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Report of Feasibility Study on Skipjack pole-and-line Fisheries in the Micronesian Waters

Japan Marine Fishery Resource Research Center

April 1977

This report was written by Ryoji Saito, researcher of Japan Marine Fishery Resource Research center.

FOREWORD

Scientists of the world concerned with fish resources generally agree that resources of skipjack are widely distributed in tropical and warm water areas, under-exploited and capable of further expansion of fishing.

Under-exploitation of the abundant skipjack resources could be attributed to the fact that ecology of skipjack has not yet been clarified and there is a need for improvement in gears such as purse seine and gill net, and also to the difficulty of ensuring live bait fishes which are indispensable to skipjack pole-and-line fishing.

If these problems are solved, expansion of skipjack fishing will surely be expected.

The Japan Marine Fishery Resource Research Center, since its establishment in 1971, has been conducting surveys on bait fish resources as well as skipjack pole-and-line fishing in tropical waters around the Islands of New Caledonia, New Hebrides, Tonga, Palau, Truk, Ponape, etc. The present survey, the third one in the series of the surveys in the Micronesian waters, covered the areas around the Palau Islands, the Truk Islands, and Ponape Island.

As surveys on bait fishes have to be conducted in inner reef areas of the Islands, understanding and agreement of the coastal countries concerned are required. We are grateful to the High Commissioner of Saipan, the local government and inhabitants of the Islands for their understanding and assistance which were instrumental to the successful completion of the present survey indicating a good possibility of bait fish preservation in the areas.

During the survey, at the request by the local government, a few trainees were taken on board the survey vessel from the Islands for the purpose of acquainting them to the practice of pole-and-line fishing, oceanographic observations and biological studies. It is hoped that such a cooperation will strengthen mutual understanding and contribute to the fishery development in the Micronesian area.

We wish to express our gratitude to Fishery Agency, Far Seas Fishery Research Institute, Tohoku Regional Fishery Research Institute, Ichthyologh Department of the Tokyo University of Fisheries, Federation of Japan Tuna Fisheries Cooperative Associations and Hokoku Suisan Company, owner of the survey vessel, for their cooperation and assistance. Our sincere thanks should be expressed also to the captain and crew of the survey vessel, the No. 3 Hatsutori-maru.

Last but not least, we are most grateful to the local governments and citizens of the Palau Islands, the Truk Islands and Ponape Islands for their kind cooperation.

Kohki Fujimura
President
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I. SUMMARY

The No. 3 Hatsutori-Maru (skipjack pole-and-line fishing vessel of 79.37 gross tons) conducted surveys on bait fish resources and feasibility of skipjack pole-and-line fishery in the Micronesian waters around the Palau, Truk and Ponape Islands for the period of 141 days from 28 May to 15 October 1976. Studies were also made by the same vessel on skipjack pole-and-line fishery in the waters from the Bonin Islands to the Mariana Islands during the vessel's outgoing cruise.

The following is a brief summary of the findings of the survey.

Bait Fishes

1. Stick-held dip-nets were used to catch bait fishes. The following fishes (10 families including 33 species) were identified as suitable bait fishes.

Main fish species suitable as bait fish

(1) Katakuchiiwashi-ka (Tarekuchi)
Indo Ainoko
Taiwan Ainoko
Batavia Katakuchi
(2) Nishin-ka
Mizun
Yamato Mizun
(3) Tougoroiwashi-ka
Tougoro Iwashi
Yakushima Iwashi

(4) Urumeiwashi-ka
Minami Kibinago
Kibinago
Nise Gin Iwashi
(5) Aji-ka
Meaji

Mabuta Shimaaji
(6) Saba-ka
Gurukuma
Tsumari Gurukuma
(7) Takasago-ka

Nise Takasago
Takasago
Sasamuro
Issen Takasago
Kumasasa Hanamuro

Engraulidae
Stolephorus indicus (Van Hassalt)
Stolephorus heterolobus (Ruppell)
Stolephorus bataviensis Hardenberg
Clupeidae
Harengula ovalis (Bennett)
Sardinella clupeoides
Atherinidae
Allanetta forskali (Ruppell)
Pranesus pinguis (Lacepede), Stenatherina temmincki (Bleeker)
Dussmieriidae
Spratelluides delicaturus (Bennett)
Spratelluides japonicus (Houttuyn)
Dussumieria hasselti Bleeker
Carangidae
Selar crumenophthalmus (Bloch)
Selar boops (Cuvier)
Scomberoides tolooparah (Ruppell)
Selaroides leptolepis (Cuvier)
Scombridae
Rastrelliger kanagurta (Cuvier)
Rastrelliger brackysoma (Bleeker)
Caesiodae
Caesio gymnoplerus Bleeker
Caesio chrysozonus Cuvier and Valenciennos
Caesio diagramma Bleeker
Caesio coerulaureus Lacepede
Caesio plsang Bleeker
Caesio tile Cuvier and Valenciennes

(8) Hiiragi-ka	Leiognathidae
Koban Hiiragi	*Gazza minuta (Bloch)*
	Leiognathus sp.
(9) Aigo-ka	Siganidae
Hana Aigo	*Siganus rostratus (Valenciennes)*
Ami Aigo	*Siganus spinus (Linnaeus)*
Goma Aigo	*Siganus guttatus (Bloch)*
Majiri Aigo	*Siganus puellus (Schlegel)*
Hifuki Aigo	*Siganus vulupinus (Schlegel)*
(10) Tenjikudai-ka	Apogonidae
Itohiki Tenjikudai	*Apogon leptacanthus*
Atohiki Tenjikudai	*Archamia zosterophera*
Kurosuji Sukashi Tenjikudai	*Rhabdamia cypselura Weber*

Table 1. Results of Stick-held dip-net Operation for Catching bast fishes (1974~1976)

Area		Palau Is.							
		Mairn Is.						Helen Reef	
		1974		1975		1976		1976	
Total catch (bucket)				1,301.3		1,860.0		427.0	
Days of operation				24		35		3	
Number of operation				53		55		4	
No. of operation perday				2.2		1.57		1.33	
Catch per day				54.2		53.1		142.3	
Catch per operation				24.6		33.8		106.8	
	Specis	(bucket)	%	(bucket)	%	(bucket)	%	(bucket)	%
1	Engraulidae			863.4	66.3	108.0	58.0		
2	Clupsidae			130.8	10.0	39.1	2.1		
3	Atherinidae			58.4	4.5	53.2	2.9	78.7	18.4
4	Dusumieriidae (Spratelulides sp.)			216.0	16.6	676.8	36.4	265.6	62.2
5	Dussumieridae S. Japonicus)							82.7	19.4
6	Caesiodae			6.0	0.5	2.0	0.1		
7	Carangidae					9.0	0.5		
8	Dussumieria Sp.			26.7	2.1				
9	Siganidae Sp.								
10	Others								
	Total			1,301.3	100	1,860.0	100	427.0	100

Table 1 shows the stick-held dip-net operations for bait fishes as well as catch by species in the last 3 years.

2. Characteristics of Bait Fishes in Each Area

(1) Main bait fish species in the Palau Islands and Ponape Island (muddy bottom) consisted of Engraulidae *(Stolephorus spp.)*

(2) Main bait fish species caught around the Truk Islands and Helen Reef (coral and sandy bottom) was *Spratelluides delicaturus (Benett).*

(3) *Spratelluides japonicus (Houttuyn)* was caught for the first time in the Helen Reef area. This species was never caught in the survey operations during the previous 2 years in the Micronesian waters.

(cnit of Cafch : 1 buckef, about 3kg)

Truk Tslands						Ponepe I					
1974		1975		1976		1974		1975		1976	
		797.9		532.0		1,056.3		717.1		295.0	
		24		10		45		24		10	
		45		19		79		49		19	
		1.88		1.9		1.76		2.04		1.9	
		33.2		29.5		23.5		29.9		29.5	
		17.7		15.6		13.4		14.6		15.6	
(bucket)	%	(bucket)	%	(bucket)	%	(bucket)	%	(bucket)	%	(bucket)	%
						248.4	23.5	412.4	57.5	169.7	57.5
		104.7	13.1	21.0	4.0	188.5	17.8	112.0	15.6	74.9	25.4
		89.4	11.2	178.0	33.5	84.4	8.0	35.5	4.9	23.7	8.0
		603.8	75.6	308.0	58.0	90.6	8.6	72.9	10.2	24.7	8.3
						22.9	2.2	28.0	3.9		
				22.9	4.3	228.9	21.7	56.3	7.9	2.0	0.8
						155.6	14.7				
				Apogonidae 2.1	0.4	37.0	3.5				
		797.9	100	532.0	100	1,056.3	100	717.1	100	295.0	100

(4) As far as the Truk Islands, only several tens of Engraulidae were found in the catch obtained in the fishing grounds of muddy bottom.

3. Survival (Preservation) Tests of Bait Fishes in Live Fish Net Cages

The survival tests were carried out in the Palau Islands, mainly on Engraulidae. The survival rate proved 70% to 80% after one week. Twenty-five bucketfuls of the test bait fishes (mainly Engraulidae) were taken to live fish well (3.25 m^3, mechanical water circulation) on board that 20% perished in 9 days. The test fishes showed a good response to feeding.

Skipjack Pole-and-line Fishing

1. Conspicuous current rips running from east to west were sighted in the waters from Urakas Island to Maug Island, north of the Mariana Islands. Many skipjack schools were found in the area which appeared to be good skipjack fishing grounds.

SJ : Skipjack
YF : Yellowfin t
B : Bonito

Table 2 Result of of aperation for Skipraek Pole–and–line Fishing

Area (Period)	Operation		Av. Catch per (kg)		Species Catck (kg)			Total catch (kg)	Av. Weigh (kg)		
	Days	Times	Day	Operation	SJ	YF	B		SJ	YF	B
Ogasawara ~maliana ('76. 5. 28~6. 7)	3	12	3,713	928	10,140	999		11,139	3.5		
Palau Is. ('76. 6. 11~8. 5)	22	30	976	715	20,895	311	255	21,461	4.5	5.5	3
Truk Is. ('76. 8. 15~9. 23)	11	12	231	212	2,418		129	2,547	3.8		1
Ponape I. ('76. 9. 28~10. 9)	5	7	3,437	2,455	16,205	979		17,184	3.4	6.4	
Total	41	61	1,276	858	49,657	2,289	384	52,331			

2. In the Micronesian waters, the bait fishes were caught locally with stick-held dip-nets of the research vessel. The skipjack fishing was one-day-trip operation, limiting the survey area normally up to 30 to 40 miles from the shore of the islands.
3. As shown in Table 2, in each place skipjack responded rather poorly to live bait fishes, resulting in poor catches. Only exception was Ponape Island waters where an average of 3,437 kg per day was caught, although the survey period was rather short.

2. Waters Around the Palau Islands

The survey in this area was the second following the one conducted last year. Present survey covered the period from June 9 to August 7, 1976 and the survey was made on bait fishes as well as pole-and-line fishery. On emphasis was placed on the survival tests of bait fishes under the cooperation by the Marine Resources Development of the local government which made available one motorized boat and 2 divers.

(1) Conditions of the fishing grounds:

1) Weather:

When small tropical depression (about 1005 mb) passed north of the Palau Islands, weather conditions deteriorated with strong southwest wind. Table 6 shows wind direction and force recorded at noons during the survey period except for those days when the vessel anchored at the harbour. South-west or South South-west winds with wind forth 3 preveiled.

2) Sea conditions:

Figure 8 shows vertical distribution of water temperatures measured by BT in the areas from Palau Main Island to Helen Reef.

i) Waters around Palau Main Island:

Surface water temperature recorded 28°C which was 0.5° – 1°C lower than last year. Thermocline was located at the depth of about 50 m.

ii) Waters around Helen Reef:

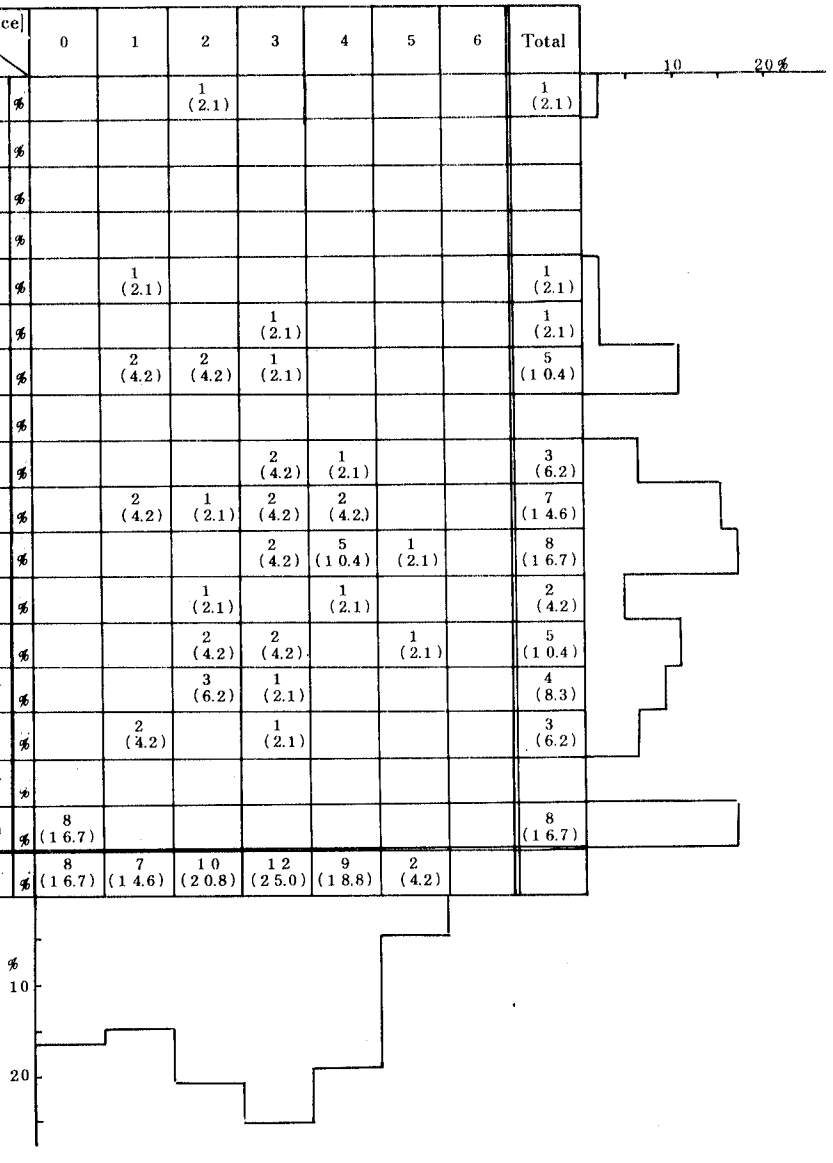
Surface water temperature was about 28.5°C and rather consistent, thermocline being located at the depth of about 100 m.

iii) Waters from Palau Main Island to Helen Reef:

Thermocline was located about 50 m deeper in the area South of 4°–30′ N, compared with the waters north of the line.

Table 6. Wind direction and force around Palan Islands
(June-July 1976, excluding to days in port)

Force / Direction		0	1	2	3	4	5	6	Total
N	%			1 (2.1)					1 (2.1)
NNE	%								
NE	%								
ENE	%								
E	%		1 (2.1)						1 (2.1)
ESE	%				1 (2.1)				1 (2.1)
SE	%		2 (4.2)	2 (4.2)	1 (2.1)				5 (10.4)
SSE	%								
S	%				2 (4.2)	1 (2.1)			3 (6.2)
SSW	%		2 (4.2)	1 (2.1)	2 (4.2)	2 (4.2)			7 (14.6)
SW	%				2 (4.2)	5 (10.4)	1 (2.1)		8 (16.7)
WSW	%			1 (2.1)		1 (2.1)			2 (4.2)
W	%			2 (4.2)	2 (4.2)		1 (2.1)		5 (10.4)
WNW	%			3 (6.2)	1 (2.1)				4 (8.3)
NW	%		2 (4.2)		1 (2.1)				3 (6.2)
NNW	%								
Calm	%	8 (16.7)							8 (16.7)
Total	%	8 (16.7)	7 (14.6)	10 (20.8)	12 (25.0)	9 (18.8)	2 (4.2)		



(2) Exploratory pole-and-line fishing for skipjack:

1) Distribution and characteristics of fish schools:

i) Palau Main Island:

Many schools were located in the area 20 to 30 miles North-west of the western channel of the Island. Table 7 shows the occurrances of the schools.

ii) Helen Reef:

Many bird-associate schools and jumping schools of yellowfin tuna were sighted. Table 8 indicates the occurrances of the schools.

2) Operations and catch:

The period from June to September is the high season for skipjack pole-and-line fishing in the area. The vessel operated in the grounds which were not exploited by the fishing boats (39 – 59 gross tons) of Van Camp Company. Therefore, operations were conducted primarily in the waters west of the Palau Islands.

Table 2 shows the summary of the results of the operations. Average catch per day showed 24% increase over the last year's catch which was 786 kg. Average body weight of the fish was 4.5 kg which was bigger than 3.0 kg in the last year. Many of the schools were feeding and the catch was rather poor.

In the area around Helen Reef (2°–55′ N, 131°–47′ E), most of the schools were bird-associate. However their response to bait fish was rather poor, average catch per day amounting to 334 kg. Bait fishes used included mainly Engraulidae in the Palau Island waters and mostly *Spratelluides delicaturus (Bennett)* and *Allanetta forskali (Rupell)* in the Helen Reef area.

(3) Bait fishes

1) Operations and catch:

Annex 7 shows the records of operations with stick-held dip-net for bait fishes and Figure 11 indicates the sites of operations. Results of the operations are shown in Table 1.

i) Palau Main Island:

Maximum catch per day, mainly Engraulidae, amounted to 200 bucketfuls, and maximum catch per operation was 130 bucketfuls. Average catch per day amounted to 54.2 bucketfuls, about same as in last year. Prevalent species caught in the grounds west of Palau Main Island was Engraulidae, but less dominant than last year (66.3%).

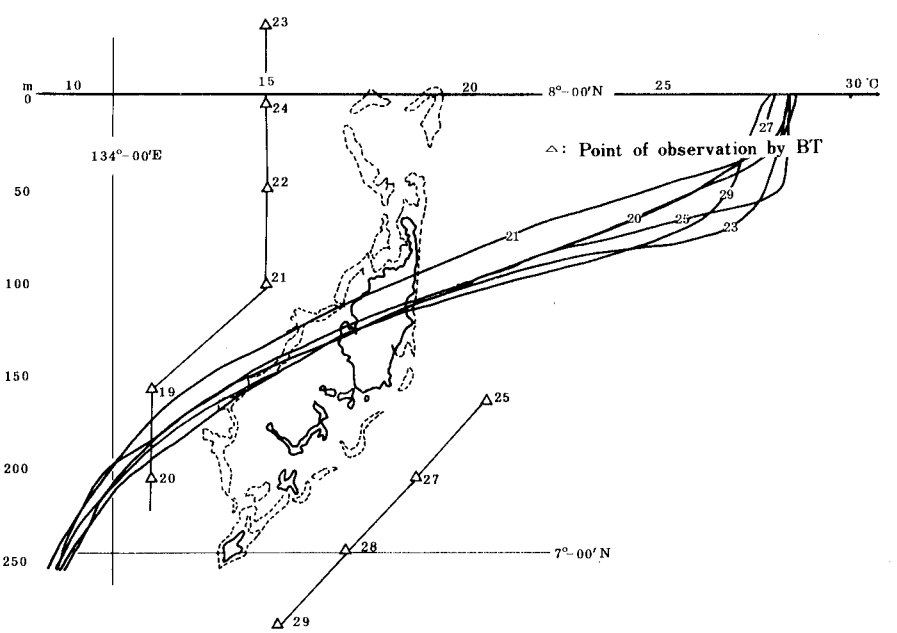


Figure 8. Vertical distribution of water termperature (waters around the palau Is. June 12~July 27)

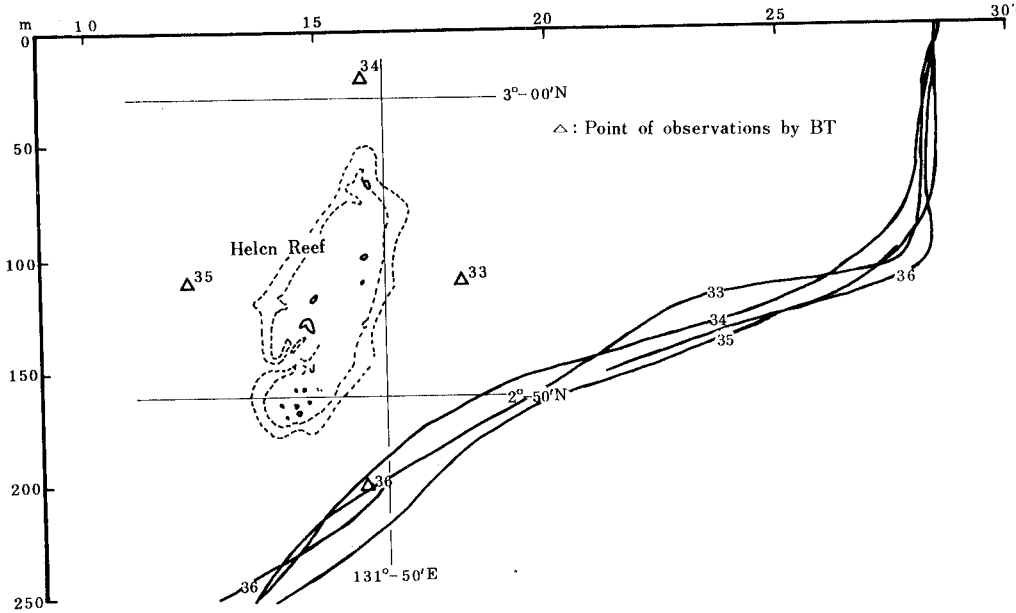


Figure 9. Vertical distribution of water temperature
(waters around Helen Reef Aug. 1~Aug. 2)

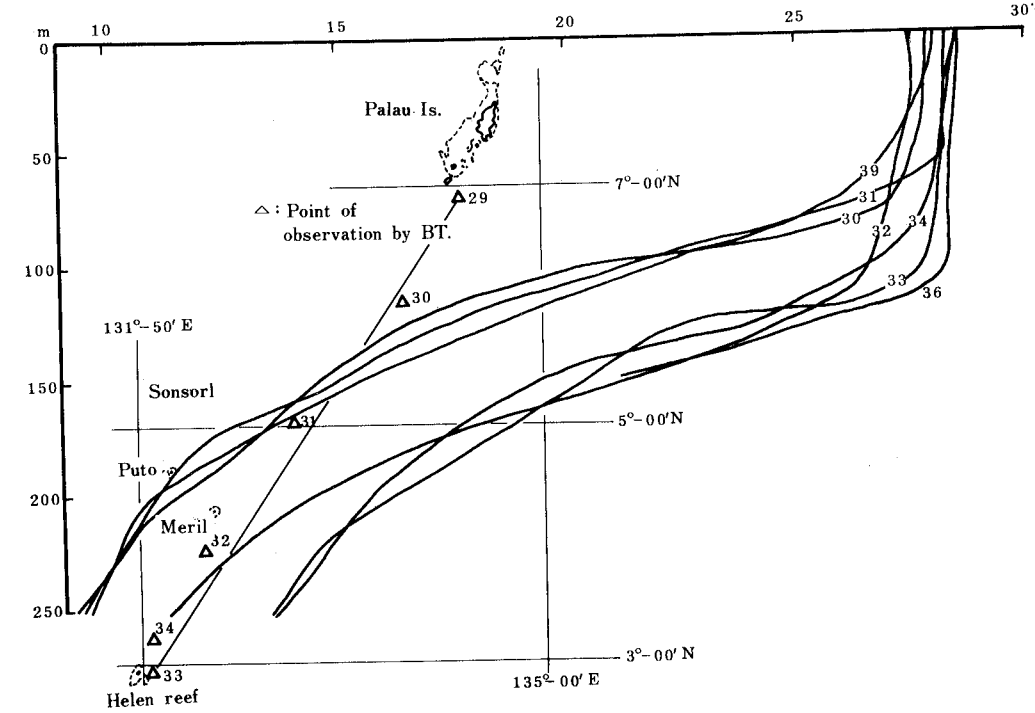


Figure 10. Vertical distribution of water temperature
(Waters frome palau to Helen Reef July 29~Aug. 2)

ii) Helen Reef:
Main species caught was *Spratelluides delicaturus (Bennett)*, maximum catch per operation of 240 bucketfuls being obtained. *Spratelluides japonicus (Houtuyn)* was caught for the first time in the Micronesian waters. There was no catch of Engraulidae.

2) Survival (preservation) tests:

i) Survival test with live fish net cages:
The test was conducted in the waters off Ngaremlengui (7°–32.'8 N and 134°–30.'6 E, water depth 30 m, muddy bottom) with 2 sets of live fish net cages. The results are shown in Table 9. Records of the tests are also presented in Table 10-(1), 10-(2), and 10-(3).

ii) Survival tests with live fish wells of the vessel:
On 25 July, 25 bucketfuls of bait fishes which had survived the preservation test in live fish net cage (Table 10-(3)) were placed in the fish well on board (3.25 m^3, mechanical water circulation) and transported as far as Helen Reef in order to observe their viability. The response of bait fishes to feeding was as good as Engraulidae caught in Tateyama, Japan. The mortality proved 20% in 9 days after the bait fishes were taken on board.

Table 7. Occurance of shipjack Schools

Area	No. of days at fishing grounds	Character of school	No. of schools sighted (A)	Catch				No. of operations (D)	D/B
				Yes (B)	B/D×100	No (C)	C/D×100		
		Simple			%		%		
Palau Is.		Bird-associated	110	24	35.8	43	64.2	67	2.8
		Log-associated							
	26	Associated with shark, whale, oolphin, etc	3			2	100	2	
			2	1	50	1	50	2	2.0
Total	26		115	25	35.2	46	64.8	71	2.84

Table 8. Occurance of skipjack Schools

Area	No. of days at fishing grounds	Character of school	No. of shools sighted (A)	Catch				No. of operations (D)	D/B
				Yer (B)	B/D×100	No (C)	C/D×100		
		Simple			%		%		
Palau Is.		Bird-assuciated	45	5	11.1	17	37.8	22	4.4
(Helen Reef)	8	Log-associated							
		Associated with shark, whaie, dolphin, etc							
Total	8		45	5	11.1	17	37.8	22	4.4

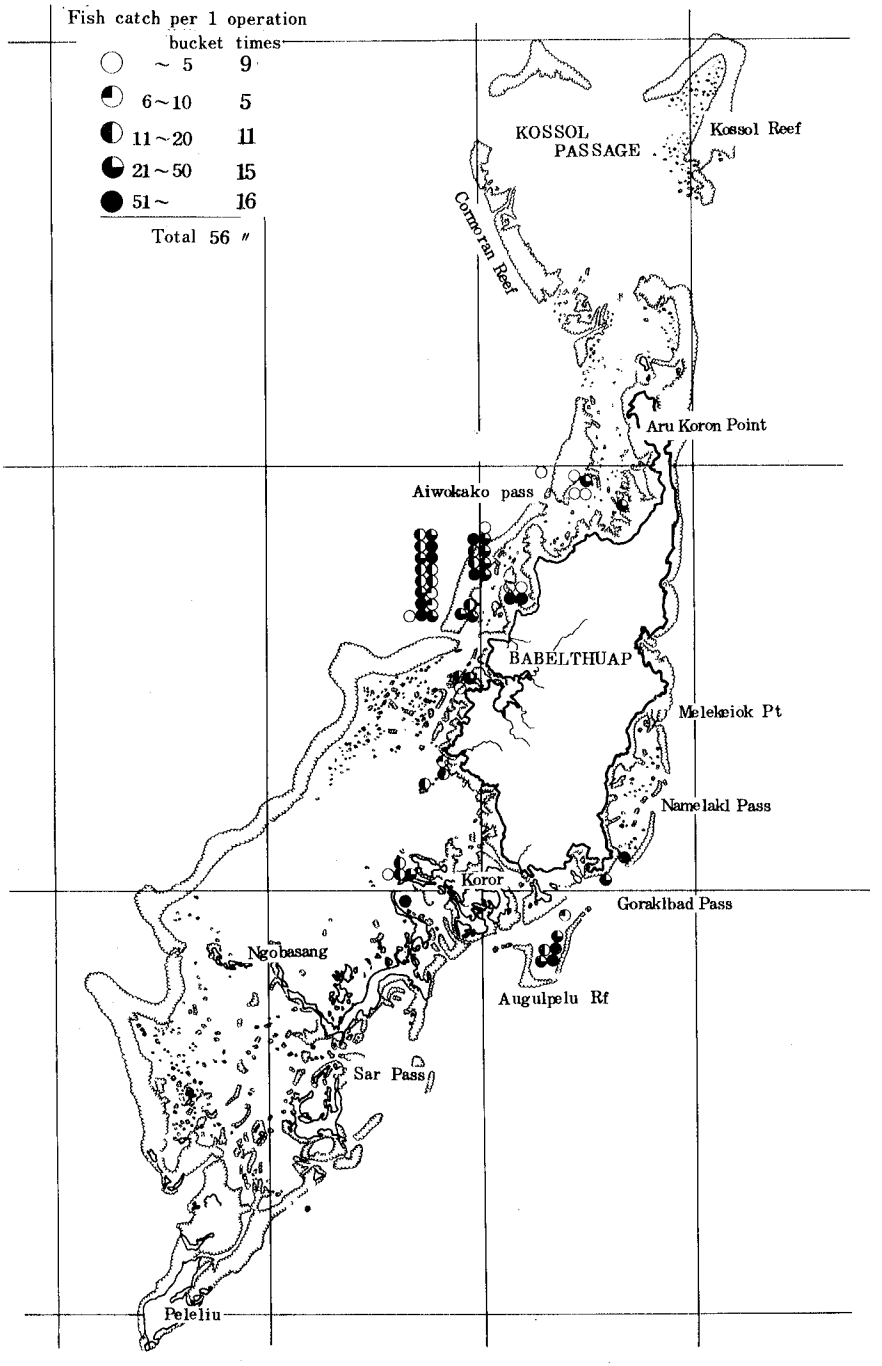


Fig 11-(1) Fshing position by stick-held dip net

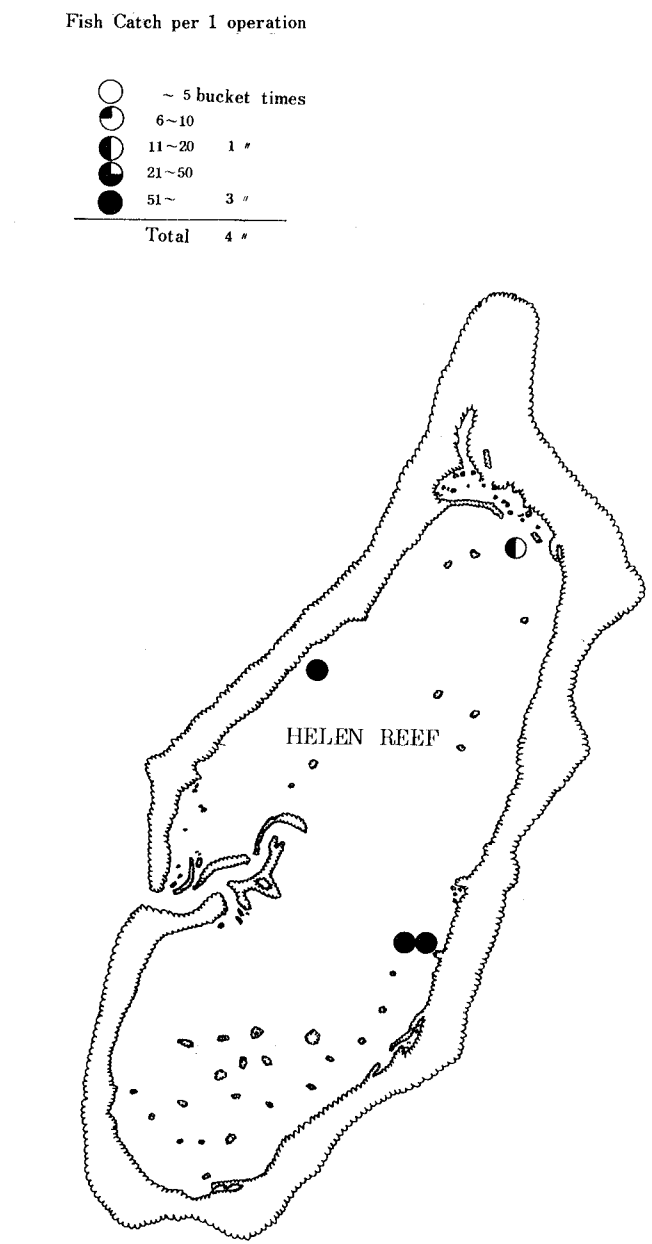


Fig 11-(2) Fshing position by stick-held dip net

(4) Biological studies

1) Skipjack

i) Body-length distribution

Figures 12-(1) and (2) show the body-length distribution of skipjack and yellowfin tuna in the waters around the Palau Islands. Figure 13 indicates the body-length distribution of skipjack in Helen Reef area.

ii) Biological data (operations No. 13 – No. 37)

Sex:

Number of fish 120, Male 60% and female 40%.

Sexual gonad:

Number of fish 180, maturing 8.9%, matured 73.9%, spawn 17.2%.

Stomach condition:

Number of fish 190, vacant 13.7%, half-full 45.3%, full 4.1%.

2) Bait fishes

i) Body-length distribution:

Figure 14 and Figure 15 show the frequency distribution of body-length of bait fishes caught in the waters around Palau Main Island and Helen Reef, respectively.

Table 9. Surviral test of bait fishes, Palau Islands

Size of net cage	Length of side No. of side depth 4 m × 8 × 7 m	Length of side No. of side depth 3 m × 8 × 8 m	Length of side No. of side depth 3 m × 8 × 8 m
Duration of the test (day)	10	6	7
No. of bucketfuls (One bucketful. 3kg)	200	60	62
Main test fish (%)			
Stolephorus Spp.	70	80	81
Spratelluides delicaturus	30	10	
Allanetta Spp.			6
Harengula Spp.		10	
Others			13
Survival rate (%)	18.9 (Carangidae, Harengula)	78.7 (Marnty stolephores Spp.)	70.9 (Mainly stolephorus Spp.)
Remarks	Frigate mackerel 98 mingled. Took several days to elimihate them with gill net.	good testing conditions. starting 2nd day formula feed given. good appetite	good testing conditions. Stanting 2nd day formula feed given. good appetite

St : Stolephorus sp.
Sp : Sprotelluides sp.
Al : Allanetta sp.

Table 10—(1) Records of survival test of bait fishes

Operation No.	No.18 No.19
Place of Catch	Ngaremlengui
Date of Catch	1976.6.24 01:15 05:20
Place of testing, distance from shore, depth	7°-32'8N 134°-30'6E · 1,260m · 29m
Size of net cage 4m×	Qctagon. Depth 7m
Date taken on board	1976.7.3 08:00~10:00

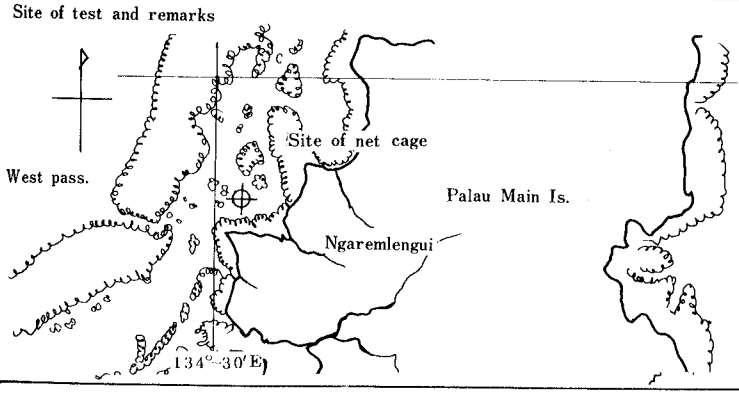
Quantity tested

Species	Percentage	Quartity	Remark
St.	80(%)	160 bucket	
Sp.	10 〃	20 〃	
Al.	10 〃	20 〃	
Total	100 〃	200 〃	

(one bucketful ≒ 3kg)

Date	Time	Operation	Received	Used	Died	Remaining		Pemarks	W.temp. (°C)
1976 6.24	01:15 05:20	No.18 No.19	bucket 200		bucket	bucket 200	(%)	St. 70% Al. 30% Sp. 30%	27.7
〃	10:00	1st observation by diving			50	150		out of to died St. St 80~90%	28.4
〃	15:00	2nd observation by diving			4.3	145.7		mainly St. died	28.3
6.25	10:00	3rd observation by diving			33.3	112.4		〃	28.5
〃	16:00	4nd observation by diving no response to feeding			3.0	109.4		of died St. 100% 0%	
6.26	08:00	5th observation by diving			12.3	97.1		5 frigate mackerel caught	
〃	16:30	6th observation by diving			6.6	90.5		Frigate mackerel chaee St.	
6.27	08:00	7th observation by diving			25.6	64.9		Ergranli dae upper layer, mackerel lover layer	28.4
〃	16:30	8th observation by diving			10.6	54.3		St., remain at bottom	28.7
6.28	08:00	9th observation by diving			11.6	42.7		〃	28.4
	17:00	10th observation by diving			1.0	41.7		76 frigate mackerel (20~26cm) caught	28.5
6.29	08:00	11th observation by diving			0.6	41.1		6 frigate mackerel caught	28.5
	17:00	12th observation by diving			1.0	40.1		respond to feeding	29.0
6.30	08:30	13th 〃			1.0	39.1		〃	29.0
	17:00	14th 〃			0.3	38.8		〃	29.2
7. 1	08:00	15th 〃			0.2	38.6		3 frigate mackerel caught. good response to feedmg	29.2
	17:00	16th 〃			0.2	38.4	19.2	In total 93 frigate mackerel canght	30.2
7. 2	08:00	No. diving						good feeding response	29.3
	17:00	17th observation by diving			0.3	38.1		〃	29.5
7. 3	08:00	〃			0.7	37.4	18.7		29.2
Total			200			37.4	18.7		

Site of test and remarks



on June 25 about 100 frigate mackerel invaded the cage, which was main reason for the high mortality, the frigate mackerel died in the cage in one week.

St : Stolephorus sp.
Ha : Harangula ovalis
Sp : Spratilluides sp.

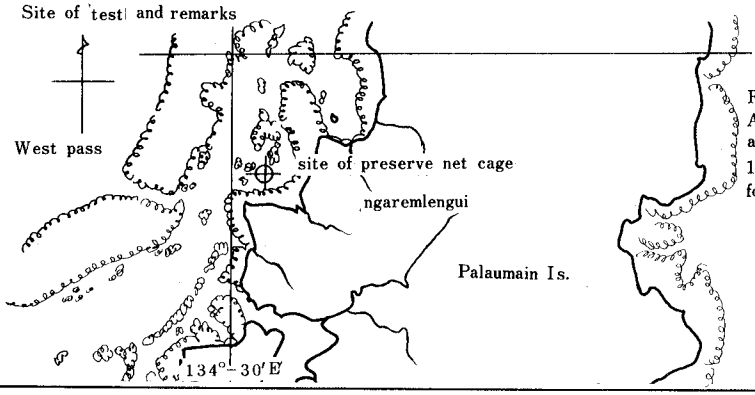
Table 10—(2) Records of survival test of bait fishes

Operation No.	No.2 0 No.2 1	Quantity tested	Species	Percentage	Quantity	Remark
Place of catch	Ngaremlengui		St.	8 0(%)	4 8.0 bucket	
Date of catch	1 9 7 6.6.2 5 0 0 : 4 0 / 0 5 : 3 5		Ha.	1 0 〃	6.0 〃	
Place of testing, distance from shore, depth	7°− 3 2′8 N / 1 3 4°− 3 0′6 E · 1,2 6 0 m · 3 0 m		Sp.	1 0 〃	6.0 〃	
Size of net cage	3 m×, Octagon, Depth 8m					
Date taken on board	1 9 7 6.7.3 0 9 : 0 0～1 0 : 0 0		Total	1 0 0 〃	6 0.0 〃	

(one bucketful≒3kg)

Date	Time	Pemarks	Received	Used	Died	Remaining		Remarks	W.temp. (℃)
1 9 7 6 6.2 5	0 0 : 4 0 0 5 : 3 5	No.2 0 No.2 1operation	bucket 6 0		bucket	bucket 6 0	(%)	St, Ha. Sp. 1 0 % 1 0 %	2 8.°0
〃	1 1 : 0 0	1st observation by diving			4.3	5 5.7			
〃	observation	2rd observation by diving feeding commenced			0.5	5 5.2		Barracuda swim lawer layer	
6.2 6	observation	3rd obsewation by diving little response to feeding			3.0	5 2.2		one Barracuda caught. no predator	2 8.°4
〃	observation	4th observation by diving active response to feeding			0.2	5 2.0		St, settle at middle layer	
6.2 7	observation	5th observation by diving active responded to feeding			0.6	5 1.4		〃	2 8.°4
〃	1 7 : 3 0	6th 〃 〃 〃			0.3	5 1.1		St. actively respord to feeding	2 8.°7
6.2 8	0 8 : 3 0	7th 〃 〃 〃			1.0	5 0.1		of died 100% St.	2 8.°4
〃	1 8 : 0 0	8th 〃 〃 〃			1.0	4 9.1		one large fish invades	2 8.°5
6.2 9	0 8 : 3 0	9th 〃 〃 〃			0.6	4 8.5		The large fish disappears	2 8.°5
〃	1 7 : 3 0	10th 〃 〃			0.6	4 7.9			2 9.°0
6.3 0	0 9 : 0 0	11th 〃 〃 〃			0.5	4 7.4			2 9.°0
	1 7 : 3 0	12th 〃 〃 〃			0				2 9.°2
7. 1	0 8 : 2 0	13th 〃 〃 〃		"Ha" almost	0.2	4 7.2	7 8.7		2 9.°2
	1 7 : 3 0	14th 〃 〃		escaped	0				3 0.°2
7. 2	0 8 : 0 0	No diving							2 9.°3
	1 7 : 3 0	15th 〃			0				
7. 3	0 8 : 2 0	16th observation by diving			0				2 9.°2
	0 9 : 0 0	taken on board				(4 7.2)			
Total			6 0			(4 7.2)	7 8.7		

Site of test and remarks



Fed twice a day (08 : 00, 17 : 00)
Actively responded to feeding after 3 days.
1.5～2% of the hzh weight of formula feed was given at on time

St : Stolephorus sp.
Sp : Spratelluides sp.
Al : Allanetta sp.

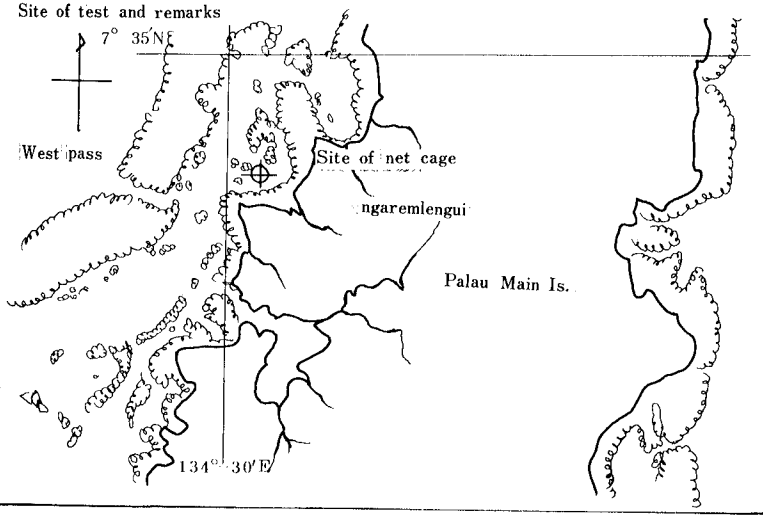
Table 10−(3) Recods of survival test of bait fishes

Operation No.	No.47 No.48	Quantity tested	Species	Percentage	Quantity	Remark
Place of catch	Ngaremlengui		St.	80.3(%)	49.8 bucket	
Date of catch	1976.7.18 · 23:30 05:40		Sp.	13.9 〃	8.6 〃	
Place of testing, distance from shore, depth	7°−32′8 N 134°−30′6 E · 1,260m · 30m		Al,	5.8 〃	3.6 〃	
Size of net cage	3m × Octagon, Depth 8m					
Date taken on board	1976.7.25 14:00 ～ 16:00		Total	100 〃	62.0 〃	

(one bucketful ≒ 3kg)

Date	Time	observation	Received bucket	Placed	Died bucket	Remaining bucket	(%)	Remarks	W.temp. (℃)
1976 7.18	23:30 ～05:40	No.47 No.48	62			62		St. (80%)	27.6
7.19	16:00	1st observation by diving			12.3	49.7		Mainly St. died	
20	12:00	2nd observation by diving			0.3	49.4		No response to feeding	28.5
〃	16:00	3rd obsewation diving			6.6	42.8		〃	28.2
7.21	08:00								
〃	16:00	4th observation by diving St. went down to bottom			1.0	41.8		good response to feeding	28.4
7.22	08:00	5th diving			0			good response to feeding	28.5
〃	17:00	6th diving			0.6	41.2		very good response to feeding	28.4
7.23	08:00	Respond to feeding						〃	28.2
〃	16:00	〃			1.0	40.2		〃	
7.24	08:00	〃			0			〃	28.0
〃	16:00	〃			0			〃	
7.25	08:00	〃			0.1	40.1		〃	
	14:00	14:00−16:00 00 taken on board				(44)	70.9	Mainly St. remain	27.8
Total			62		21.9	(44)	70.9		

Site of test and remarks



mortality decreased after 2 days, good response to feeding after 4 days very good respouse to feeding after 5 days

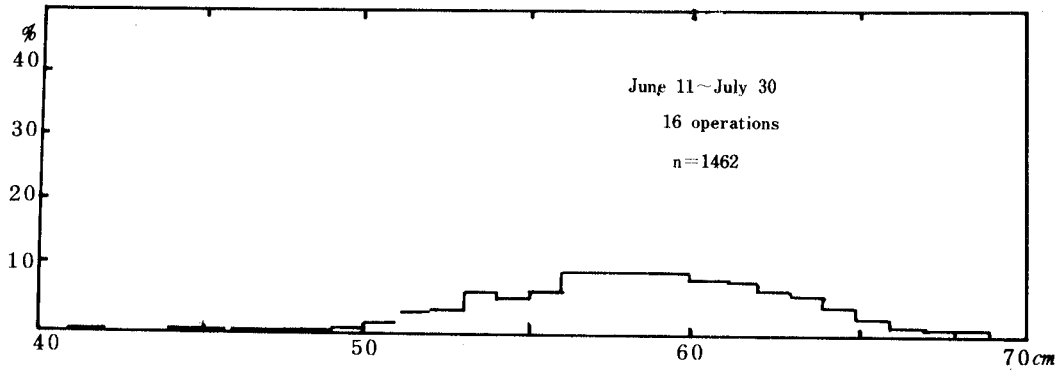


Figure 12—(1) Body length distribution of skipjack
(Waters around palou Is.; Fork length)

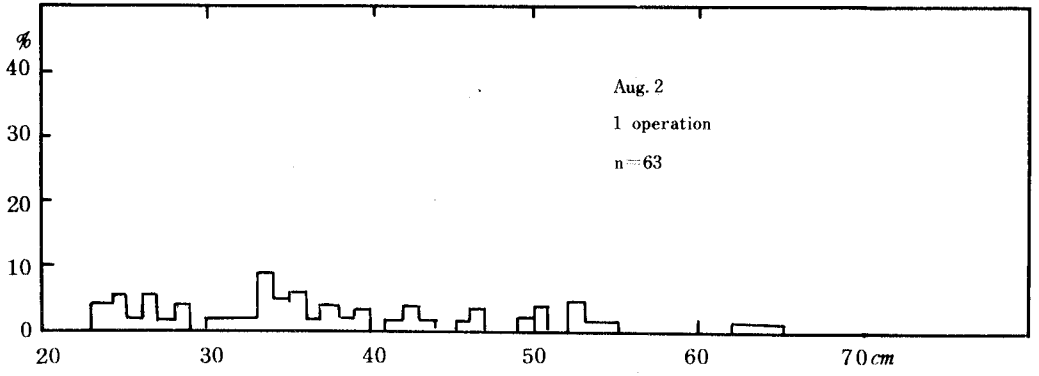


Figure 12—(2) Body length distribution of yellowfin (Waters around palou Is.Is.: Fork length)

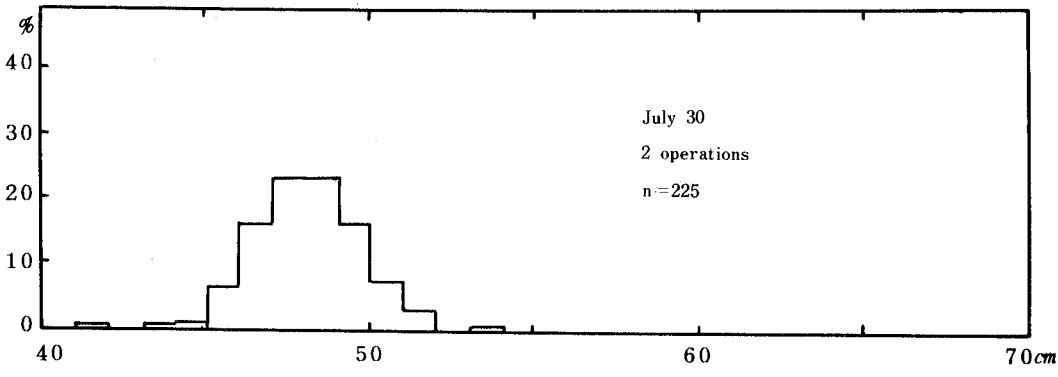


Figure 13. Body length distribution of skipjack (Helen Reef: fork length)

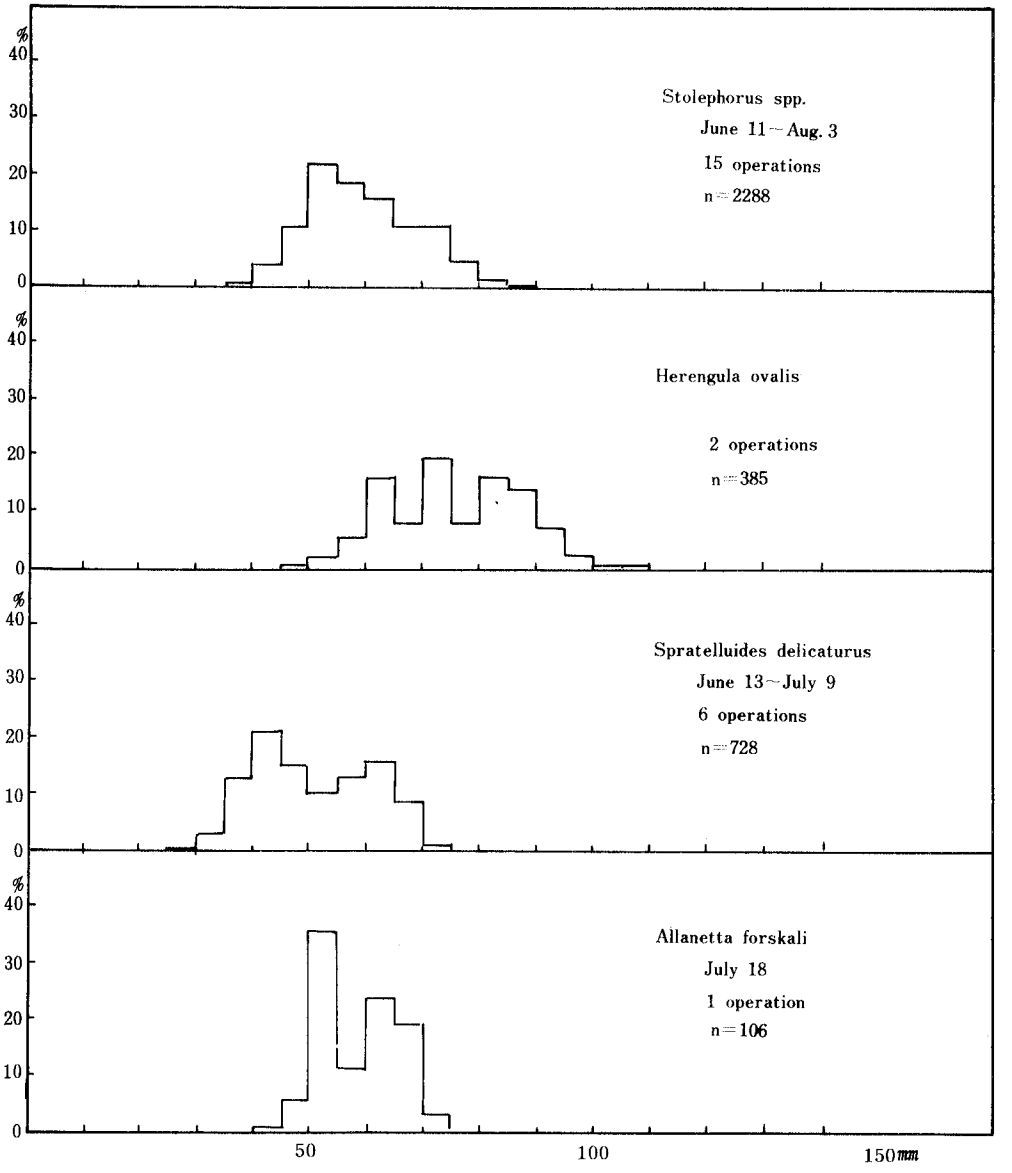


Figure 14. Body length distribution of main bait fishes by species (Waters around palau main Is; Fork length)

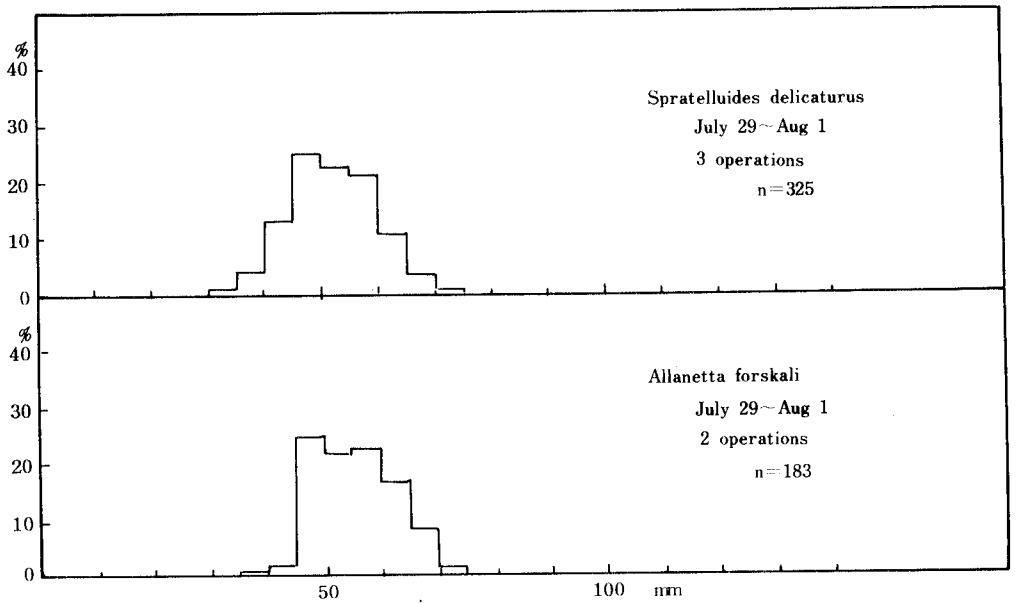


Figure 15. Body length distribution of main bait fishes by species (Helen Reef; Fork length)

Annex table 2.

Results of oceanographic observetion

No.	Date	Hour	Position		Water temperatrre						
			Lat. (N)	Long. (E)	0 m	25 m	50 m	75 m	100 m	125 m	150 m
1	'76.5.31	05 : 15	20°- 50′	145°- 00′	26.8	26.4	26.3	26.3	23.5	22.6	20.5
2	〃	16 : 40	20°- 00′	145°- 29.5′	27.3	26.4	26.4	26.1	23.5	21.8	21.1
3	6. 1	19 : 20	19°- 00′	145°- 50′	27.9	27.3	27.2	27.2	26.0	25.2	24.0
4	〃	20 : 10	18°- 00′	145°- 05′	27.9	27.3	27.1	27.0	26.5	25.8	25.0
5	6. 2	08 : 50	17°- 00′	146°- 05′	28.2	27.5	27.4	27.3	27.0	25.8	25.4
6	〃	16 : 10	16°- 00′	145°- 50′	28.2	27.6	27.5	27.3	27.0	25.9	24.6
7	6. 4	23 : 45	14°- 17′	145°- 00′	28.0	27.4	27.1	26.9	27.0	26.3	25.3
8	6. 5	10 : 15	12°- 53′	144°- 00′	28.4	27.5	27.3	27.3	27.3	26.5	25.7
9	〃	17 : 20	12°- 18′	143°- 05′	28.4	27.9	27.3	27.3	27.3	26.7	24.3
10	6. 6	02 : 15	11°- 39′	141°- 50′	28.4	27.9	27.6	27.5	27.3	25.9	24.4
11	〃	09 : 20	11°- 03′	140°- 40′	28.4	28.4	27.7	27.5	27.1	26.2	23.7
12	〃	14 : 10	10°- 26′	140°- 00′	28.8	28.7	28.7	28.3	27.3	25.4	23.0
13	〃	23 : 25	09°- 47′	139°- 00′	28.8	28.9	28.4	27.9	27.0	23.8	21.3
14	6. 7	06 : 12	09°- 08′	138°- 00′	28.6	28.6	28.5	27.5	26.4	24.2	21.4
15	〃	20 : 00	08°- 21′	137°- 00′	28.7	28.7	28.4	24.9	22.6	20.0	16.5
16	6. 8	02 : 40	07°- 54′	136°- 00′	28.9	28.5	27.6	24.3	20.1	17.6	15.5
17	〃	09 : 15	07°- 25′	135°- 00′	29.0	28.5	27.6	24.3	19.5	17.0	15.4
18	〃	11 : 45	07°- 10′	134°- 40′	29.2	28.6	26.8	23.9	20.9	17.2	14.6
19	6.12	11 : 15	07°- 20′	134°- 04′	28.8	28.6	27.8	24.5	21.5	17.8	14.3
20	〃	12 : 30	07°- 09′	134°- 04′	28.8	28.4	26.2	22.9	20.2	16.8	14.4
21	6.13	07 : 30	07°- 40′	134°- 20′	28.7	28.2	24.6	21.5	18.5	15.5	13.3
22	〃	08 : 40	07°- 50′	134°- 20′	28.4	28.2	25.2	22.9	19.9	18.2	14.6
23	〃	11 : 00	08°- 10′	134°- 20′	28.6	28.3	28.0	26.5	20.5	17.3	14.5
24	〃	11 : 55	08°- 00′	134°- 00′	28.6	28.6	27.1	23.8	20.8	15.1	14.0
25	6.14	11 : 05	07°- 20′	134°- 48′	28.6	28.6	28.4	23.6	20.0	16.5	14.4
26	〃	13 : 00	07°- 10′	134°- 35′	28.3	28.3	27.3	23.7	20.3	16.6	13.5
27	7.27	16 : 05	07°- 10′	134°- 39′	28.5	28.0	27.0	26.5	22.3	17.5	15.7
28	〃	17 : 45	07°- 00′	134°- 29′	28.2	27.9	26.2	23.4	20.0	16.9	15.4
29	〃	19 : 20	06°- 51′	134°- 20′	28.1	27.5	27.1	25.6	21.2	17.4	15.0
30	7.28	02 : 00	06°- 00′	133°- 40′	27.9	27.8	27.6	26.0	20.4	16.6	14.6

(℃)				Weater	Wind direction	Wind force	Pressure (mb)	Wave	Trans parency (m)	Atom. temperature (℃)
175m	200m	225m	250m							
19.4	18.5	17.8	17.0	b	W	2	1013.0	2		26.5
20.2	18.7	18.3	17.2	bc	N	2	1013.0	2		28.3
22.8	21.0	19.7	18.5	bc	NW	2	1013.0	1		27.0
22.8	21.0	19.3	16.6	bc	N	2	1012.0	2		27.0
24.4			19.5	bc	NNW	2	1013.0	2	45+	29.2
22.4	21.2	19.5	17.8	bc	N	3	1011.5	2	37	31.0
23.9		20.0	17.6	bc	SSE	2	1010.5	2		27.0
23.7	20.0	19.3	16.7	C	NE	2	1010.0	2	45+	29.0
21.4	18.6	15.4	13.2	bc	ESE	2	1008.6	2		28.0
21.4	17.8	14.5	12.3	b	E	2	1009.0	2		27.5
21.4	17.7	14.9	12.7	bc	E	2	1011.0	3	30	30.5
18.5	15.2	13.5	11.5	C	ESE	2	1009.0	3	30	29.0
19.5	15.7	13.7	12.4	O	E	3	1011.0	3		28.5
18.6	14.2	13.1	11.4	Q	E	3	1009.5	3		26.0
14.9	12.5	11.5	10.1	C	E	2	1011.0	1		25.0
13.6	12.0	10.9	9.6	bc	E	2	1010.0	2		26.5
12.8	11.4	10.3	9.3	bc	ESE	2	1011.0	2	45+	29.0
12.9	11.6	10.4	9.6	bc	ESE	1	1011.0	1	37	29.0
12.1	10.8	10.3	9.5	O	WNW	2	1011.1	2	32	27.0
12.4	11.1	10.4	9.4	O	W	3	1010.5	3	30	27.5
12.0	10.8	10.0	9.3	bc	Calm		1009.0	1	44	27.5
12.9	11.4	10.6	10.0	Q	NE	2	1009.5	1	35	27.0
12.4	10.5	10.0	9.5	O	E	3	1009.5	2	32	26.0
12.3	11.1	10.0	9.3	O	S	3	1009.5	3	28	25.0
13.1	11.4	10.1	9.3	O	S	4	1010.0	3	26	27.0
11.8	11.0	10.1	9.4	O	S	5	1010.0	3	25	27.0
13.0	11.1	10.3	9.6	bc	S	3	1008.0	3		29.0
12.0	10.8	10.1	9.5	bc	S	3	1009.0	3	31	28.2
12.0	11.2	10.1	9.6	bc	S	3	1009.5	3		28.0
13.2	11.4	10.2	9.3	bc	SW	3	1009.0	3		27.0

No.	Date	Hour	Position		Water temperature (℃)											Wether	Wind direction	Wind force	Pressure (mb)	Wave	Trans parency	Atom. temperature (℃)
			Lat. (N)	Long. (E)	0 m	25 m	50 m	75 m	100 m	125 m	150 m	175 m	200 m	225 m	250 m							
31	'76.7.28	09:30	05°−00′	133°−00′	28.3	28.2	28.2	26.3	22.3	18.6	15.4	13.0	10.9	10.1	9.4	C	S	3	1011.0	3	32	28.0
32	〃	19:40	04°−00′	132°−13′	27.5	27.5	27.3	27.0	26.8	25.2	21.5	17.0	14.5	12.7	11.3	b c	S	3	1009.5	3		27.0
33	8. 1	13:00	02°−55′	131°−53′	28.6	28.2	28.1	28.1	27.8	22.5	20.5	18.3	16.1	14.5	13.5	r	S S E	2	1008.5	2	27	27.0
34	〃	14:10	03°−04′	131°−49′	28.5	28.3	28.0	27.8	26.7	24.3	19.5	17.5	15.7	14.7	13.5	O	S W	3	1008.0	3	28	27.0
35	〃	15:55	02°−55′	131°−41′	28.5	28.5	28.5	27.8	27.7	25.0	23.0	18.7	17.4	16.0	14.0	r	S W	4	1008.2	4	25	24.5
36	8. 2	08:55	02°−46′	131°−45′	28.5	28.5	28.3	28.3	28.3	25.3	21.2	20.1	16.2	15.0	12.8	O	S W	3	1011.0	4	27	26.0
37	8. 8	15:45	07°−10′	136°−00′	27.8	27.8	27.8	24.8	17.8	15.3	14.0	11.8	10.9	10.1	9.5	O	S W	4	1010.0	4	26	26.5
38	8. 9	03:55	07°−10′	138°−00′	27.8	27.8	27.8	24.8	22.3	18.8	15.8	13.3	11.5	10.6	10.0	O	S W	3	1011.0	3		26.5
39	〃	18:00	07°−10′	140°−00′	28.4	27.8	27.8	26.0	20.4	14.9	12.6	11.5	10.7	10.0	9.5	C	N W	1	1011.5	1	28	27.9
40	8.10	06:10	07°−16′	142°−08′	27.8	27.7	27.7	26.8	21.3	18.0	15.0	12.9	11.3	10.3	9.9	b c	N	2	1011.4	1	38	26.7
41	〃	17:15	07°−13′	144°−00′	28.2	28.0	28.0	25.0	20.5	18.2	14.7	12.2	11.8	11.2	9.8	O	S W	3	1010.0	2	33	26.5
42	8.11	05:50	07°−13′	145°−57′	27.8	27.8	27.6	23.1	19.0	17.0	14.1	13.0	11.6	10.5	9.6	O	N N W	4	1010.3	3	30	25.8
43	〃	18:20	07°−10′	148°−00′	28.2	28.0	27.3	24.1	21.6	18.1	15.2	12.2	11.5	10.6	9.7	O	E S E	2	1009.5	2		28.1
44	8.12	08:05	07°−16′	150°−00′	27.7	27.7	26.3	23.5	19.5	16.5	14.0	12.0	10.3	10.0	9.3	r	W S W	2	1012.5	2	24	23.9
45	〃	14:05	07°−24′	151°−00′	28.9	28.0	28.0	24.3	22.3	20.7	15.8	13.5	11.3	10.7	9.8	b c	N W	2	1009.0	2	38	27.1
46	8.17	08:15	07°−25′	151°−23′	27.8	27.8	27.8	26.0	23.2	20.5	18.7	14.0	11.8	10.8	9.9	b c		Calm	1013.0	0	33	27.3
47	〃	09:15	07°−31′	151°−28′	28.0	28.0	27.7	26.0	23.2	19.2	17.2	16.0	12.2	11.5	11.0	b c	W	1	1012.5	0	39	27.5
48	〃	10:10	07°−35′	151°−33′	28.5	28.0	27.2	26.0	23.5	21.2	17.9	13.7	11.6	10.9	10.1	b c	WNW	1	1012.5	0	42	27.7
49	〃	11:10	07°−40′	151°−38′	28.2	28.1	27.5	25.2	23.5	21.4	17.8	15.2	12.5	11.0	10.3	b c	WNW	1	1012.0	1	36	27.8
50	8.19	07:45	07°−20′	151°−19′	28.0	28.0	27.0	24.4	21.9	18.9	17.9	15.0	12.0	10.7	10.2	O	N E	3	1010.5	2	27	27.5
51	〃	08:30	07°−15′	151°−13′	27.8	27.8	27.8	25.3	23.8	19.2	17.2	14.4	11.8	11.0	9.8	O	N E	2	1011.0	2	35	27.0
52	〃	09:10	07°−13′	151°−28′	27.9	27.9	27.8	25.3	23.6	19.6	16.5	13.4	11.8	11.0	10.0	b c	E N E	2	1011.2	1	35	27.0
53	〃	09:55	07°−11′	151°−33′	28.0	27.9	27.0	24.5	21.8	18.5	17.3	14.2	12.0	10.8	9.8	b c	E	2	1011.0	1	36	27.5
54	〃	10:40	07°−09′	151°−58′	28.0	28.0	26.8	24.3	22.5	19.5	16.2	15.0	11.2	10.8	10.0	b c	E	2	1010.5	1	33	27.8
55	〃	11:20	07°−08′	151°−43′	28.1	28.0	25.8	23.8	21.0	18.5	16.3	14.9	13.2	10.5	9.9	b c		Calm	1010.0	0	29	28.0
56	〃	12:00	07°−06′	151°−48′	28.5	27.8	26.6	23.5	21.3	18.8	16.5	14.2	12.8	11.0	9.8	b c		Calm	1009.5	0	29	28.1
57	9.22	09:20	07°−10′	152°−05′	28.2	27.8	27.8	25.0	23.8	20.0	16.6	15.0	11.6	10.8	9.8	b c	WNW	1	1012.0	1	41	27.9
58	〃	09:45	07°−10′	152°−07′	28.5	28.2	28.0	25.2	23.0	18.5	16.7	14.5	11.6	11.0	10.6	b c	W	1	1012.0	1	42	28.2
59	〃	11:30	07°−15′	152°−06′	29.0	28.5	28.2	25.5	23.5	19.0	17.0	14.5	12.8	11.5	10.6	b c	NW	1	1011.5	1	35	28.1
60	〃	12:15	07°−20′	152°−06′	29.1	28.0	27.8	25.2	23.8	22.7	20.8	14.7	11.5	10.6	10.0	b c	N	1	1011.0	1	35	28.0
61	〃	12:50	07°−25′	152°−05′	28.5	28.2	28.2	26.2	24.0	22.0	18.5	15.0	12.2	11.2	10.3	b c	NW	2	1010.6	1	32	27.8