

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

**Japan Marine Fishery Resource Research Center**

**April 1977**

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## 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, Ichthyology 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.

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April 1977

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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) <u>Katakuchiiwashi-ka (Tarekuchi)</u> | <u>Engraulidae</u>   |
| Indo Ainoko                               | <i>Stolephorus indicus (Van Hassalt)</i>                             |
| Taiwan Ainoko                             | <i>Stolephorus heterolobus (Ruppell)</i>                             |
| Batavia Katakuchi                         | <i>Stolephorus bataviensis Hardenberg</i>                            |
| (2) <u>Nishin-ka</u>                      | <u>Clupeidae</u>   |
| Mizun                                     | <i>Harengula ovalis (Bennett)</i>                                    |
| Yamato Mizun                              | <i>Sardinella chupeoides</i>   |
| (3) <u>Tougoroiwashi-ka</u>               | <u>Atherinidae</u>   |
| Tougoro Iwashi                            | <i>Allanetta forskali (Ruppell)</i>                                  |
| Yakushima Iwashi                          | <i>Pranesus pinguis (Lacepede), Stenatherina temmincki (Bleeker)</i> |
| (4) <u>Urumeiwashi-ka</u>                 | <u>Dussmeriidae</u>  |
| Minami Kibinago                           | <i>Spratelluides delicaturus (Bennett)</i>                           |
| Kibinago                                  | <i>Spratelluides japonicus (Houttuyn)</i>                            |
| Nise Gin Iwashi                           | <i>Dussumieria hasselti Bleeker</i>                                  |
| (5) <u>Aji-ka</u>                         | <u>Carangidae</u>  |
| Meaji                                     | <i>Selar crumenophthalmus (Bloch)</i>                                |
| Mabuta Shimaaji                           | <i>Selar boops (Cuvier)</i>  |
| (6) <u>Saba-ka</u>                        | <i>Scomberoides toloparah (Ruppell)</i>                              |
| Gurukuma                                  | <i>Selaroides leptolepis (Cuvier)</i>                                |
| Tsumari Gurukuma                          | <u>Scombridae</u>  |
| (7) <u>Takasago-ka</u>                    | <i>Rastrelliger kanagurta (Cuvier)</i>                               |
| Nise Takasago                             | <i>Rastrelliger brackysoma (Bleeker)</i>                             |
| Takasago                                  | <u>Caesiidae</u>   |
| Sasamuro                                  | <i>Caesio gymnopleus Bleeker</i>                                     |
| Issen Takasago                            | <i>Caesio chrysozonus Cuvier and Valenciennes</i>                    |
| Kumasasa Hanamuro                         | <i>Caesio diagramma Bleeker</i>                                      |
|   | <i>Caesio coeruleus Lacepede</i>                                     |
|   | <i>Caesio plsang Bleeker</i>   |
|   | <i>Caesio tile Cuvier and Valenciennes</i>                           |

- |  |  |
|--|--|
| (8) <u>Hiiiragi-ka</u><br>Koban Hiiiragi   | <u>Leiognathidae</u><br><i>Gazza minuta</i> (Bloch)<br><i>Leiognathus</i> sp.  |
| (9) <u>Aigô-ka</u><br>Hana Aigo<br>Ami Aigo<br>Goma Aigo<br>Majiri Aigo<br>Hifuki Aigo               | <u>Siganidae</u><br><i>Siganus rostratus</i> (Valenciennes)<br><i>Siganus spinus</i> (Linnaeus)<br><i>Siganus guttatus</i> (Bloch)<br><i>Siganus puellus</i> (Schlegel)<br><i>Siganus vulupinus</i> (Schlegel) |
| (10) <u>Tenjikudai-ka</u><br>Itohiki Tenjikudai<br>Atohiki Tenjikudai<br>Kurosuji Sukashi Tenjikudai | <u>Apogonidae</u><br><i>Apogon leptacanthus</i><br><i>Archamia zosterophera</i><br><i>Rhabdamia cypselura</i> 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       |      |
| Specis                                | (bucket)  | % | (bucket) | %    | (bucket) | %    | (bucket)   | %    |
| 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      |      |
| 1 Engraulidae                         |           |   | 863.4    | 66.3 | 1080     | 58.0 |            |      |
| 2 Clupsideae                          |           |   | 130.8    | 10.0 | 39.1     | 2.1  |            |      |
| 3 Atherinidae                         |           |   | 58.4     | 4.5  | 53.2     | 2.9  | 78.7       | 18.4 |
| 4 Dussumeriidae<br>(Sprateluides sp.) |           |   | 216.0    | 16.6 | 676.8    | 36.4 | 265.6      | 62.2 |
| 5 Dussumieridae<br>S. Japonicus)      |           |   |          |      |          |      | 82.7       | 19.4 |
| 6 Caesiidae                           |           |   | 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.

(unit of Catch : 1 bucket, about 3kg)

| Truk Tslands |   |          |      |                   |      | Ponepe I |      |          |      |          |      |
|--------------|---|----------|------|-------------------|------|----------|------|----------|------|----------|------|
| 1974         |   | 1975     |      | 1976              |      | 1974     |      | 1975     |      | 1976     |      |
|              |   | 797.9    |      | 532.0             |      | 1,056.3  |      | 717.1    |      | 295.0    |      |
|              |   | 2.4      |      | 1.0               |      | 4.5      |      | 2.4      |      | 1.0      |      |
|              |   | 4.5      |      | 1.9               |      | 7.9      |      | 4.9      |      | 1.9      |      |
|              |   | 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<br>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<sup>3</sup>, 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.

Table 2 Result of operation for Skipjack Pole-and-line Fishing

SJ : Skipjack  
YF : Yellowfin t  
B : Bonito

| Area<br>(Period)                          | Operation |       | Av. Catch per (kg) |           | Species Catch (kg) |       |     | Total catch<br>(kg) | Av. Weigh (kg) |     |     |
|---|-----------|-------|--------------------|-----------|--------------------|-------|-----|---------------------|----------------|-----|-----|
|   | Days      | Times | Day                | Operation | SJ                 | YF    | B   |                     | SJ             | YF  | B   |
| Ogasawara<br>-Mariana<br>(76. 5. 28~6. 7) | 3         | 12    | 3,713              | 928       | 10,140             | 999   |     | 11,139              | 3.5            |     |     |
| Palau Is.<br>(76. 6. 11~8. 5)             | 22        | 30    | 976                | 715       | 20,895             | 311   | 255 | 21,461              | 4.5            | 5.5 | 3.1 |
| Truk Is.<br>(76. 8. 15~9. 23)             | 11        | 12    | 231                | 212       | 2,418              |       | 129 | 2,547               | 3.8            |     | 1.1 |
| Ponape I.<br>(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 prevailed.

#### 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  $28^{\circ}\text{C}$  which was  $0.5^{\circ} - 1^{\circ}\text{C}$  lower than last year. Thermocline was located at the depth of about 50 m.

##### ii) Waters around Helen Reef:

Surface water temperature was about  $28.5^{\circ}\text{C}$  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  $4^{\circ}-30' \text{N}$ , compared with the waters north of the line.

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

| Force \ Direction | 0           | 1           | 2            | 3            | 4           | 5          | 6 | Total       |
|-------------------|-------------|-------------|--------------|--------------|-------------|------------|---|-------------|
| N                 |             |             | 1<br>(2.1)   |              |             |            |   | 1<br>(2.1)  |
| NNE               |             |             |              |              |             |            |   |             |
| NE                |             |             |              |              |             |            |   |             |
| ENE               |             |             |              |              |             |            |   |             |
| E                 |             | 1<br>(2.1)  |              |              |             |            |   | 1<br>(2.1)  |
| ESE               |             |             |              | 1<br>(2.1)   |             |            |   | 1<br>(2.1)  |
| SE                |             | 2<br>(4.2)  | 2<br>(4.2)   | 1<br>(2.1)   |             |            |   | 5<br>(10.4) |
| SSE               |             |             |              |              |             |            |   |             |
| S                 |             |             |              | 2<br>(4.2)   | 1<br>(2.1)  |            |   | 3<br>(6.2)  |
| SSW               |             | 2<br>(4.2)  | 1<br>(2.1)   | 2<br>(4.2)   | 2<br>(4.2)  |            |   | 7<br>(14.6) |
| SW                |             |             |              | 2<br>(4.2)   | 5<br>(10.4) | 1<br>(2.1) |   | 8<br>(16.7) |
| WSW               |             |             | 1<br>(2.1)   |              | 1<br>(2.1)  |            |   | 2<br>(4.2)  |
| W                 |             |             | 2<br>(4.2)   | 2<br>(4.2)   |             | 1<br>(2.1) |   | 5<br>(10.4) |
| WNW               |             |             | 3<br>(6.2)   | 1<br>(2.1)   |             |            |   | 4<br>(8.3)  |
| NW                |             | 2<br>(4.2)  |              | 1<br>(2.1)   |             |            |   | 3<br>(6.2)  |
| NNW               |             |             |              |              |             |            |   |             |
| Calm              | 8<br>(16.7) |             |              |              |             |            |   | 8<br>(16.7) |
| Total             | 8<br>(16.7) | 7<br>(14.6) | 10<br>(20.8) | 12<br>(25.0) | 9<br>(18.8) | 2<br>(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 occurrences of the schools.

ii) Helen Reef:

Many bird-associate schools and jumping schools of yellowfin tuna were sighted. Table 8 indicates the occurrences 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 ( $2^{\circ}$ – $55'$  N,  $131^{\circ}$ – $47'$  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%).

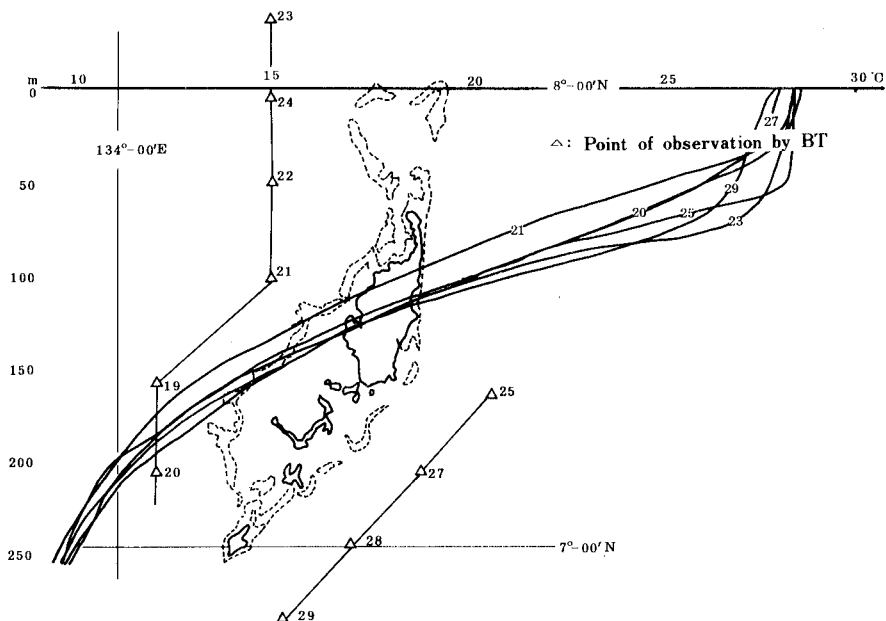


Figure 8. Vertical distribution of water temperature (waters around the palau Is. June 12~July 27)

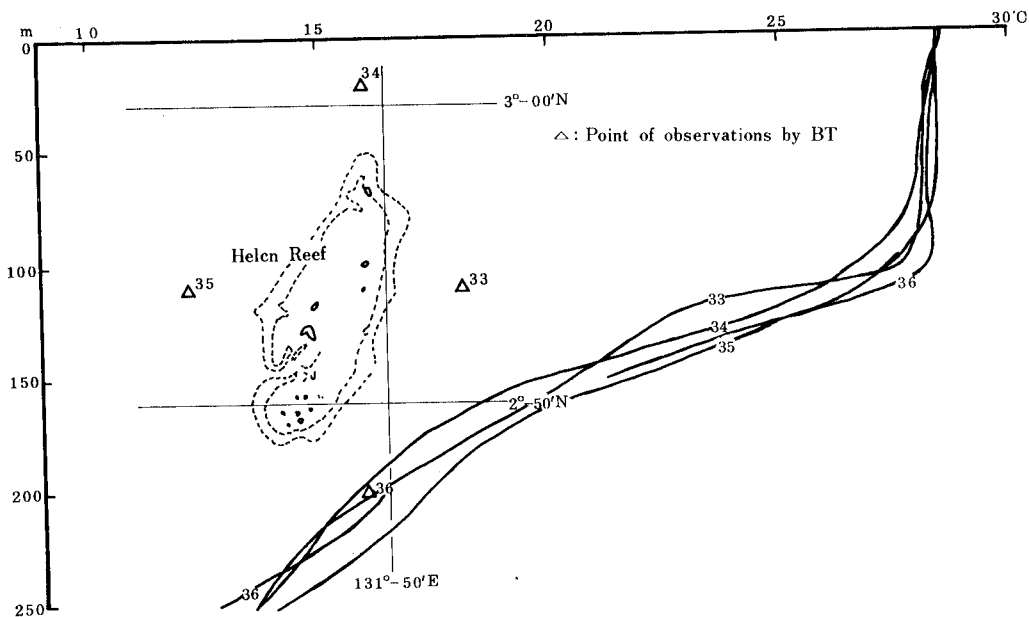


Figure 9. Vertical distribution of water temperature  
(waters around Helen Reef Aug. 1~Aug. 2)

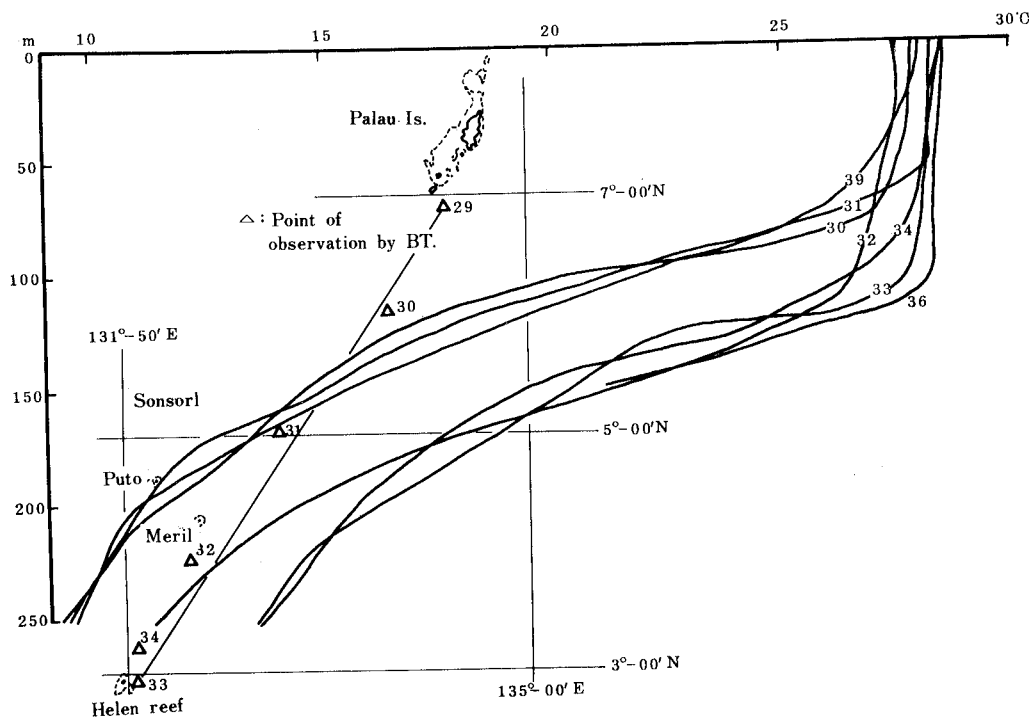


Figure 10. Vertical distribution of water temperature  
(Waters from palau to Helen Reef July 29~Aug. 2)

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 ( $7^{\circ}-32.8'N$  and  $134^{\circ}-30.6'E$ , 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 ( $3.25\text{ m}^3$ , 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 |                       |      |
| Palau Is. | 26                             | Simple                                     | 110                        | 24     | 35.8    | 43    | 64.2    | 67                    | 2.8  |
|           |                                | Bird-associated                            |                            |        |         |       |         |                       |      |
|           |                                | Log-associated                             |                            |        |         |       |         |                       |      |
|           |                                | Associated with shark, whale, dolphin, etc | 3                          | 1      | 2       | 100   | 2       | 2.0                   |      |
|           |                                |  | 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 shoals sighted (A) | Catch  |         |       |         | No. of operations (D) | D/B |
|---------------------------|--------------------------------|--|---------------------------|--------|---------|-------|---------|-----------------------|-----|
|                           |                                |  |                           | Yes(B) | B/D×100 | No(C) | C/D×100 |                       |     |
| Palau Is.<br>(Helen Reef) | 8                              | Simple                                     | 45                        | 5      | 11.1    | 17    | 37.8    | 22                    | 4.4 |
|                           |                                | Bird-associated                            |                           |        |         |       |         |                       |     |
|                           |                                | Log-associated                             |                           |        |         |       |         |                       |     |
|                           |                                | Associated with shark, whale, dolphin, etc |                           |        |         |       |         |                       |     |
| Total                     | 8                              |  | 45                        | 5      | 11.1    | 17    | 37.8    | 22                    | 4.4 |

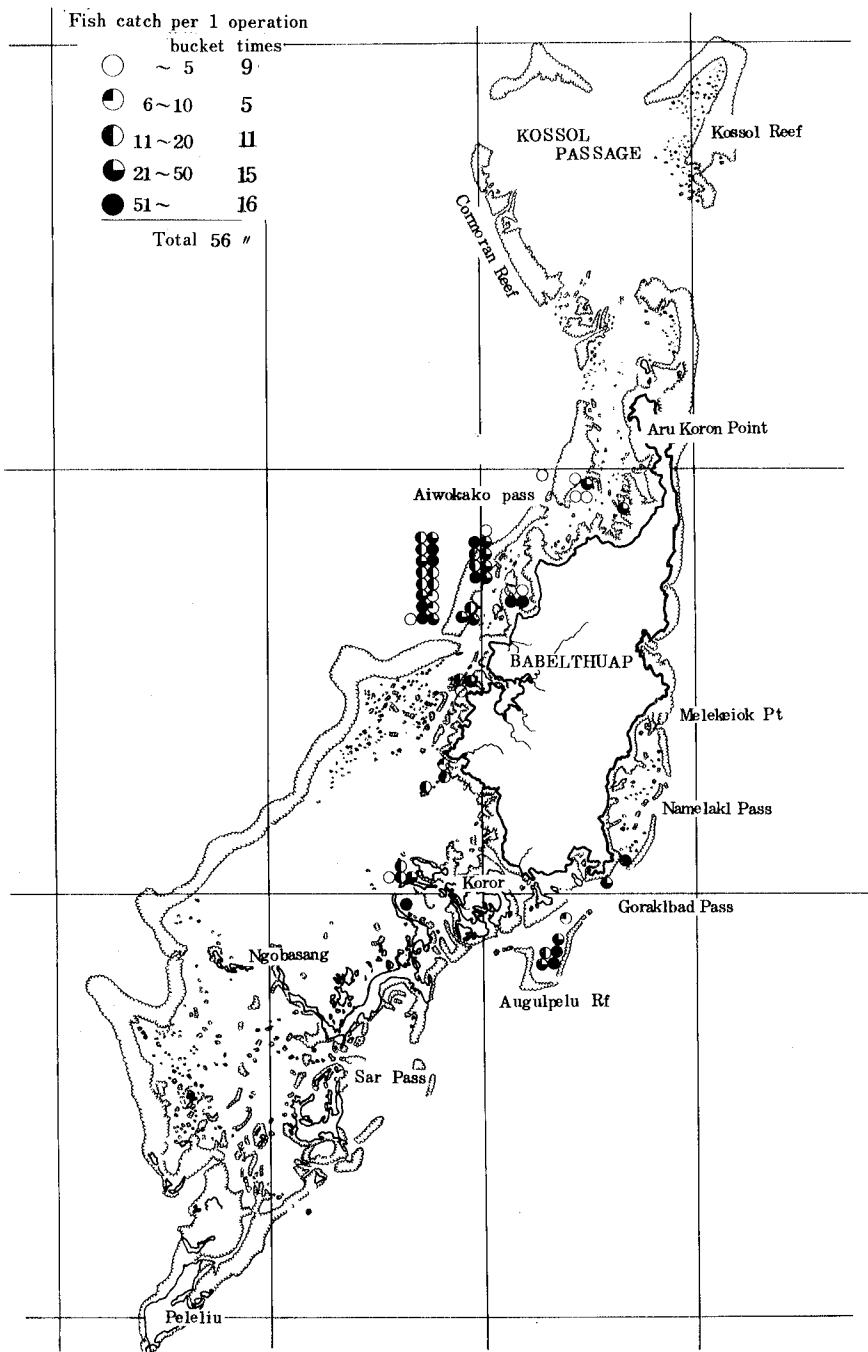


Fig 11-(1) Fshing position by stick-held dip net

Fish Catch per 1 operation

|       |                  |
|-------|------------------|
| ○     | ~ 5 bucket times |
| ◐     | 6~10             |
| ◑     | 11~20 1 "        |
| ◒     | 21~50            |
| ◓     | 51~ 3 "          |
| <hr/> |                  |
| Total | 4 "              |

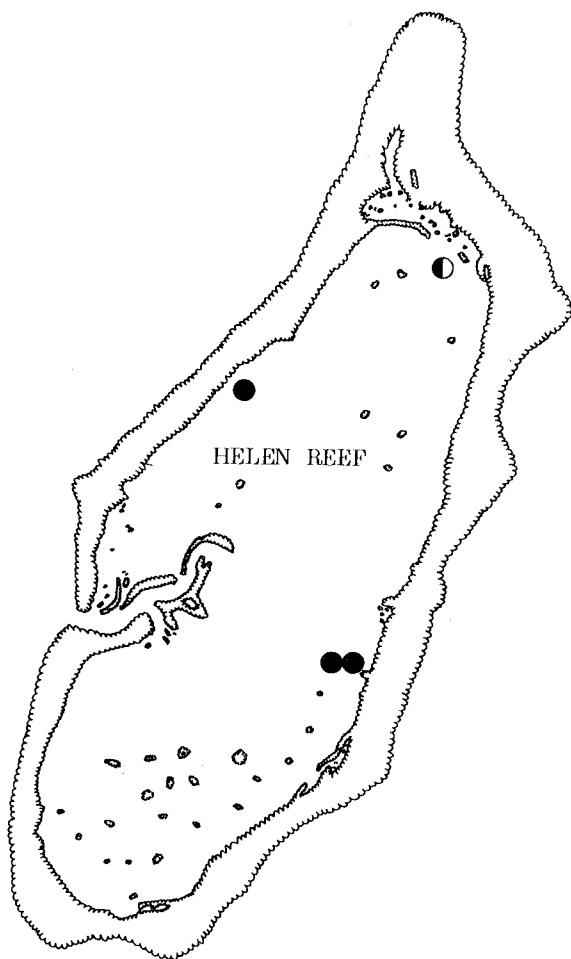


Fig 11-(2) Fshing position by stick-held dip net



(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<br>No. of side<br>depth  |   |   |
|---|---|---|---|
|   | 4 m × 8 × 7 m   | 3 m × 8 × 8 m   | 3 m × 8 × 8 m   |
| Duration of the test (day)                | 1 0   | 6   | 7   |
| No. of bucketfuls<br>(One bucketful. 3kg) | 2 0 0   | 6 0   | 6 2   |
| Main test fish (%)                        |   |   |   |
| Stolephorus Spp.                          | 7 0   | 8 0   | 8 1   |
| Spratelluides delicaturus                 | } 3 0   | 1 0   | 6   |
| Allanetta Spp.                            |   |   |   |
| Harengula Spp.                            |   | 1 0   |   |
| Others                                    |   |   | 1 3   |
| Survival rate (%)                         | 1 8.9<br>(Carangidae, Harengula)  | 7 8.7<br>(Marnty stolephores Spp.)  | 7 0.9<br>(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 |

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

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

| Operation No.                                | No.18                                   | No.19          | Quantity tested | Species | Per centage | Quantity   | Remark |
|--|---|----------------|-----------------|---------|-------------|------------|--------|
| Place of Catch                               | Ngaremlengui                            |                |                 | St.     | 80%         | 160 bucket |        |
| Date of Catch                                | 1976.6.24                               | 01:15<br>05:20 |                 | Sp.     | 10%         | 20 "       |        |
| Place of testing, distance from shore, depth | 7°-32'8"N<br>134°-30'6"E · 1,260m · 29m |                |                 | Al.     | 10%         | 20 "       |        |
| Size of net cage 4m×                         | Octagon. Depth 7m                       |                |                 | Total   | 100%        | 200 "      |        |
| Date taken on board                          | 1976.7.3                                | 08:00~10:00    |                 |         |             |            |        |

(one bucketful=3kg)

| Date      | Time           | Operation  | Received bucket | Used | Died bucket | Remaining bucket | Remarks   | W. temp (°C) |
|-----------|----------------|--|-----------------|------|-------------|------------------|---|--------------|
| 1976.6.24 | 01:15<br>05:20 | No.18 No.19                                      | 200             |      |             | 200              | St. 70% Al. 30% Sp. 30%                             | 27.7         |
| "         | 10:00          | 1st observation by diving                        |                 |      | 5.0         | 15.0             | 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 chae 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 feeding | 29.2         |
|           | 17:00          | 16th "   |                 |      | 0.2         | 38.4             | 19.2 In total 93 frigate mackerel caught            | 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  |              |

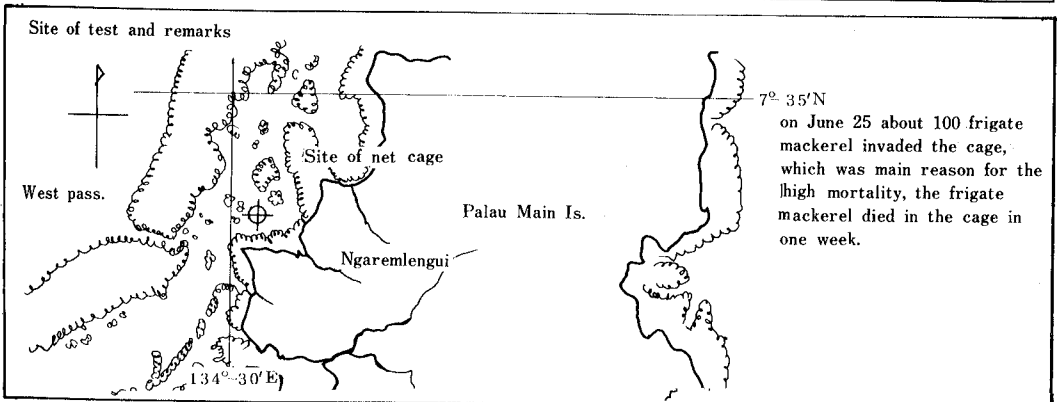


Table 10--(2) Records of survival test of bait fishes

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

| Operation No.                                | No.20                                   | No.21          | Quantity tested: | Species | Percentage | Quantity | Remark |
|--|---|----------------|------------------|---------|------------|----------|--------|
| Place of catch                               | Ngaremlengui                            |                |                  | St.     | 80%        | 48.0     | bucket |
| Date of catch                                | 1976.6.25                               | 00:40<br>05:35 |                  | Ha.     | 10%        | 6.0      | "      |
| Place of testing, distance from shore, depth | 7°-32'8"N<br>134°-30'6"E · 1,260m · 30m |                |                  | Sp.     | 10%        | 6.0      | "      |
| Size of net cage                             | 3m×Octagon, Depth 8m                    |                |                  | Total   | 100%       | 60.0     | "      |
| Date taken on board                          | 1976.7.3 09:00~10:00                    |                |                  |         |            |          |        |

(one bucketful ≐ 3kg)

| Date         | Time           | Remarks   | Received<br>bucket | Used                | Died<br>bucket | Remaining<br>bucket | (%)  | Remarks                           | W. temp.<br>(°C) |
|--------------|----------------|---|--------------------|---------------------|----------------|---------------------|------|-----------------------------------|------------------|
| 1976<br>6.25 | 00:40<br>05:35 | No.20 No.21 operation                                 | 60                 |                     |                |                     |      | St. Ha. Sp. 10% 10%               | 28.0             |
| "            | 11:00          | 1st observation by diving                             |                    |                     | 4.3            | 55.7                |      |                                   |                  |
| "            | observation    | 2rd observation by diving feeding commenced           |                    |                     | 0.5            | 55.2                |      | Barracuda swim lower layer        |                  |
| 6.26         | observation    | 3rd observation by diving little response to feeding. |                    |                     | 3.0            | 52.2                |      | one Barracuda caught. no predator | 28.4             |
| "            | observation    | 4th observation by diving active response to feeding  |                    |                     | 0.2            | 52.0                |      | St. settle, at middle layer       |                  |
| 6.27         | observation    | 5th observation by diving active responded to feeding |                    |                     | 0.6            | 51.4                |      | "                                 | 28.4             |
| "            | 17:30          | 6th " " "   |                    |                     | 0.3            | 51.1                |      | St. actively respond to feeding   | 28.7             |
| 6.28         | 08:30          | 7th " " "   |                    |                     | 1.0            | 50.1                |      | of died 100% St.                  | 28.4             |
| "            | 18:00          | 8th " " "   |                    |                     | 1.0            | 49.1                |      | one large fish invades            | 28.5             |
| 6.29         | 08:30          | 9th " " "   |                    |                     | 0.6            | 48.5                |      | The large fish disappears         | 28.5             |
| "            | 17:30          | 10th " " "  |                    |                     | 0.6            | 47.9                |      |                                   | 29.0             |
| 6.30         | 09:00          | 11th " " "  |                    |                     | 0.5            | 47.4                |      |                                   | 29.0             |
|              | 17:30          | 12th " " "  |                    |                     | 0              |                     |      |                                   | 29.2             |
| 7. 1         | 08:20          | 13th " " "  |                    | "Ha" almost escaped | 0.2            | 47.2                | 78.7 |                                   | 29.2             |
|              | 17:30          | 14th " " "  |                    |                     | 0              |                     |      |                                   | 30.2             |
| 7. 2         | 08:00          | No diving   |                    |                     |                |                     |      |                                   | 29.3             |
|              | 17:30          | 15th "  |                    |                     | 0              |                     |      |                                   |                  |
| 7. 3         | 08:20          | 16th observation by diving                            |                    |                     | 0              |                     |      |                                   | 29.2             |
|              | 09:00          | taken on board  |                    |                     |                | (47.2)              |      |                                   |                  |
| Total        |                |   | 60                 |                     |                | (47.2)              | 78.7 |                                   |                  |

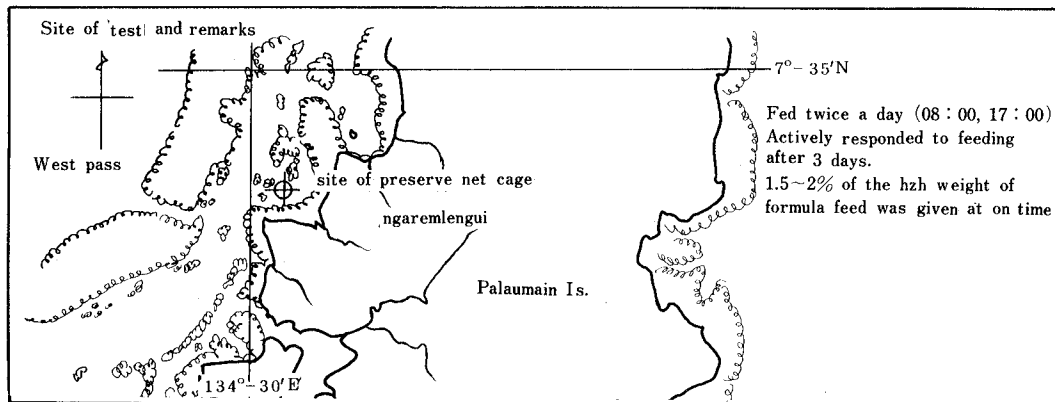


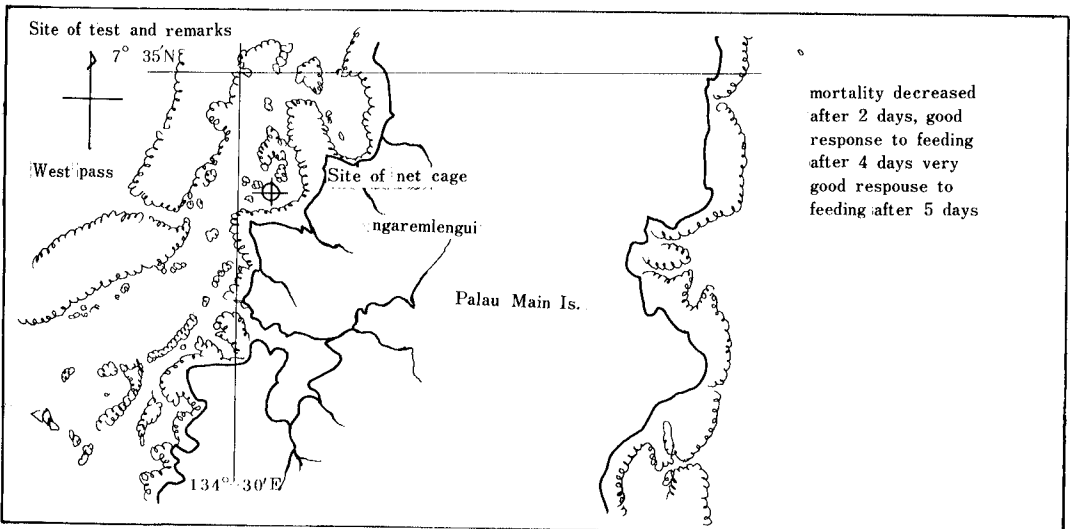
Table 10-(3) Records of survival test of bait fishes

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

| Operation No.                                | No. 4 7 No. 4 8  | Quantity tested | Species | Percentage | Quantity     | Remark |
|--|--|-----------------|---------|------------|--------------|--------|
| Place of catch                               | Ngaremlengui   |                 | St.     | 8 0.3%     | 4 9.8 bucket |        |
| Date of catch                                | 1 9 7 6.7.1 8 · 2 3 : 3 0<br>0 5 : 4 0                 |                 | Sp.     | 1 3.9 "    | 8.6 "        |        |
| Place of testing, distance from shore, depth | 7° - 3 2' 8 N · 1.2 6 0 m · 3 0 m<br>1 3 4° - 3 0' 6 E |                 | Al.     | 5.8 "      | 3.6 "        |        |
| Size of net cage                             | 3 m × Octagon, Depth 8m                                |                 |         |            |              |        |
| Date taken on board                          | 1 9 7 6.7.2 5 1 4 : 0 0 ~ 1 6 : 0 0                    |                 | Total   | 1 0 0 "    | 6 2.0 "      |        |

(one bucketful = 3kg)

| Date             | Time                     | observation                                       | Received bucket | Placed | Died bucket | Remaining bucket | (%)   | Remarks                       | W. temp. (°C) |
|------------------|--------------------------|---|-----------------|--------|-------------|------------------|-------|-------------------------------|---------------|
| 1 9 7 6<br>7.1 8 | 2 3 : 3 0<br>~ 0 5 : 4 0 | No. 4 7 No. 4 8                                   | 6 2             |        |             | 6 2              |       | St. ( 8 0 % )                 | 2 7.6         |
| 7.1 9            | 1 6 : 0 0                | 1st observation by diving                         |                 |        | 1 2.3       | 4 9.7            |       | Mainly St. died               |               |
| 2 0              | 1 2 : 0 0                | 2nd observation by diving                         |                 |        | 0.3         | 4 9.4            |       | No response to feeding        | 2 8.5         |
| "                | 1 6 : 0 0                | 3rd observation diving                            |                 |        | 6.6         | 4 2.8            |       | "                             | 2 8.2         |
| 7.2 1            | 0 8 : 0 0                |   |                 |        |             |                  |       |                               |               |
| "                | 1 6 : 0 0                | 4th observation by diving St. went down to bottom |                 |        | 1.0         | 4 1.8            |       | good response to feeding      | 2 8.4         |
| 7.2 2            | 0 8 : 0 0                | 5th diving  |                 |        | 0           |                  |       | good response to feeding      | 2 8.5         |
| "                | 1 7 : 0 0                | 6th diving  |                 |        | 0.6         | 4 1.2            |       | very good response to feeding | 2 8.4         |
| 7.2 3            | 0 8 : 0 0                | Respond to feeding                                |                 |        |             |                  |       | "                             | 2 8.2         |
| "                | 1 6 : 0 0                | "   |                 |        | 1.0         | 4 0.2            |       | "                             |               |
| 7.2 4            | 0 8 : 0 0                | "   |                 |        | 0           |                  |       | "                             | 2 8.0         |
| "                | 1 6 : 0 0                | "   |                 |        | 0           |                  |       | "                             |               |
| 7.2 5            | 0 8 : 0 0                | "   |                 |        | 0.1         | 4 0.1            |       | "                             |               |
|                  | 1 4 : 0 0                | 14 : 0 0 ~ 1 6 : 0 0 0 0 taken on board           |                 |        |             | (4 4)            | 7 0.9 | Mainly St. remain             | 2 7.8         |
| Total            |                          |   | 6 2             |        | 2 1.9       | (4 4)            | 7 0.9 |                               |               |



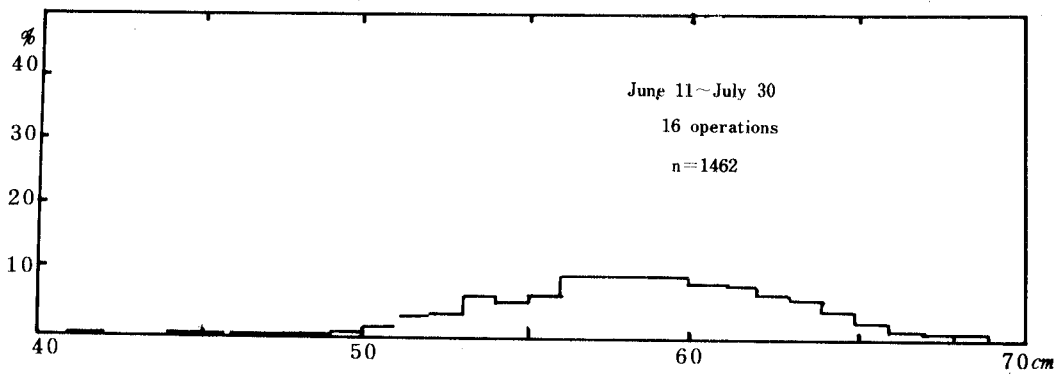


Figure 12--(1) Body length distribution of skipjack  
(Waters around palou Is.; Fork length)

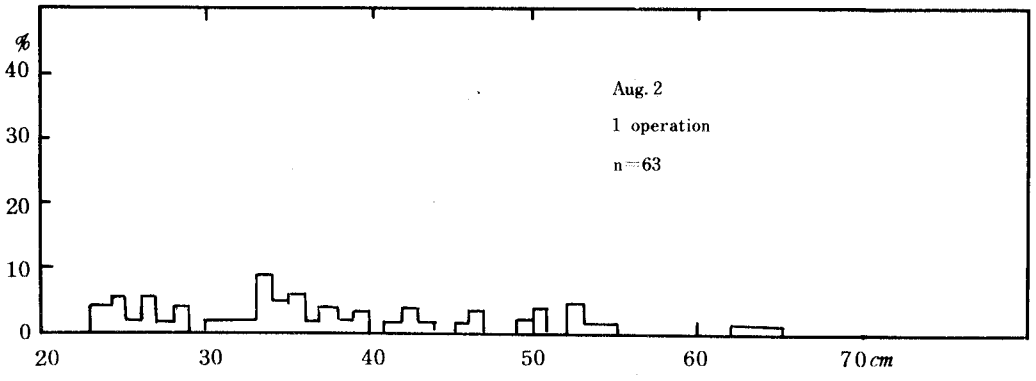


Figure 12--(2) Body length distribution of yellowfin (Waters around palou Is.Is.: Fork length)

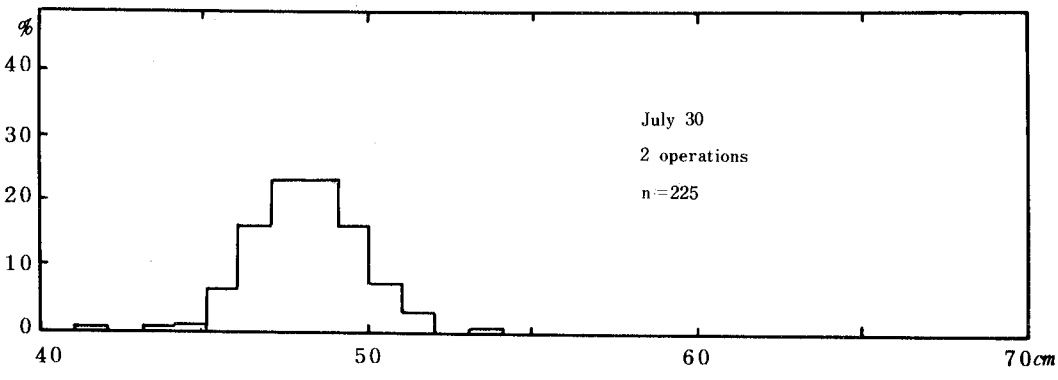


Figure 13. Body length distribution of skipjack (Helen Reef: fork length)

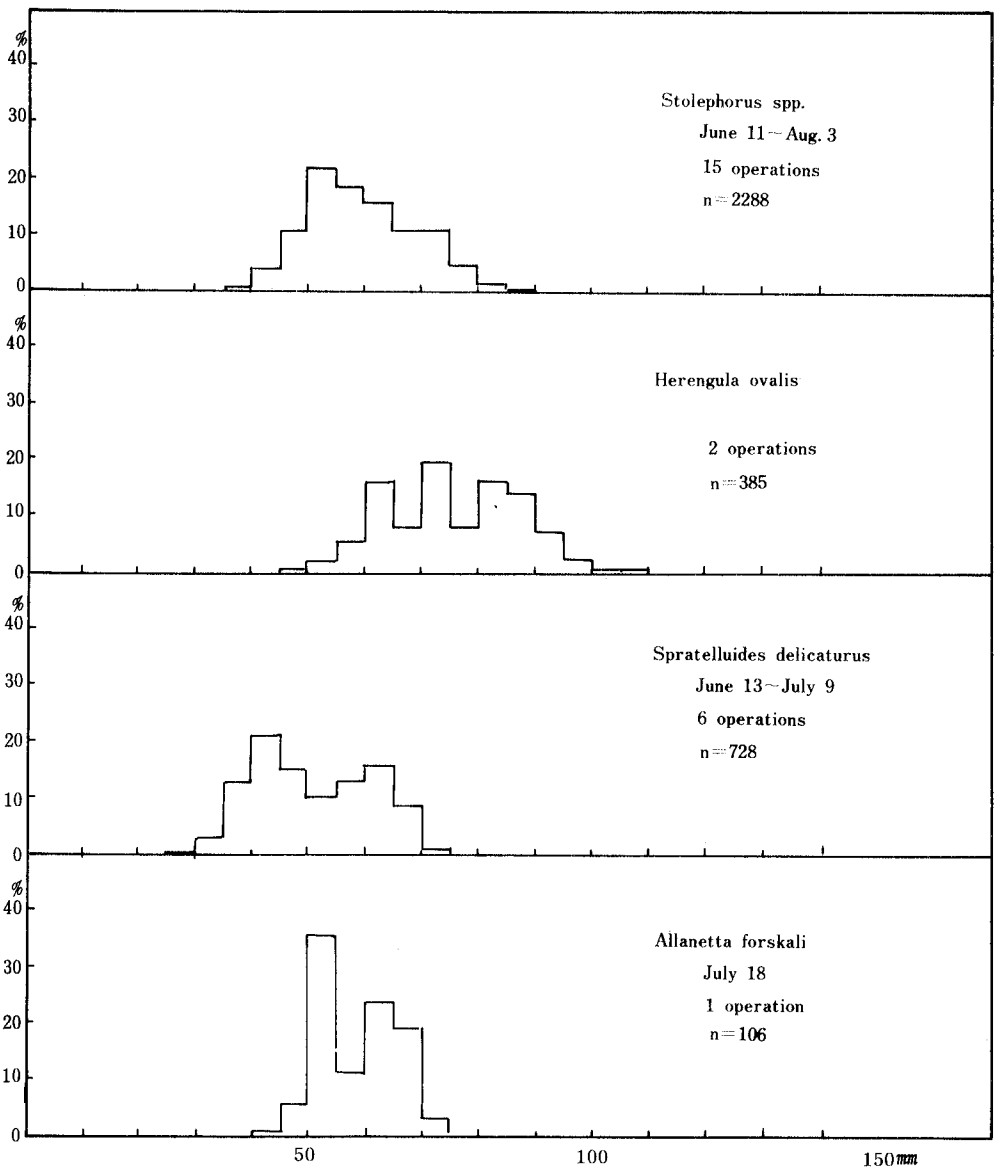


Figure 14. Body length distribution of main bait fishes by species  
(Waters around palau main Is; Fork length)

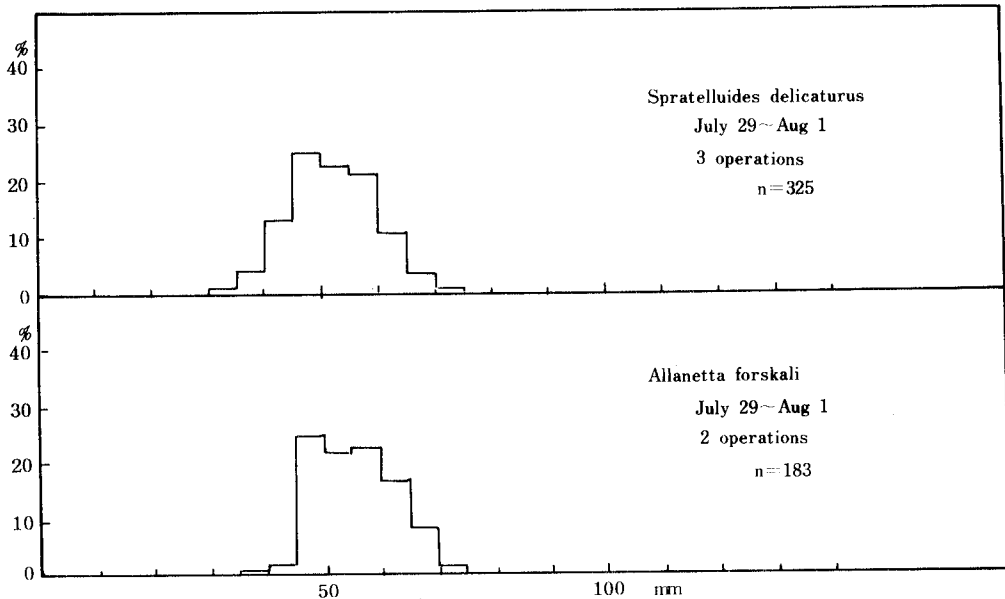


Figure 15. Body length distribution of main bait fishes by species (Helen Reef; Fork length)

## **Annex table 2.**

### **Results of oceanographic observation**



| No | Date     | Hour  | Position |            | Water temperature |      |      |      |       |       |       | (°C)  |       |       |       | Weater | Wind direction | Wind force | Pressure (mb) | Wave | Trans parency (m) | Atom. temperature (°C) |
|----|----------|-------|----------|------------|-------------------|------|------|------|-------|-------|-------|-------|-------|-------|-------|--------|----------------|------------|---------------|------|-------------------|------------------------|
|    |          |       | 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 |        |                |            |               |      |                   |                        |
| 1  | '76.5.31 | 05:15 | 20°-50'  | 145°-00'   | 26.8              | 26.4 | 26.3 | 26.3 | 23.5  | 22.6  | 20.5  | 19.4  | 18.5  | 17.8  | 17.0  | b      | W              | 2          | 1013.0        | 2    |                   | 26.5                   |
| 2  | "        | 16:40 | 20°-00'  | 145°-29.5' | 27.3              | 26.4 | 26.4 | 26.1 | 23.5  | 21.8  | 21.1  | 20.2  | 18.7  | 18.3  | 17.2  | b c    | N              | 2          | 1013.0        | 2    |                   | 28.3                   |
| 3  | 6.1      | 19:20 | 19°-00'  | 145°-50'   | 27.9              | 27.3 | 27.2 | 27.2 | 26.0  | 25.2  | 24.0  | 22.8  | 21.0  | 19.7  | 18.5  | b c    | NW             | 2          | 1013.0        | 1    |                   | 27.0                   |
| 4  | "        | 20:10 | 18°-00'  | 145°-05'   | 27.9              | 27.3 | 27.1 | 27.0 | 26.5  | 25.8  | 25.0  | 22.8  | 21.0  | 19.3  | 16.6  | b c    | N              | 2          | 1012.0        | 2    |                   | 27.0                   |
| 5  | 6.2      | 08:50 | 17°-00'  | 146°-05'   | 28.2              | 27.5 | 27.4 | 27.3 | 27.0  | 25.8  | 25.4  | 24.4  |       |       | 19.5  | b c    | NNW            | 2          | 1013.0        | 2    | 45+               | 29.2                   |
| 6  | "        | 16:10 | 16°-00'  | 145°-50'   | 28.2              | 27.6 | 27.5 | 27.3 | 27.0  | 25.9  | 24.6  | 22.4  | 21.2  | 19.5  | 17.8  | b c    | N              | 3          | 1011.5        | 2    | 37                | 31.0                   |
| 7  | 6.4      | 23:45 | 14°-17'  | 145°-00'   | 28.0              | 27.4 | 27.1 | 26.9 | 27.0  | 26.3  | 25.3  | 23.9  |       | 20.0  | 17.6  | b c    | SSE            | 2          | 1010.5        | 2    |                   | 27.0                   |
| 8  | 6.5      | 10:15 | 12°-53'  | 144°-00'   | 28.4              | 27.5 | 27.3 | 27.3 | 27.3  | 26.5  | 25.7  | 23.7  | 20.0  | 19.3  | 16.7  | C      | NE             | 2          | 1010.0        | 2    | 45+               | 29.0                   |
| 9  | "        | 17:20 | 12°-18'  | 143°-05'   | 28.4              | 27.9 | 27.3 | 27.3 | 27.3  | 26.7  | 24.3  | 21.4  | 18.6  | 15.4  | 13.2  | b c    | ESE            | 2          | 1008.6        | 2    |                   | 28.0                   |
| 10 | 6.6      | 02:15 | 11°-39'  | 141°-50'   | 28.4              | 27.9 | 27.6 | 27.5 | 27.3  | 25.9  | 24.4  | 21.4  | 17.8  | 14.5  | 12.3  | b      | E              | 2          | 1009.0        | 2    |                   | 27.5                   |
| 11 | "        | 09:20 | 11°-03'  | 140°-40'   | 28.4              | 28.4 | 27.7 | 27.5 | 27.1  | 26.2  | 23.7  | 21.4  | 17.7  | 14.9  | 12.7  | b c    | E              | 2          | 1011.0        | 3    | 30                | 30.5                   |
| 12 | "        | 14:10 | 10°-26'  | 140°-00'   | 28.8              | 28.7 | 28.7 | 28.3 | 27.3  | 25.4  | 23.0  | 18.5  | 15.2  | 13.5  | 11.5  | C      | ESE            | 2          | 1009.0        | 3    | 30                | 29.0                   |
| 13 | "        | 23:25 | 09°-47'  | 139°-00'   | 28.8              | 28.9 | 28.4 | 27.9 | 27.0  | 23.8  | 21.3  | 19.5  | 15.7  | 13.7  | 12.4  | O      | E              | 3          | 1011.0        | 3    |                   | 28.5                   |
| 14 | 6.7      | 06:12 | 09°-08'  | 138°-00'   | 28.6              | 28.6 | 28.5 | 27.5 | 26.4  | 24.2  | 21.4  | 18.6  | 14.2  | 13.1  | 11.4  | Q      | E              | 3          | 1009.5        | 3    |                   | 26.0                   |
| 15 | "        | 20:00 | 08°-21'  | 137°-00'   | 28.7              | 28.7 | 28.4 | 24.9 | 22.6  | 20.0  | 16.5  | 14.9  | 12.5  | 11.5  | 10.1  | C      | E              | 2          | 1011.0        | 1    |                   | 25.0                   |
| 16 | 6.8      | 02:40 | 07°-54'  | 136°-00'   | 28.9              | 28.5 | 27.6 | 24.3 | 20.1  | 17.6  | 15.5  | 13.6  | 12.0  | 10.9  | 9.6   | b c    | E              | 2          | 1010.0        | 2    |                   | 26.5                   |
| 17 | "        | 09:15 | 07°-25'  | 135°-00'   | 29.0              | 28.5 | 27.6 | 24.3 | 19.5  | 17.0  | 15.4  | 12.8  | 11.4  | 10.3  | 9.3   | b c    | ESE            | 2          | 1011.0        | 2    | 45+               | 29.0                   |
| 18 | "        | 11:45 | 07°-10'  | 134°-40'   | 29.2              | 28.6 | 26.8 | 23.9 | 20.9  | 17.2  | 14.6  | 12.9  | 11.6  | 10.4  | 9.6   | b c    | ESE            | 1          | 1011.0        | 1    | 37                | 29.0                   |
| 19 | 6.12     | 11:15 | 07°-20'  | 134°-04'   | 28.8              | 28.6 | 27.8 | 24.5 | 21.5  | 17.8  | 14.3  | 12.1  | 10.8  | 10.3  | 9.5   | O      | WNW            | 2          | 1011.1        | 2    | 32                | 27.0                   |
| 20 | "        | 12:30 | 07°-09'  | 134°-04'   | 28.8              | 28.4 | 26.2 | 22.9 | 20.2  | 16.8  | 14.4  | 12.4  | 11.1  | 10.4  | 9.4   | O      | W              | 3          | 1010.5        | 3    | 30                | 27.5                   |
| 21 | 6.13     | 07:30 | 07°-40'  | 134°-20'   | 28.7              | 28.2 | 24.6 | 21.5 | 18.5  | 15.5  | 13.3  | 12.0  | 10.8  | 10.0  | 9.3   | b c    | Calm           |            | 1009.0        | 1    | 44                | 27.5                   |
| 22 | "        | 08:40 | 07°-50'  | 134°-20'   | 28.4              | 28.2 | 25.2 | 22.9 | 19.9  | 18.2  | 14.6  | 12.9  | 11.4  | 10.6  | 10.0  | Q      | NE             | 2          | 1009.5        | 1    | 35                | 27.0                   |
| 23 | "        | 11:00 | 08°-10'  | 134°-20'   | 28.6              | 28.3 | 28.0 | 26.5 | 20.5  | 17.3  | 14.5  | 12.4  | 10.5  | 10.0  | 9.5   | O      | E              | 3          | 1009.5        | 2    | 32                | 26.0                   |
| 24 | "        | 11:55 | 08°-00'  | 134°-00'   | 28.6              | 28.6 | 27.1 | 23.8 | 20.8  | 15.1  | 14.0  | 12.3  | 11.1  | 10.0  | 9.3   | O      | S              | 3          | 1009.5        | 3    | 28                | 25.0                   |
| 25 | 6.14     | 11:05 | 07°-20'  | 134°-48'   | 28.6              | 28.6 | 28.4 | 23.6 | 20.0  | 16.5  | 14.4  | 13.1  | 11.4  | 10.1  | 9.3   | O      | S              | 4          | 1010.0        | 3    | 26                | 27.0                   |
| 26 | "        | 13:00 | 07°-10'  | 134°-35'   | 28.3              | 28.3 | 27.3 | 23.7 | 20.3  | 16.6  | 13.5  | 11.8  | 11.0  | 10.1  | 9.4   | O      | S              | 5          | 1010.0        | 3    | 25                | 27.0                   |
| 27 | 7.27     | 16:05 | 07°-10'  | 134°-39'   | 28.5              | 28.0 | 27.0 | 26.5 | 22.3  | 17.5  | 15.7  | 13.0  | 11.1  | 10.3  | 9.6   | b c    | S              | 3          | 1008.0        | 3    |                   | 29.0                   |
| 28 | "        | 17:45 | 07°-00'  | 134°-29'   | 28.2              | 27.9 | 26.2 | 23.4 | 20.0  | 16.9  | 15.4  | 12.0  | 10.8  | 10.1  | 9.5   | b c    | S              | 3          | 1009.0        | 3    | 31                | 28.2                   |
| 29 | "        | 19:20 | 06°-51'  | 134°-20'   | 28.1              | 27.5 | 27.1 | 25.6 | 21.2  | 17.4  | 15.0  | 12.0  | 11.2  | 10.1  | 9.6   | b c    | S              | 3          | 1009.5        | 3    |                   | 28.0                   |
| 30 | 7.28     | 02:00 | 06°-00'  | 133°-40'   | 27.9              | 27.8 | 27.6 | 26.0 | 20.4  | 16.6  | 14.6  | 13.2  | 11.4  | 10.2  | 9.3   | b c    | SW             | 3          | 1009.0        | 3    |                   | 27.0                   |

| No. | Date     | Hour  | Position |           | Water temperature |      |      |      |       |       |       |
|-----|----------|-------|----------|-----------|-------------------|------|------|------|-------|-------|-------|
|     |          |       | Lat. (N) | Long. (E) | 0 m               | 25 m | 50 m | 75 m | 100 m | 125 m | 150 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  |
| 32  | "        | 19:40 | 04°-00'  | 132°-13'  | 27.5              | 27.5 | 27.3 | 27.0 | 26.8  | 25.2  | 21.5  |
| 33  | 8.1      | 13:00 | 02°-55'  | 131°-53'  | 28.6              | 28.2 | 28.1 | 28.1 | 27.8  | 22.5  | 20.5  |
| 34  | "        | 14:10 | 03°-04'  | 131°-49'  | 28.5              | 28.3 | 28.0 | 27.8 | 26.7  | 24.3  | 19.5  |
| 35  | "        | 15:55 | 02°-55'  | 131°-41'  | 28.5              | 28.5 | 28.5 | 27.8 | 27.7  | 25.0  | 23.0  |
| 36  | 8.2      | 08:55 | 02°-46'  | 131°-45'  | 28.5              | 28.5 | 28.3 | 28.3 | 28.3  | 25.3  | 21.2  |
| 37  | 8.8      | 15:45 | 07°-10'  | 136°-00'  | 27.8              | 27.8 | 27.8 | 24.8 | 17.8  | 15.3  | 14.0  |
| 38  | 8.9      | 03:55 | 07°-10'  | 138°-00'  | 27.8              | 27.8 | 27.8 | 24.8 | 22.3  | 18.8  | 15.8  |
| 39  | "        | 18:00 | 07°-10'  | 140°-00'  | 28.4              | 27.8 | 27.8 | 26.0 | 20.4  | 14.9  | 12.6  |
| 40  | 8.10     | 06:10 | 07°-16'  | 142°-08'  | 27.8              | 27.7 | 27.7 | 26.8 | 21.3  | 18.0  | 15.0  |
| 41  | "        | 17:15 | 07°-13'  | 144°-00'  | 28.2              | 28.0 | 28.0 | 25.0 | 20.5  | 18.2  | 14.7  |
| 42  | 8.11     | 05:50 | 07°-13'  | 145°-57'  | 27.8              | 27.8 | 27.6 | 23.1 | 19.0  | 17.0  | 14.1  |
| 43  | "        | 18:20 | 07°-10'  | 148°-00'  | 28.2              | 28.0 | 27.3 | 24.1 | 21.6  | 18.1  | 15.2  |
| 44  | 8.12     | 08:05 | 07°-16'  | 150°-00'  | 27.7              | 27.7 | 26.3 | 23.5 | 19.5  | 16.5  | 14.0  |
| 45  | "        | 14:05 | 07°-24'  | 151°-00'  | 28.9              | 28.0 | 28.0 | 24.3 | 22.3  | 20.7  | 15.8  |
| 46  | 8.17     | 08:15 | 07°-25'  | 151°-23'  | 27.8              | 27.8 | 27.8 | 26.0 | 23.2  | 20.5  | 18.7  |
| 47  | "        | 09:15 | 07°-31'  | 151°-28'  | 28.0              | 28.0 | 27.7 | 26.0 | 23.2  | 19.2  | 17.2  |
| 48  | "        | 10:10 | 07°-35'  | 151°-33'  | 28.5              | 28.0 | 27.2 | 26.0 | 23.5  | 21.2  | 17.9  |
| 49  | "        | 11:10 | 07°-40'  | 151°-38'  | 28.2              | 28.1 | 27.5 | 25.2 | 23.5  | 21.4  | 17.8  |
| 50  | 8.19     | 07:45 | 07°-20'  | 151°-19'  | 28.0              | 28.0 | 27.0 | 24.4 | 21.9  | 18.9  | 17.9  |
| 51  | "        | 08:30 | 07°-15'  | 151°-13'  | 27.8              | 27.8 | 27.8 | 25.3 | 23.8  | 19.2  | 17.2  |
| 52  | "        | 09:10 | 07°-13'  | 151°-28'  | 27.9              | 27.9 | 27.8 | 25.3 | 23.6  | 19.6  | 16.5  |
| 53  | "        | 09:55 | 07°-11'  | 151°-33'  | 28.0              | 27.9 | 27.0 | 24.5 | 21.8  | 18.5  | 17.3  |
| 54  | "        | 10:40 | 07°-09'  | 151°-58'  | 28.0              | 28.0 | 26.8 | 24.3 | 22.5  | 19.5  | 16.2  |
| 55  | "        | 11:20 | 07°-08'  | 151°-43'  | 28.1              | 28.0 | 25.8 | 23.8 | 21.0  | 18.5  | 16.3  |
| 56  | "        | 12:00 | 07°-06'  | 151°-48'  | 28.5              | 27.8 | 26.6 | 23.5 | 21.3  | 18.8  | 16.5  |
| 57  | 9.22     | 09:20 | 07°-10'  | 152°-05'  | 28.2              | 27.8 | 27.8 | 25.0 | 23.8  | 20.0  | 16.6  |
| 58  | "        | 09:45 | 07°-10'  | 152°-07'  | 28.5              | 28.2 | 28.0 | 25.2 | 23.0  | 18.5  | 16.7  |
| 59  | "        | 11:30 | 07°-15'  | 152°-06'  | 29.0              | 28.5 | 28.2 | 25.5 | 23.5  | 19.0  | 17.0  |
| 60  | "        | 12:15 | 07°-20'  | 152°-06'  | 29.1              | 28.0 | 27.8 | 25.2 | 23.8  | 22.7  | 20.8  |
| 61  | "        | 12:50 | 07°-25'  | 152°-05'  | 28.5              | 28.2 | 28.2 | 26.2 | 24.0  | 22.0  | 18.5  |

| (°C) |      |      |      | Wether | Wind direction | Wind force | Pressure (mb) | Wave | Trans parency | Atom. temperature (°C) |
|------|------|------|------|--------|----------------|------------|---------------|------|---------------|------------------------|
| 175m | 200m | 225m | 250m |        |                |            |               |      |               |                        |
| 13.0 | 10.9 | 10.1 | 9.4  | C      | S              | 3          | 1011.0        | 3    | 32            | 28.0                   |
| 17.0 | 14.5 | 12.7 | 11.3 | b c    | S              | 3          | 1009.5        | 3    |               | 27.0                   |
| 18.3 | 16.1 | 14.5 | 13.5 | r      | SSE            | 2          | 1008.5        | 2    | 27            | 27.0                   |
| 17.5 | 15.7 | 14.7 | 13.5 | O      | SW             | 3          | 1008.0        | 3    | 28            | 27.0                   |
| 18.7 | 17.4 | 16.0 | 14.0 | r      | SW             | 4          | 1008.2        | 4    | 25            | 24.5                   |
| 20.1 | 16.2 | 15.0 | 12.8 | O      | SW             | 3          | 1011.0        | 4    | 27            | 26.0                   |
| 11.8 | 10.9 | 10.1 | 9.5  | O      | SW             | 4          | 1010.0        | 4    | 26            | 26.5                   |
| 13.3 | 11.5 | 10.6 | 10.0 | O      | SW             | 3          | 1011.0        | 3    |               | 26.5                   |
| 11.5 | 10.7 | 10.0 | 9.5  | C      | NW             | 1          | 1011.5        | 1    | 28            | 27.9                   |
| 12.9 | 11.3 | 10.3 | 9.9  | b c    | N              | 2          | 1011.4        | 1    | 38            | 26.7                   |
| 12.2 | 11.8 | 11.2 | 9.8  | O      | SW             | 3          | 1010.0        | 2    | 33            | 26.5                   |
| 13.0 | 11.6 | 10.5 | 9.6  | O      | NNW            | 4          | 1010.3        | 3    | 30            | 25.8                   |
| 12.2 | 11.5 | 10.6 | 9.7  | O      | ESE            | 2          | 1009.5        | 2    |               | 28.1                   |
| 12.0 | 10.3 | 10.0 | 9.3  | r      | WSW            | 2          | 1012.5        | 2    | 24            | 23.9                   |
| 13.5 | 11.3 | 10.7 | 9.8  | b c    | NW             | 2          | 1009.0        | 2    | 38            | 27.1                   |
| 14.0 | 11.8 | 10.8 | 9.9  | b c    |                | Calm       | 1013.0        | 0    | 33            | 27.3                   |
| 16.0 | 12.2 | 11.5 | 11.0 | b c    | W              | 1          | 1012.5        | 0    | 39            | 27.5                   |
| 13.7 | 11.6 | 10.9 | 10.1 | b c    | WNW            | 1          | 1012.5        | 0    | 42            | 27.7                   |
| 15.2 | 12.5 | 11.0 | 10.3 | b c    | WNW            | 1          | 1012.0        | 1    | 36            | 27.8                   |
| 15.0 | 12.0 | 10.7 | 10.2 | O      | NE             | 3          | 1010.5        | 2    | 27            | 27.5                   |
| 14.4 | 11.8 | 11.0 | 9.8  | O      | NE             | 2          | 1011.0        | 2    | 35            | 27.0                   |
| 13.4 | 11.8 | 11.0 | 10.0 | b c    | ENE            | 2          | 1011.2        | 1    | 35            | 27.0                   |
| 14.2 | 12.0 | 10.8 | 9.8  | b c    | E              | 2          | 1011.0        | 1    | 36            | 27.5                   |
| 15.0 | 11.2 | 10.8 | 10.0 | b c    | E              | 2          | 1010.5        | 1    | 33            | 27.8                   |
| 14.9 | 13.2 | 10.5 | 9.9  | b c    |                | Calm       | 1010.0        | 0    | 29            | 28.0                   |
| 14.2 | 12.8 | 11.0 | 9.8  | b c    |                | Calm       | 1009.5        | 0    | 29            | 28.1                   |
| 15.0 | 11.6 | 10.8 | 9.8  | b c    | WNW            | 1          | 1012.0        | 1    | 41            | 27.9                   |
| 14.5 | 11.6 | 11.0 | 10.6 | b c    | W              | 1          | 1012.0        | 1    | 42            | 28.2                   |
| 14.5 | 12.8 | 11.5 | 10.6 | b c    | NW             | 1          | 1011.5        | 1    | 35            | 28.1                   |
| 14.7 | 11.5 | 10.6 | 10.0 | b c    | N              | 1          | 1011.0        | 1    | 35            | 28.0                   |
| 15.0 | 12.2 | 11.2 | 10.3 | b c    | NW             | 2          | 1010.6        | 1    | 32            | 27.8                   |