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A LOOK INTO THE RELATIONSHIP OF LARVAL SKIPJACK TUNA TO COMMERCIAL LANDINGS IN HAWAII AND EASTERN PACIFIC

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Sampling for tuna larvae has been done over many years by the Honolulu Laboratory and has resulted in the accumulation of a large number of plankton samples. However, due to spotty coverage of both time and space and the employment of various types of towing methods, the usefulness of the data for large area-long term considerations is limited. We can thus look at the relationship of skipjack tuna larvae to commercial landings only on a very rough basis.

Definition of Areas

Figure 1 shows the number of tows made in each 5° square sampled by our vessels and the areas selected for this analysis. The areal separation was based roughly on the major ocean currents: Hawaii, in the North Equatorial Current, from 10°N to 30°N; Equatorial Countercurrent (ECC), from 5°N to 10°N; and South Equatorial Current (SEC), from 5°N to 10°S. Each of the areas within the ECC and SEC was looked at separately, but the distribution of tows in each area was too spotty for analysis. Consequently, the three areas in the ECC were combined, as well as those in the SEC. Even so, the data still showed gaps in the yearly coverage (Table 1).

Hawaii (Area 1)

Because of poor sampling in the first and fourth quarters (Table 1) and the fact that nearly all of the larval catches occurred in the second and third quarters (Figure 2), the larval catches were plotted by year instead of by quarters. It is of course assumed that since spawning occurs nearly equally in the second and third quarters, the catch rate in either quarter or in both quarters combined would be a representative measure of the yearly abundance of larvae.

Figure 3 shows the skipjack tuna larvae taken per tow, with catch rates plotted separately for the surface and oblique tows. The overlay for the figure shows the annual landings of skipjack tuna by the local aku fleet. The catches in the overlay are given in annual landings rather than in (Uchida's) catch per standard effective trip (CPSET), since the two do not differ by much and the CPSET values were not available beyond 1965.

Despite doubts about the data, a simple test (Spearman rank correlation coefficient: r_s) was made to see if any possible relationship existed between larval and adult catches. Summary below:

Surface tows

	r_s	t	df	P(2-tail)
Same year	0.217	0.588	7	>0.50
1 year lag*	0.158	0.423	7	>0.50
2-year lag	Negative			
3-year lag	0.533	1.667	7	>0.10

Oblique tows

	r_s	t	df	P(2-tail)
Same year	0.679	2.068	5	<0.10
1 year lag	Negative			
2-year lag	Negative			
3-year lag	0.214	0.490	5	>0.50

*Fish catch 1 year after larval catch.

The larval catch curve for the oblique tows appears to follow that of the annual landings for the same year. Although the test showed no significant correlation, perhaps more data points could have provided positive results. It seems logical to expect that a large spawning would reflect the presence of a large spawning population, which in turn would result in large catches of adults. Other comparisons with a 1 year, 2-year or 3-year lag in the landings curve were far from being significant.

The closest to being significant among the surface tows was the 3-year lag comparison. The failure to attain significance could have been due to lack of data in 1958, 1960, and 1966-68. Other causes, however, cannot be ruled out. For example, the local fishery is extremely confined in range. Consequently, its annual catches may not truly reflect the abundance of fish in the area. Seckel has shown that good catches by the fishery occur when the transitional water in the California Current Extension passes through the island chain and low catches when this water is either to the north or south of the islands. If the skipjack tuna are truly associated with this type of water and the center of abundance shifts in unison with it, then those years of poor catches could be the result of the fleet's inability to reach the concentrations of fish rather than an indication of a drop in the abundance of the fish. If this situation holds true, then there is no reason to expect correspondence between larval catches and commercial landings in these waters. This would be especially true when the transition water moves to the north of the islands, for fish could spawn in local waters during their passage northward and be out of range of the fleet within a day or two.

Closer correlation could be obtained if sampling for larvae had been confined to within the limits of the fishery. Although the number of tows are large within the 5° squares adjacent to the islands, most of these tows were from sites beyond the range of the fleet.

Equatorial Countercurrent (Areas 2-4) and South Equatorial Current (Areas 5-7)

Figure 2 (lower two panels) shows the occurrence and catch of skipjack tuna larvae by month. With a few exceptions, larvae have been taken relatively evenly throughout the year. Consequently the catch rates of any or all quarters were assumed to be a representative measure of the yearly abundance of larvae.

Figure 4 gives the catch rates of skipjack tuna larvae in the ECC and SEC areas. The catches are all from oblique tows, since surface tows were not made there over any extended period. The overlay for Figure 4 gives the total annual landings and catch per day's fishing standardized to Class 4 bait boat. The standardized CPDF was used because data points could be found or estimated to the year 1951. As in the Hawaii data the Spearman rank correlation test was used to determine the larval-adult relationship. The summary of the test is as follows:

Equatorial Countercurrent

	r_s	t	df	P(2-tail)
Same year	0.067	0.178	7	>0.50
1 year lag	0.636	2.331*	8	<0.05
2-year lag	0.539	1.811	8	>0.20
3-year lag	Negative			

South Equatorial Current

Same year	Negative			
1 year lag	Negative			
2-year lag	0.483	1.459	7	>0.17
3-year lag	0.167	0.449	7	>0.50

Taking these results for what they are worth, it seems that there is a significant correlation between larval catch in the Countercurrent area and fishery landings 1 year later. At least the large proportion of small fish taken in the eastern Pacific fishery, if these are 1 year olds, bear this out. On the basis of an equally large proportion of 50-60 cm fish in the eastern Pacific, there should also be a significant correlation between larval catch and adult catch 2 years later. This could show up with better sampling.

There also is a likelihood that the 2-year lag correlation in the SEC area could be significant with better sampling data. If so, the question is, could some of these fish also swing north, thence eastward, and into the eastern Pacific fishery?

Countercurrent vs. Hawaii

Several authors have suggested that some portion of the skipjack tuna landed by the Hawaiian fishery come from the ECC area. Such a movement is not discernible from a comparison of larval catches in the ECC and commercial landings in Hawaii (below):

	r_s	t	df	P(2-tail)
Same year	Negative			
1 year lag	0.224	0.649	8	>0.50
2-year lag	0.212	0.614	8	>0.50
3-year lag	Negative			

The lack of correlation again could be due to insufficient sampling of larvae or to the unreliability of the Hawaiian landings, per above discussion.

Closing Remarks

The lack of significant correlation between larval catches and skipjack tuna landings in Hawaiian waters could be due to inadequate sampling for larvae, to the restricted range of the fishing fleet, or to both. Meaningful data to assess adult abundance in these waters and to determine better larval-adult catch relationships may not be possible until the Hawaiian fleet increases its capabilities to fish over a wider range.

Whether the significant correlation found between larval catches in the Countercurrent area and adult catches in the eastern Pacific fishery is real or fortuitous, remains to be seen. My reservation is due to doubts about (1) the adequacy of the larval catch data in the area east of 140°W, and (2) the failure of the 2-year lag comparison to show significant correlation, contrary to what one would expect from looking at the size composition of the catches in the eastern Pacific fishery.

May 2, 1975

Table 1.--Distribution of tows by quarters

Hawaii (Area 1 = 10° to 30°N; 145° to 170°W)

	Year	Quarters with plankton tows				No. tows
		I	II	III	IV	
Oblique	1951		39	12	74	125
	1952			30		30
	1953	60	29	72	6	167
	1954		21			21
	1955			12		12
	1956		40	44		84
	1957				19	19
	1958		8	2		10
		60	137	172	99	468
Square	1956			2		2
	1957		17	44	4	65
	1958					--
	1959			24		24
	1960					--
	1961		6	39		45
	1962			9		9
	1963			12	6	18
	1964	39	57	33	58	187
	1965	58	57			115
	1966					--
	1967					--
	1968					--
	1969		19			19
		97	156	163	68	484

OVERLAY FOR FIG. 3

ANNUAL LANDINGS OF SKIPJACK IN HAWAII

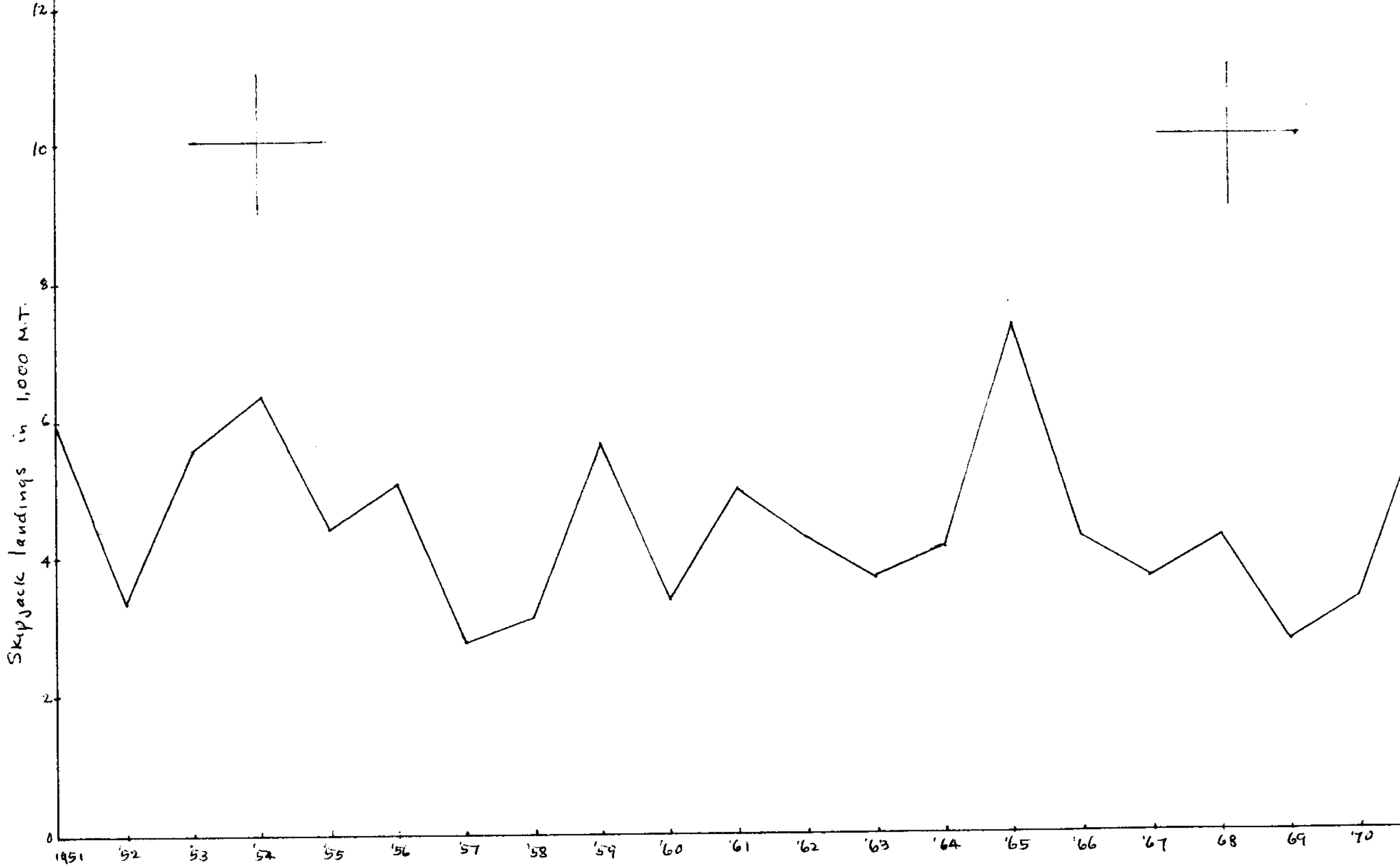
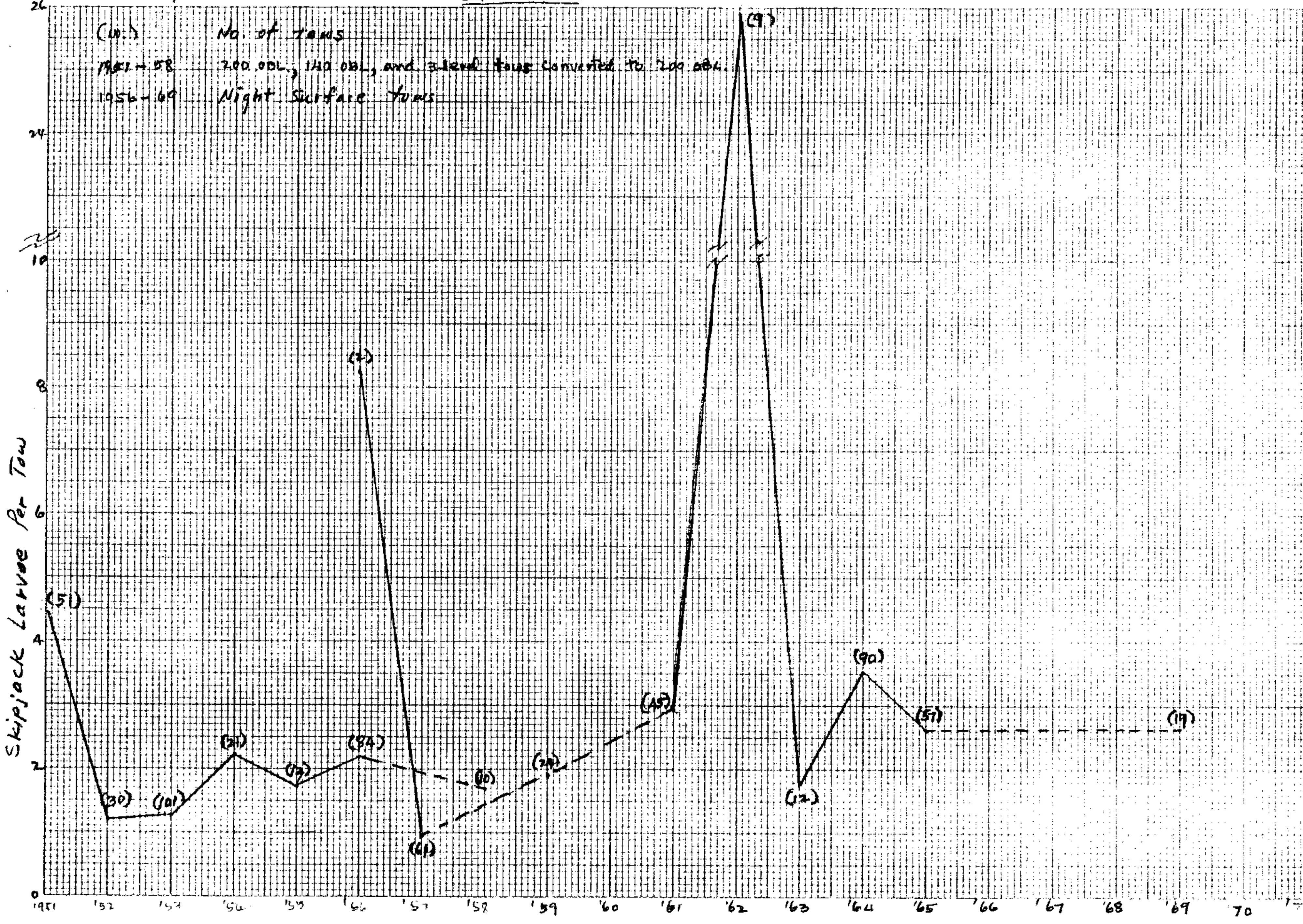


Fig. 3 - LARVAL SKIPJACK PER TOW IN HAWAIIAN WATERS



OVERLAY FOR FIG. 4

LANDINGS AND BAITBOAT CATCH-PER-DAYS FISHING IN THE EASTERN PACIFIC

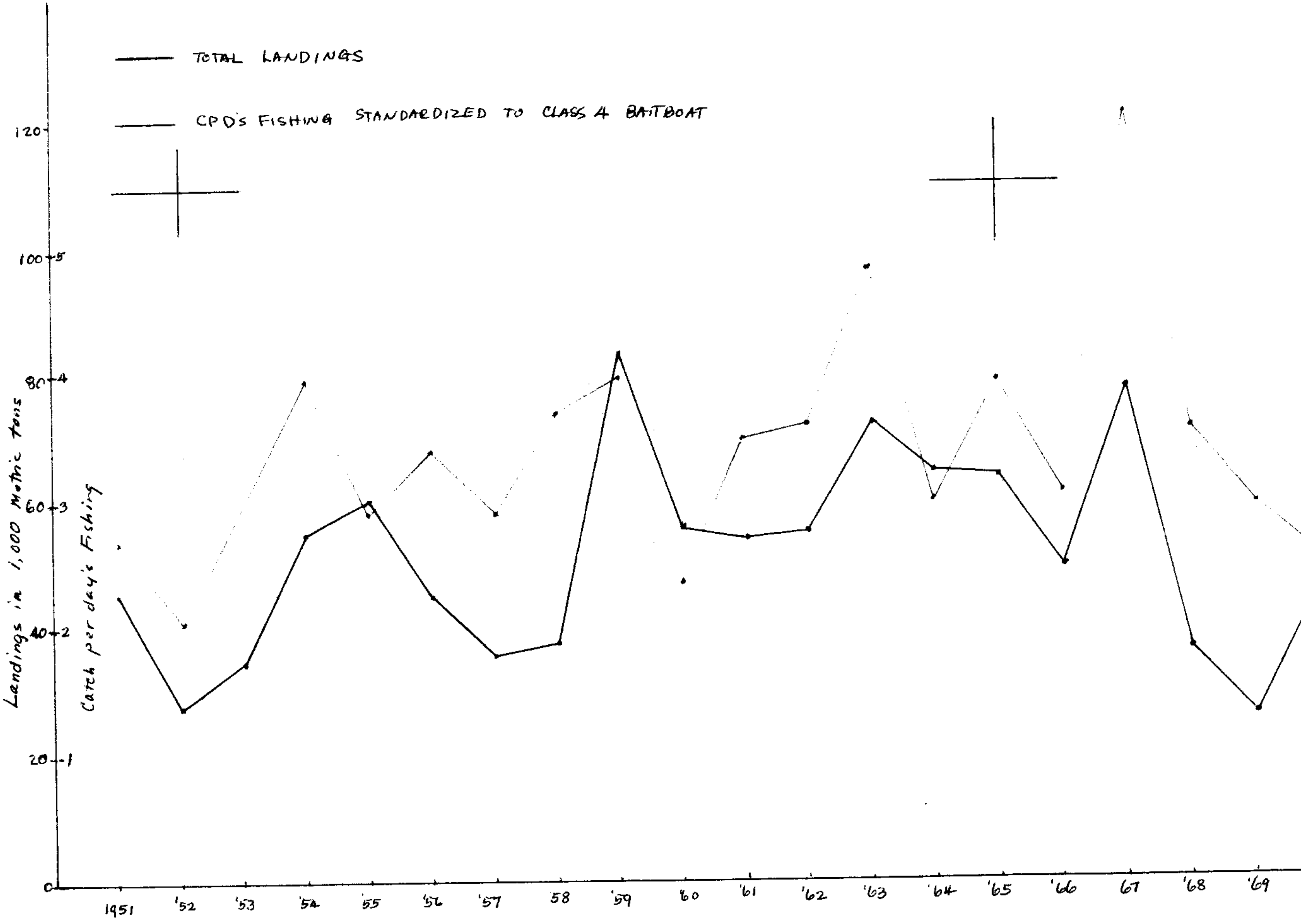


Fig. 4 — LARVAL SKIPJACK CAUGHT IN EQUATORIAL WATERS (OBLIQUE TOWS)