
34.0	1												
36.0	0												
38.0	0												
40.0	0												
42.0	1												
44.0	1												
46.0													
48.0													
Σ	70		39					14	21	59	34	38	275

Table A12

Family: Ariidae
Species: *Arius maculatus*

Location: Java Sea (Tegal, Central Java)
Year: 1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
21								–		–		1	
23								–		2		1	
25								–		1		3	
27								3		0		10	
29								9		3		22	
31								32		3		12	
33								57		12		9	
35								35		39		20	
37								26		72		7	
39								16		64		7	
41								6		14		5	
43								4					
Σ								188		210		97	495

Table A13

Family: Ariidae
Species: *Arius thalassinus*

Location: Java Sea (South Kalimantan)
Year: 1976

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
13.0													
15.0						1		3					
17.0						6		3					
19.0						4		2					
21.0						2		1					
23.0						9	1	0					
25.0						11	0	1	4				
27.0						16	0	4	12				
29.0						17	0	2	14				
31.0						21	2	3	14				
33.0						12	3	6	34				
35.0						8	9	3	27				
37.0						13	7	5	20				
39.0						1	1	0	9				
41.0						2	1	1	3				
43.0						0		2	0				
45.0						0		1	0				
47.0						1			0				
49.0						0			1				
51.0						2							
53.0						0							
55.0						0							
57.0						0							
						1							
Σ						126	24	37	138				325

Table A14

Family: Priacanthidae
Species: *Priacanthus macracanthus*

Location: Java Sea (Central Java)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
6.5													
7.5							2						
8.5							78						
9.5							19						
10.5							2				3		
11.5							0				18		
12.5	32	26					0				9		
13.5	226	334		4			0				10		
14.5	212	420		61			0				70		
15.5	56	182		149			0				150		
16.5	31	99		55			2				87		
17.5	9	59		20			8				14		
18.5	2	21		11			10				0		
19.5	2	5		7			11				3		
20.5		2					6						
21.5							4						
22.5							2						
23.5							1						
24.5							1						
25.5							0						
							2						
Σ	570	1,148		307			148				364		2,537

Table A15

Family: Priacanthidae
Species: *Priacanthus macracanthus*

Location: Java Sea (Central Java)
Year: 1978-1979

Midlength	J	F	M	M	J	J	A	S	O	N	D	Σ
9.5												
10.5									1	3		
11.5								8	10	6		
12.5	8	6						2	46	5		
13.5	45	23	1					7	32	5		
14.5	22	59	9					16	5	27		
15.5	5	17	27					4		43		
16.5	2	6	37					2		51		
17.5	2	4	21					8		10		
18.5		4	5					14				
19.5		2	4					22				
20.5		1						10				
								2				
Σ	84	122	104					95	84	150		649

Table A16

Family: Carangidae
Species: *Decapterus macrosoma*

Location: Java Sea (Pekalongan, Central Java)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
11.5	–												
12.5	–							1	–	–			
13.5	38							7	5	–			
14.5	71			3				39	36	3		11	
15.5	104	21	5	12				98	28	16		35	
16.5	172	168	72	52				183	43	35	21	190	
17.5	251	669	136	72				66	69	49	50	293	
18.5	160	722	193	97				5	34	21	72	143	
19.5	68	457	135	86					10	24	38	41	
20.5	9	105	28	31						34	9	5	
21.5	1	–	8	1						16	1		
22.5	–									9	0		
23.5	–									5	1		
										–			
Σ	873	2,142	577	354				399	225	212	192	718	5,692

Table A17

Family: Carangidae
Species: *Decapterus maruadsi*

Location: Java Sea (Tegal, Central Java)
Year: 1981-1982

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
8.5	–	–	–	–	–	3	–	–	–	–	–	–	
9.5	–	–	–	–	–	5	5	–	–	–	–	–	
10.5	–	–	–	2	–	5	18	–	–	–	–	–	
11.5	–	–	1	5	–	5	18	1	5	2	–	–	
12.5	–	–	0	3	–	12	2	1	13	7	–	–	
13.5	–	–	1	4	–	12	6	7	16	20	1	5	
14.5	–	3	4	15	–	3	3	20	5	24	3	8	
15.5	14	16	3	10	–	1	1	13	4	23	3	11	
16.5	17	22	20	7	–	2	1	9	3	11	13	17	
17.5	18	19	20	5	10	2	–	5	1	4	18	23	
18.5	12	8	4	–	12	1	–	1	2	2	11	14	
19.5	10	6	2	–	15	2	–	–	1	–	6	9	
20.5	2	–	1	–	7	–	–	–	–	–	5	2	
21.5	1	–	–	–	7	–	–	–	–	–	0	1	
22.5	–	–	–	–	1	–	–	–	–	–	1	–	
Σ	74	74	56	51	52	53	54	57	50	93	61	90	765

Table A18

Family: Carangidae
Species: *Decapterus maruadsi*

Location: Java Sea (Tegal, Central Java)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
8.5	–	–	–	–	2	3		–	–	–	–	–	
9.5	–	–	–	–	2	3		–	–	–	–	–	
10.5	–	–	–	–	14	2		–	2	1		–	
11.5	–	5	7	–	23	3		2	7	18	6	1	
12.5	–	14	12	–	9	13		25	21	16	20	4	
13.5	5	18	15	8	3	36		22	20	32	18	23	
14.5	32	24	14	16	6	43		18	11	36	19	19	
15.5	14	19	11	27	10	10		22	9	22	18	13	
16.5	14	24	18	9	11	9		16	2	27	11	18	
17.5	28	14	0	19	6	4		7	–	20	6	15	
18.5	13	3	1	26	5	1		–	–	6	1	9	
19.5	–	–	–	–	13	4		–	–	5	–	–	
20.5	–	–	–	–	10	1		–	–	3	–	–	
21.5	–	–	–	–	5	–		–	–	2	–	–	
22.5	–	–	–	–	1	–		–	–	1	–	–	
23.5	–	–	–	–	–	–		–	–	0	–	–	
24.5	–	–	–	–	–	–		–	–	0	–	–	
25.5	–	–	–	–	–	–		–	–	1	–	–	
Σ	106	121	78	105	120	132		112	73	190	99	102	1,238

Table A19

Family: Carangidae
Species: *Decapterus maruadsi*

Location: Java Sea (Pekalongan, Central Java)
Year: 1981-1982

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
8.5			7				2	6	1	–	–		
9.5			16				8	17	6	–	–		
10.5			3				20	12	6	7	–		
11.5			0				25	14	20	47	4		
12.5			0				31	26	30	135	47		
13.5			4				27	34	60	187	90	3	
14.5	2		17	1	1	2	29	28	95	143	179	27	
15.5	9		21	4	7	9	21	16	82	73	133	52	
16.5	29		74	20	3	21	16	26	93	74	69	69	
17.5	23		178	19	36	31	1	41	62	109	56	65	
18.5	8		74	37	36	20	0	65	16	94	142	73	
19.5	6		10	20	35	6	1	59	3	61	137	47	
20.5	2		4	6	8	2	0	31	2	22	65	5	
21.5	1		1	2	8		1	23		13	25	2	
22.5	1		3	1	6		2	12		12	29	1	
23.5	–				5		1	4		11	13		
24.5	–				2		–			3	1		
25.5	–				–		–			1			
Σ	104		412	110	147	91	185	414	476	992	990	344	4,265

Table A20

Family: Carangidae
Species: *Decapterus maruadsi*

Location: Java Sea (Pekalongan, Central Java)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
9.5	–							–				7	
10.5	6							1			2	41	
11.5	36							3			11	98	
12.5	61							17	4	14	14	146	
13.5	71	10	6					13	35	40	17	173	
14.5	57	151	120					45	73	42	20	175	
15.5	54	472	181	11		1		81	165	31	37	173	
16.5	105	530	162	63		21		96	220	28	72	155	
17.5	138	295	255	78		49		35	114	23	221	137	
18.5	134	166	272	71		81		2	42	24	143	105	
19.5	60	104	73	72		106	10	7	14	26	102	48	
20.5	29	67	41	44		39	9	11	5	26	67	26	
21.5	20	32	24	14		10	4	21	–	11	44	23	
22.5	10	4	16	–		–	18	19	–	3	29	17	
23.5	–	–	8	–		–		6	–	4	13	13	
24.5	–	–	1	–		–		1	–	–	3	4	
25.5	–	–	–	–		–		–	–	–		2	
Σ	781	1,831	1,149	351		307	51	358	672	272	795	1,343	7,910

Table A21

Family: Carangidae
Species: *Decapterus russelli*

Location: Jakarta Bay (Seribu Isl.)
Year: 1973

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
14.5					–			16			3	–	
15.5					–			25			27	16	
16.5					–			18			71	67	
17.5					1		2	18			19	29	
18.5					1		23	15				2	
19.5					8		24	9				3	
20.5					10	8	10					2	
21.5					10	16	6					3	
22.5					25	16	4					2	
23.5					6	6	3						
24.5					1	2							
25.5						1							
Σ					62	49	72	98			120	124	525

Table A22

Family: Carangidae
Species: *Decapterus russelli*

Location: Jakarta Bay (Seribu Isl.)
Year: 1973

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
10.5	–			–	–	–	3	–	–				
11.5	–			–	–	1	18	–	–				
12.5	–			23	–	0	6	2	2				
13.5	–			16	10	16	36	7	7		1		
14.5	–			0	25	41	27	3	11	1	1	1	
15.5	5			1	5	38	6	1	15	4	7	1	
16.5	79	6		1		32	11	7	13	11	16	3	
17.5	42	29		1		5	12	10	16	18	16	13	
18.5	3	29		2			5	17	18	22	14	43	
19.5	–	5		8			1	3	11	19	17	42	
20.5	–	–		5				2	6	9	21	24	
21.5	–	–		2						1	18	8	
22.5	–	–		–						1	1	1	
Σ	129	69		59	40	137	125	52	99	86	112	136	1,044

Table A23

Family: Carangidae
Species: *Decapterus russelli*

Location: Jakarta Bay (Seribu Isl.)
Year: 1975

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
9.5	–	–	–	1	3	–	–		–		–	–	
10.5	–	–	–	6	3	–	–		–		–	–	
11.5	–	3	–	20	4	1	–		–		–	–	
12.5	4	18	10	59	20	8	–		2		3	–	
13.5	16	8	54	27	38	16	1		4		9	–	
14.5	18	3	33	14	15	12	9		6		6	30	
15.5	19	6	3	9	5	11	27		14	3	5	37	
16.5	13	2	–	4	22	6	18		2	25	7	17	
17.5	17	–		2	1	8	6		1	18	10	5	
18.5	27			1	–	7	–		1	2	4	6	
19.5	4			–	–	4	–		3	2	6	4	
20.5	4			–	–	–	–		4	–	1	1	
21.5	1			–	–	–	–		2	–	1	–	
22.5	–			–	–	–	–		–	–		–	
Σ	123	40	100	142	105	73	60	–	39	50	53	100	885

Table A24

Family: Carangidae
Species: *Selar crumenopthalmus*

Location: Java Sea (Pekalongan)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
13.5								–	5	3	–		
14.5	13	35						–	28	7	–		
15.5	45	96	20					–	95	19	–		
16.5	65	144	37					12	70	56	30	9	
17.5	130	238	54					10	27	71	139	61	
18.5	225	550	152	7				10	5	56	192	121	
19.5	111	521	245	47				16	3	36	98	115	
20.5	70	269	287	89				10		17	33	70	
21.5	13	67	190	102				6		7	18	14	
22.5		24	87	76						3	12	2	
23.5		6	27	4							7	3	
24.5		2	2								2		
Σ	672	1,952	1,101	325				64	233	275	531	396	5,540

Table A25

Family: Carangidae
Species: *Selaroides leptolepis*

Location: Java Sea (Tegal)
Year: 1978-1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5		–			1								
6.5		–			5								
7.5		1			19						5		
8.5		0			21					2	5		
9.5		0			21					19	12		
10.5		2			45					97	56		
11.5		9			52					47	37		
12.5		51			41					4	30		
13.5		91			8					7	11		
14.5		103			5					3	6		
15.5		43			1								
16.5		15											
17.5		8											
18.5		1											
Σ		324			219					179	162		884

Table A26

Family: Carangidae
Species: *Selaroides leptolepis*

Location: Riau Waters (Tintan Isl.)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
7.5					11				–	2			
8.5					28				1	21			
9.5	1	5			45	11			7	45	1	1	
10.5	39	21	11		53	105		2	37	98	9	1	
11.5	69	3	5		51	114		37	79	104	48	34	
12.5	87	25	46	2	30	44		89	77	44	32	110	
13.5	67	54	50	24	43	31		17	43	28	43	1	
14.5	35	41	12	90	9	45		8		3	20		
15.5	2	7	9	30		8		24			4		
16.5		4				3		12					
17.5								4					
Σ	300	160	133	146	270	361		193	244	345	157	147	2,456

Table A27

Family: Formionidae
Species: *Formio niger*

Location: Java Sea (Central Java)
Year: 1979

Midlength	J	F		A	M	J	J	A	S	O	N	D	Σ
10.5	–	–			3								
11.5	–	–			7								
12.5	–	–			7								
13.5	–	1			10								
14.5	–	4			8								
15.5	–	8			1								
16.5	–	6			1								
17.5	–	3			0								
18.5	–	15			0								
19.5	–	56		3	4								
20.5	–	49		15	0								
21.5	1	53		37	0								
22.5	1	20		18	4								
23.5	3	14		14	2								
24.5	6	4		2	3								
25.5	1	1		1	–								
26.5	2	1		–	–								
27.5	2	–		–	–								
28.5	1	–		–	–								
Σ	17	235		90	50								392

Table A28

Family: Leiognathidae
Species: *Leiognathus bindus*

Location: Java Sea (Central Java)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
2.75										200	5		
3.25									116	300	18	19	
3.75	13								434	155	123	104	
4.25	43								376	173	220	126	
4.75	143								172	187	173	81	
5.25	108								145	106	20	26	
5.75	74						117		143	164	33	341	
6.25	70						183		182	273	93	10	
6.75	85						86		122	182	294	1	
7.25	40						17		78	54	164	3	
7.75	25						9		75	27	56	1	
8.25	7								73		11		
8.75	2								43				
9.25									43				
9.75									14				
10.25									14				
10.75									14				
11.25									9				
11.75									6				
Σ	610						412		2,059	1,821	1,210	712	6,824

Table A29

Family: Leiognathidae
Species: *Leiognathus brevirostris*

Location: Java Sea (Central Java)
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.0	2												
5.5	3												
6.0	6												
6.5	9			9									
7.0	16			32									
7.5	29			34	1								
8.0	26			25	3								
8.5	14			12	14								
9.0	14	2		7	20								
9.5	4	2		3	28								
10.0	3	6		2	7								
10.5	4	5		1	5								
11.0		2		1	1								
11.5		1											
12.0		1											
Σ	130	19		128	89								364

Table A30

Family: Leiognathidae
Species: *Leiognathus equulus*

Location: Java Sea (Central Java)
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
6.5													
7.5							3		–				
8.5							22		–				
9.5							60		–				
10.5							75		–				
11.5							73		1				
12.5							38		2	1	1		
13.5							42		4	1	2		
14.5							14		1	1	6		
15.5							8		6	3	14		
16.5							1		3	4	9		
17.5									6	7	11		
18.5									1	3	4		
19.5									1	1	1		
20.5										0	1		
										1	2		
Σ							336		25	22	51		434

Table A31

Family: Leiognathidae
Species: *Leiognathus decorus*

Location: Java Sea (Central Java)
Year: 1977–1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
4.5	1												
5.0	–												
5.5	2									3			
6.0	2				1					4			
6.5	12				3		1			2			
7.0	7				1		3		6	33	6		
7.5	9				0		1		18	97	0		
8.0					5		5		30	52	0		
8.5					9		9		40	25	2		
9.0					47		47		23	48	1		
9.5					43		43		4	37	1		
10.0					27		27		5	16	6		
10.5					8		8		5	6	5		
11.0					1					19	1		
11.5										36	2		
12.0										37			
12.5										30			
										6			
Σ	33				145		144		131	441	24		918

Table A32

Family: Leiognathidae
Species: *Leiognathus leuciscus*

Location: Java Sea (Central Java)
Year: 1982–1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
3.5	–				–		–		–		1	12	
4.5	9				6		2		5		57	46	
5.5	50				23		43		9		16	31	
6.5	26				41		52		14		4	47	
7.5	9				23		8		66		1	18	
8.5	0				2		2		36			5	
9.5	3								24			5	
10.5	3								13			1	
11.5									11				
12.5									4				
Σ	100				95		112		182		79	160	728

Table A33

Family: Leiognathidae
Species: *Leiognathus splendens*

Location: Riau Waters (Bintan)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
6.5	–		–	–	–	–				4	–		
7.0	–		–	5	–	1				7	5		
7.5	1		–	8	3	15				13	2		
8.0	15	2	5	4	9	15			4	16	16		
8.5	20	14	7	12	13	32			9	20	4		
9.0	31	14	29	19	28	41			20	35	21		
9.5	24	16	14	110	25	46			21	19	22		
10.0	21	33	52	79	28	7		5	21	12	29	2	
10.5	15	29	57	20	29			11	60	7	17	13	
11.0	40	5	72	13	36			15	10	5	32	40	
11.5	25		23		18			5	4	2	5	81	
12.0	11		9		92			36			17	72	
12.5	5		5		15			19			1	13	
13.0	5		1		–			39			3	1	
13.5	–		–		–			4			–	–	
Σ	213	113	274	270	296	157		134	149	140	174	222	2,142

Table A34

Family: Leiognathidae
Species: *Leiognathus splendens*

Location: Java Sea (South Kalimantan)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
2.5	–						–		–	19		–	
3.5	6						–		–	125		38	
4.5	54						24		–	107		210	
5.5	98						96		–	11		284	
6.5	107						112		54	73		361	
7.5	41						242		82	360		102	
8.5	2						193		20	168		63	
9.5	26						87		1	69		35	
10.5	74						66		1	54		59	
11.5	17						46		0	18		84	
12.5	3						23		1	3		98	
13.5	–						11		0	–		89	
14.5	–						11		1			26	
15.5	–						2					4	
Σ	428						913		160	1,007		1,453	4,227

Table A35

Family: Leiognathidae
Species: *Leiognathus splendens*

Location: Java Sea (Central Java)
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	C	N	D	Σ
3.5	5			–	–				–				
4.5	216			2	1				–				
5.5	592			2	0				7				
6.5	733			37	14				27				
7.5	261			264	373				129				
8.5	61			171	232				206				
9.5	36			128	101				195				
10.5	9			103	64				48				
11.5	10			80	81				25				
12.5	3			57	82				4				
13.5	7			29	46				0				
14.5	3			6	18				1				
15.5	1			2	1								
Σ	1,937			881	993				642				4,453

Table A36

Family: Leiognathidae
Species: *Secutor ruconius*

Location: Java Sea (Tegal)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
2.5	1								1	–			
3.0	8								5	2			
3.5	18								27	26			
4.0	38								32	61	17	2	
4.5	52								14	5	86	5	
5.0	15								9	1	67	7	
5.5	4								5	1	48	14	
6.0	16								1		20	5	
6.5	34								1		1	5	
7.0	22								0		1		
7.5	9								1				
8.0	1												
Σ	218								96	96	240	38	688

Table A37

Family: Leiognathidae
Species: *Secutor ruconius*

Location: Java Sea (Central Java)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
3.25	–	–		5			2	1	1	–			
3.75	1	–	22	0		1	5	7	3	1			
4.25	2	6	18	3		1	12	22	25	19			
4.75	3	21	43	19		8	11	14	10	22			
5.25	20	79	57	31	2	12	3	10	0	7			
5.75	26	36	14	18	14	4	0	1	0	7			
6.25	8	3	2	2	5		1	2	1	2			
6.75	1				1		0	0	1				
7.25							1	0					
7.75								1					
Σ	61	145	156	78	22	26	35	58	41	58			680

Table A38

Family: Nemipteridae
Species: *Nemipterus hexodon*

Location: Java Sea
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5					–					1		15	
6.5					–					0		0	
7.5					16				46	1		13	
8.5					15				11	2		26	
9.5					25				75	3		12	
10.5					46				201	2	2	28	
11.5					84				195	1	10	33	
12.5					61				188	1	14	19	
13.5					10				82	0	10	26	
14.5					13				61	3	2	9	
15.5					30				17	2	2	18	
16.5					10				25	1	1	5	
17.5					2				20	0	1	18	
18.5					9				8	0		5	
19.5					7				0	1		5	
20.5					0				4			5	
21.5					3								
22.5					5								
23.5					2								
Σ					338				933	18	42	237	1,568

Table A39

Family: Nemipteridae
Species: *Nemipterus japonicus*

Location: Java Sea (Central Java)
Year: 1977

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5													
6.5												2	
7.5												1	
8.5												4	
9.5										2		8	
10.5							1		3	6		15	
11.5							0		37	1		4	
12.5							3		65	12	1	32	
13.5							1		47	16	5	25	
14.5							3		11	7	6	19	
15.5							2		3	2	5	20	
16.5							4				12	11	
17.5							5				5	14	
18.5							5				9	12	
19.5							2				5	11	
20.5							0				2	3	
21.5							2				4	1	
22.5											1		
											1		
Σ							28		166	46	56	182	296

Table A40

Family: Nemipteridae
Species: *Nemipterus mesoprion*

Location: Java Sea (Central Java)
Year: 1978-1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
6.5	1				2				5	2		–	
7.5	2				2				8	7		1	
8.5	4				13				7	6		7	
9.5	3				14				2	13		21	
10.5	12				20				6	13		16	
11.5	44				10				27	7		22	
12.5	42				8				14	1		24	
13.5	24				16				10	0		6	
14.5	28				13				14	1		9	
15.5	17				3				9	1		11	
16.5	10								1	2		8	
17.5									0				
18.5									1				
Σ	187				101				104	53		125	570

Table A41

Family: Gerridae
Species: *Pentaprion longimanus*

Location: Java Sea (Semarang)
Year: 1978-1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
3.75	–				4								
4.25	–				15								
4.75	–			1	48								
5.25	–			1	39						2		
5.75	2			5	87						0		
6.25	10			13	252						2		
6.75	18			48	695						1		
7.25	26			103	974						5		
7.75	40			74	701						20		
8.25	57			21	281						52		
8.75	45			6	117						95		
9.25	46			5	31						105		
9.75	76			20	46						185		
10.25	199			41	54						178		
10.75	212			81	42						139		
11.25	96			52	29						84		
11.75	22			10	21						29		
12.25	7			1	9						3		
12.75	–				1						1		
Σ	856			482	3,446						901		5,685

Table A42

Family: Pomadasyidae
Species: *Pomadasys hasta*

Location: Java Sea (South Kalimantan)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
15											3		
17											0		
19											0		
21											3		
23										1	6		
25										6	6		
27			1							3	6		
29			1							0	7		
31			5					1		5	15		
33			3					0		6	11		
35			10					3		7	18		
37			13					6		4	25		
39			20					22		11	23		
41			16					21		20	15		
43			4					27		17	7		
45			4					10		12	2		
47			0					6		2	3		
49			2					–		1	–		
51								–		3	–		
Σ			79					96		100	150		425

Table A43

Family: Mullidae
Species: *Upeneus sulphureus*

Location: Java Sea (Central Java)
Year: 1977-1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5					32								
6.5					169		2				20	2	
7.5					283		37				88	9	
8.5					378		131				49	128	
9.5					204		143		78	51	27	130	
10.5					139		59		226	259	500	119	
11.5					191		17		161	138	501	256	
12.5					92		11		139	52	124	159	
13.5					26		4		43	16	39	36	
14.5					6		2		20	4	3	29	
15.5					3		1		2	1		3	
16.5												4	
Σ					1,523		412		675	520	1,351	875	5,356

Table A44

Family: Mullidae
Species: *Upeneus sulphureus*

Location: Java Sea (Central Java)
Year: 1978-1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5					1								
6.5				23	13								
7.5	3			50	39								
8.5	6			7	130								
9.5	52			7	89					8	6		
10.5	71			24	18					53	25		
11.5	58			49	53					33	60		
12.5	23			34	84					34	52		
13.5	3			10	55					19	57		
14.5	1			2	26					4	17		
15.5				1	3						10		
Σ	217			207	511					151	227		1,313

Table A45

Family: Drepanidae
Species: *Drepane punctata*

Location: Java Sea (South Kalimantan)
Year: 1977

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
13													
15						1	–	–		–			
17						1	–	–		–			
19						0	1	4		–			
21						0	0	2		–			
23						7	0	3		2			
25						16	2	22		7			
27						28	4	24		16			
29						35	7	20		52			
31						11	14	20		93		2	
33						9	19	59		59		6	
35						5	17	51		19		38	
37						2	10	43		8		21	
39						1	4	18		5		17	
41						1	2	5		3		3	
						–	1	–					
Σ						117	81	271		264		87	820

Table A46

Family: Scombridae
Species: *Auxis thazard*

Location: Indian Ocean (Pelabuan Ratu, West Java)
Year: 1980

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25							14						
27							48					12	
29							130					24	
31							61					15	
33							67					21	
35					45		33			3	3	27	
37					132		110			21	11	23	
39					65		34			8	12	25	
41					13		8			5	4	17	
43					5		1			3		12	
45												4	
Σ					260		506			40	30	180	1,016

Table A47

Family: Scombridae
Species: *Auxis thazard*

Location: Indian Ocean (Pelabuan Ratu, West Java)
Year: 1981

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
15							6						
17					2		12			2			
19			1		7	2	14			2		2	
21			6	6	14	2	15			0		7	
23			6	5	37	12	22	6	42	5	3	15	
25			10	5	90	67	69	40	58	32	26	15	
27			7	4	86	88	60	43	6	30	31	6	
29	4		20	6	14	8	9	6	7	9		2	
31	0		16	23	9	11	30	2	4	2		1	
33	2		7	45	15	1	30	5	0	0		0	
35	3	7	26	61	16	2	18	22	7	2		5	
37	12	12	29	30	8	5	14	23	3	4		3	
39	13	11	8	5	8	2	1	18	3	2		1	
41	2	6	2	9	9			2	2			1	
43	2	5	2	1	1			2	2				
45	0	9						1					
47	0							1					
49	3							1					
Σ	41	50	140	200	316	200	300	180	134	90	60	58	1,769

Table A48

Family: Scombridae
Species: *Katsuwonus pelamis*

Location: West Pacific (Sorong, Irian)
Year: 1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
23												1	
26												2	
29												1	
32												11	
35												7	
38												2	
41		2										25	
44	3	5			1		1					56	
47	6	7	5	6	3	3	2			4		155	
50	16	17	4	9	4	4	3	5	2	21	2	261	
53	20	57	20	57	12	17	11	14	9	28	16	123	
56	15	48	21	56	9	9	6	13	13	38	15	55	
59	10	51	24	54	13	12	9	14	20	27	20	14	
62	0	21	16	25	4	5	6	4	10	13	14	4	
65	1	15	70	36	2	1		0	12	18	11		
68		18	7	14				1	7	9	8		
71		4	2	11					5	6	3		
74		4	1	5					1	1	1		
77										1			
Σ	71	259	170	273	48	51	38	51	79	166	90	717	2,013

Table A49

Family: Scombridae
Species: *Katsuwonus pelamis*

Location: West Pacific (Sorong, Irian)
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
37				1	1	–						–	
39				0	1	–						1	
41				10	7	1	1					0	
43				25	23	14	3					3	
45				46	23	21	12				4	5	
47				57	23	29	15	4	3		6	1	
49				53	25	33	38	23	4	3	36	15	
51				40	24	40	40	39	22	16	51	29	
53				37	23	39	48	57	32	15	48	28	
55				32	24	33	68	46	49	21	46	26	
57				26	13	35	106	64	22	8	35	34	
59				20	16	39	117	82	44	24	55	38	
61				19	14	13	84	42	59	35	20	16	
63				5	8	21	96	40	48	20	23	12	
65				4	4	15	93	68	27	38	53	44	
67				3	8	13	35	5	71	27	18	10	
69				–	0	3	8	12	21	18	6	1	
71					4	0	2	1	15	4		1	
73					3	0	0	2	3	–			
75						0	2	1	5	–			
77						2	1		2	–			
Σ				378	244	351	769	486	427	223	401	264	3,543

Table A50

Family: Scombridae
Species: *Rastrelliger brachysoma*

Location: Java Sea (Central Java)
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
5.5										2			
6.5										4			
7.5										8			
8.5										3			
9.5													
10.5													
11.5													
12.5					1								
13.5					4								
14.5					25								
15.5				14	24								
16.5				10	32				4				
17.5				19	52				9				
18.5				13	43				24				
19.5				22	21				32				
20.5				7	1				23				
21.5				1					5				
Σ				86	203				97	17			403

Table A51

Family: Scombridae
Species: *Rastrelliger kanagurta*

Location: Java Sea (Pekalongan)
Year: 1982-1983

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
8.5					27		–		–	–			
9.5					36		–		–	–			
10.5					37		–		–	–			
11.5					34		–		–	–			
12.5					4		1		1	–			
13.5					0		3		3	–			
14.5					0		5		24	1			
15.5					0		2	2	89	18		1	
16.5	11				32		1	5	123	62		0	
17.5	32				38		0	23	160	96	3	25	
18.5	89	6	5		22		0	117	68	61	57	168	
19.5	210	52	41	7	6		0	88	41	74	162	462	
20.5	260	111	133	47			4	38	27	38	231	352	
21.5	179	102	78	72			39	18	6	33	169	103	
22.5	50	56	30	94			81	2	1	10	48	20	
23.5	4	15	8	72			65				7	1	
24.5				16			12				1		
Σ	835	342	295	308	236		213	293	543	393	677	1,132	5,267

Table A52

Family: Stromateidae
Species: *Pampus argenteus*

Location: Java Sea (Central Java)
Year: 1978-1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
12.5											2		
13.5											18		
14.5											6		
15.5											8		
16.5											10		
17.5				1	4						13		
18.5				5	9						9		
19.5				18	47						9		
20.5				26	64								
21.5				15	61								
22.5				5	31								
23.5				3	25								
24.5				1	27								
25.5				2	11								
26.5				3	12								
27.5					9								
28.5					11								
29.5					3								
30.5													
Σ				75	84						327		486

Table A53

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1969

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
29.75	–	–	–		60	40	16	–	–	–	16	17	
31.25	88	66	117		120	291	290	255	137	200	159	154	
32.75	44	100	83		181	302	250	287	154	185	127	136	
34.25	73	116	33		151	100	305	256	205	171	191	85	
35.75	–	25	17		30	100	193	208	103	43	16	17	
37.25	15	42	50		15	190	274	256	86	57	8	34	
38.75	22	17	25		75	120	210	240	137	43	64	17	
40.25	58	66	25		15	30	32	64	34	178	127	53	
41.75	95	–	17		15	50	24	112	68	36	48	102	
43.25	22	17	25							14	16	17	
Σ	417	449	392		662	1,223	1,596	1,678	924	927	772	638	9,678

Table A54

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1974

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	8	126	465	262	211	86	349	292	130	260	157	345	
26.75	190	140	202	688	158	167	87	712	394	462	218	181	
28.25	148	307	310	317	531	273	163	500	681	265	76	198	
29.75	206	164	225	475	151	157	166	405	406	58	83	80	
31.25	123	179	123	297	306	332	32	647	526	72	33	97	
32.75	25	36	175	323	72	88	250	178	388	48	65	33	
34.25	37	27	78	71	96	35	29	67	233	27	7	21	
35.75	15	19	62	50	35	40	35	14	57	8	5	68	
37.25	22	2	25	32	17	8	19	58	206	3	1	10	
38.75	6	6	55	22	3	10	24	22	10	1	1	14	
40.25	4	3	24	10	5	4	8	14	20	3	4	1	
41.75	–	1	3	22	10	9	1	1	1	2	–	9	
43.25	–	–	1	–	–	4	6	–	4	1	–	–	
44.75	–	–	–	–	–	–	–	–	–	3	–	–	
Σ	784	1,010	1,748	2,569	1,655	1,217	1,228	3,039	3,156	1,227	650	1,057	19,340

Table A55

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1975

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	222	263	174	30	32	156	196	361	166	15	173	316	
26.75	143	356	126	152	213	106	103	86	136	143	145	149	
28.25	142	150	185	85	312	105	81	149	104	244	147	129	
29.75	212	110	143	240	79	117	110	130	215	210	131	87	
31.25	137	61	134	203	199	99	138	43	83	136	112	85	
32.75	76	28	90	139	69	225	68	69	129	34	41	38	
34.75	29	13	53	48	39	93	172	20	33	71	85	34	
35.75	21	10	40	38	29	65	55	58	81	26	35	51	
37.25	6	3	7	21	9	11	74	16	18	54	67	27	
38.75	8	13	27	11	20	8	14	33	10	20	27	57	
40.25	16	8	17	31	9	21	24	26	26	29	36	18	
41.75	–	–	–	9	–	–	7	4	–	–	–	–	
43.25	–	–	–	6	–	–	5	12	–	–	–	–	
44.75	–	–	–	12	–	–	12	2	–	–	–	–	
Σ	1,012	1,015	998	1,025	1,010	1,006	1,059	1,012	1,001	982	999	991	12,110

Table A56

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1976

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	1,632	311	882	1,237	334	507	529	244	102	642	295	159	
26.75	433	1,131	776	894	1,165	431	431	296	178	183	422	326	
28.25	525	395	2,811	1,685	684	952	471	202	382	78	75	270	
29.75	473	415	847	1,352	1,776	568	393	406	338	270	159	265	
31.25	625	206	871	1,205	568	1,635	878	181	254	254	76	316	
32.75	498	302	533	876	1,630	257	379	444	134	146	41	263	
34.25	195	102	673	325	262	534	195	94	389	307	22	97	
35.75	95	78	380	382	370	181	134	74	116	90	80	202	
37.25	139	31	317	241	97	102	309	28	94	87	7	47	
38.75	75	62	217	261	127	52	99	68	154	65	4	57	
40.25	56	10	117	292	67	102	179	18	124	103	17	97	
41.75	4	9	7	42	–	21	13	–	–	5	–	13	
43.25	10	–	21	33	–	–	–	–	–	–	–	–	
44.75	–	–	–	123	–	–	–	–	–	–	–	–	
Σ	4,831	3,052	8,452	8,938	7,110	5,352	4,010	2,055	2,[illegible]	2,235	1,198	2,112	51,610

Table A57

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1977

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	154	46	150	85	135	113	360	63	120	271	285	831	
26.75	75	215	84	170	119	299	132	86	115	144	152	165	
28.25	119	69	250	72	134	39	59	171	249	175	237	12	
29.75	88	196	88	209	143	136	92	242	54	11	89	2	
31.25	104	181	188	81	225	73	55	163	80	94	90	2	
32.75	109	131	116	197	44	152	135	54	26	99	44	4	
34.25	104	54	34	64	88	40	26	154	87	12	12	2	
35.75	84	42	28	45	39	83	74	44	29	70	43	11	
37.25	58	14	11	27	14	14	22	76	61	17	11	–	
38.75	29	40	19	18	35	23	11	9	140	87	29	–	
40.25	47	21	15	42	22	19	43	16	58	38	9	–	
41.75	9	4	6	2	–	–	–	–	–	–	–	–	
43.25	3	8	3	4	–	–	–	–	–	–	–	–	
44.75	5	3	9	3	–	–	–	–	–	–	–	–	
Σ	968	1,024	1,002	1,019	998	994	1,010	1,078	1,019	1,021	1,010	1,029	12,192

Table A58

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1978

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	349	137	130	109	212	360	229	356	211	188	434	10	
26.75	147	343	129	166	197	155	388	49	200	188	282	10	
28.25	69	153	496	108	67	172	41	157	107	242	2	95	
29.75	161	91	109	301	81	97	85	107	249	48	168	240	
31.25	92	104	41	124	261	36	50	74	65	180	105	168	
32.75	74	77	74	35	36	90	150	56	38	43	31	340	
34.25	8	11	9	72	38	12	25	134	95	15	12	40	
35.75	9	13	6	29	71	35	9	17	10	72	78	60	
37.25	23	19	12	11	17	12	21	35	–	10	–	–	
38.75	11	26	4	29	10	8	9	13	–	14	–	–	
40.25	13	15	2	14	28	7	10	23	–	7	–	–	
41.75	–	4	–	–	9	–	13	–	–	–	–	–	
43.25	–	8	–	–	14	–	6	–	–	–	–	–	
44.75	–	15	–	–	6	–	5	–	–	–	–	–	
Σ	956	1,016	1,012	998	1,047	984	1,041	1,021	979	1,007	1,112	963	12,136

Table A59

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1979

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	616	536	477	1,282	214	819	588	360	306	272	835	491	
26.75	116	965	380	313	548	598	434	804	128	252	791	350	
28.25	140	457	1,246	432	333	727	879	139	196	801	268	181	
29.75	14	203	48	625	818	341	426	489	35	37	626	29	
31.25	75	85	162	322	142	841	162	53	72	89	109	128	
32.75	11	192	48	156	458	313	286	165	17	15	176	48	
34.25	1	14	107	178	65	160	58	35	42	45	6	11	
35.75	7	25	22	42	108	79	18	20	7	7	16	8	
37.25	29	44	58	57	25	175	78	13	4	2	7	23	
38.75	8	93	38	88	32	55	10	63	15	1	11	1	
40.25	16	33	70	46	43	36	26	8	2	10	6	2	
41.75	–	–		–		7	–	2	1	0	21	9	
43.25	–	–		–		2	–	10	4	2	–	1	
44.75	–	–		–		9	–	4	7	1	–	4	
Σ	1,033	2,647	2,656	3,541	2,786	4,162	2,965	2,165	836	1,534	2,872	1,286	28,483

Table A60

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1980

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	215	298	201	149	274	85	25	51	35	48	–	105	
26.75	313	104	242	183	122	351	57	208	83	348	173	128	
28.25	210	330	101	134	162	138	702	177	197	339	373	376	
29.75	110	55	274	98	103	166	72	342	194	51	207	174	
31.25	73	39	71	296	57	99	40	117	345	189	49	97	
32.75	22	23	47	61	157	55	20	64	91	45	143	41	
34.25	77	10	27	30	19	132	63	18	30		9	127	
35.75	12	37	70	13	9	25	10	53	70		6	35	
37.25	7	8	18	29	28	10	3	13	21			7	
38.75	2	13	5	11	8	31	5	5	4			2	
40.25	12	3	15	9	8	9	13	23	7			12	
41.75	–	–	–	–	1	15	–	–					
43.25	–	–	–	–	11	5	–	–					
44.75	–	–	–	–	4	15	–	–					
Σ	1,053	920	1,071	1,013	963	1,136	1,010	1,071	1,077	1,020	960	1,104	12,398

Table A61

Family: Penaeidae
Species: *Penaeus merguiensis*

Location: Arafura Sea
Year: 1981

Midlength	J	F	M	A	M	J	J	A	S	O	N	D	Σ
25.25	353	54	119	79	253	160	209	38	138	306	237		
26.75	138	255	151	122	321	216	162	303	199	270	147		
28.25	203	83	369	56	341	212	11	83	397	231	55		
29.75	61	151	94	354	212	166	40	115	183	78	4		
31.25	46	60	223	70	45	90	20	182	108	314	11		
32.75	28	8	72	36	122	36	19	98	56	66	–		
34.25	2	5	49	22	31	63	7	63	27	35	–		
35.75	7	5	9	15	25	23	6	61	13	28	–		
37.25	1	–	32	6	10	11	18	18	16	14	–		
38.75	2	–	9	19	8	9	6	48	46	10	–		
40.25	–	–	3	14	5	8	5	8	6	34	–		
41.75	–	–	–	–	14	17	7	2	2	3	–		
43.25	–	–	–	–	–	5	24	3	1	4	–		
49.75	–	–	–	–	–	9	8	3	6	13	–		
Σ	927	621	1,130	783	1,387	1,025	520	1,025	1,198	1,406	454		10,476