Occurrence of Milkfish, *Chanos chanos* (FORSSKÅL) Eggs around Panay Island, Philippines

Tetsushi SENTA, Shigeru KUMAGAI* and Nelson M. CASTILLO*

A total of 551 milkfish eggs was collected by horizontal tows with a fish larval net in the waters around Panay island during the period from April 1976 to June 1979. The maximum number obtained by a single tow was 33 eggs. Most of the eggs were collected from Cuyo East Pass, with some eggs from the waters around the Cagayan Islands and a single egg from the Sibuyan Sea. Almost all the eggs were collected during the period from March to June, with a peak in April, one month ahead of the peak of fry occurrence.

Very often milkfish eggs occurred in shallow waters around islands or close to the coasts, while they were sometimes found at locations remote from land and as deep as 900 m. Water temperatures and salinities at locations where milkfish eggs were found ranged from 26.7 to 30.8°C and from 32.9 to 34.5 ppt. The eggs were rather evenly distributed from the surface to at least 20 m down. The eggs found in the early morning collections were in the early stages of development; those found later in the day were more advanced. It seems that spawning of milkfish takes place at midnight, and that the incubation period of eggs in the wild is about 20 hours.

On three occasions during his numerous cruises in the Java Sea from 1919 to 1928, Delsman (1926, 1929) found fifteen fish eggs which he believed to be milkfish eggs. The correctness of his identification was proven by the recent success in the artificial insemination of milkfish eggs by Vanstone et al. (1977) and Chaudhuri et al. (1977, 1978). Aside from the Java Sea, recoveries of milkfish eggs were reported only from the coastal waters of India (Jacob and Krishnamoorthi, 1948; Chacko, 1950).

The Philippines is one of the three countries where milkfish is extensively cultured and where its fry is abundantly caught along the coasts. Nevertheless, no recovery of milkfish eggs from Philippine waters was reported till 1976 when the present authors were able to collect the eggs from the waters around Panay island. This paper deals with the successful collection of milkfish eggs from the northern Sulu and Sibuyan Sea. Some initial observations have been reported earlier (Senta, et al., 1976).

Materials and Methods

During the four-year period from April 1976 to June 1979, a total of 1663 larval net tows was made on board SEAFDEC II (20 GT) and other small boats of the SEAFDEC Aquaculture Department, in the waters around Panay island (Fig. 1, Table 1).

At each location, the net was horizontally towed for ten minutes at a speed of 1-2 knots. While most tows were made at the surface, subsurface tows were also made at several layers up to 30 meters deep to determine the vertical distribution of eggs.

* Aquaculture Dept., Southeast Asian Fisheries Development Center, P.O. Box 256 Iloilo City, Philippines

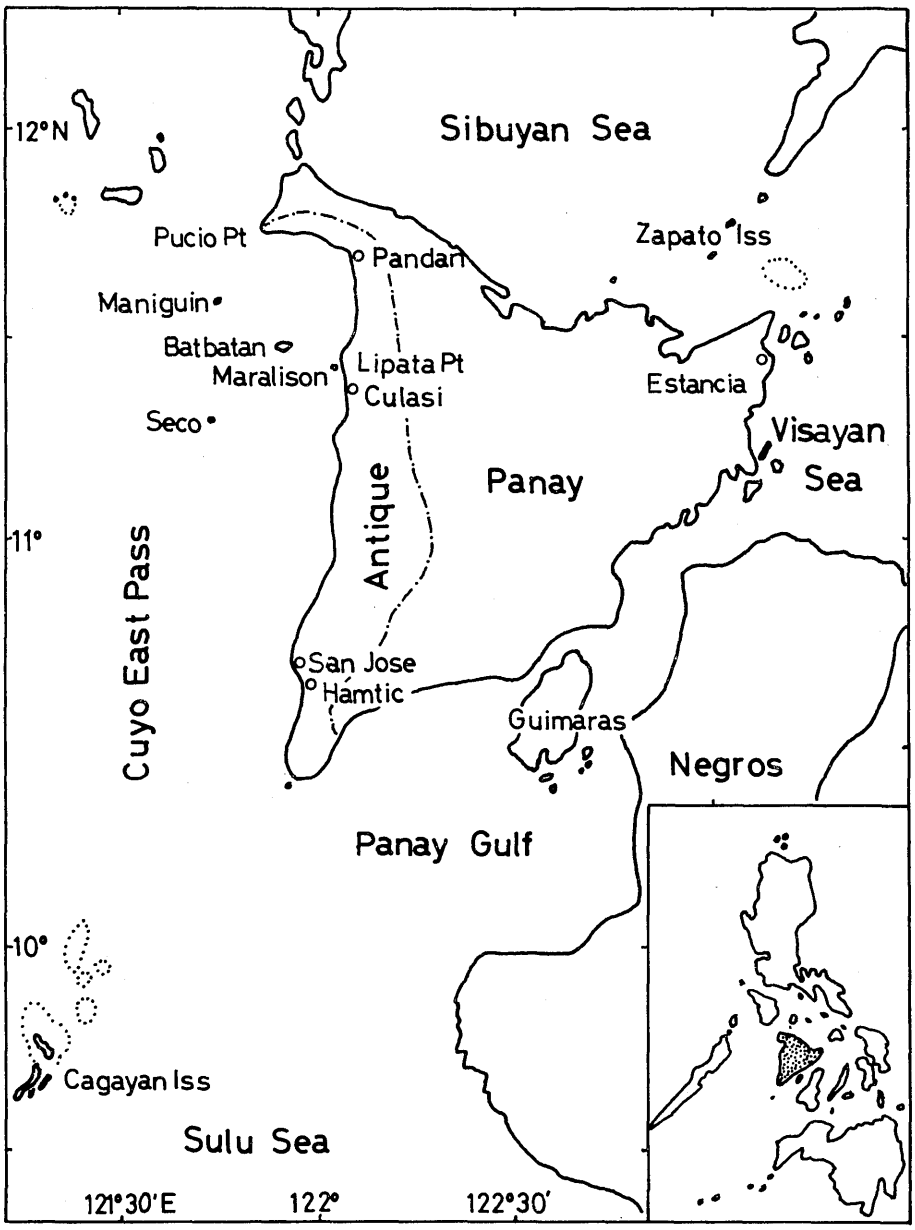

Fig. 1. The areas covered by the milkfish egg surveys in the Philippines, 1976~1979.

The net mainly used was made of nylon grid gauze NGG 38 (0.49 mm mesh) and had a mouth diameter of 71.5 cm and a length of 185 cm. A TSK 4-hand type flowmeter was often attached to the mouth of the net. The readings of the flowmeter showed that the volume of water filtered was in the order of 50-175 m^3 per tow.

Since the fry season of milkfish in Panay extends from March to December, with the main peak from April to June, effort to collect the eggs was more extensive in March, April, May and June than in other months. Antique Province, the west coast of Panay, is one of the most productive fry grounds in the Philippines. During the initial stage of the present study, the authors succeeded in obtaining milkfish

Table 1. The number of larval net tows made by areas and by months from 1976 to 1979.

Month \ Area	Cuyo East Pass	Cagayan Iss. waters	Panay Gulf	Visayan Sea	Sibuyan Sea	Total
February	25	–	19	–	–	44
March	160	–	56	–	–	216
April	443	–	89	42	32	606
May	416	–	4	63	26	509
June	196	16	–	–	–	212
July	4	–	3	9	–	16
August	22	–	–	–	–	22
September	10	–	–	–	–	10
October	23	–	–	–	–	23
November	5	–	–	–	–	5
Total	1304	16	171	114	58	1663

eggs from the waters of Batbatan island off the Antique coast. For these reasons, the waters off the province was surveyed more often than other areas.

Surface water temperature and salinity at each tow site were determined either with a temperature-salinity bridge (EIL type MC 5) or with a mercury thermometer and an Akanuma-type hydrometer.

In most cases, milkfish eggs were sorted alive from the plankton sample just after towing, and placed in containers with seawater for use in experiments on incubation and larval rearing. The rest of the collection was preserved in 5 % seawater-formalin and later re-examined for milkfish eggs in the laboratory. Some plankton samples received formalin before milkfish eggs were sorted out; such eggs preserved on the spot were utilized for determination of developmental stages by time of collection.

Results

Number of eggs collected

A total of 551 milkfish eggs were collected during the study period: 89 in 1976, 198 in 1977, 82 in 1978 and 182 in 1979. Table 2 gives the frequency of successful tows by number of milkfish eggs collected. In most cases, the eggs occurred in small numbers, ten or less in a single tow. The maximum number so far obtained by a single tow was 33 eggs.

Table 2. The frequency of successful tows by number of milkfish eggs collected.

Number of eggs	1	2	3	4	≥ 5	≥10	≥20	≥30
Frequency of successful tows	31	15	8	8	12	12	2	2

Seasonal and geographical occurrence

Table 3 shows the monthly occurrence of milkfish eggs in Cuyo East Pass. All the eggs were collected during the period from March to June, except a single one obtained in October. The greatest number of eggs per tow (0.73) was in April.

Table 4 compares the occurrence of milkfish eggs by areas in the months from

Table 3. The monthly occurrence of milkfish eggs in Cuyo East Pass from 1976 to 1979

Month	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Total
No. of tows	25	160	443	416	196	4	22	10	23	5	1304
No. of eggs	0	72	323	123	26	0	0	0	1	0	545
No. of eggs per tow	0	0.45	0.73	0.29	0.13	0	0	0	0.04	0	0.42

Table 4. The number of milkfish eggs collected in March-June, 1976-1979, by areas.

Areas	Cuyo East Pass	Cagayan Iss. waters	Panay Gulf	Visayan Sea	Sibuyan Sea	Total
No. of tows	1240	16	168	105	58	1587
No. of eggs	544	5	0	0	1	550
No. of eggs per tow	0.44	0.31	0	0	0.02	0.35

March through June. Most of the milkfish eggs, 545 out of 551, were collected from Cuyo East Pass. Very often they occurred in shallow waters around islands or islets such as Batbatan, Seco, Maniguin and Maralison. Some larval net tows at stations close to the Antique coast, e.g. off Pucio Point, off Pandan and off Hamtic, also yielded the eggs. Further, milkfish eggs were found at two locations which were rather remote from land (12.4 km and 23.4 km away) and rather deep (380 m and 900 m, respectively). The average number of milkfish eggs per tow in Cuyo East Pass calculated for March-June was 0.44.

The waters around the Cagayan Islands was surveyed only once in June 1977 when 16 larval net tows were made at 14 stations. A total of five milkfish eggs were collected from two stations. The average number of milkfish eggs per tow in this area was 0.31.

No milkfish eggs were obtained from either Panay Gulf or the Visayan Sea in spite of rather extensive larval net operations in these areas, especially around the southwestern coast of Guimaras island and off Estancia.

In the Sibuyan Sea, three trips consisting of a total of 58 larval net tows were undertaken. A single milkfish egg was found from a station near Zapato island.

Topography and oceanography

In the Appendix Table are summarized the water depths, distances from the nearest land, water temperatures and salinities at all locations where tows yielded milkfish eggs.

The milkfish eggs were found in waters of a wide range of depth, from as shallow as 10 m to as deep as 900 m, although most of the eggs were obtained from waters up to 200 m deep. Majority of the eggs was found close to the coast, within a few kilometers from the nearest land. As mentioned earlier, some eggs were obtained from rather remote locations – 7 eggs 12.4 km and 17 eggs 23.4 km away from land.

Water temperatures and salinities at locations where milkfish eggs were found ranged from 26.7 to 30.8 °C and from 32.9 to 34.5 ppt respectively.

Vertical distribution of eggs

In April and May 1976 and from March

Table 5. The vertical distribution of milkfish eggs in Cuyo East Pass.

Locations	Pandan 1976			Batbatan 1976			Batbatan-Culasi 1979			Hamtic 1976			Total			
Depths	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	C/B
0-meter	2	0	0	8	7	47	64	7	32	3	1	1	77	15	80	5.3
5-meter	2	0	0	9	4	16	–	–	–	3	0	0	14	4	16	4.0
10-meter	1	1	1	1	0	0	65	17	70	–	–	–	67	18	71	3.9
15-meter	1	0	0	3	2	11	–	–	–	2	0	0	6	2	11	5.5
20-meter	1	0	0	3	2	10	60	10	37	2	0	0	66	12	47	3.9

A: number of tows made; B: number of successful tows; C: number of milkfish eggs

to June 1979, simultaneous horizontal tows at the surface and subsurface layers up to 20 m deep were made in the coastal waters off Antique. The results are summarized in Table 5. Although similar experiments were conducted in the Panay Gulf and in the Visayan Sea in April and May 1976, no eggs were found in these waters.

Table 5 shows that milkfish eggs were distributed from the surface to at least 20 m down, and rather evenly it seems.

Developmental stages of eggs by time of collection

All preserved milkfish eggs were examined for their developmental stages. Based on the results of the breeding experiments of milkfish by Vanstone et al. (1977), and Chaudhuri et al. (1977, 1978), the following staging system for the eggs was employed. The shortest time required in the above-mentioned experiments for the eggs to develop from spawning till the end of each given developmental stage, at water temperatures of 26.4 to 29.2°C, is indicated after the explanation of each stage.

Aa: From fertilization until the blastoderm covers one-third of the yolk and the germinal ring becomes distinct. 6 hours.

Ab: The blastoderm covers two-thirds of the yolk. 8-10 hours.

Ac: Yolk invasion is completed; the yolk plug and blastopore become visible, and the embryonic streak becomes faintly indicated. 10-13 hours.

Ba: Somite formation starts and embryonic rudiment bears 9-10 somites; Kupfer's vesicle becomes visible and optic vesicles start to develop. 11.5-15.5 hours.

Bb: Embryonic rudiment reaches its maximum length on the yolk, though its posterior end is still flat; the head becomes distinctly differentiated and 19-20 somites can be counted; the optic and auditory vesicles become visible in the resulting C-shaped embryo. 14-19 hours.

Bc: The embryo forms a girdle over the yolk with its posterior end swelling to make the profile vertical to the surface of the yolk; brain differentiation is in progress. 17-23 hours.

Ca: The tail of the embryo starts to separate from the yolk, but is not yet quite elongated; the unpaired finfold appears; the optic lenses form; the heart develops. 20-29 hours.

Cb: Immediately before hatching; the embryo is fully developed, its tail elongated almost reaching the head. 25-35 hours.

The numbers of milkfish eggs found in the preserved plankton samples by developmental stages and by time of collection are presented in Table 6. Although a considerable number of larval net tows were made at night (2300 h to 0200 h), besides extensive daytime operations, milkfish eggs were obtained only between 0400 h and 1800 h.

As clearly seen in the table, the eggs found in the early morning collections were in the early stages of development; those found later in the day were more advanced. The eggs of stage Ca occurred in late afternoon samples. No egg of stage Cb was found; however, almost all the eggs brought back alive to the laboratory hatched at about 1900-2000 h.

Discussion and Conclusion

Despite the extensive surveys in Cuyo East Pass during the main spawning season of milkfish for four years, the total number of milkfish eggs found was only 545 and the maximum number obtained by a single tow was only 33 eggs. These numbers may seem to be very small when the following facts are taken into consideration: 1) the Antique coast is one of the best milkfish fry grounds in the Philippines, and 2) the fecundity of milkfish is very high, 3.1 to 5.7 million eggs (Schuster, 1960). During his numerous cruises in the Java Sea for almost ten years, Delsman (1929) could collect a total of only 15 milkfish eggs on three occasions. Two alternative interpretations may be forwarded to explain the few occurrence of milkfish eggs in larval net samples of Delsman as well as of the present authors. Either the areas surveyed did not cover the main spawning grounds of milkfish; or the population density of the milkfish spawners is rather low and they spawn only in pairs, or at most, in small schools distributed sporadically over a vast sea. In the latter case, the population density of the eggs in a given area at a given time would not be very high.

Table 6. The number of milkfish eggs found in preserved plankton samples, by developmenlal stages, and by time of collection.

Time of coll. / Dev. Stages	0400–0600h	0600–0800h	0800–1000h	1000–1200h	1200–1400h	1400–1600h	1600–1800h
Aa	3	–	1	2	–	–	–
Ab	–	9	2	–	–	–	–
Ac	–	4	34	–	–	–	–
Ba	–	1	7	–	–	–	–
Bb	–	3	25	29	1	–	–
Bc	–	–	2	2	9	–	–
Ca	–	–	1	4	5	49	19
Cb	–	–	–	–	–	–	–

Delsman (1929) found all his milkfish eggs at the end of September, and October is the main fry season in Java (Schuster, 1960). Almost all the eggs recovered in Cuyo East Pass during the present study occurred in March to June, with a peak in April, and April to June is the main fry season in Antique, with its peak in May (Kumagai and Bañada, in preparation). In both cases, the peak of egg occurrence seems to come one month ahead of the peak of fry occurrence. This agrees well with the results of the breeding experiments in which milkfish larvae took three to four weeks from hatching to reach average fry size of 13.5 mm TL (Vanstone et al., 1977).

Adult milkfish including gravid females are often caught from the coastal waters of Panay by fish corral (traditional fish trap made of bamboo), set net, gill net and hook-and-line (Anon., 1974; Mateo et al., 1976; Vanstone et al., 1976).

Although the Antique coast makes the best fry ground, milkfish fry are also collected by fishermen from the other coasts of Panay. Nevertheless, all the eggs in this study were found in Cuyo East Pass and the waters near the Cagayan Islands, except a single egg from the Sibuyan Sea. The authors have no convincing explanation for the non-recovery of milkfish eggs from the Panay Gulf and the Visayan Sea.

Based on studies on the seasonal occurrence of milkfish fry along the Antique coast and the current off the coast, Schmittou (1977) concluded that the spawning grounds for the fry collected along the coast must be located far from the fry grounds, either southwest in the Sulu Sea (April to May) or north/northeast in the Sibuyan Sea (July to December). The waters around the Cagayan Islands is one of those considered by Schmittou as possible spawning grounds of milkfish. Although some milkfish eggs were surely recovered from this area during this study, they were more abundantly found in the waters just off the Antique coast, not far from the fry grounds.

According to the Hydrographic Office, U. S. Navy (Anon., 1945) the current in Cuyo East Pass flows due westerly during the period from November to April, and northerly or southerly parallel to the Antique coast from May to October. Likewise, the results of the drift card experiments by Kumagai and Bagarinao (in preparation) showed that the surface currents of Cuyo East Pass flow away westerly or west-southwesterly from the Antique coast from December to April, and along the coast from June to November. To understand how milkfish larvae are drifted toward the Antique coast in March to June, and to clarify how the eggs occurring in Cuyo East Pass relate to the fry appearing along the Antique coast, a detailed pool of information on the coastal oceanography of this area is necessary.

Summarizing the available data, Schuster (1960) noted the following features as characteristic of the spawning grounds of milkfish: location with clear, shallow water and sandy or coral bottom, situated at distance not more than 30 km from shore. These features apply well to most of the locations where majority of the eggs in this study were found. Still, it is also true that a considerable number of eggs (133) was found at locations as deep as 200 m or more. Whether such eggs have been drifted from shallow spawning grounds, or milkfish also spawn in such deep waters remain unclear.

According to the laboratory experiments on bouyancy of developing milkfish eggs (Vanstone et al., 1977; Chaudhuri et al., 1977, 1978), the eggs tended to sink in still

water of salinity less than 34.0 ppt. The eggs from the wild were found at the surface even where the salinity was below 34.0 ppt. This must be due to the fact that sea water is never completely still.

The minimum temperature recorded for the locations where milkfish eggs were obtained was 26.7°C. This agrees well with the temperature threshold (27.0°C) for the appearance and disappearance of milkfish fry in Vietnamese waters (Kuronuma and Yamashita, 1962).

The salinity range in the present study was from 32.9 to 34.5 ppt. On the other hand, Delsman (1929) obtained all his milkfish eggs at salinities below 33.0 ppt. This difference can simply be attributed to the fact that the prevailing salinity is always lower in the Java Sea than in the Sulu Sea (Wyrtki, 1961).

Milkfish eggs in the early stages of development were collected early in the morning, and those in the later stages in the afternoon. The eggs brought back to the laboratory hatched at 1900-2000 h. Breeding experiments on milkfish show that it takes 8-10 hours for the eggs to develop to stage Ab from fertilization. From these facts, it seems reasonable to conclude that spawning of milkfish in the wild takes place at midnight, and that the incubation period of eggs in the wild is about 20 hours, a little shorter than that obtained in the laboratory.

Many aspects of the spawning behavior of milkfish are still not known. Locating and delimiting the main spawning grounds from which the fry appearing in the Antique shore waters are recruited is a most important study to undertake. For this purpose, it is necessary to conduct a systematic, extensive survey simultaneously covering a wide area such as the Sulu Sea.

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フィリピン，パナイ島周辺におけるサバヒー卵の出現

千田哲資・熊谷　滋*・N. M. Castillo*

パナイ島周辺海域において，1976～1979年に延1663回の稚魚網による水平曳きをおこない，合計551個のサバヒー卵を得た．1回の曳網で得た最大卵数は33個であった．卵の大部分はクヨー東水道で採集され，カガヤン諸島水域からも少数得られた．シブヤン海でも1個の卵が得られたが，ビサヤン海・パナイ湾では採集されなかった．卵は主に3～6月に出現し，盛期は4月で，これはこの地方における天然種苗（fry）出現の最盛期の1カ月前に当る．

サバヒー卵が最も頻繁に得られたのは島の周辺や岸近くの浅海域であるが，時として比較的陸から離れた場所やかなり深い（900*m*）ところでも採集された．卵が出現した水温・塩分の範囲は26.7～30.8℃および32.9～34.5‰であった．表層から20*m*層まで5*m*毎におこなった各層採集の結果では，これら層の間でサバヒー卵の分布密度に大きな差はなかった．早朝採集された卵は発生段階の初期のものであり，夕刻の卵は後期のものであった．天然における産卵は夜半におこなわれるようであり，孵化時間は20時間前後と推定された．

* フィリピン，イロイロ市外，東南アジア漁業開発センター増殖部局

Appendix Table. The depths, distances from nearest land, water temperatures and salinities of all locations where milkfish eggs were collected with the larval net.

Location		Depths	DFNL*	Date			W. temp.	Salinity	No. of
Lat. N	Long. E	m	m	d	mn	y	℃	‰	eggs
Near Zapato Island									
11°45.0′	123°02.0′	20	1300	25	4	79	29.1	33.5	1
Off Pucio Point									
11°45.0′	121°50.0′	200	1300	26	4	79	29.0	33.0	1
Pandan Bay									
11°44.0′	122°03.5′	10	2500	4	4	76	–	–	1
do	do	10	2500	5	5	76	30.8	33.8	2
Maniguin Island									
11°37.4′	121°39.9′	160	3000	16	4	78	28.2	34.1	1
Batbatan Island									
11°29.0′	121°56.0′	10–20	300	4	4	76	–	–	1
11°28.3′	121°55.7′	30–40	300	4	4	76	–	–	32
11°28.4′	121°56.2′	10–70	750	5–6	5	76	29.7–30.2	34.0	51**
11°28.0′	121°56.0′	10–70	200	2	10	76	29.4	33.8	1
11°28.3′	121°56.1′	10–70	200	29	3	77	27.8	34.3	14
do	do	10–20	100	19	4	77	28.8	33.9	6
do	do	10–70	200	22	4	77	28.3	34.0	9
do	do	10–20	100	23	4	77	28.6	33.8	33
do	do	10–70	200	24	4	77	28.6	33.7	23
do	do	10–20	100		do		28.9	34.1	16
do	do	10–20	100	25	4	77	29.3	33.8	5
do	do	10–20	100	28	4	77	30.2	33.8	14
do	do	10–70	200	11	5	77	29.4	33.3	2
do	do	10–20	100		do		29.7	33.7	19
do	do	10–20	100	25	5	77	30.4	33.9	3
do	do	10–20	100	3	6	77	30.0	34.2	9
do	do	10–70	200	11	6	77	30.6	34.3	17
do	do	10–20	100	20	3	78	27.3	34.3	6**
11°27.2′	121°54.9′	10–20	100		do		27.3	34.2	1
11°26.9′	121°54.3′	200	1800		do		–	–	1
11°28.6′	121°56.2′	30	600	12	5	79	28.9	33.9	1
11°28.4′	121°56.0′	10–20	250	12	4	79	28.7	34.1	1
do	do	10–20	250	12	5	79	30.0	33.9	4
11°28.2′	121°55.8′	10–20	250	11	5	79	30.1	33.2	1
do	do	10–20	250	12	5	79	30.0	34.4	2
11°28.0′	121°55.4′	10–20	250	25	3	79	28.0	33.9	2
11°27.8′	121°55.2′	10–20	250		do		28.0	33.8	1
do	do	10–20	250	30	3	79	27.8	33.7	2
do	do	10–20	250	31	3	79	28.2	33.9	2
11°28.2′	121°56.0′	40	500	30	3	79	27.8	33.9	1
11°28.0′	121°55.7′	40	500	31	3	79	28.5	33.8	1
do	do	40	500	30	4	79	28.8	33.2	6
11°27.8′	121°55.5′	40	500		do		28.8	33.5	2

* Distance from the nearest land.

** Results of more than two hauls are combined.

Location		Depths	DFNL*	Date			W. temp.	Salinity	No. of
Lat. N	Long. E	m	m	d	mn	y	℃	‰	eggs
Off Lipata Point									
11°28.2′	122°01.8′	120	2400	27	4	79	29.6	33.6	2
Betw. Culasi & Maralison									
11°24.7′	122°02.2′	40	500	1	4	79	28.3	–	2
do	do	40	500	8	4	79	28.9–30.3	33.5	7**
do	do	40	500	10	4	79	27.4–29.2	34.2–34.5	32**
do	do	40	500	8	5	79	28.7–29.8	33.2–33.6	3**
do	do	40	500	27	5	79	29.7	33.3	1
NW of Maralison									
11°25.8′	122°00.4′	200	2000	1	4	79	28.7	–	10
do	do	200	2000	8	4	79	28.7	33.5	7
do	do	200	2000	15	4	79	28.5	33.8	1
do	do	200	2000	29	4	79	28.7	33.0	1
do	do	200	2000	8	5	79	26.7–29.6	33.2–33.6	2**
Betw. Maralison & Batbatan									
11°26.7′	121°58.9′	200	4800	25	3	79	–	–	30
do	do	200	4800	1	4	79	28.7	–	4
do	do	200	4800	8	4	79	27.3	33.4	6
do	do	200	4800	10	4	79	28.5–29.0	–	12**
do	do	200	4800	8	5	79	29.4	33.3	1
11°27.4′	121°57.7′	200	4300	8	4	79	26.9–27.9	33.4–33.5	2**
do	do	200	4300	15	4	79	28.2	33.5	2
do	do	200	4300	8	5	79	29.8	33.2	3
do	do	200	4300	27	5	79	27.7–29.9	33.3–33.4	4**
11°28.1′	121°56.7′	200	2000	8	4	79	26.9–29.5	33.2–33.5	21**
do	do	200	2000	8	5	79	30.0	33.7	1
Around Seco Island									
11°21.6′	121°40.7′	110	3900	9	5	77	29.2	33.3	3
11°20.4′	121°39.2′	130	2600	26	5	77	30.0	33.5	1
11°18.5′	121°39.5′	130	1800	do			30.2	33.5	2
11°18.6′	121°42.3′	130	3300	19	3	78	27.7	34.2	4
11°20.4′	121°39.2′	100	2400	17	4	78	28.3	34.0	62**
Betw. Seco & Batbatan									
11°23.8′	121°48.3′	380	12400	19	3	78	28.1	34.4	7
Betw. San Jose & Batbatan									
11°02.1′	121°47.5′	540–900	23400	9	5	77	30.6	32.9	17
Off Hamtic									
10°42.6′	121°57.7′	20	1000	5	4	76	28.1	34.0	1
Cagayan Islands									
9°44.2′	121°20.2′	20	700	10	6	77	30.2	33.6	4
9°42.5′	121°18.7′	20	1300	do			30.5	33.8	1