WP 4

THE RELEVANCE OF DATA COLLECTED IN PAPUA NEW GUINEA TO SKIPJACK POPULATION STUDIES IN THE WESTERN PACIFIC

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During the course of the Papua New Guinea pelagic fisheries research program, tagging skipjack has received priority until quite recently. Results of the tagging experiments thus comprise a large part of the data potentially applicable to skipjack population studies. Other data likely to be useful include:

i) length/frequency data from research vessel and commercial catches

ii) information on spawning periodicity

iii) variation in abundance/availability inferred from the catch effort data

iv) genetic data

v) growth rates

Little information is available in other potentially useful areas such as meristics, morphometrics and fecundity.

Many factors caution restraint in the interpretation of the available data. Population structure in P.N.G. adjacent waters is clearly not simple. Skipjack are available all year round, but abundance as inferred from catch effort data varies widely within years between years and between adjacent areas. The limited length frequency data indicates that the fishery is basically a size-specific one, dependent on more or less continuous recruitment. Some size specificity by area is also apparent (Lewis, MS). Spawning in the region appears to occur year round (Ueyanagi, 1969), although a peak in spawning activity is discernible (Lewis et, al, 1974). Fishing effort in surrounding areas, other than the Solomon Islands, is patchy, since the Japanese southern water fishery does not operate year round and effort is not uniformly distributed, being biassed towards areas of maximal skipjack availability. Difficulties posed by this are exacerbated by the time lag between collection and distribution of catch statistics from this fishery. No reliable ageing method is yet available for skipjack although optimism surrounds the otolith "daily" growth ring studies. All releases of tagged skipjack were from aggregations whose genetic makeup is unknown. Collection of biochemical data in conjunction with tagging is a recent undertaking only and very few results are to hand.

Despite these difficulties, there are some positive factors. The data from the Papua New Guinea fishery are sound, and as the fleets operate on a short-range basis from fixed localities, can be used to gauge availability in these areas with some confidence. The results of the tagging experiments compare favourably with others involving skipjack and are probably as good as can reasonably be expected.

Tagging Experiments

Results of these for 1971-72, 1973, 1974 and 1975 have been summarized in detail in a series of internal reports (Lewis et al, unpublished) but the following points are worth restating:

i) the local migration pattern observed (i.e. clockwise movement around the Bismarck Sea with later retracing), although complex, appears consistent within and between years

ii) a high proportion of recoveries, even after long periods at liberty, were made within the P.N.G. area. Even allowing for the irregular temporal and spatial distribution of effort in adjacent area, this indicates that the geographical range of elements of the exploited stock may centre on the P.N.G. area.

iii) all 45 recoveries made beyond the P.N.G. area (Figure 1) lie within the proposed limits of Fujino's western Pacific sub-population. Genetic analysis of all blood samples taken in the area have also identified the skipjack as belonging to the western sub-population.

iv) despite expenditure of considerable amounts of effort by the Japanese home and southern water fleets in the western Pacific north of 10°N, no skipjack tagged in P.N.G. have been recovered there (Figure 1). However, skipjack tagged north of 10°N by Japanese scientists have been recovered within the P.N.G. area (Figure 2).

v) a very low recovery rate has been obtained from fish tagged by the usual method in the northern Coral Sea: these fish do not appear to enter the Bismarck or Solomon Sea fisheries to any extent.

Basic agreement with the broad aspects of Fujino's hypothesis are indicated (point iii). His division of the western sub-population into two groups may however be an over-simplification. What seems more likely is the existence of a number of components, possibly genetically distinct, whose centres of distribution are geographically separated but whose overall distribution overlaps to a large degree. For example, points (iv) and (v) suggest that at least three components exist in the P.N.G. area alone - one centred north of the Equator, but ranging south into P.N.G.; another perhaps centred on the Bismarck Sea, but ranging west to Irian Jaya, north of the Equator (but not further north than 10°N) east to the sub-population boundary and at least as far south as the Solomon Islands, with a third group centred south of P.N.G., but ranging into the area. The total number of such groups or components making up the western sub population could well be much higher. In this respect i.e. internal structure, the P.N.G. data shows closer agreement with the models of Matsumoto (1974) and Kawasaki (1955a, 1955b, 1964), both of whom recognize the presence of moderate number of components within the western Pacific sub-population, or at least the area typically occupied by it. It would seem highly desirable in future tagging work in the area to collect genetic/biochemical data concurrently, enabling genetic identity and homogeneity within each lot of releases to be established.

Length frequency data

Data on size composition of the catch is available from two sources:

i) the daily catch statistics, from which the average size of skipjack and yellowfin taken each day can be read off. A sample (20-30 fish) is taken from the thoroughly mixed catch of each vessel during weighing operations on the mother ships to obtain this. Daily averages are rarely used in their own right, but contribute to the more frequently used monthly averages by company, boat and area.

ii) length frequency data obtained at the same time by Government employees. The scarcity of adequately trained technicians has hampered collection of this information. There is a reasonable series of samples for 1972-73 (Figures 3, 4 & 5) but very little for 1974-75.

Only the length frequency data for 1972-73 is considered here. In the figures for the Cape Lambert fishery (Figs. 3 & 4) an absence of modal progression is immediately evident i.e. the fishery tends to be size specific, presumably because of continual movement of skipjack through the area. The data from the New Hanover fishery, 100 miles north, shows more irregularity (Figure 5) but still no obvious modal progression. Tagging results (Lewis et al, unpublished data) have shown movements through this sector of the fishery to be more complex, with some influxes not penetrating as far south as the Cape Lambert fishery.

Cursory analysis of data from adjacent area (Solomon Islands, Caroline Islands) gives cause to believe that a similar pattern (i.e. size specificity with continuous recruitment though not always fish of identical size) may be common to most equatorial areas, where internal structure of the population may be at its most complex.

The rarity of large skipjack in the catch is conspicuous as has been noted by Kearney (1975) and is not a function gear selectivity (Lewis et al, 1974). This may prove to be an important characteristic of the western sub-population, possibly related to oceanographic conditions.

Wider application of the length frequency data has thus far been restricted by the lack of a reliable ageing technique for the species.

Spawning periodicity

(to be inserted later)

Variations in CPUE

(not included)
Figures 6 & 7 show the variation in CPUE (monthly) for two companies during the five year period 1971-75. These data in general, show the general absence of seasonality in the fishery and reflect the variation in availability between years. This tends to confirm what was inferred from the length frequency data i.e. recruitment occurs rather irregularly.

Genetic/biochemical data

At the time of writing, six large series, each consisting of at least 130 individual samples, had been collected for analysis of serum, esterase and transferrin allele frequencies by IATTC staff (Table 1). Results of the four analysed so far reveal considerable heterogeneity within each series with respect to esterase 2 frequencies: there is also heterogeneity in esterase 2 frequencies between series. This is in contrast with material collected in New Zealand which exhibits striking homogeneity (G. Sharp - pers. comm.) and further highlights the complexity of the P.N.G. situation.

Six smaller lots (sample size 14-30, total 123 fish - Table 1) have been sent to Professor Fujino, as have three other samples (54 fish) collected in the P.N.G. area by Japanese scientists in November-December 1972. All proved, on the basis of the frequency of the E'$_{sj}$ allele to belong to the western Pacific sub-population (Fujino, MS).

It is hoped to expand involvement in this field and begin collecting morphometric data at the same time, to facilitate more direct inter-areal comparisons.

Growth rates

In the absence of a reliable ageing technique and as the length frequency data does not lend itself to modal progression analysis, the release/recapture information remains the best available data for estimates of skipjack growth rates in the P.N.G. area. Over the size range 50-60 cm, estimates of 6-8 cm growth per year have been derived from the data. (West in MS). These annual increments are considerably lower than those obtained elsewhere from tagging and other data.

Otoliths collected from skipjack in the P.N.G. area have been examined by two overseas workers in the field, with both obtaining comparable estimates for this size range of skipjack (Worker A - 20 cm p.a., Worker B - 30cm p.a. - Figure 8). Although the "ages" ascribed were regarded as preliminary by both workers, growth rates beyond the adolescent or juvenile stage are felt to be less prone to error because the rings close to the focus, which are often difficult to read, need not be considered.

It could thus be implied that the effects of tagging process and/or ransport of the tag may inhibit normal growth. This is difficult to confirm but there are indications that this may not be the case. Firstly, growth observed in double and single tagged skipjack does not appear to be significantly different although available data is limited. Secondly in otoliths from recaptured skipjack sent to one worker, the growth checks noted by him and presumed to be caused by tagging bore little relation to the time of release (see below). "Ages" given for the tagged fish differed little from untagged fish (Figure 8).

LCF	Estimated days at liberty (i.e. since growth check)	Actual days at liberty
60.2	91	348
58.9	336 - 339	340
59.8	20, 76 or 96	394
56.2	120 - 180	58

Footnote: The days at liberty data was supplied with the otolith for the second fish only.

As the estimates from otolith readings are in closer agreement with previous studies in other areas of the Pacific, the reasons for the discrepancy between tag data and this data needs to be clarified before inter-areal comparisons of growth rates can be made.

CONCLUSIONS

The value of the P.N.G. data lies in its confirmation of the complexity of the internal sub-population structure, particularly in equatorial areas; it underlines the need for a multidisciplinary approach if significant advances in unravelling this complexity are to be made - in the ideal situation, from each tag release set, biochemical, otolith, morphometric and reproductive material should be collected concurrently as a minimum in future studies. Practical considerations will probably necessitate some compromise. Attention needs to be directed also at refining ageing techniques, and improving international access to all available length frequency and catch effort data which should additionally be upgraded if deemed to be inadequate at present. It seems doubtful if any one country has the resources or finance at its disposal to tackle these formidable problems alone.

Table 1

SKIPJACK BLOOD SERIES COLLECTED IN THE PAPUA NEW GUINEA AREA

Date	Series Size	Locality	Size Range (cm)	Other data collected
26/10/75	146	3°55'S,151°21'E	49-63	Otoliths
27/10/75	162	3°55'S,151°15'E	49-63	Otoliths
13/11/75	154	11°52'S,154°22'E	43-51	Otoliths, 160 tagged
12/11/75	200	11°18!2'S,150° 52'E	46-60	Otoliths, 105 skipjack tagged
19/4/76	139	2°00'S,150°30'E	n.a.	Nil
18/6/76	179	2°45'S,150°10'E	44-51	Morphometrics
Jan.-March 1975	21	Port Moresby (9°40'S,147°10'E)	51-62	-
11/11/75	17	9°40'S,147°05'E	55-58	Gonad weight, 21 skipjack tagged
28/11/75	13	9°11'S,153°54'E	29-34	160 skipjack tagged
1/12/75	30	9°27'S,153°57'E	27-36	84 skipjack tagged
2/12/75	20	9°16'S,153°59'E	45-55	Gonad weights, 4 skipjack tagged
2/12/75	20	9°14'S,153°56'E	29-69	Otoliths, gonad weights, 10 skipjack tagged

FIGURE 1

Tag Recoveries outside Papua New Guinea adjacent waters.

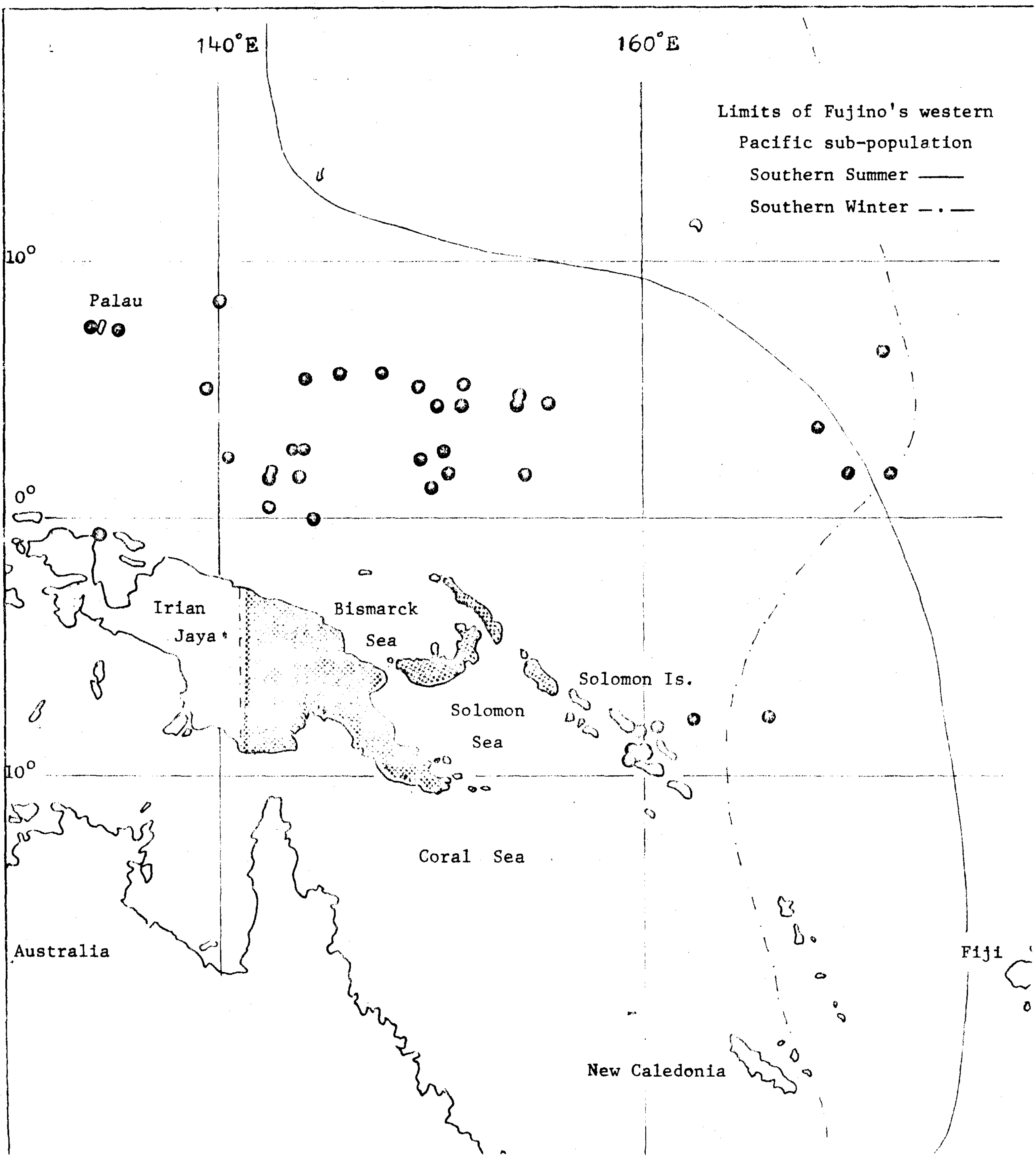


FIGURE 2

Selected Recoveries of Skipjack tagged north of Papua New Guinea by Japanese research organizations.

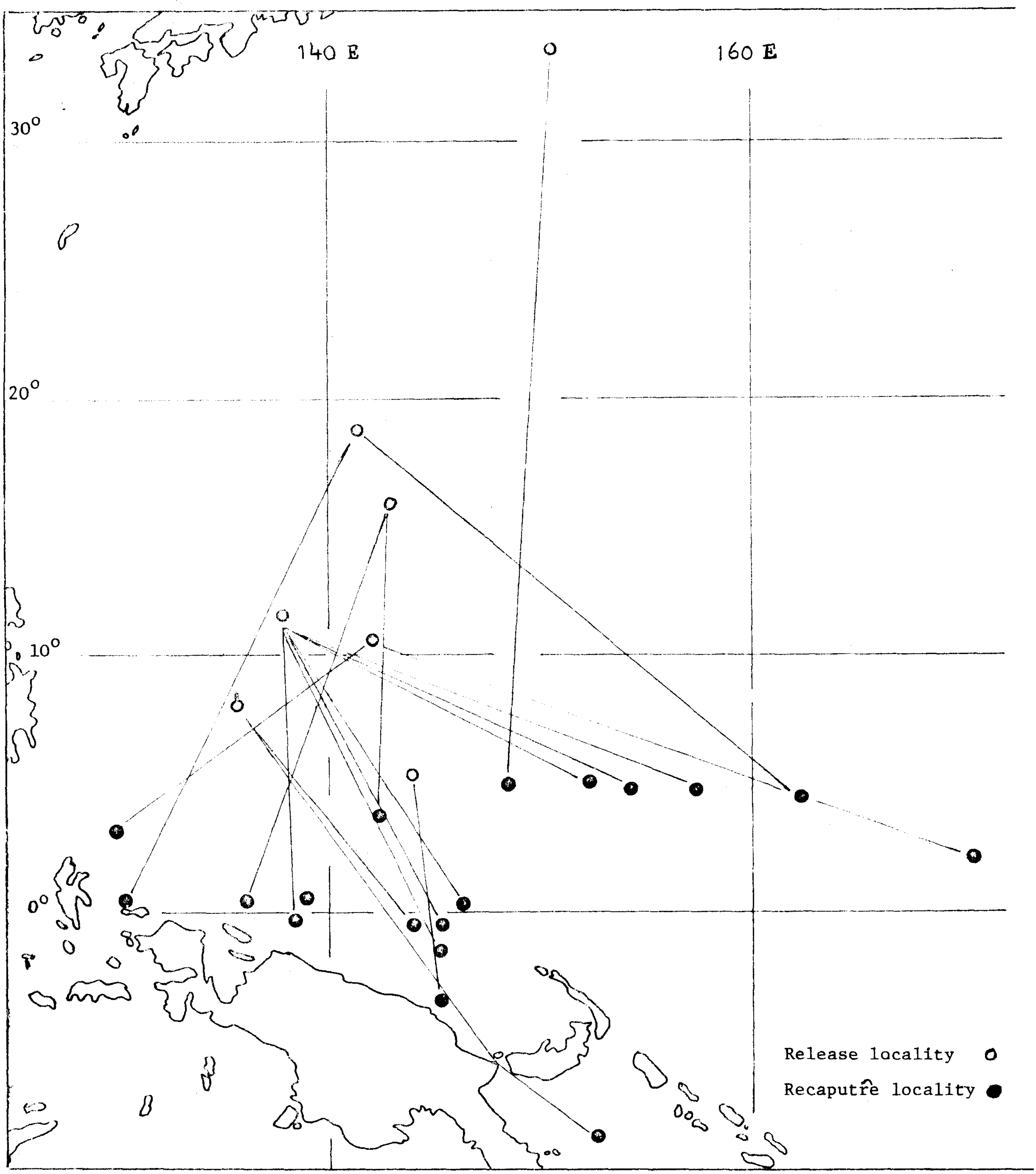


FIGURE 3

Length Frequency Data from the Cape Lambert Fishery during 1972.

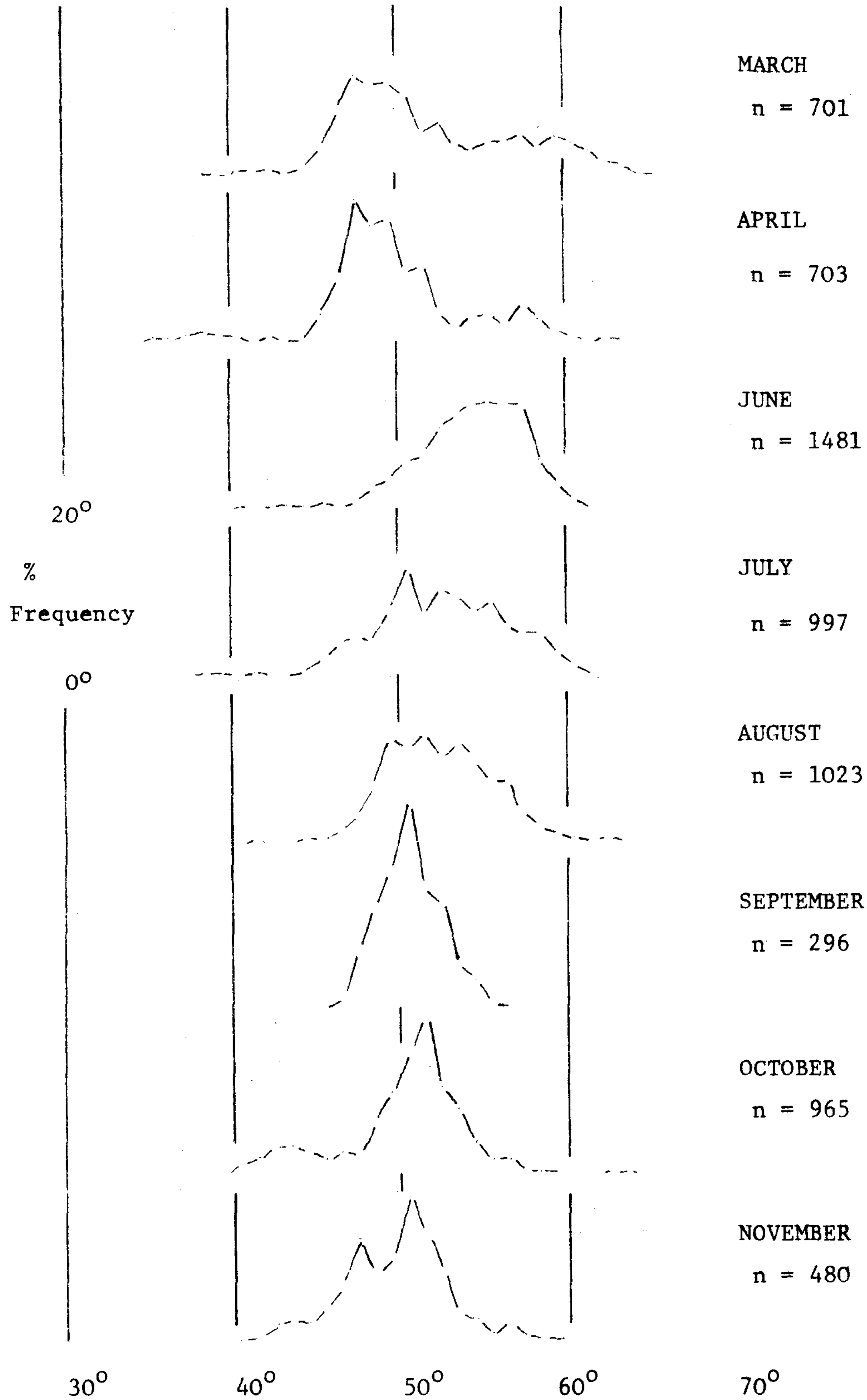


FIGURE 4

Length Frequency Data from the Cape Lambert Fishery during 1973.

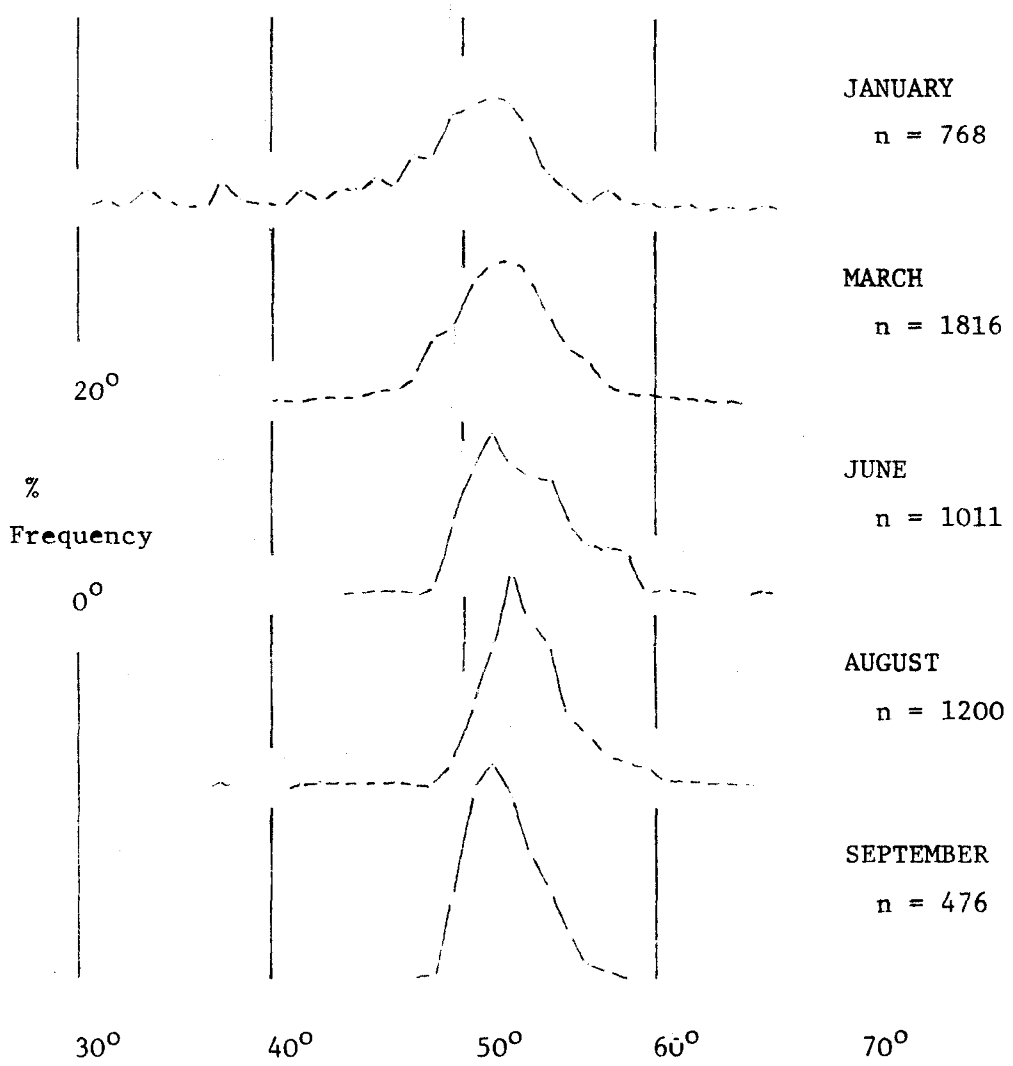


FIGURE 5

Length Frequency Data from the New Hanover Fishery during 1972.

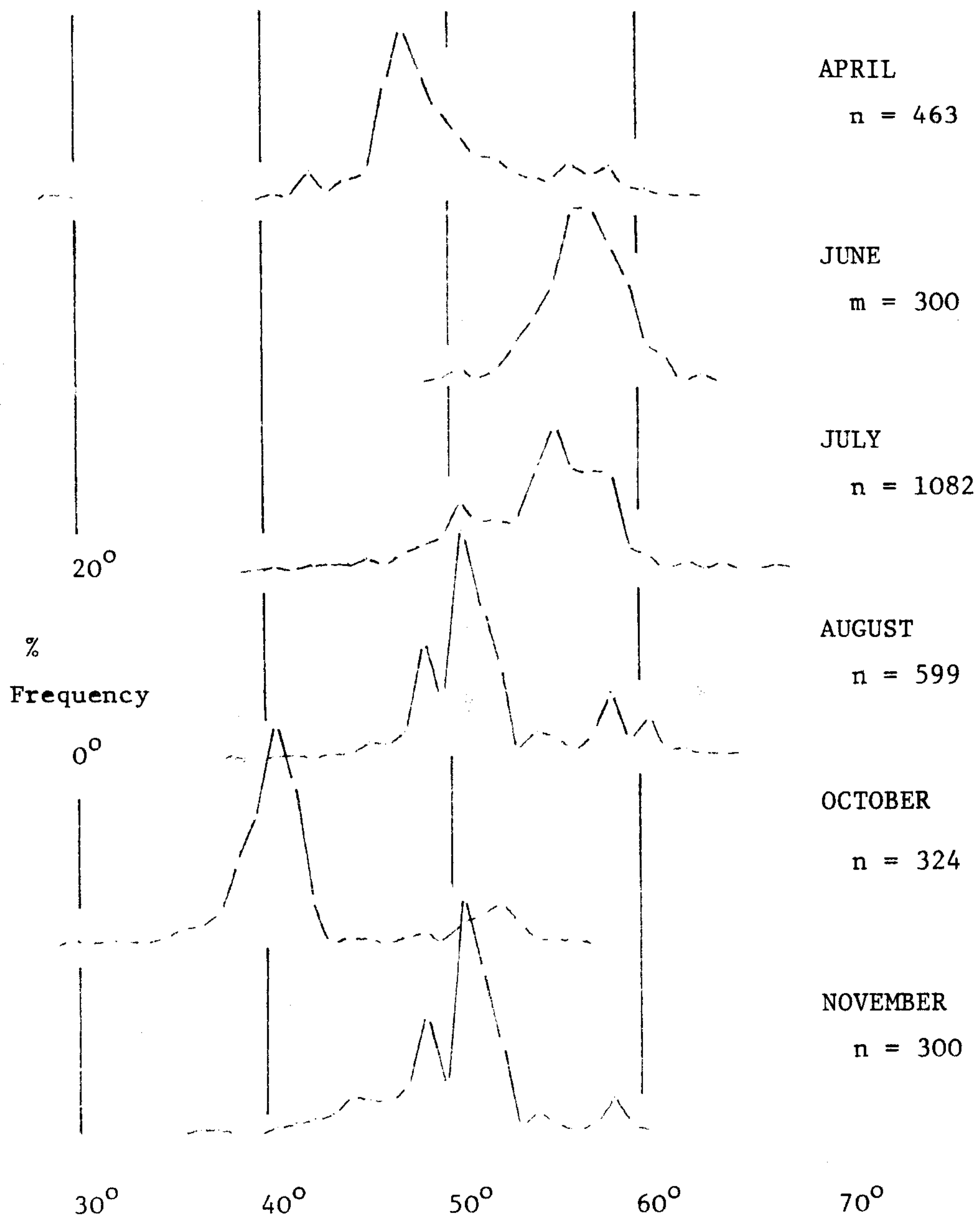


FIGURE 6. Monthly CPUE (Company A) for the years 1971 to 1975. Months when the number of fishing days did not exceed 80 days have not been included.

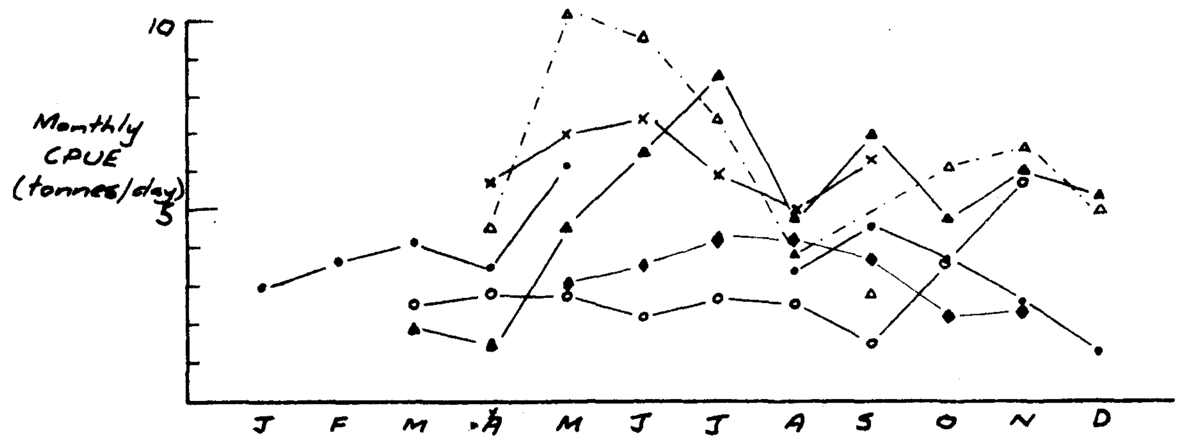
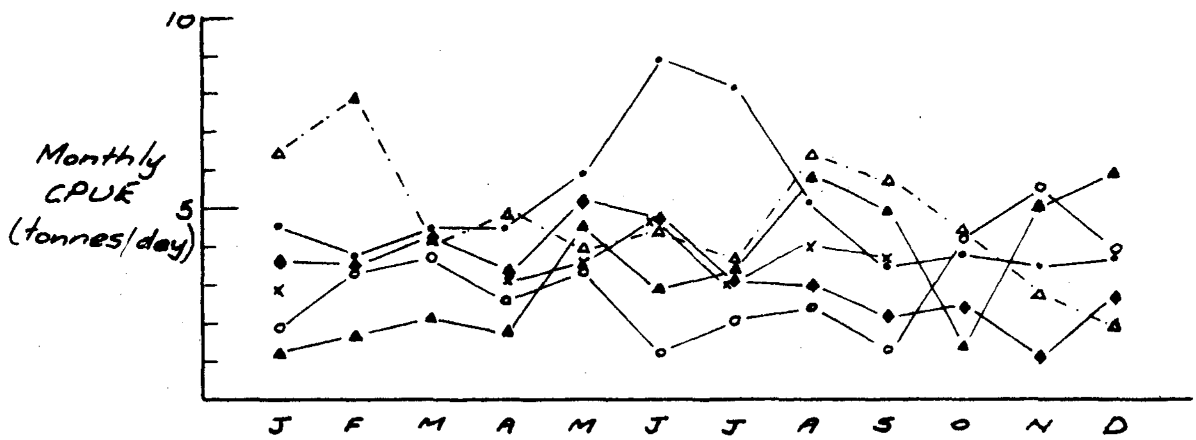
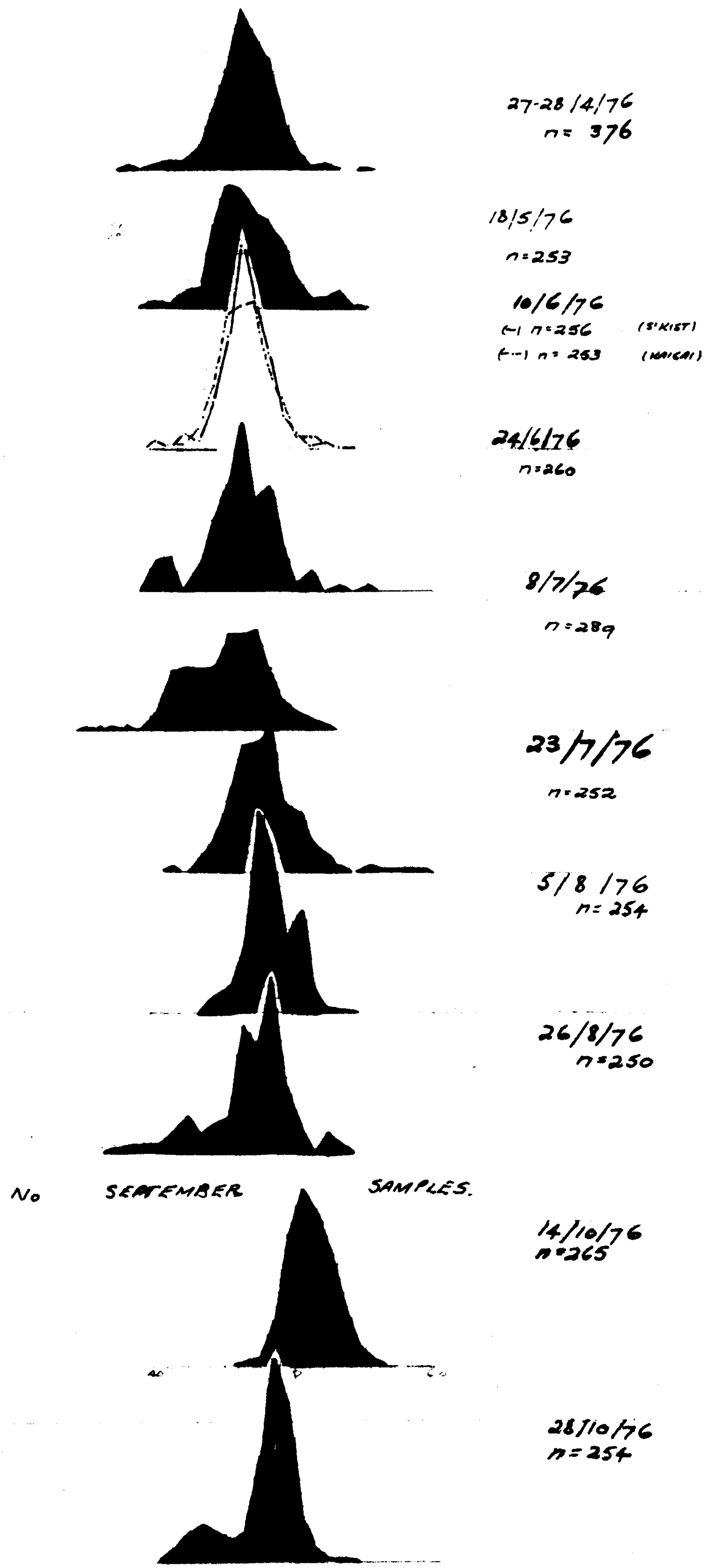


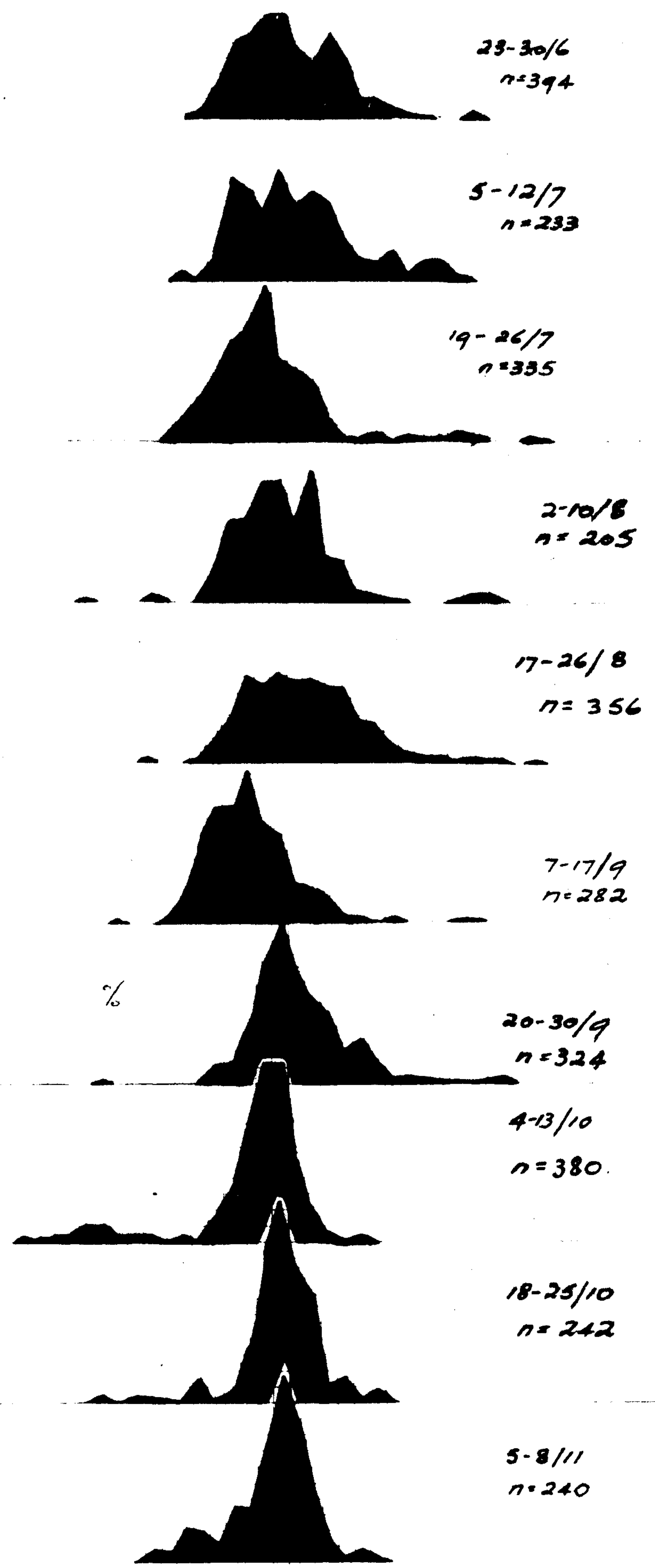
FIGURE 7. Monthly CPUE (Company B) for the years 1971 to 1975.



Key to symbols used.

1971	● —— ●
1972	○ —— ○
1973	▲ —— ▲
1974	△ —— △
1975	◆ —— ◆
1976	× —— × (incomplete)


27-28/4/76
n= 376
18/5/76
n=253
10/6/76
(—) n=256 (S'KIST)
(-·-) n= 253 (WAICAI)
24/6/76
n=260
8/7/76
n=289
23/7/76
n=252
5/8/76
n=254
26/8/76
n=250
No SEPTEMBER SAMPLES.
14/10/76
n=265
28/10/76
n=254



23-30/6
n=394
5-12/7
n=233
19-26/7
n=335
2-10/8
n=205
17-26/8
n=356
7-17/9
n=282
%
20-30/9
n=324
4-13/10
n=380
18-25/10
n=242
5-8/11
n=240

FIGURE 8

Results of Age & Growth Studies on Otoliths from Papua New Guinea Skipjack by two Workers.