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OBSERVATIONS ON THE GROWTH OF YELLOWFIN TUNA IN THE EASTERN PACIFIC OCEAN DERIVED FROM TAGGING EXPERIMENTS

by

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PREFACE

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PREFACIO

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INTRODUCTION

Data from tagging experiments initiated prior to 1960 were used to study the growth of yellowfin tuna, *Thunnus albacares*, by Yabuta and Yukinawa (1959), Blunt and Messersmith (1960), Schaefer, Chatwin, and Broadhead (1961), and Suzuki (1971). A considerable amount of data has accumulated since that time, which makes it desirable to again study the growth of yellowfin from tagging data.

ACKNOWLEDGMENTS

Advice and assistance with the analysis of the data were rendered by Drs. Robert C. Francis and William H. Lenarz and Mr. Christopher T. Psaropulos.

MATERIALS AND METHODS

The methods of tagging the fish and handling the tag return data are described by Fink (1965), Fink and Bayliff (1970), and Bayliff (1973). Most of the calculations were performed on the CDC 3600 and Burroughs 6700 computers at the University of California at San Diego. The following programs were used for this purpose:

least-squares regression--Weighted Linear Regression for Two Variables (Paulik and Gales, 1965);

estimation of growth parameters--CIAT F06 (Psaropulos, 1966);

analysis of variance--BMD X64 (Dixon, 1969).

DATA EMPLOYED

Data on fish released from 1952 through 1969 by the California Department of Fish and Game (Blunt and Messersmith, 1960) and the Tuna Commission were used for this report. Seventeen areas of release of the fish were used (Figure 1). These correspond to the areas used by Fink and Bayliff (1970), except that some offshore areas have been added due to the recent expansion of the fishery further offshore (Calkins and Chatwin, 1967 and 1971). Most of these areas correspond roughly to natural regions of occurrence of tuna concentrations. Some of the fish were not measured when they were released and others were not measured when they were recovered, and those could not be used in the analysis, of course. Only the data for fish at liberty more than 50 days were employed for estimation of the rates of growth. The data for these fish are summarized in Table 1.

ANALYSES AND RESULTS

Adjustment of the lengths at release

When the fish were released they were measured hurriedly under difficult conditions and usually only to the nearest 5 centimeters, whereas when they were recovered they were usually returned to Tuna Commission employees who carefully measured them to the nearest millimeter. Some tags were returned by fishermen or cannery employees without the fish, and in these cases estimates of the weights of the fish were usually furnished. Many of these estimates appeared to be ridiculous, so none of them were converted into lengths. In a few cases the lengths of the fish in inches were furnished and, since these appeared to be reasonable, all of them were converted to millimeters and used.

The measurements of the fish at release appear to have been more carefully made for the cruises supervised by U. S.- and Ecuador-based personnel than for those supervised by Peru-based personnel, as all fish released on some days of some of the latter cruises were recorded as having been the same length, whereas such was not the case for the former cruises. Therefore the errors in the measurements of the lengths at release are presumably greater for the Peru cruises, and the biases, if any, are likely to differ.

It is assumed that all the measurements of the lengths at return correspond to the actual lengths of the fish at recapture (*i. e.* that they are accurate and that the fish did not shrink or stretch between recapture and return). It is further assumed that the growth during the first 5 days after release is negligible. Thus the differences between the actual and estimated lengths at release can be determined for each fish which was at liberty less than 6 days and, if necessary, correction factors can be calculated which will apply to all the fish. This was done separately for the U. S. and Ecuador cruises and for the Peru cruises by calculating by the method of least squares the constants of the regression line $y = a + bx$, where y = length in millimeters at return and x = estimated length in millimeters at release. The data for the returns from the Peru cruises initiated in May 1960 were not used for this calculation, as the returns may have been fraudulent (Fink and Bayliff, 1970: pages 45-46). t tests were used to determine whether the slopes of the lines differed significantly from 1. The employment of observations which are subject to error as the independent variable was justified by Joseph and Calkins (1969: page 44), who performed a similar operation for data on tagged skipjack tuna, Katsuwonus pelamis. The results are as follows:

Cruises	Number of observations	a	b	t	Probability
U.S.A. and Ecuador	816	78.4	0.8462348	-13.78	<0.01
Peru	94	343.8	0.4574123	- 3.85	<0.01

The significant results of the t tests indicate that biases existed and that the data on the lengths at release should be adjusted. The bias was so great for the Peru cruises that it was decided not to use these for estimation of the growth rates.

The adjustment factor for the U. S. and Ecuador cruises, obtained from the above estimates of the parameters a and b, is believed to be imperfect, for it is probable that the degree of accuracy and the amount of bias in the measurements made of the tagged fish at the times of release varied somewhat among these cruises and even among taggers on the same cruises. Evidence that such was the case for one cruise will be given later. The data are insufficient, however, to calculate a separate adjustment factor for each tagger on each cruise. (On more recent cruises the fish have been measured to the nearest 1 cm instead of the nearest 5 cm, and the taggers have been instructed to make the measurements as carefully as possible without delaying the return of the fish to the water.)

Differences in growth among areas, years, times at liberty, and lengths at release

Anonymous (1967: page 31) pointed out that tagged yellowfin released north of 5°N tended to grow more rapidly than did those released south of 5°N. Fink and Bayliff (1970: page 58) observed that fish released in the northern Panama Bight which migrated to the south grew more slowly than did fish which remained in that area or migrated to the north. Other preliminary observations indicated that the growth of the fish released in Area 7 was relatively rapid. Thus the data were provisionally divided into the following four area categories or groups: those for fish which were released in Areas 1-7 and also recaptured there; those for fish which were released in Areas 1-7 and recaptured in Areas 8-11; those for fish which were released in Areas 8-11 and recaptured in Areas 1-7; those for fish which were released in Areas 8-11 and also recaptured there. There are very few returns for fish which migrated from Areas 1-5C and 6B-7 to

Areas 8-11 or from Areas 8-11 to Areas 1-7; thus for simplicity all fish released in Areas 1-5C and 6B-7 were considered to belong to Group 1 and all fish released in Areas 8-11 were considered to belong to Group 4. The fish released in Areas 6 and 6A belong to Group 1 if they were recaptured in Areas 1-7 and to Group 2 if they were recaptured in Areas 8-11.

Blunt and Messersmith (1960) observed that tagged fish released in the Baja California-Revillagigedo Islands area in 1953 grew more slowly than did those released there in 1955 and 1958. Therefore the growth of tagged fish released in different years should be considered separately initially. Studies of numerous species of fish, including yellowfin, have shown that the growth is curvilinear. Thus the growth rates of fish at liberty different times would be expected to differ. Accordingly, the data were divided into two groups, one for fish at liberty 61-150 days and one for fish at liberty more than 150 days. Also, for the same reason, the growth rates of fish of different lengths at the times of release would be expected to differ. Therefore the data were divided into groups according to those lengths.

The data for the fish released in Areas 1 and 6 in 1959 and 1961 were used to test initially the effects of group, year, and time at liberty on the rate of linear growth of the fish. The great majority of the fish was between 50 and 65 cm at release, so the others, a total of 32 fish, were eliminated from consideration. The data are summarized in Table 2, and the results of an analysis of variance were as follows:

Factor	Sum of squares	Degrees of freedom	Mean square	F	Probability
Group	0.45365	3	0.15122	0.890	>0.05
Year	0.06429	1	0.06429	0.378	>0.05
Time of liberty	0.97320	1	0.97320	5.726	<0.05
Group x time at liberty	1.43003	3	0.47668	2.805	<0.05
Year x time at liberty	0.14823	1	0.14823	0.872	>0.05
Error	76.30996	449	0.16996		

The analysis shows significant differences for time at liberty and group x time at liberty only. It can be seen in Table 2 that in every case the growth was less for the fish at liberty more than 150 days, so it is not surprising that there is a significant difference for time at liberty. The significant difference for group x time at liberty is due to the fact that the growth for Groups 1a and 2 was more than twice as fast for the fish at liberty 61 to 150 days as for those at liberty more than 150 days, while for Groups 1b and 1c the difference was only about 15 percent. The data for Groups 1a and 2 for fish at liberty 61 to 150 days include only 9 fish, so not much importance should be attached to this result.

To study the rates of growth of fish of a wider range of lengths at release it is necessary to use all the data. Accordingly, the data were pooled into two groups, Group 1 (faster growth) and Groups 2 and 4 combined (slower growth), two periods of time at liberty, 61-150 days and over 150 days, and eight intervals of length at release, under 50 cm, 50-55 cm, 55-60 cm, 60-65 cm, 65-70 cm, 70-75 cm, 75-80 cm, and over 80 cm. (As the lengths at release were adjusted, none was exactly 50, 55, ..., or 80 cm.) The pooling into two groups was done on the basis of the information on page 3, not the statistical analyses just performed. The data are summarized in Table 3.

Most of the fish of Groups 2 and 4 were 50 to 55 cm long at release, and it appears that the growth of these fish was slower than that of the fish of Group 1. Therefore an analysis of variance for these two groups and the two times at liberty was performed for the 50-55-cm fish only. The results were as follows:

Factor	Sum of squares	Degrees of freedom	Mean square	F	Probability
Group	1.35034	1	1.35034	7.336	<0.01
Time at liberty	1.33478	1	1.33478	7.252	<0.01
Group x time at liberty	0.03753	1	0.03753	0.204	>0.05
Error	97.55111	530	0.18406		

These results in regard to group are in agreement with the information given on page 3, but in disagreement with the results of the previous analysis.

It is desirable to establish whether or not the growth rate is significantly different among fish of different lengths. Since the growth rate may differ among fish of different groups, and since Groups 2 and 4 are poorly represented in all but two time at liberty-length at release strata, it is better to use only the data for Group 1 for the analysis of variance. The results were follows:

Factor	Sum of squares	Degrees of freedom	Mean square	F	Probability
Time at liberty	3.85315	1	3.85315	12.939	<0.01
Length at release	15.44734	7	2.20676	7.410	<0.01
Time at liberty x length at release	3.49308	7	0.49901	1.676	>0.05
Error	345.15367	1,159	0.29780		

Thus there were significantly different growth rates among fish of different lengths at relaase. No trends are evident, though it would be expected that, if the growth curve is convex upward, the growth of the fish which were smallest at release would be greatest.

The parameters of the von Bertalanffy growth equation were estimated for many different combinations of area (with Areas 6 and 6A each ddvided into Groups 1 and 2), year of release, and tagging cruise, and practically all of these appeared to be biologically ridiculous. Elimination of the outliers (points more than three standard deviations from the least-squares lines) did not produce reasonable results. Therefore it does not seem to be feasible to estimate the parameters of this equation for yellowfin from tagging data.

The rates of linear growth were estimated by area (with Areas 6 and 6A each divided into Groups 1 and 2), year of release, time at liberty, and length at release. The growth rates were higher, on the average, for the fish of Group 1 than for those of Groups 2 and 4, but there were no consistent differences in the growth rates of fish of the same groups released in different areas. Therefore the data for the different areas were combined. These data are shown in Table 4.

Artificial factors affecting growth

It is possible that the effects, if any, of loop and dart tags on the growth of the fish are different, though it is not apparent why this could be so. The results from two cruises on which both loop and dart tags were used were as follows:

Cruise	Year	Area	Tag type	Number of fish	Growth rate
1023	1958	1	loop	25	0.76
			dart	7	0.66
1033	1960	3 and 4	loop	8	0.68
			dart	41	0.79

It appears that the effect, if any, of these two types of tags on the growth is the same.

Also, it is possible that the growth of baitboat-caught tagged fish is inhibited by injuries to the mouths of the fish. This can be tested from the data for fish released on Cruises 1054 (baitboat) and 1055 (purse seine) conducted in Areas 2, 3, 4, 5A, 5B, 5C, 6B, and 6C in 1969. Only a few of the fish from Cruise 1054 were recaptured after more than 150 days at liberty, so only those at liberty 61-150 days were considered. These data are summarized in Table 5, and the results of the analysis of variance were as follows:

Factor	Sum of squares	Degrees of freedom	Mean square	F	Probability
Gear	2.50162	1	2.50162	6.000	<0.05
Length at release	4.95919	3	1.65306	3.964	<0.01
Gear x length at release	2.50418	3	0.83473	2.002	>0.05
Error	94.65191	227	0.41697		

It appears that the growth rates of baitboat-caught tagged fish of all lengths were significantly lower than those of purse seine-caught tagged fish of the same lengths. The growth rate decreased significantly with increasing length at release. This result differs from that for the data of Table 3, but conforms to the hypothesis stated earlier concerning the relative growth rates of smaller and larger fish.

Finally, it is possible that, if carrying one or two tags inhibits the growth of the fish, the effect of double tags is more than that of single tags. Fish were both single and double tagged on Cruise 1055, so it is useful to compare the growth rates of single-tagged fish, double-tagged fish which lost one tag sometime between release and recapture, and double-tagged fish which retained both tags. These data summarized in Table 6, and the results of the analysis of variance were as follows:

Factor	Sum of squares	Degrees of freedom	Mean square	F	Probability
Tags	0.23519	2	0.11760	0.336	>0.05
Time at liberty	0.03294	1	0.03294	0.094	>0.05
Length at release	3.70201	4	0.92550	2.645	>0.05
Tags x time at liberty	0.43071	2	0.21536	0.615	>0.05
Tags x length at release	2.77193	8	0.34649	0.990	>0.05
Time at liberty x length at release	0.82374	4	0.20594	0.589	>0.05
Error	74.52828	213	0.34990		

These data indicate no significant differences among the growth rates of the fish with the single tags and the two types of double tags. If double-tagged fish grow as rapidly as single-tagged fish, then it is likely, though not certain, that tagged fish grow as rapidly as untagged ones (provided, of course, that the former were tagged from purse seiners rather than bait-boats).

Davidoff (1963) used length-frequency data to estimate the rate of growth of yellowfin tuna in the eastern Pacific Ocean, which he expressed by

$$l_t = 167(1 - e^{-0.05(t - 10)}) \qquad (1)$$

where l_t = length in centimeters at time t (expressed in months). The formula was rearranged to express t as a function of l_t. For each of the 59 fish of Group 1 at liberty more than 1 year t_1, the estimated age on the day of released, was computed from l_1, the adjusted length at that time. Then the time at liberty, Δt, was added to t_1 to calculate t_2, and the length at the time of recapture, l_2, was plotted against t_2 on a graph showing Davidoff's estimated growth curve (Figure 3). (A similar procedure was not followed for Groups 2 and 4 because there were only six fish in these groups which had been at liberty more than 1 year.) Most of the points fall below the curve, indicating that the rate of growth of the tagged fish was less than that of the fish of all groups combined estimated by Davidoff's formula.

It has already been shown that the rate of growth may be inhibited for baitboat-caught tagged fish relative to that for purse seine-caught tagged fish. Only five of the points are for fish released from purse seiners, but three of them are above the curve, indicating tentatively that the growth of these fish was as rapid as that indicated by Davidoff. To investigate this further all the data for fish released from purse seiners which were at liberty over 150 days (63 fish) were plotted in the same manner (Figure 4). All these belonged to Group 1, as none of the fish of Group 2 and 4 considered in this report were released from purse seiners. About half the points are above the curve, so the growth appears to have been about as rapid as that indicated by Davidoff. For two reasons, however, the growth of these fish is believed to have been slower than normal. First, Davidoff's curve is for fish of Groups 2 and 4 as well as those of Group 1, and if he had had a curve for Group 1 only and the points had been plotted on it most of them would probably have fallen below the curve. Second, the adjustment for the bias in measuring the fish at release is believed to be too great. All but 5 of the 63 fish were from Cruise 1055, and most of them were more than 70 cm long. The adjusted lengths at release of fish recorded as being 70, 80, 90, and 100 cm are 67, 76, 84, and 92 cm, respectively. On that cruise the fish were measured fairly carefully, so it is unlikely that the bias was so great. If the measurements were judged to be unbiased and the adjustment eliminated the points would be moved varying distances to the right on the figure, and most of them would be below the curve. Thus the growth of the purse seine-caught tagged fish of Group 1 was apparently slower than would be expected from Davidoff's data. This could be due to inhibition of the growth of the tagged fish, slower than normal growth of all fish during 1969-1970, or error in Davidoff's curve.

SUMMARY AND CONCLUSIONS

Data for tagged fish at liberty more than 60 days for which the lengths at release and at recovery were available were selected to study the growth of yellowfin tuna. Data on the lengths at release and at recovery for tagged fish at liberty less than 6 days were used to estimate the bias of the measurements made at release, it being assumed that the measurements at recovery were accurate and that the fish did not change lengths during this interval. Then the lengths at release of the fish at liberty more than 60 days were adjusted to compensate for the bias.

The average rate of growth was roughly 1 mm per day. Analyses of variance were made to compare the rates of linear growth of fish of different area, year, time at liberty, and length at release strata. Fish at liberty 61-150 days grew more rapidly than did those at liberty more than 150 days. One of two analyses showed more rapid growth for the fish of Group 1 (fish released west of 85°W and fish released in the northern Panama Bight which did not travel south of 5°N and east of 85°W) relative to that of the fish of Groups 2 (fish released in the northern Panama Bight which travelled south of 5°N and east of 85°W) and 4 (fish released south of 5°N and east of 85°W). Also, two of three analyses showed different rates of growth for fish of different lengths at release.

The parameters of the von Bertalanffy growth equation were estimated for many different combinations of area, year at release, and tagging cruise, and practically all of these estimates were ridiculous. Therefore it does not seem feasible to estimate the parameters of this equation for yellowfin tuna from tagging data.

The growth of baitboat-caught tagged fish is inhibited, probably due to injuries to the mouths of the fish. The growth of purse seine-caught tagged fish may also be inhibited, but to a lesser extent.

Figure 1. Map of the eastern Pacific Ocean, showing the areas used in this study.

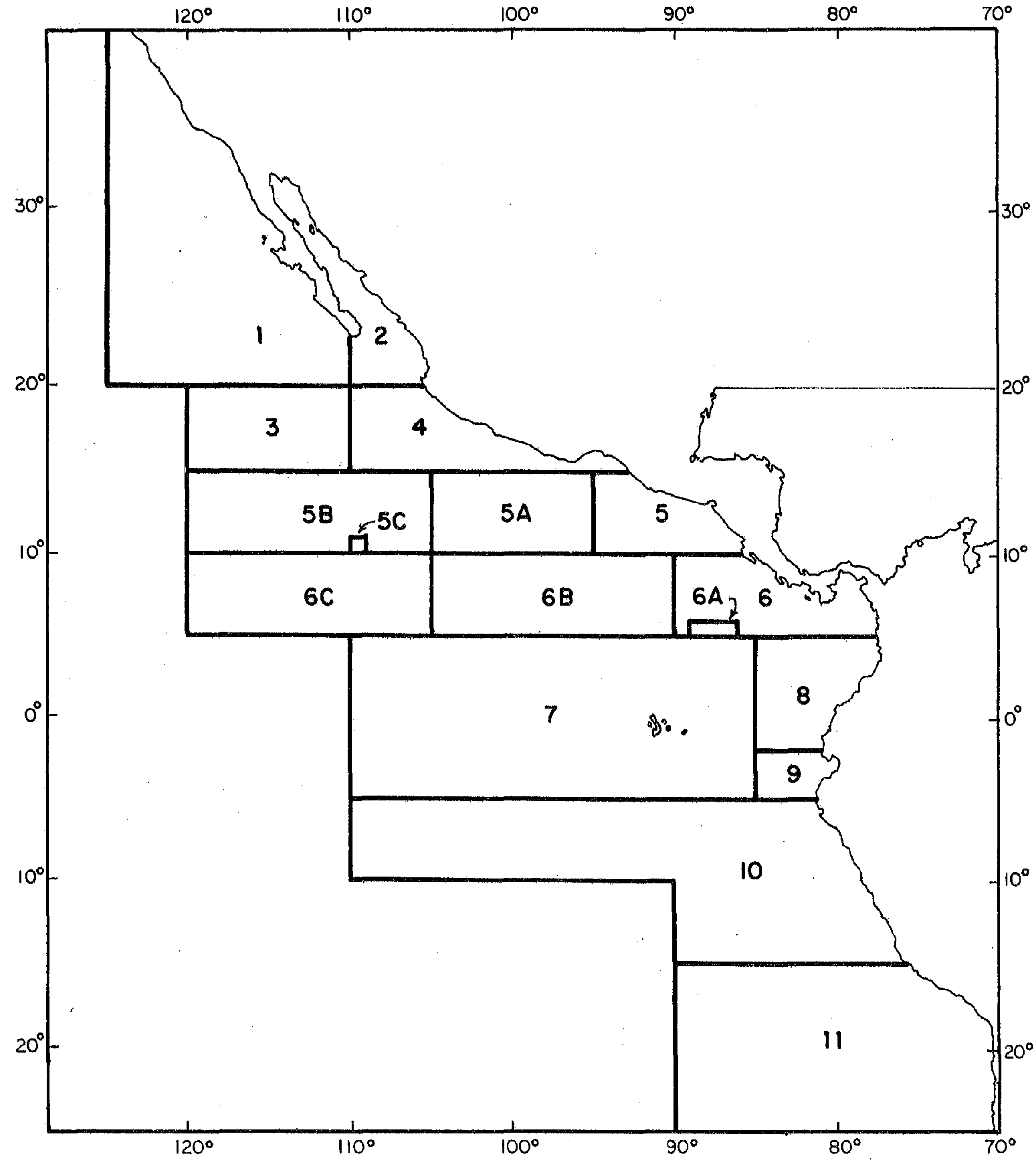

Figure 2. Relationships between the estimated (recorded) and actual (adjusted) lengths at release for fish released on cruises supervised by U. S.- and Ecuador-based personnel and on cruises supervised by Peru-based personnel.

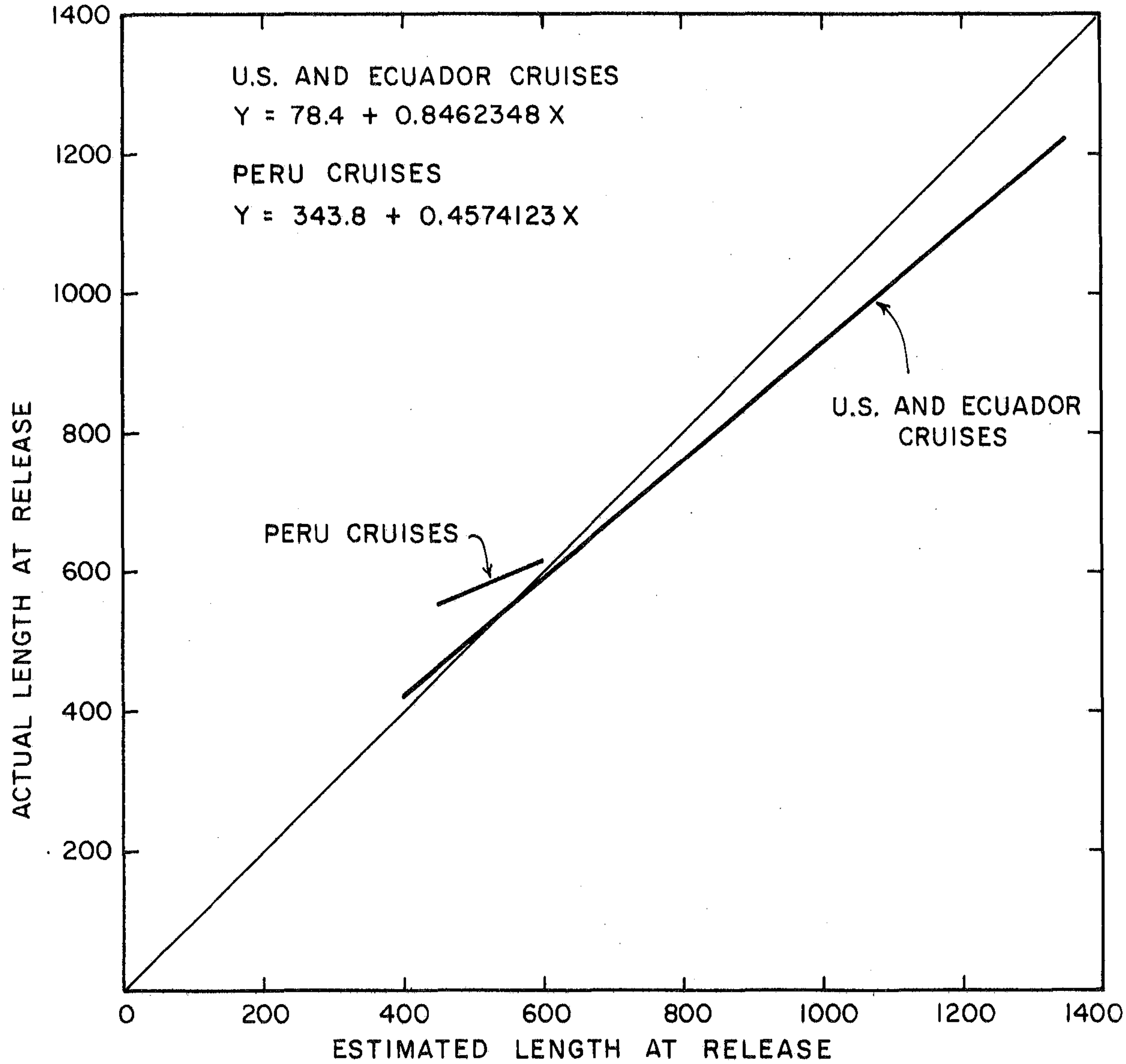

Figure 3. Davidoff's (1963) growth curve for yellowfin tuna in the eastern Pacific Ocean, with lengths at release (heavy portion of curve) and lengths at recapture (dots and circles) for tagged fish of Group 1 at liberty more than 1 year.

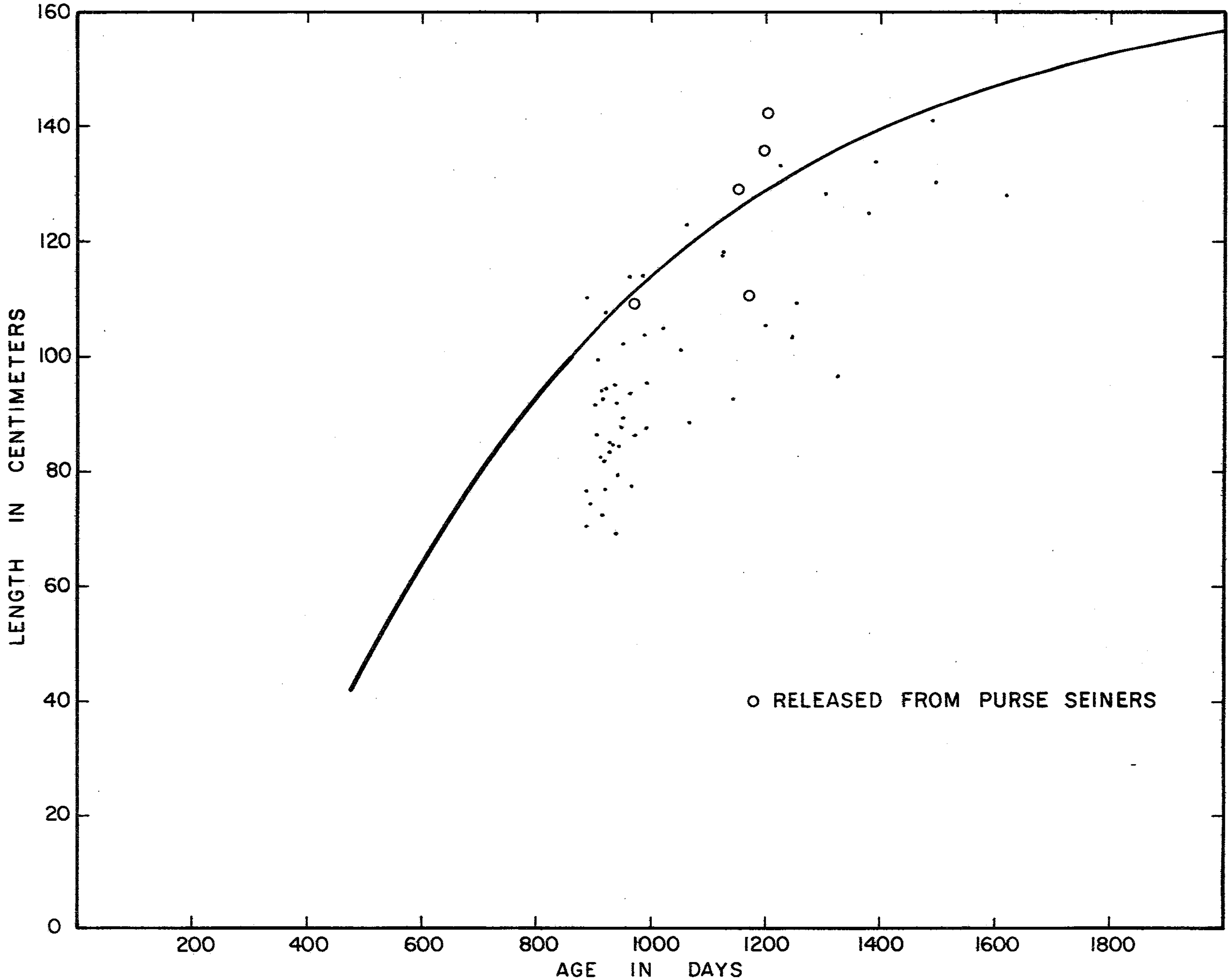

Figure 4. Davidoff's (1963) growth curve for yellowfin tuna in the eastern Pacific Ocean, with lengths at release (heavy portion of curve) and lengths at recapture (dots and circles) for tagged fish of Group 1 released from purse seiners and at liberty more than 150 days.

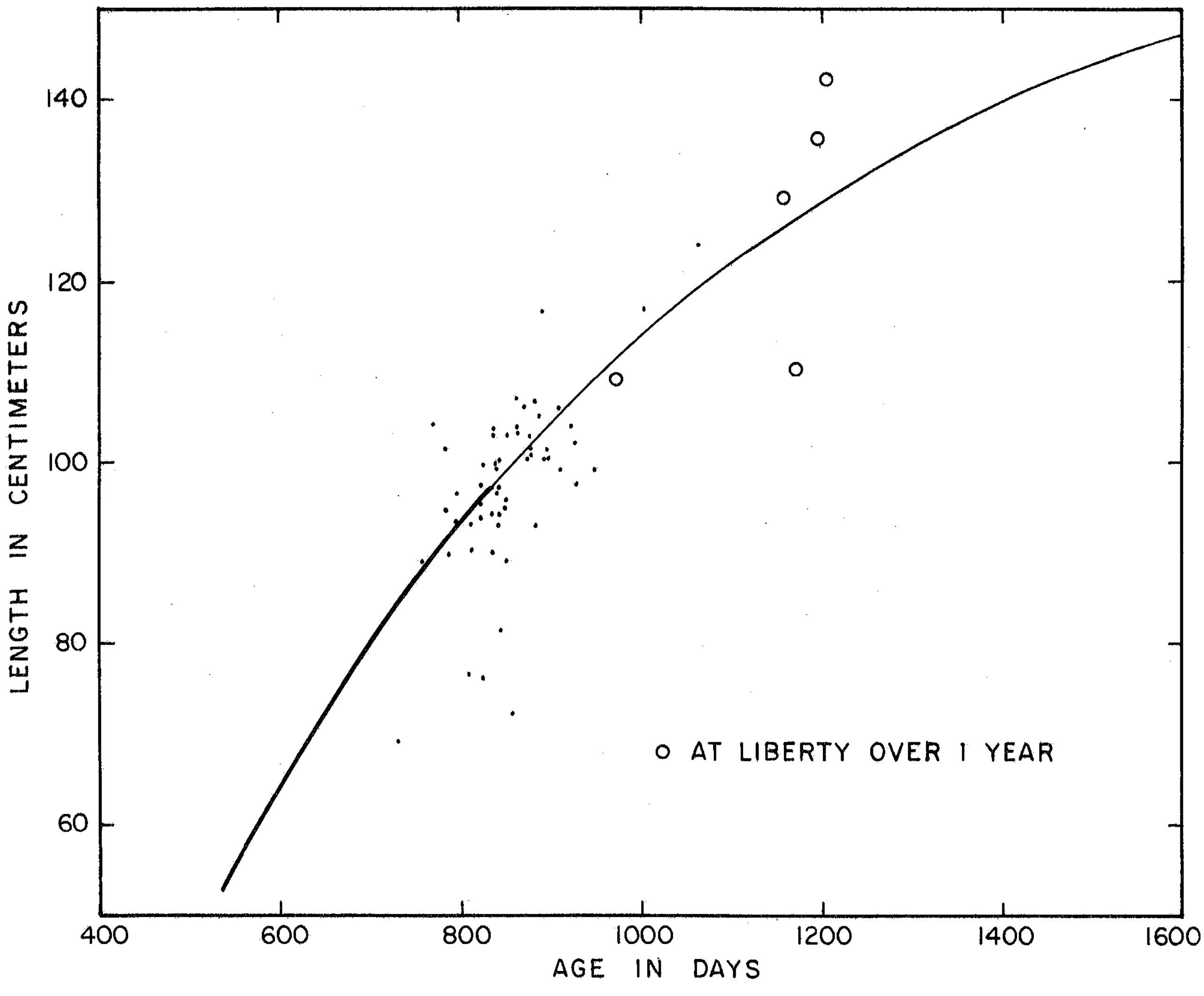

Table 1. Numbers of returns of tagged fish employed in this study, by area and year of release.

	Area of release																	
Year of release	1	2	3	4	5	5A	5B	5C	6	6A	6B	6C	7	8	9	10	11	Total
1952	4	1													1			6
1953	6																	6
1954									1				2		1			4
1955	12				1	3			1									17
1956	2	5	2															9
1957		1			2										2		1	6
1958	85		1	1										2	6	5		100
1959	25	2							35				4			5		71
1960			38	16	6										1			61
1961					2				431				2	2				437
1962	127	1																128
1963	67																	67
1964									3	3								6
1965			23															23
1966																		0
1967			38					1		6			7					52
1968					1													1
1969		3	41	120		71	18	2			32	8						295
Total	328	13	143	137	12	74	18	3	471	9	32	8	15	4	11	10	1	1,289

Table 2. Growth rates (millimeters per day) of tagged fish 50 to 65 mm in length released in Areas 1 and 6 in 1959 and 1961, by time at liberty.

Group	Year of release	61-150 days at liberty		> 150 days at liberty	
		Number of fish	Growth rate	Number of fish	Growth rate
1a (fish released in Area 1)	1959	2	1.54	20	0.70
	1961	0	-	0	-
1b (fish released in Area 6 and recaptured in Areas 1-5C)	1959	0	-	12	0.97
	1961	77	0.95	108	0.84
1c (fish released in Area 6 and recaptured in Areas 6-7)	1959	0	-	10	0.86
	1961	33	0.98	116	0.81
2 (fish released in Area 6 and recaptured in Areas 8-11)	1959	1	0.79	9	0.59
	1961	6	1.14	65	0.57
Total	1959	3	1.29	51	0.78
	1961	116	0.97	289	0.77
Grand total		119	0.98	340	0.77

Table 3. Growth rates (millimeters per day) of tagged fish of three groups released in all years, by time at liberty and length at release.

Length at release in centimeters	Group 1				Groups 2 and 4			
	61-150 days at liberty		Over 150 days at liberty		61-150 days at liberty		Over 150 days at liberty	
	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate
<50	45	1.33	36	0.87	1	3.54	3	0.75
50-55	231	1.07	229	0.88	7	0.99	67	0.62
55-60	124	0.92	94	0.81	5	1.11	20	0.46
60-65	83	0.85	28	0.58	4	0.77	4	0.33
65-70	44	1.03	22	1.06			3	0.79
70-75	52	1.29	19	1.09				
75-80	66	1.20	25	1.15				
>80	56	0.95	21	0.94				
Total	701	1.05	474	0.88	17	1.12	97	0.58

Table 4. Growth rates (millimeters per day) of tagged fish of three groups, by time at liberty, year of release, and length at release.

		Group 1				Groups 2 and 4			
		61-150 days at liberty		>150 days at liberty		61-150 days at liberty		>150 days at liberty	
Year of release	Length at release	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate
1952	<55	1	0.15	1	0.64				
	55-65	1	-0.05	2	0.49			1	0.93
	65-75								
	>75								
1953	<55	2	0.82	4	0.52				
	55-65								
	65-75								
	>75								
1954	<55	1	0.17	1	0.23	1	0.68		
	55-65	1	1.37						
	65-75								
	>75								
1955	<55								
	55-65	13	0.75	2	1.11				
	65-75			2	1.21				
	>75								
1956	<55	1	0.94						
	55-65	3	0.88	2	0.82				
	65-75			1	0.86				
	>75			2	0.95				
1957	<55								
	55-65					2	0.40		
	65-75	3	1.28					1	1.16
	>75								
1958	<55	27	0.92	16	0.67	1	3.54	10	0.44
	55-65	29	0.86	7	0.89	1	1.10	1	0.64
	65-75	6	0.87	2	0.84				
	>75								
1959	<55	2	1.54	40	0.82	2	0.87	10	0.61
	55-65	4	1.46	8	0.85	1	1.44	2	0.57
	65-75			2	0.73				
	>75								
1960	<55	21	0.67	7	0.98	1	1.29		
	55-65	10	1.22	4	1.03				
	65-75	3	0.74	1	0.22				
	>75	6	1.09	8	0.66				
1961	<55	68	1.06	157	0.90	4	1.04	46	0.66
	55-65	45	0.82	73	0.68	4	0.94	20	0.39
	65-75	10	0.48	6	0.37			2	0.61
	>75	1	3.13	1	1.52				

Table 4 (continued)

		Group 1				Groups 2 and 4			
		61-150 days at liberty		>150 days at liberty		61-150 days at liberty		>150 days at liberty	
Year of release	Length at release	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate
1962	<55	102	1.28	3	0.78				
	55-65	18	0.67						
	65-75	2	1.21	1	1.34				
	>75	1	1.68	1	1.00				
1963	<55	18	1.00	3	0.80				
	55-65	31	0.53	11	0.65				
	65-75	2	0.70	2	0.73				
	>75								
1964	<55			2	1.05				
	55-65			3	1.36				
	65-75			1	1.28				
	>75								
1965	<55	11	1.37	9	1.04				
	55-65	2	1.20	1	1.32				
	65-75								
	>75								
1967	<55	18	1.18	22	1.03			3	0.73
	55-65	3	0.50	6	0.90				
	65-75								
	>75								
1968	<55								
	55-65								
	65-75			1	1.61				
	>75								
1969	<55	3	1.02	1	1.30				
	55-65	48	1.22	3	0.92				
	65-75	70	1.32	22	1.35				
	>75	114	1.05	34	1.14				
Total	<55	275	1.11	266	0.88	9	1.26	69	0.63
	55-65	208	0.89	122	0.76	8	0.89	24	0.44
	65-75	96	1.17	41	1.07			3	0.79
	>75	122	1.09	46	1.05				
Grand total		701	1.05	475	0.88	17	1.09	96	0.58

Table 5. Growth rates (millimeters per day) of fish released from baitboats and from purse seiners, by length at release.

Length at release	Baitboat		Purse seine	
	Number of fish	Growth rate	Number of fish	Growth rate
<60	5	1.33	14	1.44
60-70	30	1.13	26	1.21
70-80	7	1.18	102	1.23
>80	1	-0.72	50	0.98
Total	43	1.12	192	1.18

Table 6. Growth rates (millimeters per day) of single-tagged fish, double-tagged fish which were recaptured with only one tag, and double-tagged fish which were recaptured with two tags, by time at liberty and length at release.

Length at release	61-150 days at liberty						Over 150 days at liberty					
	Single		Double → Single		Double		Single		Double → Single		Double	
	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate	Number of fish	Growth rate
<50	0	-	0	-	0	-	0	-	0	-	0	-
50-55	2	1.18	0	-	1	0.70	0	-	0	-	1	1.30
55-60	0	-	2	2.69	9	1.30	0	-	0	-	0	-
60-65	3	0.48	5	1.20	7	1.16	1	0.57	0	-	2	1.10
65-70	5	1.62	1	0.77	5	1.43	0	-	3	1.58	4	1.82
70-75	11	1.63	8	1.39	22	1.19	4	1.01	3	1.28	6	1.21
75-80	15	1.81	11	1.13	35	1.14	2	1.06	9	1.27	9	1.03
>80	6	0.90	4	1.07	40	0.99	1	1.08	4	1.11	9	1.05
Total	42	1.49	31	1.29	119	1.12	8	0.98	19	1.29	31	1.19

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