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The IDRC Milkfish Project 1975-1978

W.E. Vanstone and W.E. Ricker

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CANADA

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Table of Contents

		Page
Introduction		5
1.0	Species Description and Geographic Distribution	
1.1	Species description	14
1.2	Geographic distribution	15
2.0	Ecological Studies	
2.1	Size, estimated age, and fecundity of adult milkfish	18
2.2	Food of adult milkfish at sea	18
2.3	Movements of adult milkfish	20
2.4	Morphological variations among milkfish	21
2.5	Place and time of milkfish spawning	25
2.6	Distribution of milkfish larvae and fry	27
3.0	Artificial Culture of Milkfish	
3.1	Capture and holding of adult milkfish	28
3.2	Sexing of milkfish	39
3.3	Spawning of captive milkfish in 1976, 1977 and 1978	41
3.4	Egg incubation, embryology, and hatching in 1977 and 1978	47
3.5	Rearing milkfish larvae in 1977 and 1978	49
3.6	Description of milkfish larvae in 1977 and 1978	62
4.0	Related Studies	
4.1	Changes in length and weight of milkfish fry preserved in formalin	78
4.2	Salinity preference of milkfish fry	78
4.3	Ecological studies of the Batbatan Island spawning ground	78
4.4	Bibliographies	80
4.5	Spawning and larval rearing of fishes other than milkfish	80
Acknowledgements		81
References		82
Appendices		
A	Provisional keys to pelagic fish eggs preserved in formalin	91
B	Ichthyoplankton study of the milkfish spawning ground off the east coast of Batbatan Island	105
C	Phytoplankton/zooplankton study of the milkfish spawning ground off the east coast of Batbatan Island	141
D	Personnel	269

Introduction *

The milkfish, Chanos chanos Forsskol 1775, is widely distributed in the tropical waters of the Indo-Pacific region, from Africa to the Americas, and in the central part of this range it is very important in aquaculture. Culture of milkfish in brackish water ponds in the Philippines was first observed by Europeans during the discovery voyages of Magellan 450 years ago. At present, it is extensively cultivated in Indonesia, the Philippines, and Taiwan. The total pond area devoted to its culture is about 400,000 hectares, producing about 200,000 metric tons of marketable fish per year (Rabanal and Ronquillo 1975). The most intensive culture operations are in Taiwan, which produces about 2 metric tons per hectare per year. The average production in Indonesia and the Philippines is only 350 and 600 kg per hectare, respectively. In addition, milkfish are now being cultured on a moderate or experimental basis in several other countries in the Indo-Pacific region for use as human food or as tuna bait. The attractiveness of milkfish to fish culturists stems from the fact that they can convert plant food directly to edible fish flesh, and from the ease with which they can be reared in brackish or freshwater ponds or in enclosures.

The milkfish industry in the Philippines makes a significant contribution to the country's economy. Over 90% of the country's 176,000 hectares of fishponds are devoted to milkfish culture, with total investments of US $50 million. About 200,000 people are employed directly in milkfish production and about five times that number in the secondary and tertiary industries.

At present, however, the industry is faced with a major constraint, namely, the lack of fry to permit its expansion and intensification. The current supply of milkfish fry comes entirely from traditional capture methods, which are subject to the vagaries of the weather (Figs. 1-4). Such methods are also destructive of the juvenile forms of several marine species. According to current estimates, the total fry requirement in the Philippines alone is about 1300 million fry per year. Fry collection from natural grounds amounts to only 500 million per year, a deficiency of some 800 million. Because of fry shortage, thousands of hectares of fishponds sometimes lie idle. In Indonesia, the shortage of milkfish fry is 750 million per year just to stock existing ponds. Taiwan, the third major milkfish-producing country, obtains most of its fry from Indonesia and the Philippines, mainly by smuggling, as export of fry from these two countries is forbidden by law.

In contrast with the foregoing picture of fry shortage, which is widely believed throughout the region, Smith et al. (1978) have presented a more optimistic analysis of the fry industry in the Philippines. They

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* Since the research was completed (1978), the techniques of milkfish production have changed somewhat. Thus specific numerical values may no longer be correct. It is hoped that an updated publication reflecting the changes will be prepared.

Figs. 1 and 2 - Two traditional methods of collecting milkfish fry in the Philippines.

Figs. 3 and 4 - Traditional method of sorting milkfish fry from larvae and fry of other fishes and crustaceans. The unwanted larvae and fry are discarded on the sand.

estimate the annual fry collection to be 1350 million, which would be sufficient to meet present stocking requirements. But even if this is correct, the infusion of improved technology into pond culture could easily double or treble the current yield of 600 kg per hectare per year. This production target cannot be achieved unless the country can provide the necessary 2600 to 3900 million fry for intensive culture. This would require, among other things, the stabilization of fry supply through induced spawning under controlled conditions to ensure a steady, dependable and adequate supply. Although the numbers of fry quoted above might seem impossible targets for hatchery production, they are in fact realistic, for milkfish have a fecundity of 5 to 6 million eggs per 10-kg female.

On 27 October 1974, the Aquaculture Department of Southeast Asia Fisheries Development Center (SEAFDEC) requested a grant from the Canadian International Development Research Centre (IDRC) to assist them in their milkfish research program. The major objectives of the program were as follows: (1) to ensure an adequate and reliable supply of milkfish fry, in addition to those collected from natural sources, and to extend and stabilize the period of fry availability throughout the year by domestication and breeding of adult fish from the wild and by inducing maturation in pond-grown juvenile milkfish by providing them with natural environmental conditions and artificial feed conducive to gonad development; (2) to develop economically and nutritionally effective feeds from local sources for juvenile stages of the fish, while evolving improved methods of pond culture and management, including pond engineering and polyculture with shrimps and other compatible species; (3) to provide the means for overseas and local training of researchers, as well as short-term training for milkfish pond operators, technicians, and extension workers; and (4) to determine, assess, and alleviate critical socioeconomic constraints in the entire structure of the milkfish aquaculture industry, while controlling biological factors of predation and disease, and to evaluate the profitability and other effects of innovations.

In July 1975, IDRC awarded a 3-year grant (Project No. 3-P-74-0146), amounting to Cdn $826,000, to support the Milkfish Program of SEAFDEC's Aquaculture Department. Funds from the IDRC were intended to underwrite the costs of imported materials, supplies, and major equipment; services of foreign scientists and consultants; short-term training abroad of SEAFDEC research staff, and fellowship grants for long-term training abroad leading to Master's and Doctor's degrees; and part of the expenses for publications and workshops.

Counterpart funds amounting to Cdn $2.18 million came from the Aquaculture Department and were intended to cover the cost of physical facilities and equipment; services of its research and administrative staff; and research, training, and extension activities in milkfish research and development.

Prior to the award of the IDRC grant, SEAFDEC study teams were stationed at Barrio Mag-aba, Pandan, Antique, on the northwest corner of Panay Island, and at Hamtik on the west coast of the island (Fig. 5) from 13 May to 25 June 1975 (Figs. 6-8). These teams were involved in: developing techniques for catching adult milkfish during their spawning migration and their subsequent handling, transportation, and domestication; determining the stages of gonadal development of milkfish; making morphometric measurements and examining stomach contents; determining the spawning area and pattern of drift or migration of milkfish eggs and larvae; and monitoring the ecological conditions of the area under investigation.

These two stations in Antique Province were initially chosen because of the existence of two otoshi-ami nets and several fish corrals (Figs. 9-10) along the coast (described by Kumagai et al. 1976; Manacop 1975); the assured cooperation of Congressman Enrique Zaldivar (now Governor of Antique) and local fishermen; the presence of large numbers of sexually mature or recently spawned milkfish; and the fact that the coast of Antique is one of the most productive milkfish fry collecting grounds in the Philippines (Villaluz 1975). Because of these factors, and the fact that excellent sources of both freshwater and seawater were available, it was suggested that the permanent site for the milkfish breeding program be located at Mag-aba. SEAFDEC approved the site selection on 29 July 1975 and started construction of housing and laboratory facilities on 1 September 1975. The team members moved into the partially completed facilities on 19 October and many remained there for the duration of the project (Figs. 11-13).

Also in July 1975, the SEAFDEC Aquaculture Department spearheaded the First National Bangos Symposium in cooperation with the Bureau of Fisheries and Aquatic Resources (BFAR), the Philippine Council for Agriculture and Resources Research (PCARR), and the University of the Philippines College of Fisheries (UPCF). The symposium attempted to consolidate existing knowledge and experience on the milkfish industry in the Philippines and to identify the knowledge gaps for an integrated national research and development program.

To provide a sequel to the national symposium, SEAFDEC, in cooperation with IDRC, sponsored the First International Milkfish Workshop Conference at Tigbauan, Iloilo, in May 1976. The main objective of the international conference was to plan the directions and magnitude of milkfish research, as well as to develop a collaborative program among countries, research institutions, and other interested international development organizations.

Although a great deal was known about fry collection and milkfish culture at the start of the IDRC/SEAFDEC Milkfish Seed Production Project in 1975, very little was known of the biology of the milkfish in the wild. Most of what was known was documented by Schuster (1960) in his review of biological data, but many aspects of the life history data were scanty and in some cases doubtful (Juliano 1975). There were: (1) a fair knowledge

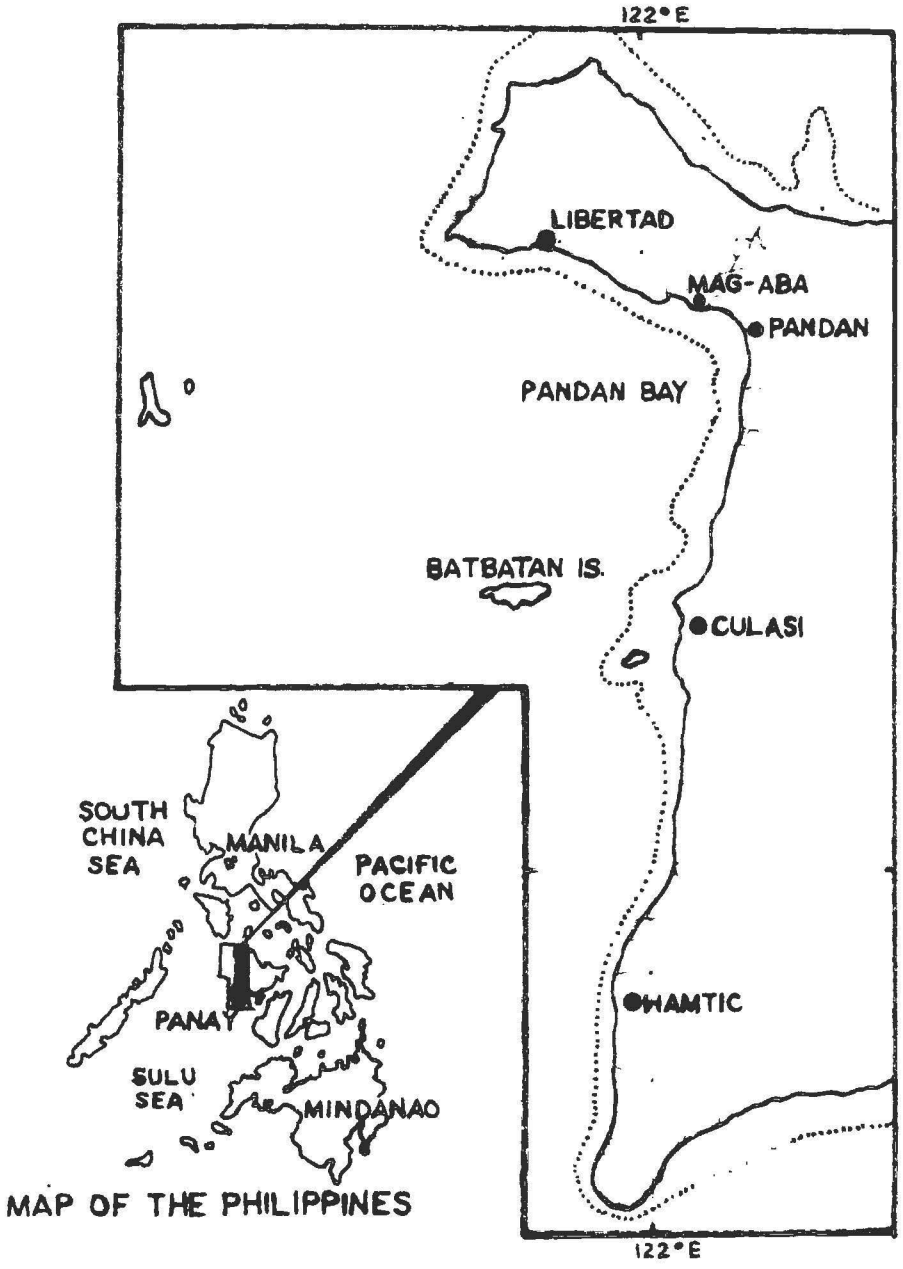

Fig. 5. The western coast of Panay Island, Republic of the Philippines, including the shoreline of Antique Province, where this study was conducted.

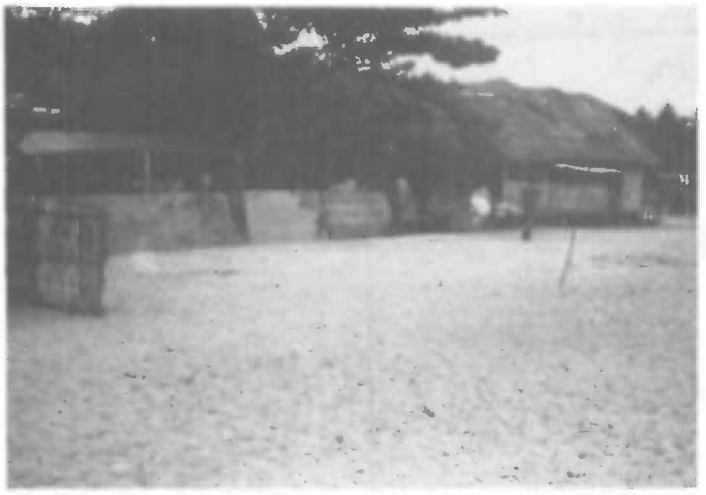

Fig. 6 - Laboratory and living quarters at Mag-aba during May and June 1975.

Fig. 7 - "Pandan Hilton": The Vanstone's home during May and June 1975.

Fig. 8 - Field laboratory and living quarters at Hamtik.

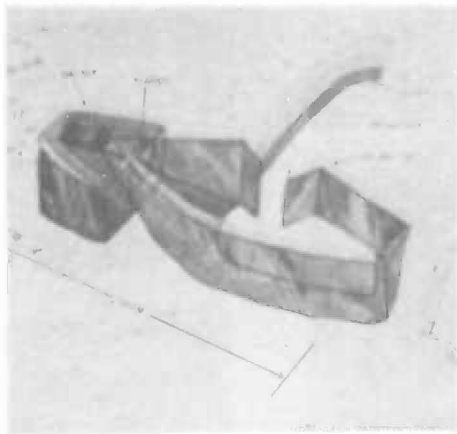

Fig. 9 - Diagram of an otoshi-ami, a Japanese-designed bag net. One otoshi-ami was located in 30-m deep water along the outer limits of a 500-m wide dead coral reef adjacent to the laboratory at Mag-aba.

Fig.10 - Aerial view of a typical fish corral.

Fig. 11 - Completed housing and laboratory facilities at Mag-aba as seen looking north from Pandan Bay. The raft for the otoshi-ami is in the foreground. The buildings are (from left to right): two staff houses; large dormitory containing 12 double rooms, a cafeteria and a radio room; pump house; and the laboratory, office, fish tanks, etc.

Fig. 12 - Plasticized canvas fish-holding, algal-culture, and rotifer-culturing tanks. The laboratory is to the right and the pump house and dormitory in the background.

Fig. 13 - Some of the spawning team at Mag-aba, May 1976.

of geographic distribution of spawning adults and fry; (2) some indications of the location of spawning grounds; and (3) limited information on egg and larval development of suspected milkfish eggs and early larvae obtained from plankton tows. It was known that, after spawning, the fry appear along the coast, mainly on the rainy side of each island. They remain there for a few days, then most of those not captured by fry collectors disappear out to sea and are not seen again until they return as spawning adults. A few fry do migrate into lakes, where they spend about 2 years of their life before migrating to the sea as sexually immature fish.

Before 1975, there were about 10 significant published reports on the feeding habits, postulated spawning grounds, gonadal development, and anatomy of milkfish from the wild. Research groups in Hawaii, Indonesia, Philippines, and Taiwan had been attempting to rear milkfish from fry to sexually mature adults and to spawn sexually mature adult milkfish captured at sea. They were unsuccessful in obtaining sexual maturation in fish reared in ponds or tanks, and were unable to spawn sexually mature adults.

The present report is a brief summary of the work conducted at the Pandan and Hamtic substations of SEAFDEC under the IDRC/SEAFDEC grant from May 1975 to June 1978, which attempted to fill in some of the gaps in our knowledge of milkfish biology, and to spawn and rear the fish in captivity.

1.0 Species Description and Geographic Distribution

1.1 Species description

The milkfish was first described from specimens taken from the Red Sea by Forskkål in 1775 as Mugil chanos. Lacapède in 1803 separated the milkfish from the mullet genus Mugil of Linnaeus because of immense morphological disparity, and elevated the specific name chanos to the generic level. Kluzinger (1871) was the first author to name the species Chanos chanos, and Jordan (1905) was the first to recognize the milkfish to be a single species throughout its geographic range. Various scientific names have been assigned by 22 authors between 1775 and 1903.

The following description of the milkfish, prepared by Villaluz (1979), is the first compilation of all characters recognized by these authors and accurately describes all specimens examined from Philippine waters. Body fusiform and compressed (Günther 1868). Eye and side of head covered with thick transparent adipose membrane (Jordan and Everman 1896). Snout depressed; mouth terminal, transverse, toothless (Günther 1868), nonprotractile (Greenwood et al. 1966), bordered only by premaxillaries and without supramaxillaries (Berg 1940). Maxillaries broad and slipping under the adipose preorbital (Jordan and Everman 1896). Lower jaw slightly shorter than upper jaw, with a symphysical tubercle that fits into a notch in the upper jaw between the premaxillaries (Herre and Mendoza 1929). Branchiostegal rays four on each side; gill membranes completely united below and free from isthmus; gill rakers lanceolate, in two diverging rows, very fine and numerous; pseudobranchiae well developed; epibranchial organ highly developed (Günther 1868). Air bladder transversely subdivided by a constriction into an anterior and posterior portion near the origin of the pneumatic duct (Greenwood et al. 1966). Pectoral fins situated well below the median longitudinal axis of the body, each with a pointed axillary scale below and above; ventral fins with a long pointed axillary scale above; caudal fin large and deeply forked, upper lobe slightly longer, median base with two semilunar axillary scales (Herre and Mendoza 1929). Dorsal iv to vi, 11 to 13; anal iii, 6 to 8 (Fowler 1941). Pectoral i, 15 to 17; ventral i, 10 to 11 (Herre and Mendoza 1929). Caudal 19 principal rays with 9 to 12 rudimentary or procurrent rays on the dorsal side and 9 to 11 on the ventral side (Rabor 1938); vertebrae 40 to 45 (Senta and Kumagai 1976). In early stages the single median dorsal fin and anus are more posteriorly placed than in the adult (Delsman 1926, 1929). In the young, the interorbital is flat, but it becomes rounded in large adult specimens (Herre and Mendoza 1929). Scales cycloid, relatively small or medium sized, arranged longitudinally, regularly imbricated, strongly adherent, silvery, basal margin with a deep cuneiform notch at middle portion (Jordan and Everman 1896). Lateral line scales 78 to 80 up to caudal base and 8 to 11 on the latter; 12 to 13 scales above the lateral line and 9 to 11 below

(Fowler 1941). Mucous membrane of oesophagus raised into a spiral fold; oesophagus terminates in a well developed "gizzard" that is homologous with the pyloric part of the stomach of other teleosts (Bridge and Boulanger 1910).

The colour of the live Philippine specimens examined was: body brilliant silver sides with greenish or grayish back, the top of the head yellowish olive and the sides whitish, the underside of the head white and sometimes with golden lustre along sides. Dorsal fin greenish to grayish. Pectoral, ventral, and anal fins yellowish or whitish. Caudal fin gray or greenish with a blackish posterior margin and/or the lower lobe yellowish.

The milkfish is a marine species, although it may ascend estuaries and rivers and live for several years in freshwater lakes (Schuster 1960, Delmendo and Angeles 1969, Tampi and Bensam 1976). It is not known to reach sexual maturity in fresh or brackish waters (Schuster 1960), but recent findings of Nash and Kuo (1976) suggest that it is possible in brackish waters. Wild fish as large as 11.9 and 17.6 kg have been reported from coastal waters of Java (Sunier 1921-1922), Taiwan (Chen 1952) and the Philippines (Herre and Mendoza 1929). Sexually mature Chanos caught during the study along the Antique coast of Panay Island measured from 50 to 120 cm in standard length; the males were generally smaller than the females.

1.2 Geographic distribution

The milkfish is the only living member of the genus Chanos, although several representatives of both Chanos and Prochanos are recorded in the Cretaceous, Eocene, and Miocene deposits of Europe (Jordan 1905). Although once a member of the formerly circumtropical Tethys fauna, Chanos became extinct in the Atlantic, presumably because of great climatic transformations occurring in the middle and late Tertiary. However, oceanographic and climatic conditions in the Indo-Malayan region remained favourable for the species (Ekman 1953, Brooks 1970). From this triangular area formed by the Philippines, the Malay Peninsula, and New Guinea, which Ekman (1953) considers to be the faunistic centre for many fish and marine organisms, the species has extended to its present range (Fig. 14) in the tropical and subtropical sections of the Indo-Pacific region.

The western limit of common occurrence of the milkfish is the east coast of Africa, extending southward from the Red Sea (Forskål 1775, Kluzinger 1871, White and Barwani 1971) to the vicinity of Durban in South Africa and rarely further to the south (Peters 1852, Martens 1866, Smith 1949). It is reported also around the offshore islands in the western Indian Ocean, including Madagascar (Weber and Beaufort 1913, Rabanal and Ronquillo 1975) and the island chains of Mauritius,

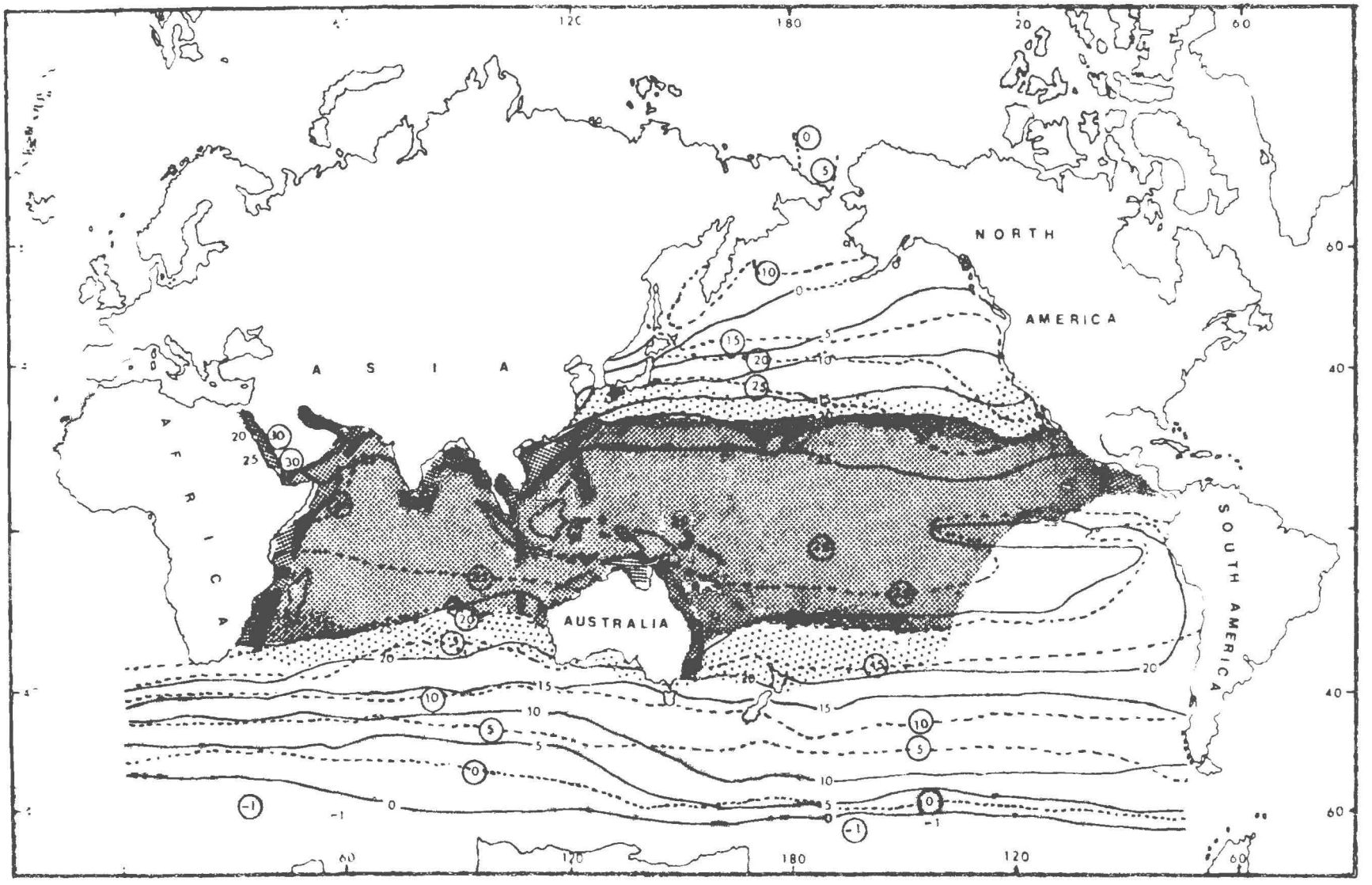

Fig. 14. Geographic distribution of Chanos chanos. Broken lines represent summer (August) and solid lines, winter (February) surface isotherms (after Sverdrup et al. 1942). Widely spaced dots represent areas of reported sporadic occurrence of milkfish and closely spaced dots represent area of general occurrence.

Seychelles, Reunion (Valenciennes 1846, Playfair 1867), Rodriguez (Fowler 1941), Diego Garcia, Chagos Archipelago, Maldive, and Laccadive Archipelago (Regan 1903, Tampi and Bensam 1976). In the eastern Indian ocean, its presence has been recorded along the Malabar and Coromandel coast of India (Cuvier 1829, Cantor 1849, Tampi and Bensam 1976) and in the coastal waters of Bangladesh (Qureshi 1957) and Sri Lanka (Bennet 1832, Munro 1955, Canagaratnam 1975).

In Southeast Asia, the milkfish is common in the coastal waters of Burma (Sein Lwin 1975), Thailand (Thiemmedh 1955), Vietnam (Le-Va-Dang 1961, Kuronuma and Yamashita 1962), the Philippines (Herre and Mendoza 1929, Herre 1953, Oshima 1973), Malaysia (Scott 1959), New Guinea (Bleeker 1872, Munro 1958), Indonesia (Van Hasselt 1823, Djajadiredja and Poernomo 1974), and Taiwan (Jordan and Everman 1902, Liao et al. 1977).

In the western Pacific Ocean, the northernmost limit of milkfish occurrence is recorded from the southern coast of Japan (Kamohara 1958). It has been reported from Okinawa (Jordan and Starks 1907), Riu Kiu Island (Schmidt 1930), Solomon Islands (Gray 1974), New Caledonia, Samoa (Günther 1909. Van Pel 1960), and from Palau and Caroline Island (Rabanal and Ronquillo 1975). In the more southern Pacific region, its distribution extends southward to the Australian States of Queensland, Western Australia, Northern Territory, and New South Wales, also to Norfolk Island and occasionally to New Zealand (Fowler 1941, Marshall 1964).

In the central Pacific Ocean, it is resident in the region of the Hawaiian Islands (Gosline and Brock 1965), Fiji Islands, Society Islands, and the Tuamotu Archipelago (Fowler 1982, Randal 1973). Its most easterly limit is the western coast of America where its range extends from the vicinity of San Francisco southward along the Mexican coast (McHugh and Fitsch 1951, Ricker 1959), at least to Costa Rica (H.E. Nanne, pers. com. to A.C. Villaluz), and there is a recent report of its occurrence in Ecuador (W.H.L. Allsopp, pers. com.).

The present recorded world distribution of milkfish, therefore, covers a vast area of the Indian and Pacific Oceans, approximately from 40°E to 100°W Longitude and between 40°N and 40°S Latitude.

2.0 Ecological Studies

2.1 Size, estimated age, and fecundity of adult milkfish

Tiro et al. (1976) tabulated lengths and weights of 81 sexually maturing or recently spawned milkfish caught 500 m offshore from Mag-aba in May and June 1976. Females averaged 6.2 kg and males 5.8 kg with average fork lengths of 80.1 and 75.5 cm, respectively. Daytime water temperature at depths from 5 to 30 m during this period ranged from 28 to 30°C, while salinity ranged from 32 to 35 parts per thousand (ppt).

Scales from 63 of these adults were examined and found to have 3 to 5 zones of discontinuous circuli (Fig. 15). These have been shown to indicate the number of years of life completed in many species of fish. It is probable that in milkfish also they are "annuli". If so, of the 26 females examined, 6 were 3 years old, 18 were 4 years old, and 2 were 5 years old; of the 37 males examined 9 were 3 years old, 26 were 4 years old, and 2 were 5 years old.

Eggs were counted in one sexually maturing female from Mag-aba and two from Hamtic. The 6.5-kg fish from Mag-aba contained 2,113,000 ovarian eggs, while the fish which were each approximately 7.5 kg from Hamtic contained 3,717,000 and 3,968,000 eggs, respectively.

2.2 Food of adult milkfish at sea

The little that was known of the food of milkfish in the wild had been reported by Sunier (1922), Reijntjes and Schuster (unpublished report cited by Schuster, 1949) and Schuster (1949) in Java, and by Chacko (1949) in the Gulf of Mannar, and Tampi (1958) also in Southern India. All but Chacko were of the opinion that milkfish in the sea are benthic feeders. Chacko concluded that the milkfish are plankton feeders, and Schuster (1960) revised his opinion to suggest that they are facultative feeders.

Contents of the anterior (spiral) portion of the oesophagus of 96 adult milkfish caught in Pandan Bay between 10 May and 16 June 1975 were examined (Villaluz et al. 1976). Most of the food was of plankton origin (Table 1). Plants included green, bluegreen, and red algae and diatoms. Predominant among the animal material were crustaceans (especially copepods) and fish eggs and larvae, with a small representation of other phyla.

Although adult milkfish during their spawning migration were feeding mainly on plankton material, it was found that, once captured and adapted to confinement, they readily fed on a mixed diet of ground trash fish and rice bran.

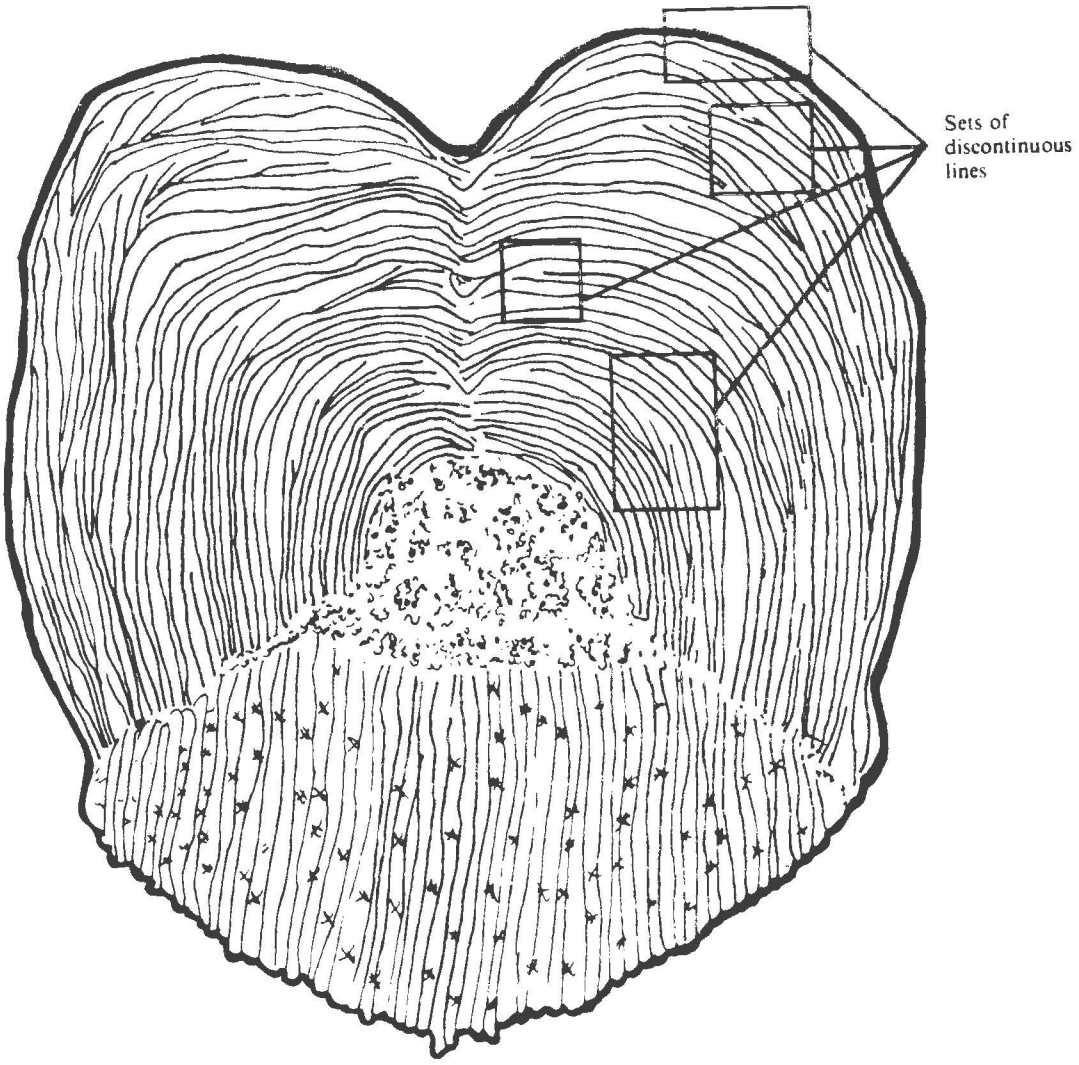

Fig. 15. Diagram of a typical milkfish scale with an estimated age of 4 years.

Table 1. Oesophagus contents from 96 adult milkfish captured in the otoshi-ami at Mag-aba between 10 May and 16 June 1975.

Food items	Number of specimens containing each item	Percentage of specimens containing each item
Diatoms	56	58.3
Nitzchia, *Thallasiothrix*, *Fragillaria*, *Rhizosolenia*, *Coscinodiscus*, *Deratium*, *Navicula*, *Chaetoceros*, *Eucampia*, *Ditylum*, *Melosira*, *Biddulphia*		
Animal Forms	90	93.7
Vorticellid	1	1.0
Sarcodinan	1	1.0
Foraminifiran	1	1.0
Ciliophoran	2	2.1
Echinoderm larvae	1	1.0
Cladoceran	1	1.0
Copepods	83	86.5
Crustacean eggs and egg cases	9	9.4
Crustacean nauplii	2	2.1
Crustacean zoea	4	4.2
Crustacean juvenile	1	1.0
Crustacean shell and appendages	4	4.2
Fish eggs	14	14.6
Fish larvae	5	5.2
Algae	71	74.0
Chlorophytes	39	40.6
Cyanophytes	37	38.5
Rhodophytes	28	29.2
Other Items	70	72.9
Detritus	70	72.9
Sand	1	1.0

2.3 Movements of adult milkfish

Trials were made of sonar tracking of milkfish during the 1976 spawning season, using equipment similar to what had been successful with salmon (Groot 1976, Groot et al. 1976). Four male milkfish were tagged externally with 50 or 74 kHz sonic tags, and their movements, after release,

were followed in a boat equipped with a hydrophone. Numerous problems arose in adapting the apparatus to local conditions. These included failure of the 74 kHz tags; background biological signals from fish, crustaceans, and other sources in the surrounding sea; and an adverse effect on the range of tag reception as the sea surface layer warmed as the day progressed. In the most successful experiment the fish was followed for a full 24-hour period in Pandan Bay.

Swimming speeds during the first hour after release were about 2 km/hour. Average speeds thereafter varied from 1 to 2 km/hour with maximum speeds up to 6 km/hour for short periods (30 minutes). Fish often slowed down and remained in one position for periods of up to 6 hours.

Patterns of movement indicated initial headings toward shore after release. Thereafter, movements were primarily parallel to the shore at a distance of 1 to 2 km. Fish usually avoided or found their way around the local bamboo fish traps, although it was noted that at the end of the 24-hour track the fish entered a trap off Pandan. However, since it is illegal for fishermen to retain adult milkfish, no reports were received of milkfish being taken in that trap.

2.4 Morphological variations among milkfish

Milkfish occupy a very wide range in the tropical Indian and Pacific Oceans and, although they may have only one spawning season in most of the region, two seasons have been reported in parts of the Philippines, India, Indonesia, Thailand, and Vietnam (Schmittou 1977, Kumagai et al. 1978). It is unlikely that there would be a single interbreeding stock spawning at different times of the year over so wide a range. There has, however, been no comprehensive search for characters that might distinguish fish from different parts of the region. A contribution to this subject was made by members of the project (Senta and Kumagai 1976, 1977; Villaluz 1979).

Philippines milkfish samples had a larger mean number of vertebrae than those from southern India and Thailand, whereas they had fewer vertebrae than samples from the Rangiroa Atoll in Tahiti. Samples from Indonesia and Taiwan were similar to Philippines samples. Within the Philippines region, there was a significant difference between April and October samples taken at Tigbauan on the south coast of Panay. This could be a racial difference or a result of the seasonal difference in oceanic conditions during development. Senta and Kumagai (1976, 1977) suggested that there may be at least four subpopulations throughout the tropical Indo-Pacific waters: southern India; Thailand; Indonesia, Philippines and Taiwan; and Tahiti. Another local difference was that

Table 2. Descriptive statistics of fin ray and vertebral counts of milkfish specimens collected from five localities in Philippine waters.

Localities	Number of specimens	Statistic	Character				
			DR	DU	DB	AR	AU
Ilocos	100	Mean	0.4131	5.94	12.01	0.3967	4.02
		$S\bar{x}$	0.0035	0.0239	0.0732	0.0059	0.0348
		Range	0.307-0.50	5-6	10-13	0.25-0.5714	3-5
Panay	100	Mean	0.3881	5.83	12.47	0.3743	3.89
		$S\bar{x}$	0.0035	0.0378	0.054	0.0080	0.049
		Range	0.307-0.454	5-6	11-13	0.25-0.7143	3-5
Bicol	99	Mean	0.4106	5.97	12.14	0.3951	3.9
		$S\bar{x}$	0.0027	0.0173	0.0658	0.0104	0.0617
		Range	0.307-0.454	5-6	11-13	0.25-0.6667	3-5
Zamboanga	100	Mean	0.4073	5.94	12.2	0.3784	3.88
		$S\bar{x}$	0.0032	0.0239	0.0725	0.0063	0.0383
		Range	0.307-0.50	5-6	10-13	0.25-0.5714	3-5
Davao	100	Mean	0.4017	6.0	12-47	0.3576	3.79
		$S\bar{x}$	0.0017	0	0.0521	0.0055	0.0409
		Range	0.384-0454	6.0	11-13	0.25-0.4286	3-4
Grand mean			0.4041	5.94	12.26	0.3804	3.9
Overall range			0.306-0.50	5-6	10-13	0.25-0.7143	3-5
Mean intra-locality CV			7.23	4.19	5.19	18.84	15.53
Overall CV			7.42	4.85	5.23	19.44	15.84

Table 2. Cont'd.

Localities	Number of specimens	Statistic	Character AB	P	V	Vt
Ilocos	100	Mean	7.66	15.36	8.89	43.20
		$S\bar{x}$	0.0517	0.0718	0.0737	0.0471
		Range	6-9	14-17	7-10	42-45
Panay	100	Mean	7.88	15.56	8.99	43.22
		$S\bar{x}$	0.0504	0.0743	0.1141	0.0504
		Range	6-9	14-17	7-11	42-44
Bicol	99	Mean	7.44	15.88	9.94	43.31
		$S\bar{x}$	0.0629	0.0790	0.0450	0.0586
		Range	6-9	14-17	9-11	41-44
Zamboanga	100	Mean	7.66	15-63	10.51	43-32
		$S\bar{x}$	0.0497	0.0525	0.5024	0.0584
		Range	7-9	14.16	10-11	42-45
Davao	100	Mean	7.82	15-74	10.56	43.37
		$S\bar{x}$	0.0411	0.063	0.4989	0.0580
		Range	7-9	15-17	10-11	42-44
Grand mean			7.67	15.63	9.78	43.28
Overall range			6-9	14-17	7-11	41-45
Mean intra-locality CV			6.68	4.35	7.0	1.29
Overall CV			6.72	4.39	7.31	1.29

Abbreviations: DR, ratio of unbranched to branched dorsal fin rays; DU, number of unbranched dorsal rays; DB, number of branched dorsal rays; AR, ratio of unbranched to branched anal fin rays; AU, number of unbranched anal rays; AB, number of branched anal rays; P, number of pectoral fin rays; V, number of ventral fin rays; Vt, number of vertebrae; CV, coefficient of variability; $S\bar{x}$, standard error of the mean.

Table 3. Statistical significances of differences between samples of milkfish from five localities in the Philippine waters.

Comparison	Characters								
	DR	DU	DB	AR	AU	AB	P	Vt	V
I vs P	**	**	**						
I vs B						*	**		**
I vs Z									**
I vs D	*		**	**	*		**		**
P vs I	**	**	**						
P vs B	**	**	**			**	**		**
P vs Z	**	**	*						**
P vs D	**	**							**
B vs I						*	**		**
B vs P	**	**	**			**	**		**
B vs Z						**			**
B vs D			**	**		**			**
Z vs I									**
Z vs P	**	**	*						**
Z vs B						**			**
Z vs D			*						
D vs I	*		**	**	*				**
D vs P	**	**							**
D vs B			**			**	**		**
D vs Z			*						

* 95% level ** 99% level

Abbreviations: DR, ratio of unbranched to branched dorsal fin rays; DU, number of unbranched dorsal rays; DB, number of branched dorsal rays; AR, ratio of unbranched to branched anal fin rays; AU, number of unbranched anal rays; AB, number of branched anal rays; P, number of pectoral fin rays; V, number of ventral fin rays; Vt, number of vertebrae; CV, coefficient of variability; Sx, standard error of the mean.

I, Ilocos; P, Panay; Z, Zamboanga; D, Davao.

samples taken at Hamtik off the southern part of the west coast of Panay were significantly more variable in respect to vertebra number than those taken at most other Philippines localities, including Tigbauan just around the corner on the south coast. However, the Hamtik samples had been taken over 5 weeks time, whereas other samples were taken on single days. In absolute terms, however, milkfish vertebral numbers are not very variable; the means of all populations sampled lie within the range 43 to 44, and the individual extremes were 40 and 45.

Villaluz (1979) studied the variability of 10 morphological characters of adult milkfish in five Philippines localities, including the number of vertebrae, number of rays in all four fins, and (for the anal and dorsal fins) the number of branched and unbranched rays and their ratio (Tables 2, 3). There were no significant differences in number of vertebrae and, although there were many among the fin characters, the nature of these (hereditary or environmental) was not ascertained. The closer resemblances between samples from adjacent areas suggest that the five samples could be grouped into three "populations": South China Sea (Ilocoa and Panay), Pacific Ocean (Bicol), and Celebes Sea (Zamboanga and Davao).

2.5 Place and time of milkfish spawning

To identify the source of milkfish fry in any region it is first necessary to know where the adults spawn. This can be indicated by the presence of milkfish eggs in plankton collected from or adjacent to a spawning ground, and it requires reliable identification of the egg in question. On three occasions during his numerous cruises in the Java Sea from 1919 to 1928, Delsman (1926, 1929) found a total of 15 fish eggs, which he believed to be those of milkfish. Aside from the Java Sea, recoveries of eggs identical to those described by Delsman have been reported only from the coastal waters of India (Jacob and Krishnamurthi 1948, Chachko 1950). The correctness of Delsman's descriptions was proven with the artificial fertilization of known milkfish eggs in 1977 (see section 3).

From April 1976 to June 1979, Senta et al. (1976, 1979, 1980) collected 551 milkfish eggs in plankton tows in the waters around Panay Island. The majority of the eggs (545) were obtained from Cuyo East Pass in the northern Sula Sea off the coast of Antique Province, of which 544 were collected during the 4-month period of March to June, and one egg in October. Antique Province is one of the most productive fry grounds in the Philippines; the fry season extends from March to December with a main peak from April to June all along the coast, and a minor peak in November/December which is limited to southerly portions of the province.

One egg was collected from Cuyo East Pass in October. Five eggs were collected from the waters around Cagayan Islands, in the Sula Sea southwest of Panay Island, in June 1977, but this area was surveyed only once. Despite extensive surveys no eggs were obtained from either Panay Gulf or the Visayan Sea off the south/southeast and western coasts, respectively, of Panay Island, and only one egg was obtained from the Sibuyan Sea off the northern coast.

Fishermen had suggested that Batbatan Island was a major spawning area and the shallow water over a coral reef on its eastern coast was the major source of milkfish eggs. The shallow waters near adjacent islands also yielded eggs and some net tows close to the Antique coast yielded a few eggs. Additionally, milkfish eggs were found in waters more remote from land (12.4 and 23.4 km away) and rather deep (380 and 900 m, respectively). It remains uncertain whether these latter eggs drifted from shallow spawning grounds, or whether milkfish also spawn in deep water.

From indirect evidence we concluded that milkfish spawn during the first and last quarter of the lunar calendar: (1) Collectors in the Philippines obtain most of their fry during the period from 4 days preceding to 4 days following the new and full moon; (2) Kuronuma and Yamashita (1962) observed that higher concentrations of fry are present during periods of higher tides associated with the lunar calendar in Vietnam; (3) the size and stage of development of shore-caught fry in the Philippines are similar to 21-day-old laboratory reared larvae (see section 3); and (4) Kumagai et al. (1978) converted the dates on which they and Delsman collected milkfish eggs into lunar dates and found that the majority of eggs were collected during the first and last quarters.

Fishermen informed us that they never captured adult milkfish in their bamboo fish corals or bag nets until the dry season when the grass in their villages became brown and brittle. That there is indeed a temperature threshold below which milkfish do not spawn was suggested by Kuronuma and Yamashita (1962) who collected milkfish fry along the Vietnam coast. They found that the time of high concentration of fry moved up the coast as the season progressed from April to August, and then southward again during September. This movement of the peak of fry collection was correlated with increasing and then decreasing water temperature as the season progressed, and they suggested a threshold water temperature of 27°C. The lowest water temperature at which milkfish eggs were collected by Senta et al. (1976, 1979, 1980) was 26.7°C and the highest was 30.6°C, while the range in salinity was 32.9 to 34.5 ppt.

2.6 Distribution of milkfish larvae and fry

Milkfish larvae or fry were never collected in the 1663 larval net tows made by Senta et al. during their four years of study. However, 1500 larvae ranging from 5.8 to 14.6 mm were obtained from the otoshi-ami located 500 m offshore from the laboratory site at Mag-aba after the bag of the net was lifted through 30 m of water (Kumagai et al. 1976). From these limited observations, it was suggested that the larvae, once hatched in the surface water layers, locate themselves in the mid-water layer and drift in this layer from the spawning/egg incubation grounds toward shore, while growing to a total length of about 9 to 10 mm. At this size they have well developed dorsal and anal fins and probably an air bladder, and float to the surface. The larvae are then carried to shore by tidal or onshore currents and winds (Kamagai et al. 1978, 1979, in preparation) where they can be collected as 11- to 14-mm fry. Although the term fry is used to describe the young milkfish collected along the shore by collectors, the animal at this stage does not have ventral fins. These fins develop 11 to 14 days after the fry are collected.

3.0 Artificial Culture of Milkfish

3.1 Capture and holding of adult milkfish

The difficulties of capture and holding of adult milkfish, which are called sababo in the Philippines, has been documented (Anon. 1974, Oceanic Foundation 1975, Schmittou 1975). The fish are very excitable and active, and injure themselves during capture, transport, and initial holding in captivity. In addition, even in apparently uninjured fish, the thick transparent adipose membrane covering the eyes and sides of the head becomes opaque after 2 or 3 days in captivity. If these newly captured fish are held in undiluted seawater they die within 4 or 5 days.

This problem was solved in Hawaii (Madden et al. 1976) and in the Philippines (Vanstone et al. 1976a). The following is a description of the method developed in the Philippines.

After capture in an otoshi-ami (Figs. 16-19) or a fish corral, the adults were transferred to a holding-transport cage that was in an upright position (Figs. 20-21). The frame of the 3.5 x 1.5 x 1.5 m cage was constructed of 5-cm PVC pipe and fittings, which supported a knotted 1.25- or 2.0-cm stretch nylon netting bag. The buoyancy of the cage could be adjusted by filling the frame with water through a stoppered 5-cm PVC Tee.

Once the fish were in the cage the drawstring open end was secured and the cage rotated 90 degrees. The cage was then either lashed to the frame of the outrigger of a large pump boat (Fig. 22) or hitched to the stern of a small pump boat. The cage was then brought close to the shore at a speed of 1.0 to 1.5 knots, and then hand-carried to water approximately 50 cm in depth.

When milkfish were captured in the otoshi-ami at Mag-aba, the cage was brought to the shore near the laboratory (Fig. 23). One team member then entered the cage with a 1.5-m long plastic bag made of 0.6-mm plastic tubing, 81 cm in circumference, knotted at one end (Fig. 24). The plastic bag was then filled with water, an individual fish was guided into it, and the bag, with its open end held securely closed, floated out of the cage onto a hammock (Figs. 25-26). Two men then carried the hammock, while a third man kept the open end of the bag securely closed (Figs. 27-28). The hammock was placed beside the experimental tank and the bag containing fish and water was lifted and passed to two men waiting inside the tank, who then released the fish (Figs. 29-33).

When milkfish were captured at other sites, they were transferred from the holding-transport cage to a waterproof canvas tank on a pickup truck (Fig. 34). A flow of oxygen was maintained in the tank during the trip to Mag-aba where the fish were placed in a plastic bag with water and transferred from the tank to the experimental tank as above.

Fig. 16. Capture of adult milkfish in the otoshi-ami located in Pandan Bay 500 m offshore from Mag-aba.

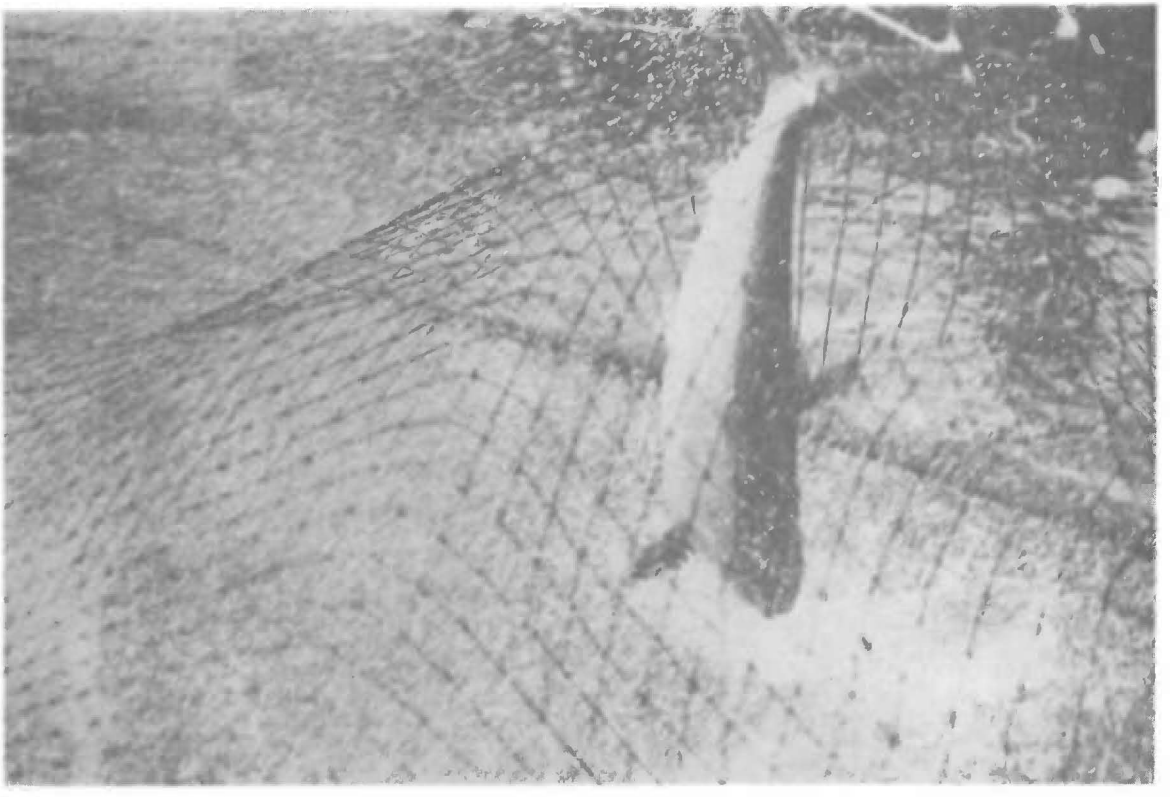

Fig. 17. Capture of adult milkfish in the otoshi-ami located in Pandan Bay 500 m offshore from Mag-aba.

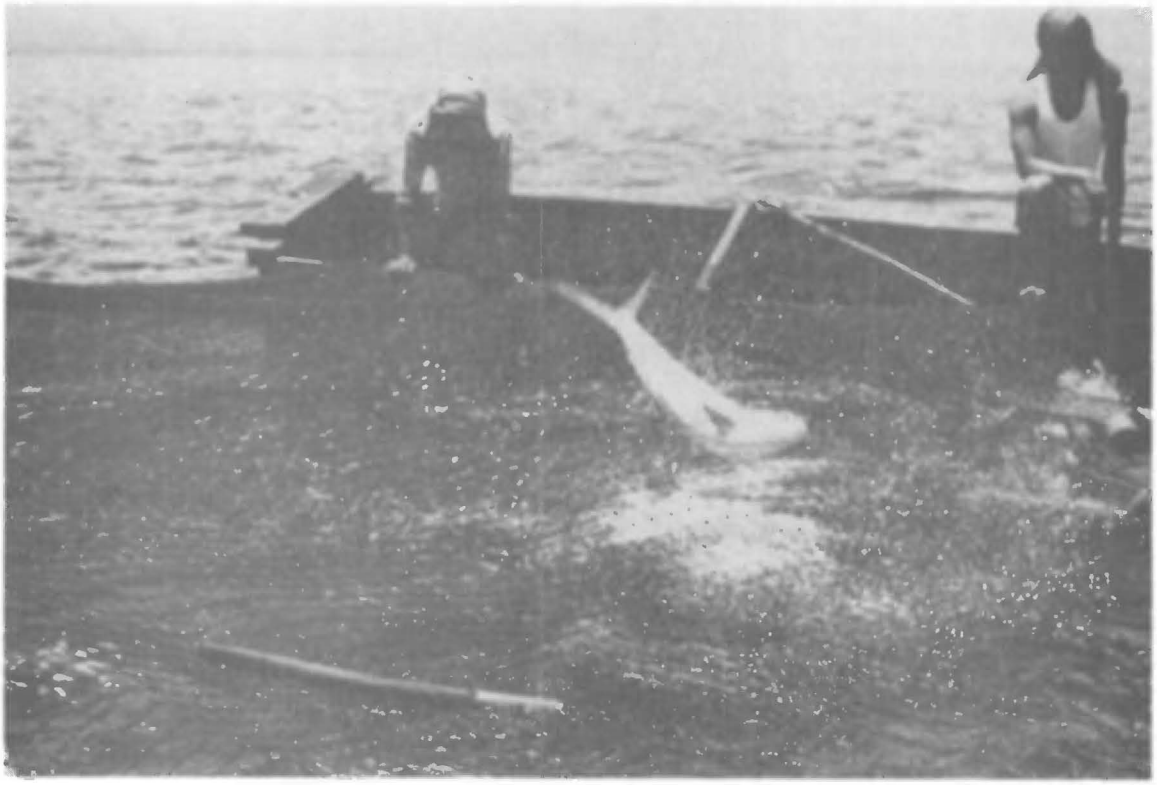

Fig. 18. Capture of adult milkfish in the otoshi-ami located in Pandan Bay 500 m offshore from Mag-aba.

Fig. 19. Capture of adult milkfish in the otoshi-ami located in Pandan Bay 500 m offshore from Mag-aba.

Fig. 20. Transfer of the fish after capture to the transport cage.

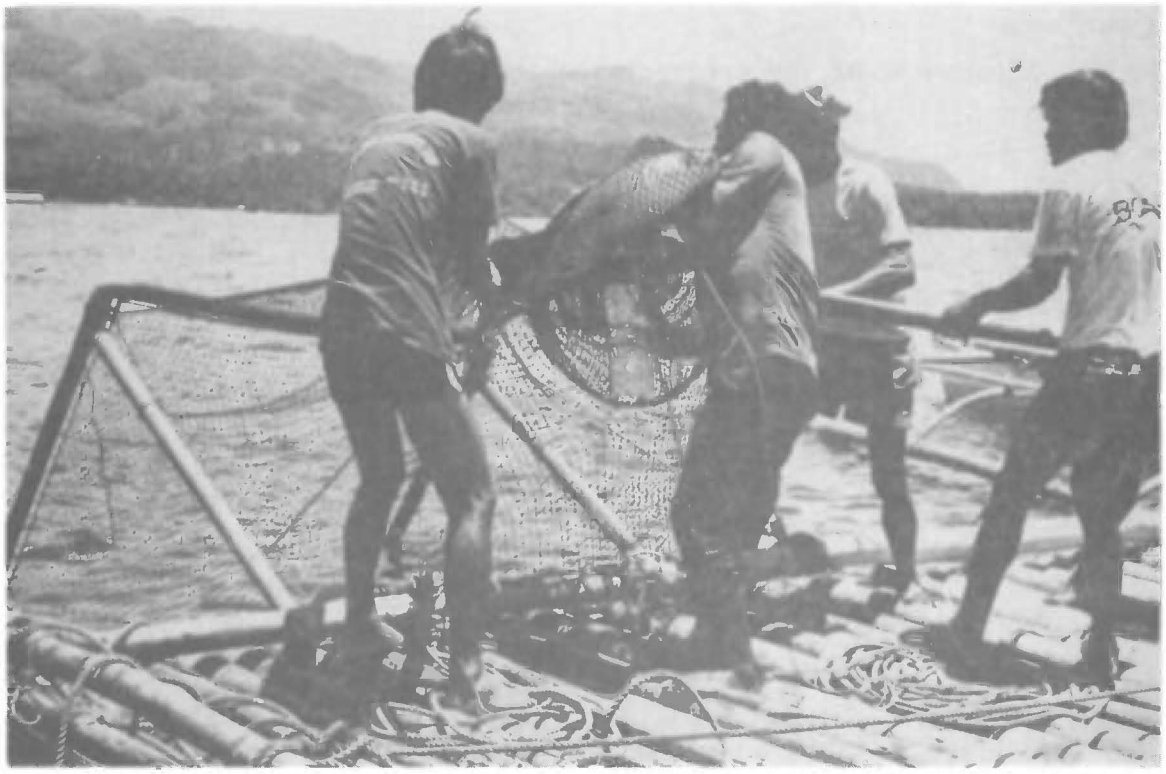

Fig. 21. Transfer of the fish after capture to the transport cage.

Fig. 22. Attachment of the transport cage to the outrigger of a pumpboat.

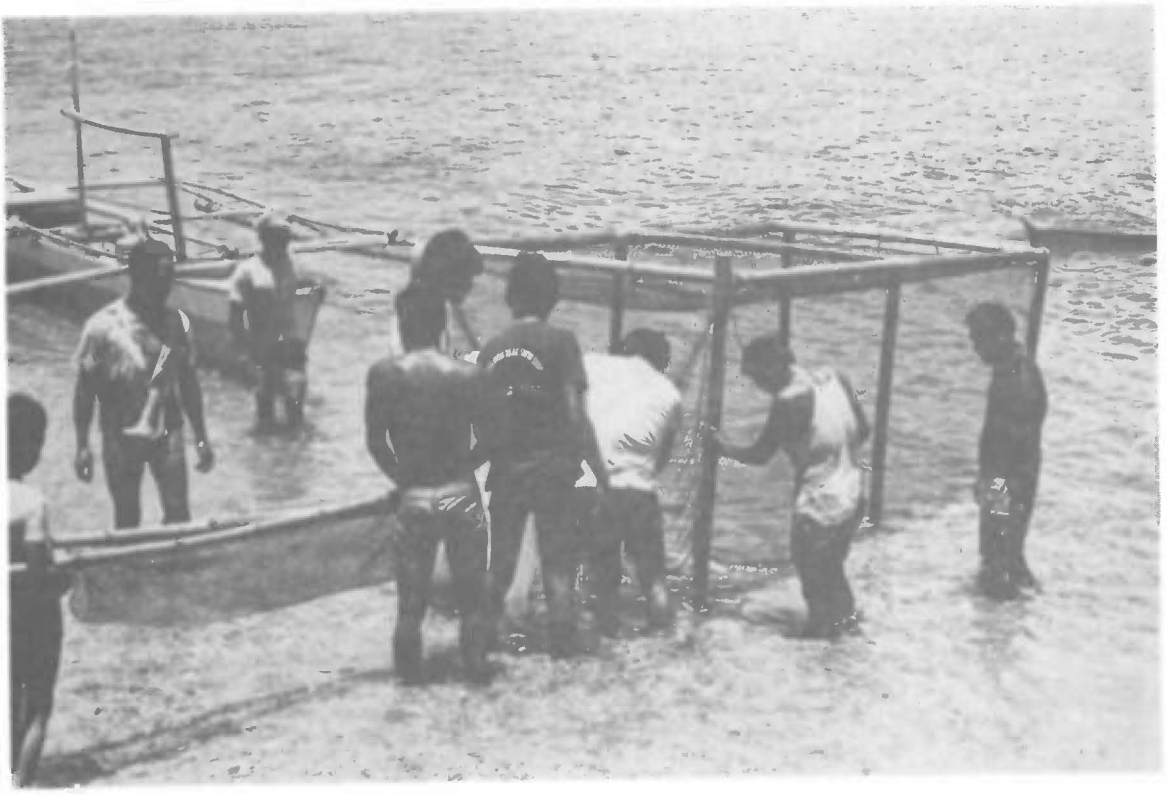

Fig. 23. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 24. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 25. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 26. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 27. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

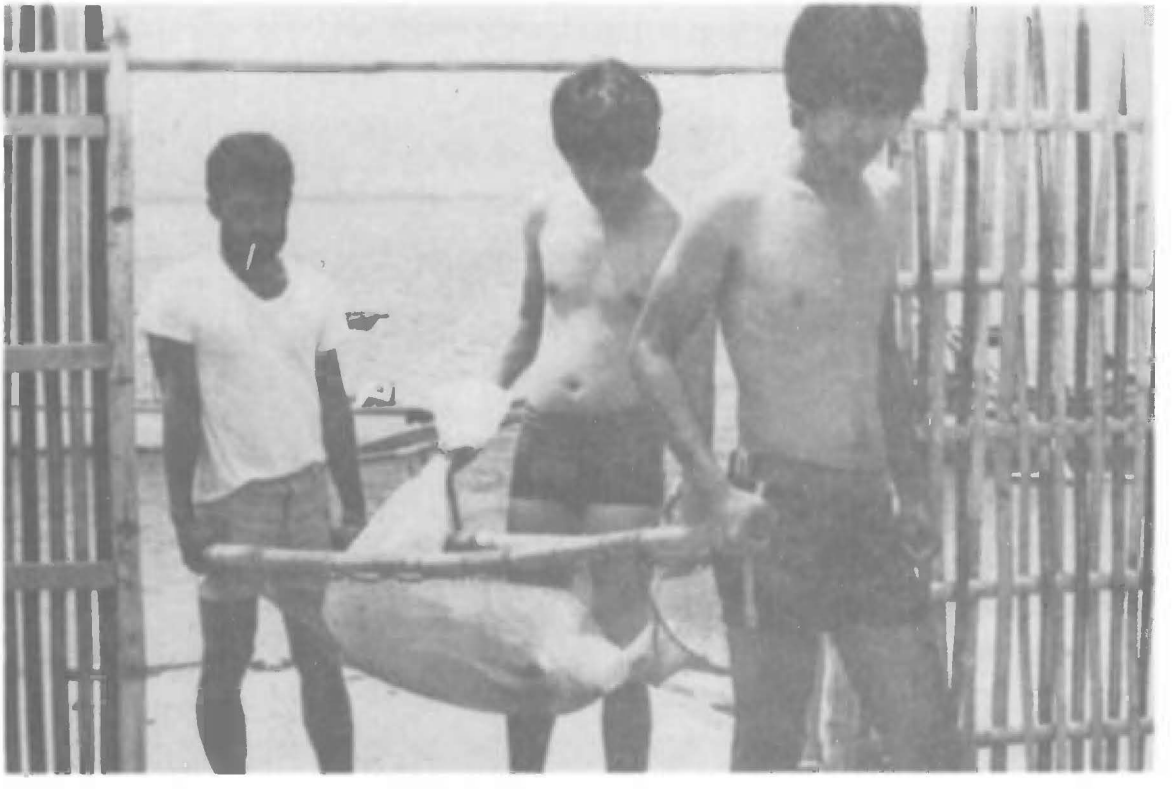

Fig. 28. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 29. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 30. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

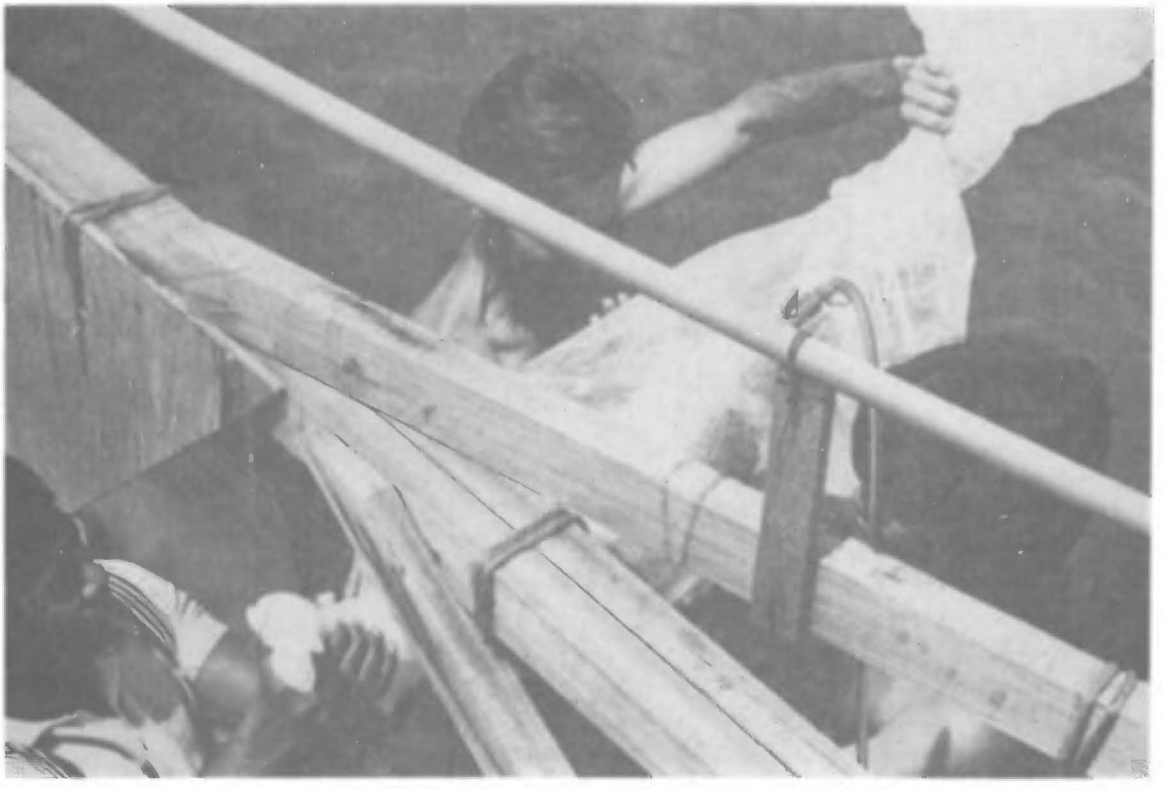

Fig. 31. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

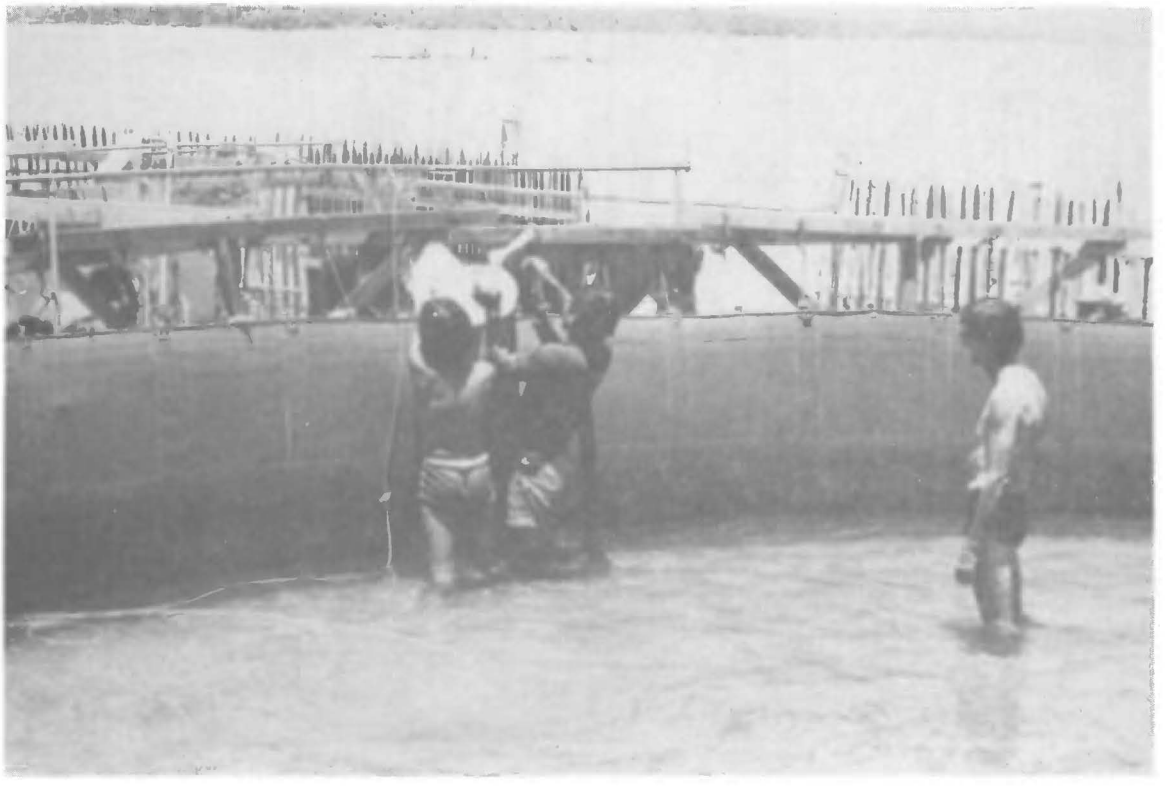

Fig. 32. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 33. Transfer of adult milkfish from the transport cage at the shore to holding/experimental tanks.

Fig. 34. Plasticized canvas tank on pickup truck used for transporting milkfish a long distance by road.

The seawater in the experimental tanks was maintained at 12-15 ppt during the initial fish-holding period. Although the adipose membrane of all but one of over 300 adult milkfish captured became opaque, it cleared after 8-16 days of captivity. As soon as the eyecover cleared, the salinity of the water was increased to 32-35 ppt and the fish began to actively feed on the diatoms and protozoans which formed a scum on the water surface, and on algae and animal forms which were attached to and living near the tank bottom and sides. Approximately 2 to 3 weeks after capture the fish were fed to satiation twice a day with a mixture of chopped trash fish and rice bran (300 g rice bran/kg of trash fish).

A second major problem encountered in holding adult milkfish was an infestation of our stocks with an ectoparasite of the genus Caligus, species unidentified and possibly new. Its morphology, life cycle, and control were described by Lavina (1977a, 1977b, 1978). This parasite most probably infested some milkfish in the open sea and was introduced to our holding tanks by an infected host. Within the tanks the parasite reproduced and infected the other fish.

It was found that a concentration of 0.25 ppm of 0,0-dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate (manufactured by Bayer Co. under the trade name Neguvon) for 12-24 hours in the tanks containing infected milkfish was effective in killing the parasite. During treatment the flow of water through the tanks was stopped but heavy aeration was supplied.

A similar, if not the same, parasite infected our stocks of rabbit fishes (five species of Siganus) and was controlled in the same manner.

3.2 Sexing of milkfish

In any breeding program it is desirable to know the sex of the breeders. Milkfish show no obvious signs of their sex externally; however, team members discovered that a recognizable distinction was available upon close inspection (SEAFDEC 1976, Tiro and Vanstone, unpublished).

In both sexes the anus (Figs. 35-36) is situated at the anterior end of the cloaca, and a papilla with an opening at its tip is located posterior to the anus. In females the opening at the tip of the papilla leads to large urinary ducts adjacent to each kidney. In males the papilla opening leads to the urinary ducts as in females and also to the large spermatic ducts of each testes. In females a third opening, the genital pore, is located between the anus and the urinary papilla. In males two pores, lateral to each other, are located between the anus and urogenital papilla. These two pores open directly into the body cavity of the male but their function is unknown.

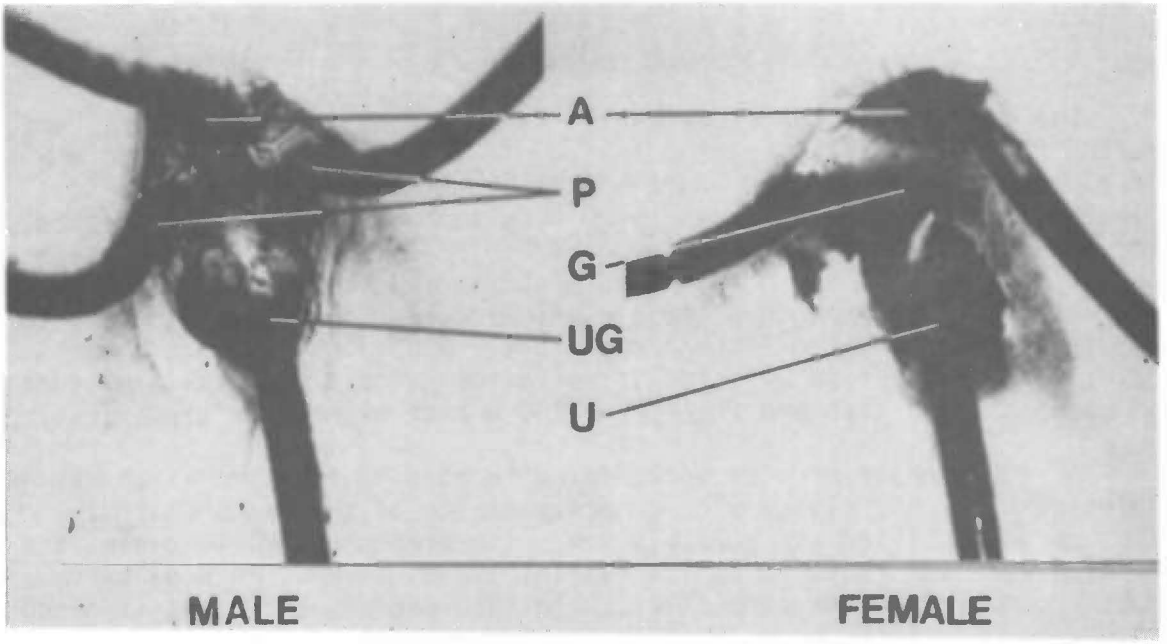

Fig. 35. Cloacal region of adult milkfish: A, anus; G, genital pore; P, lateral pores; U, urinary pore; UG, urogenital pore. Body weight: male, 4.5 kg; female 7.17 kg. Fork length: male, 73.0 cm; female, 81.2 cm.

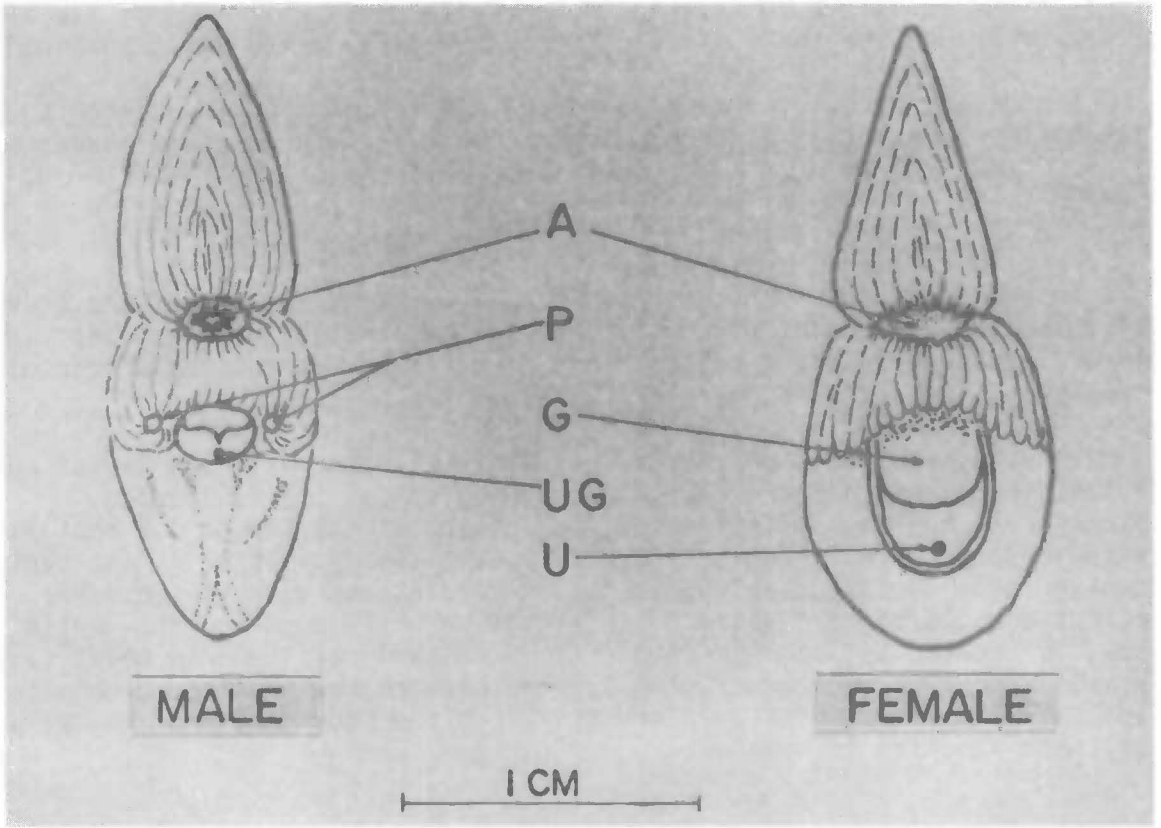

Fig. 36. Scale drawing of cloacal region of the milkfish in Fig. 35.

To sex the fish they were either anaesthetized with 2-phenoxyethanol if already acclimated to captivity or not anaesthetized if still in shock after capture and transport. The cloaca of each fish was then distended with curved blunt forceps and a polyethylene tube used to determine the location and number of each opening. If the fish was a maturing female the same tube was then used as a canula through her genital pore to obtain samples of ovarian eggs (Fig. 37).

3.3 Spawning of captive milkfish in 1976, 1977, and 1978

1976 experiments

During capture, and also after their release in the holding tanks, the adult milkfish were very active. On several occasions between 6 April and 4 May 1976, sexually mature males released milt, and occasionally maturing females would release immature, non-hydrated eggs. The milt contained very motile spermatozoa. The eggs released had a mean diameter of 0.89 mm (range 0.80-1.07), and were filled with very finely segmented yolk.

Vanstone et al. (1976b) attempted to induce complete maturation of eggs in females that were nearly ripe but whose eggs were not yet hydrated. They were given injections of semi-purified chum salmon gonadotropin (SG-G 100), prepared by Dr. E.M. Donaldson of the Fisheries and Marine Service of Canada and donated to SEAFDEC by IDRC. Injections were made into the dorsal musculature 2-3 cm below the dorsal fin (Fig. 38). Each fish of 7-8 kg received 3 ml of 1% NaCl solution containing 10 mg of SG-G 100 per ml, while fish of 6-7 kg received 2 ml. Males were similarly injected. Following injection, the milkfish were held in large tanks to see whether spawning would occur spontaneously. Plankton tows were made in the spawning tanks, and hydrated eggs of 1.18-mm mean diameter(range 1.07-1.36) were collected. These eggs contained finely segmented yolk and a very narrow perivitelline space. No fertilized eggs were obtained.

1977 experiments

For inducing the final stage of maturation in milkfish in 1977 and 1978 we used a hormone solution containing 15 mg of acetone-dried coho salmon pituitary powder and 1000 I.U. chorionic gonadotropin per ml. The pituitary powder, Code No. 62, containing 17.6 mg gonadotropin per gram, was prepared by the British Columbia Research Council, Vancouver, Canada, and was donated to SEAFDEC by IDRC. The chorionic gonadotropin, A.P.L. Control No. 1 WWO, was purchased from Ayerst Laboratories Inc., New York. The diluent was supplied with the gonadotropin (SEAFDEC 1977, Vanstone et al. 1977).

Fig. 37. Sex determination of a newly captured milkfish.

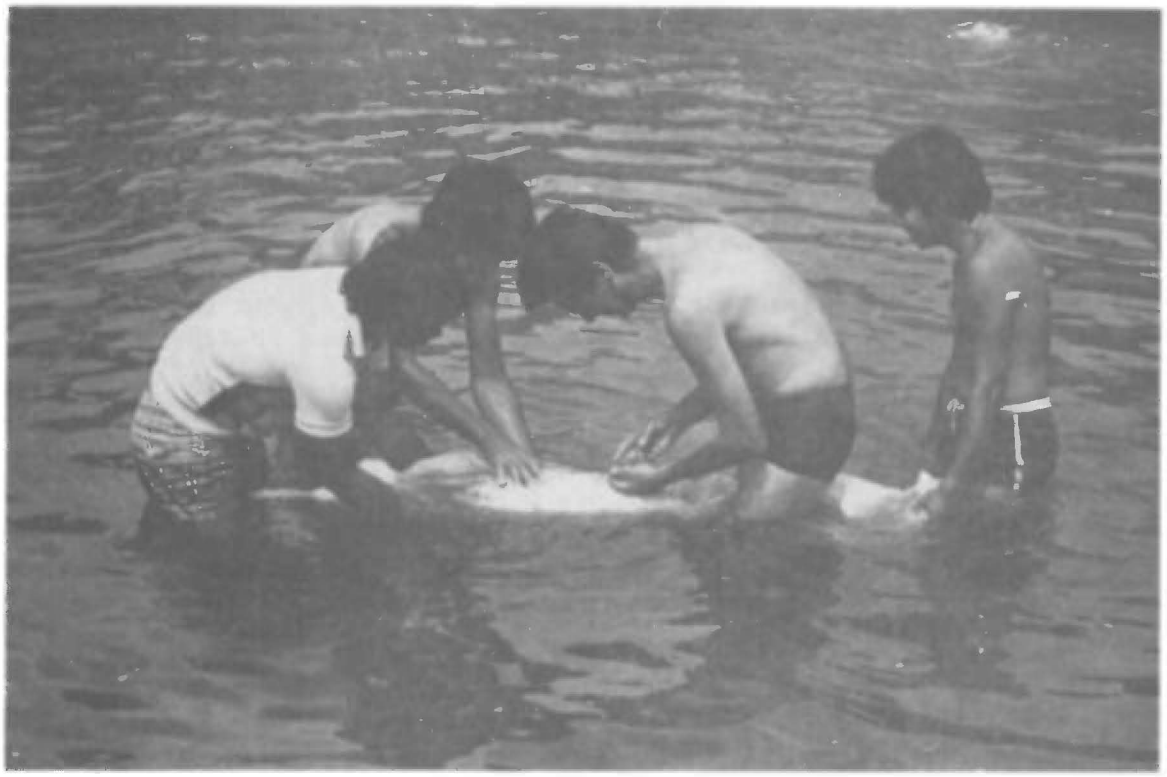

Fig. 38. Hormone injection into the dorsal musculature of a maturing female milkfish.

Fig. 39. Transfer of a maturing female milkfish from a 6-m diameter tank to a 2-m diameter tank suspended within it.

Early in the morning of 14 April 1977, several adult milkfish were captured in one of the two corrals at Hamtic. They were transported at three per load to the laboratory at Mag-aba, Pandan, 130 km north of Hamtic, where they were sexed, and placed in a 6-m diameter canvas holding tank containing seawater 1 m deep. The transport from Hamtic to Mag-aba took between 2½ to 3 hours.

Fourteen freshly spawned milkfish were captured in the 16 April noon catch in the otoshi-ami about 500 m from the shore at Mag-aba in Pandan Bay. These fish, 9 females and 5 males, were brought to the laboratory and released into a canvas holding tank 10 m in diameter containing seawater 1 m deep.

On the morning of 17 April, a gravid female was captured in a corral located in Libertad, 17 km west of Mag-aba, brought to the laboratory and released into a 6-m diameter canvas holding tank containing seawater 1 m deep.

Among the adult milkfish captured on 14 April were a sexually mature male and a gravid female whose firm abdomen was distended as far back as a point midway between the pelvic fins and the cloaca. On arrival at Mag-aba at 2040 hours, these were placed in a 6-m canvas holding tank. At 2100 hours, 4 ml of hormone solution was injected into the dorsal musculature 2-3 cm below the dorsal fin of each fish. A second sexually mature male, which arrived at 2135 hours, was placed in the same holding tank and similarly injected at 2150 hours. The female began to imbibe water about 1 hour after the injection.

At 0530 hours on 15 April, the fish were captured in a plastic bag, gently placed in a 2-m diameter canvas tank suspended within the 6-m tank, and anaesthetized with quinaldine sulphate (6 ppm) (Fig. 39). At this time the abdomen of the female was further distended and softer, and the cloacal region was slightly enlarged and protruding. Each fish was injected with 6 ml of hormone solution and released into the 6-m tank. The 2-m tank and its contents were then removed.

At 1620 hours on 15 April, a number of nonhydrated eggs were observed floating in the holding tank. The female was still imbibing water. Her belly was softer to the touch, and further belly distension and protrusion was observed.

At 2100 hours, the female stopped imbibing water. When examined, its cloacal region was larger than it was earlier and, when gentle pressure was applied on it, hydrated eggs were released. The female and the two males were killed by a blow to the head; their gill arches were cut and they were left to bleed freely.

The body of the female was opened and all loose eggs within her abdominal cavity were removed. About the same quantities were placed in each of two basins, for fertilization by both dry and wet methods with mixed sperm from the two males. The salinity of the water in the holding tank was 31 ppt and the temperature range 28.3-29.0°C.

The gravid female captured in Libertad on 17 April arrived in Mag-aba at 1300 hours the same day. Her abdomen was distended and firm with little enlargement in the cloacal region. She was placed in a 6-m holding tank and immediately injected with 4 ml of the hormone solution. She began to imbibe water at 1500 hours. At 2215 hours on the same day, and again at 0630 hours on 18 April, she was recaptured and placed gently in a 2-m canvas tank suspended in the holding tank where she was anaesthetized with 2- phenoxyethanol at 50 ppm and injected with 6-ml of the hormone solution. In order to minimize stress on the fish, the salinity of the water was decreased from 31 to 27.6 ppt between 0630 and 0800 hours.

By 1300 hours the fish had stopped imbibing water and at 1430 hours, while being transferred to the 2-m tank for closer examination under anaesthetic, she ejected her calcium plug and released a few hydrated eggs. She was immediately set free in the larger tank and continuous underwater observations of her behaviour were made.

At 1500 hours, the fish was releasing a large number of eggs. At this stage she was recaptured, killed, and bled, and the loose eggs were removed. Three of the spawned males captured at Mag-aba on 16 April were killed. The small amount of motile sperm remaining in the spermatic ducts of each male was mixed and used to fertilize by the dry method.

Approximately 5 minutes after the first hormone injection in both 1977 experiments, the bodies of both male and female changed colour from their natural dark bluish green backs and silver sides to pale green. The edges of all fins darkened, and the tips of all fins, the edge of the snout, and crown of the head became jet black. Body colours returned to normal as soon as the gill arches were cut and the fish bled.

1978 experiments

A sexually mature male and a maturing female were captured at Hamtik during the morning of 13 March 1978 and were transported to Mag-aba. Although the developing ova had a mean diameter of only 0.35 mm (standard deviation 0.03 mm), an unsuccessful attemptwas made to mature the eggs and spawn the fish (Table 4). Kuo et al. (1979) have stated that for milkfish an ovum diameter of at least 0.7 mm is necessary for induced ovulation to be successful.

Table 4. Summary of milkfish used in spawning experiments, and procedures used.

	Place of Capture										
	HAMTIK			MAG-ABA			LIBERTAD	HAMTIK		PATRIA	
Fish number	77-18	77-20	77-22	77-49	77-50	77-51	77-54	78-2	78-11	78-12	78-13
Date captured	14/4/77	14/4/77	14/4/77	16/4/77	16/4/77	16/4/77	17/4/77	13/3/78	24/3/78	24/3/78	24/3/78
Sex	F	M	M	M	M	M	F	F	F	M	M
Standard length, cm	-	-	-	72.0	70.0	75.6	83.0	73.0	71.9	-	-
Fork length, cm	-	-	-	74.5	72.0	78.7	85.0		75.6	-	-
Body weight, kg	9.4	-	-	5.9	5.8	6.1	9.0	5.1	6.9	-	-
Gonad weight, g	-	-	-	-	-	86	420	100	145	-	-
1st hormone injection											
Time	2100	2100	2150				1300	1130	1145		
Date	14/4	14/4	14/4				17/4	13/3	24/3		
Egg diameter								0.35(.03)	0.82(.06)		
Dosage, ml	4	4	4				4	4	4		
2nd hormone injection											
Time	0530	0530	0530				2215	0300	2340		
Date	15/4	15/4	15/4				17/4	14/3	24/3		
Egg diameter, mm								0.38(.03)	-		
Dosage, ml	6	6	6				6	6	6		
3rd hormone injection											
Time							0630	0840	1500		
Date							18/4	15/3	25/3		
Egg diameter, mm								0.37(.03)	-		
Dosage, ml							6	6	6		
4th hormone injection											
Time								0800			
Date								16/3			
Egg diameter, mm								-			
Dosage, ml								6			
5th hormone injection											
Time								0645			
Date								17/3			
Egg diameter, mm								0.39(.04)			
Dosage, ml								0			
1st artificial spawning											
Time	2100	2100	2100	1500	1500	1500	1500		0915		0915
Date	15/4	15/4	15/4	18/4	18/4	18/4	18/4		25/3		25/3
"Natural" spawning											
Time									1030		
Date									25/3		
2nd artificial spawning											
Time									1510	1510	
Date									25/3	25/3	
Killed for gonads											
Time	2100	2100	2100	1500	1500	1500	1500				
Date	15/4	15/4	15/4	18/4	18/4	18/4	18/4				
Died											
Time								?	0345		
Date								28/3	1/4		

Three recently spawned milkfish males and a maturing female were captured in the otoshi-ami at Patria, Pandan, 6 km west of Mag-aba at 0530 hours on 24 March. Although the males had already spawned, they still contained small amounts of motile sperm. The female contained developing ova having a mean diameter of 0.82 mm (standard deviation 0.06 mm). She was placed in a 6-m canvas tank and injected with hormones at 1145 hours and again at 2340 hours on the day of capture. The males were placed in an adjacent 6-m tank.

At 0900 hours on 25 March, it was observed that the female had released fully developed eggs in the holding tank. The three males were immediately placed in the tank with her. The female was anaesthetized, lifted in the experimentors arms, and her loose eggs allowed to drain into a large basin. Two of the males were captured by hand, traces of their milt manually expressed and admixed with the eggs. The four fish were left in the holding tank. The fertilization of this batch of eggs is referred to as "artificial" fertilization No. 1.

An hour later it was observed that the female was releasing eggs and one of the males swam over her and released milt. A sample of these eggs was removed and found to be fertilized. This fertilization is referred to as "natural" fertilization.

Between 1500 and 1520 hours on the same day, one of the males was killed and the remaining two males transferred to a 4-m diameter holding tank. The female was transferred to the tank with the males, but before her release, her loose eggs were collected as before. One half of these eggs were fertilized with sperm obtained from the excised testes from the killed male. The remaining eggs were fertilized with sperm expressed from one of the living males. This fertilization is referred to as "artificial" fertilization No. 2.

3.4 Egg incubation, embryology, and hatching in 1977 and 1978

Eggs obtained from the spawning on 15 April 1977 were incubated in a tank 4 m in diameter. It contained seawater 1 m deep, which had been filtered through a 60 µm mesh screen 4 to 5 days earlier. Moderate aeration was supplied through a ring 4 m in diameter, made of 2.5-cm PVC pipe with 1.5-mm holes spaced at 7.5-cm intervals. Samples of developing eggs were removed periodically for observation. Hatching occurred between 0800 and 0900 hours on 17 April (Table 5).

Eggs from the spawning on 18 April 1977 were placed in carp egg incubators (Yu et al. 1973) suspended in a tank 4 m in diameter and supplied with recirculated water from the same tank. Filtered seawater had been aged in this tank for 8 days prior to the beginning of incubation. Hatching occurred between 0300 and 0400 hours on 20 April.

Table 5. Embryonic development of milkfish at a temperature range of 28.4-29.5°C and salinity of 33-34 ppt. Fertilized eggs were obtained from the spawnings on April 15 (A) and April 18 (B), 1977.

Stage	Time from fertilization (hr. min) A	B	Remarks
2-cell	01.10		
4-cell	01.15-01.20		
8-cell	01.30-01.35		
16-cell	01.40-01.50	01.50	
32-cell	02.10-02.15	02.00	
64-cell	02.30		
Many-cell	03.30		
Blastula	05.10-09.25	05.30	Blastulation in progress
Gastrula	09.30-12.10	10.50	Gastrulation in progress
Neurula	12.50		Appearance of neural groove
	13.50		Beginning of optic vesticle differentiation
	14.27		Start of notochord formation
	15.30	16.05	Somite segmentation begins
	18.30	18.42	Embryo ½ of egg circumference
	22.50	23.50	Embryo 3/4 of egg circumference, heart beating, tail free from yolk and occasional body movement
	24.10		Frequent body movements
	30.00		Tip of tail reaches the head
	34.00		Tip of tail past the head
Hatching	35.00-36.00	35.50-36.50	Hatching in progress

In 1978, eggs from the first artificial spawning on 25 March were incubated in two 4-m tanks supplied with water and aerated similarly to the tank used in 1977. Hatching occurred between 1600 and 1830 hours on 26 March. Eggs from the second artifical spawning on 25 March were incubated in two fibreglass tanks 1 m in diameter and 1 m high, containing 80 cm of seawater which had been aged for 3 days and PVC aeration rings. Hatching occurred between 0015 and 0300 hours on 27 March.

Eggs from the "natural" spawning on 25 March 1978 were left in the tank, 6 m in diameter with a 6-m PVC aeration ring. Hatching occurred between 1600 and 1830 hours on 26 March.

During the above incubations the salinity of the water was 32 ppt in 1977 and 34 ppt in 1978. Temperature ranged from 28.4 to 29.5°C. There were no apparent differences between the various methods of fertilization and incubation of the eggs.

The newly fertilized milkfish egg is spherical. Diameters ranged from 1.10 to 1.23 mm on 15 April 1977, and from 1.14 to 1.20 mm on 18 April 1977, the mean being 1.16 mm on both occasions. The egg is non-adhesive and lacks any special structures on its outer surface. The perivitelline space is about 20 μm wide and contains scattered cortical granules which disappear between 20 and 45 minutes after fertilization. The yolk is slightly yellowish, finely granulated, and devoid of oil globules. The granules range in size from 12 to 20 μm. Newly fertilized eggs in water of 32 or 34 ppt salinity form a layer above unfertilized eggs, and float off the bottom whenever the water is slightly disturbed.

Embryonic development in eggs obtained from the spawning on 15 April 1977 is portrayed in Figures 40 to 56. It is very similar to that of other pelagic fish eggs. Table 4 shows the sequence of events for the spawning on 15 and 18 April 1977. First cleavage occurs 70 minutes after fertilization, with subsequent major events occurring at intervals of 5 to 26 minutes. In addition to the hatching times shown in Table 5, eggs from the three spawnings on 25 March 1978 hatched after the intervals indicated below:

First artificial spawning	31.00-33.30 hours
Natural spawning	30.00-32.30 hours
Second artificial spawning	33.05-35.50 hours

Immediately before hatching, the tail of the embryo extends forward of the head. The embryo then contains 34 well-defined myotomes in front of the posterior end of the anus. Small pigmented melanophores are distributed along the median dorsal line. Total incubation time varied from 30 to 37 hours. During this time the eggs gradually became a little more buoyant, and in the later stages they floated at or near the under surface of the 32 ppt or 34 ppt seawater.

3.5 Rearing milkfish larvae in 1977 and 1978

Six larvae obtained from the spawning on 15 April 1977 and the 7 surviving larvae obtained from the spawning on 18 April 1977 were reared in glass aquaria (30.8 x 15.7 x 20.5 cm) containing filtered seawater

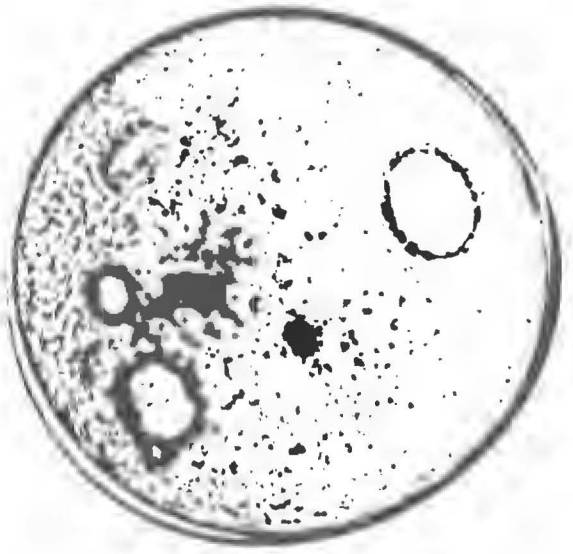

Fig. 40. Newly fertilized milkfish egg, with three cortical granules present. The granules disappeared 25-45 minutes after fertilization.

Fig. 41. Two-cell stage 70 minutes after fertilization.

Fig. 42. Four-cell stage, 75-80 minutes after fertilization.

Fig. 43. Eight-cell stage, 90-95 minutes after fertilization.

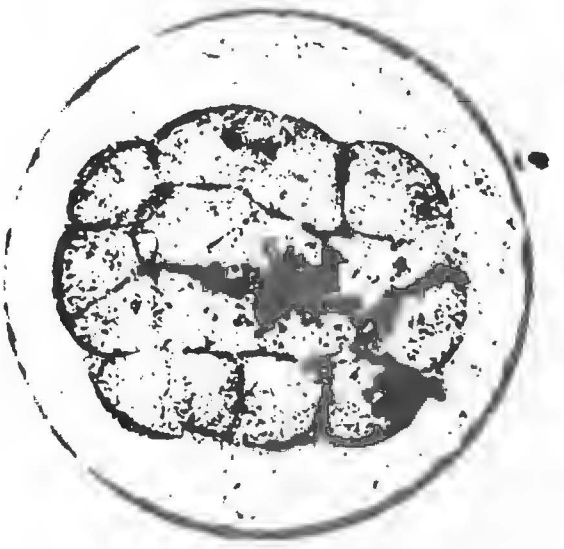

Fig. 44. Sixteen-cell stage, 100-110 minutes after fertilization.

Fig. 45. Thirty-two-cell stage, 130-135 minutes after fertilization.

Fig. 46. Sixty-four-cell stage, 150 minutes after fertilization.

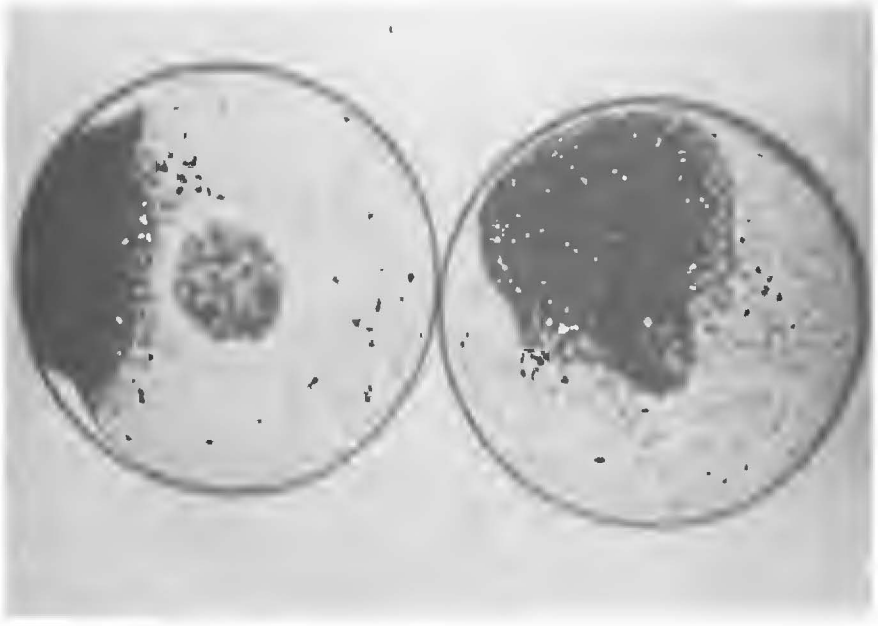

Fig. 47. Many-cell stage, 4 hours 15 minutes after fertilization.

Fig. 48. Blastula stage, 7 hours 25 minutes after fertilization.

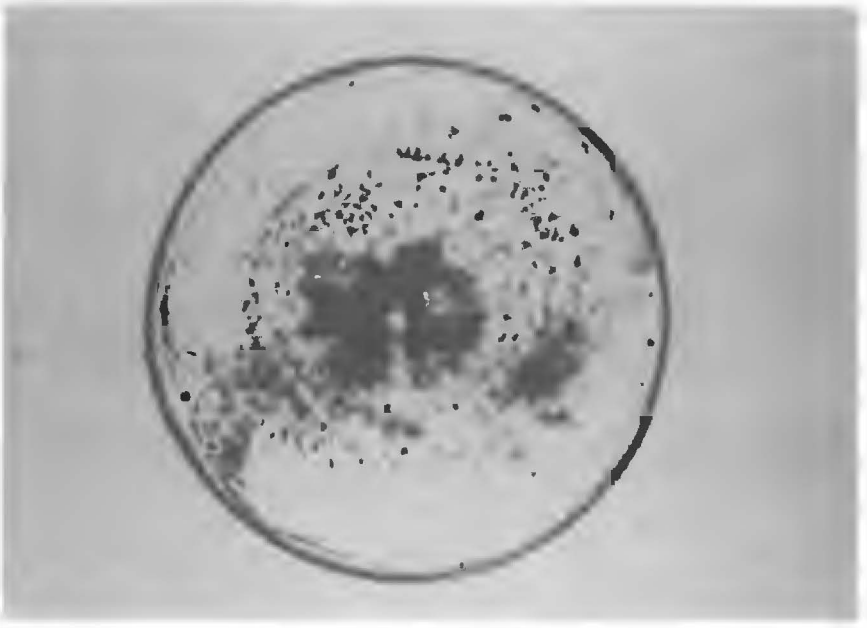

Fig. 49. Gastrula stage, 10 hours after fertilization.

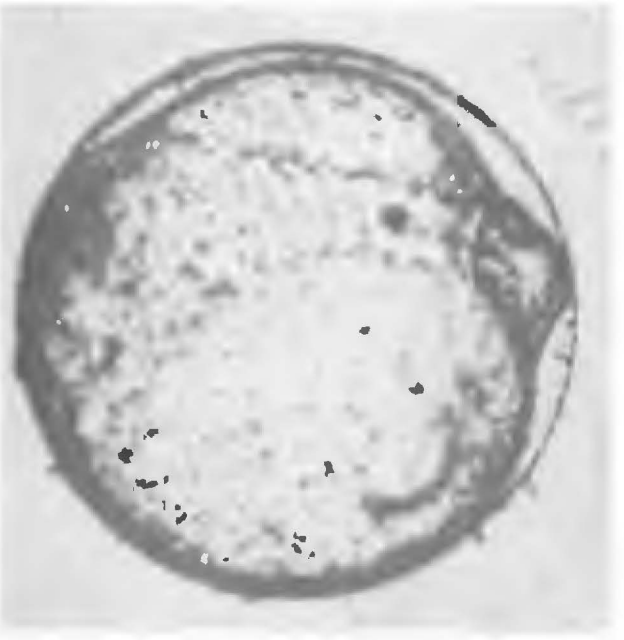

Fig. 50. Neurula stage, 16 hours after fertilization.

Fig. 51. Neurula stage, 19 hours after fertilization. Embryo more than one-half the egg circumference.

Fig. 52. Neurula stage, 22 hours after fertilization. Embryo two-thirds of the egg circumference. Heart beating. Tail not free from yolk.

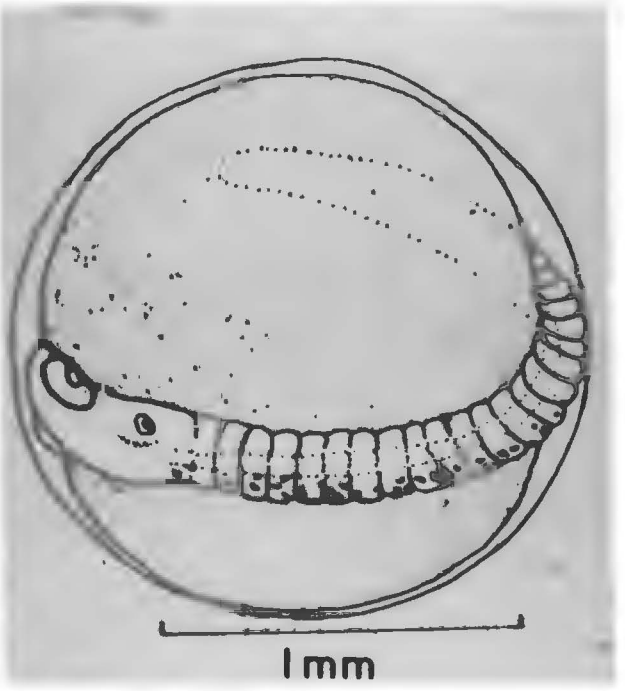

Fig. 53. Diagram of neurula stage, 22 hours after fertilization.

Fig. 54. Neurula stage, 25 hours after fertilization.

Fig. 55. Neurula stage, 35 hours after fertilization. Immediately prior to hatching.

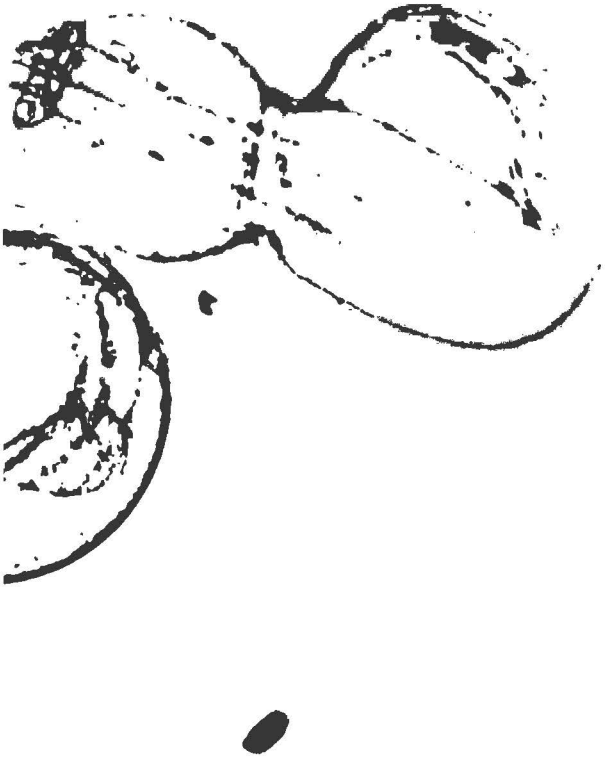

Fig. 56. Hatching, 35 to 36 hours after fertilization.

which was gently aerated with a stream of fine bubbles. The larvae were fed various mixtures: (1) Chlorella with contaminating diatoms and protozoa, (2) immature Brachionus plicatilis (40-60 μm), and (3) mixed zooplankton between 40 to 60 μm in size which were collected by means of an airlift pump (Novotny, 1971) from the lagoon adjacent to the laboratory. During larval rearing in the aquaria, the salinity ranged from 32 to 34 ppt and the temperature from 27.5 to 29.7°C. All attempts to rear larvae in glass aquaria were unsuccessful; the larvae began to die 24 hours after hatching, and the last died on its 7th day.

An unknown number of almost invisible larvae and dead eggs were left in the 4-m diameter tank used for incubating the eggs obtained from the spawning on 15 April 1977. Chlorella, at a final density of 150,000 cells/ml, was added at 1600 hours on 17 April. Immature Brachionus (40-60 μm) and mixed zooplankton (40-60 μm) were added the following day. A bloom of Chlorella, diatoms, and protozoa occurred. On 13 May the bloom had declined to a level where it was possible to observe between 40 and 50 26-day-old milkfish larvae, together with Enteromorpha and mixed copepods.

Because of evaporation between 17 April and 13 May, salinity in the incubation tank increased to 36 ppt. Half of the water volume was siphoned off on 14 May and a mixture of freshwater and filtered seawater was added over the next 24 hours to decrease the salinity to 31 ppt. Mixtures of Chlorella, Brachionus, and cultured mixed diatoms were added daily from 14 May. Starting 23 May a supplement of mixed wild zooplankton (40-191 μm) was added daily.

Thirty-two 74-day-old fingerlings were alive on 30 June 1977, when they were transferred from the canvas incubator to a canvas rearing tank, 12 m in diameter, containing flowing seawater of 31-32 ppt salinity. Nine of these fingerlings, anaesthetized with 2-phenoxyethanol and measured prior to being transferred, had an average fork length of 108 mm (standard deviation 5 mm) and an average total length of 121 mm (s.d. 7 mm).

Larvae from the first artificial fertilization and the natural fertilization from the spawning on 25 March 1978 were left in the 4-m and 6-m tanks in which they had hatched, to which were added daily Brachionus, Chlorella, and oyster eggs and larvae. None of these milkfish larvae survived more than a few days.

Ten hours after hatching in the 1-m incubators the larvae from the second artificial fertilization of 25 March 1978 were pooled and placed in two canvas tanks 2 m in diameter. These contained filtered seawater to a depth of 80 cm, which had been aged in the tanks for 4 days. In one tank the seawater was of 27 ppt salinity; in the other it was 32 ppt.

Chlorella and immature Brachionus had been added to each tank on 26 March (day 0-1). Between 0800 and 1100 hours on day 2 and each day thereafter the inside walls of each rearing tank were brushed down and two-thirds of the water was drained out. The tanks were then refilled with new seawater that had been aged for 3 days, and Chlorella, Brachionus, and oyster eggs and larvae were added. The final concentration of each of these food organisms at 1100 hours in the tank containing seawater of 32 ppt salinity is shown in Fig. 57. Starting on day 24, small amounts of minced fish were added daily to the tank.

There were 11 surviving 14-day-old larvae on 10 April 1978 from the original 224 larvae reared at 27 ppt - a survival rate of 5%. The last of the larvae died on 17 April (day 21).

In the tank having a salinity of 32-34 ppt larvae were reared successfully to the fry stage. Of the 222 larvae stocked on day 0, 36 were sampled at intervals and preserved in 5% seawater formalin, and 7 survived to day 35 (Table 6, Fig. 57). Because of the samples removed, whose fate, had they remained in the tank, is unknown, no accurate survival rate can be computed for this experiment, but it must lie between 4 and 19%, probably closer to the former.

Table 6. Length range and mean length in millimetres of milkfish larvae and fry obtained from the second artificial spawning on 25 March 1978, hatched 27 March, and reared at 32-34 ppt salinity.

Date	Age (days)	Standard length (live) Mean	Standard length (live) Range	Total length (preserved) Range	No. of larvae Present	No. of larvae Sampled
March 27	0	-	-	3.7--4.0	222	4
28	1	5.47	5.41- 5.51	4.8- 5.1	-	4
29	2	5.17	4.45- 5.96	4.9- 5.1	-	4
31	4	4.91	4.82- 4.98	5.3- 5.7	-	4
April 2	6	5.48	4.82- 5.86	5.7- 6.0	-	4
5	9	6.66	6.28- 7.19	6.4- 7.1	-	4
10	14	8.53	7.59- 9.61	8.1- 8.5	27	4
17	21	12.50	11.32-13.9	13.3-14.8	-	4
24	28	14.89	14.55-15.7	15.0-16.6	15	4
May 1	35	20.60	-	21.7-22.4	7	4

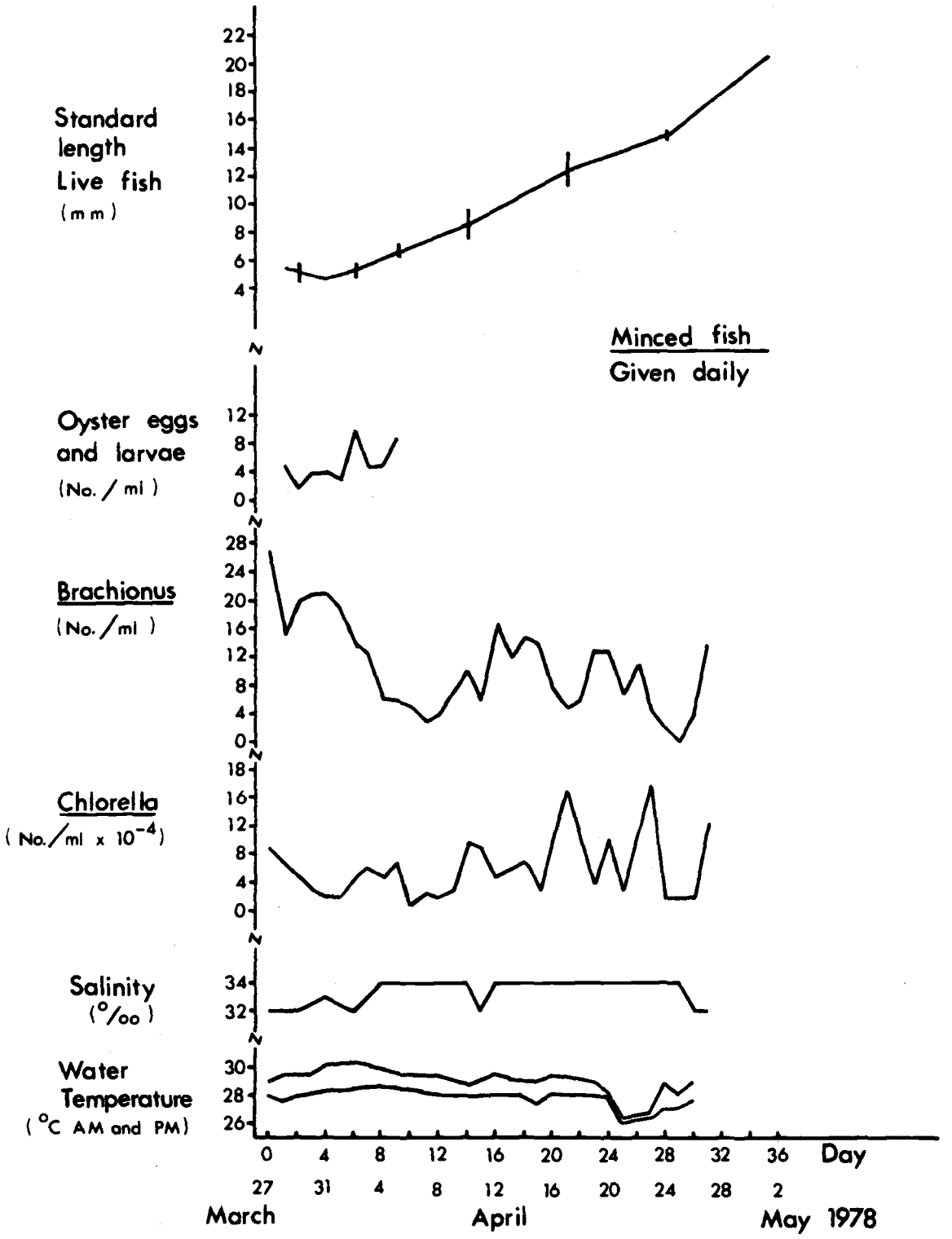

Fig. 57. Standard lengths, feeding regime and water salinity and temperature of milkfish larvae from the second artificial spawning of 25 March 1978.

3.6 Description of milkfish larvae in 1977 and 1978

Delsman (1926, 1929) collected and described embryonic milkfish eggs from the Java Sea. The eggs hatched within 12 hours of collection, but the longest living larvae died on the 4th day upon reaching a length of about 5 mm. Vanstone et al. (1977) also prepared descriptions of dead or dying larvae 2, 3 and 4 days old that had been reared in glass aquaria, but they expressed doubts about the adequacy of their account because of the poor quality of the material.

In 1978 active young larvae were sampled, as were older larvae and fry in both 1977 and 1978. These healthy specimens, with diagrams prepared by R.E. Bombeo, form the basis of the following descriptions (slightly modified from Villaluz, 1979) of larval morphology, bone ossification, and changes in the position of the anus and dorsal fin.

The larvae sampled were first anaesthetized with 2-phenoxyethanol, then photographed, examined, and measured in standard or total length (see below). Illustrations were drawn using a stereoscopic microscope. The larvae were then preserved in 5% seawater formalin. After 7 or more days they were cleared and stained with alizarin (Hollister 1934), in order to determine the sequence of ossification of the bones. At this stage they were measured in modified total length, but because of shrinkage in the preservative these lengths tend to be less than standard lengths from the anaesthetized specimens of the same age (Table 6).

The lengths used are defined as follows. Standard length (SL) was the distance from the tip of the snout to the tip of the notochord in the early larval period, and later to the posterior edges of the hypural plates. The total length (TL) used was from the tip of the snout to the end of the rounded caudal fold in young larvae, and after the terminal fork of the tail appeared it was to the tip of the longer lobe when the fin was in the position it assumed in the anaesthetized or preserved specimens.

3.6.1 Morphology

Newly hatched larvae (Figs. 58-59)

The mouth parts are not yet formed, eyes are small and unpigmented, and the anlagen of the pectoral fins are not yet visible. The body is transparent, elongated, and flattened. The yolk is elongated, with a yellowish tinge, and tapers to a point posteriorly. The head projects in front of the yolk and the statocysts are a short distance behind the eye. There are 34 preanal and 8 to 10 postanal myomeres. The notochord is

Fig. 58. Anaesthetized newly hatched larva, 0845 hours, 17 April 1977, total length 3.5 mm.

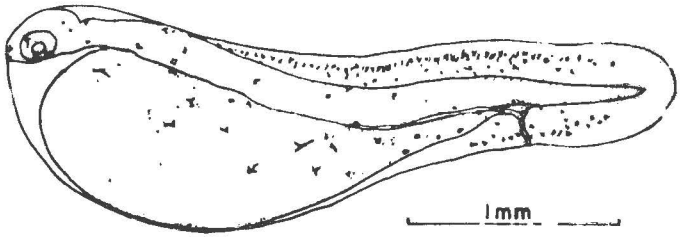

Fig. 59. Diagram of same larva as Fig. 55 after preservation in 5% seawater formalin, total length 3.1 mm.

straight. Muscle fibres are parallel to the longitudinal axis of the body, diverging slightly in the dorsal half of the myotome to the dorsal side, and in the ventral half to the ventral side.

Both fin folds are narrow and are still developing. The dorsal fold is continuous from the 4th somite backward around the caudal region to the anus, and the preanal fold extends from the anus forward for about a quarter of the length of the yolk.

Pigmentation consists of stellate melanophores scattered in the dorsal and ventral fin folds, with the exception of the hindmost part of the tail. The yolk is sparsely pigmented.

Newly hatched larvae float ventral side up except during brief convulsive episodes of swimming. At such times the larva turns dorsal side up and moves toward the bottom in a head-down position. When body movement stops, the larva passively turns ventral side up and floats toward the surface. This swimming behaviour lasts for about 24 hours. At this stage the larvae also exhibit an avoidance reaction to objects placed near them.

One-day-old larvae (Fig. 60)

The larvae have become more elongated, with markedly reduced yolk and eyes faintly pigmented. Anlagen of the pectoral fins and the first gill opening have appeared. There are 33 preanal and 11 postanal myomeres. The hindgut is straight, outside of the body wall proper, and it extends backward to the 33rd myomere. It turns downward and ends in the vent located behind the ventral section of the fin fold.

The fin folds have become wider and well developed. The dorsal fold is continuous from the occiput to the anus, while the preanal fin fold extends from the anus to the jugular region. Actinotrichia appear in the caudal fin fold, originating at the tip of the notochord and extending to the edges of the fold. Pigmentation is confined to the fin folds, but without obvious melanophores in the caudal region. The larvae have begun to swim in the normal position, dorsal side up. Swimming movement is a sidewise undulation of the body musculature and fin folds.

Two-day-old larvae (Fig. 61)

The mouth is fully formed and the eyes are heavily pigmented. A remnant of the yolk is still present. The fin fold is constricted in the region of the future caudal peduncle, and is scalloped behind the future dorsal and anal fins. Pigmentation in the fin fold has disappeared because the melanophores have shifted and have become concentrated along the dorsal and ventral edges of the myomeres. Pectoral fins have become functional but the eel-like mode of locomotion is retained.

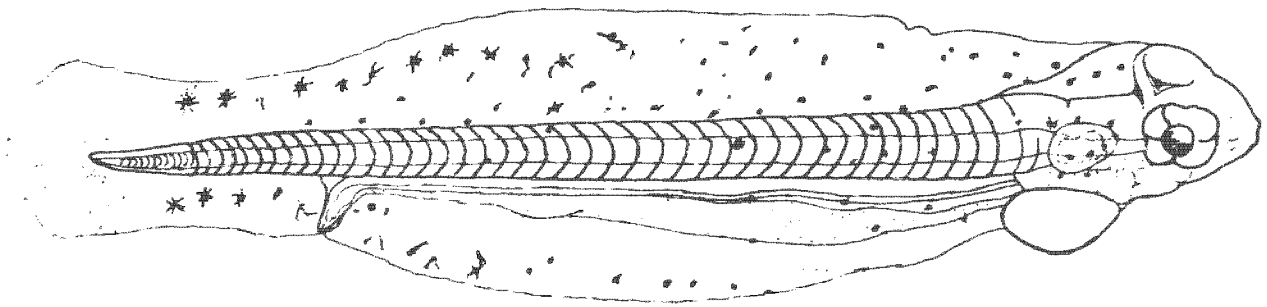

Fig. 60. Diagram of anaesthetized 1-day-old larva, 1000 hours, 28 March 1978, standard length 5.46 mm.

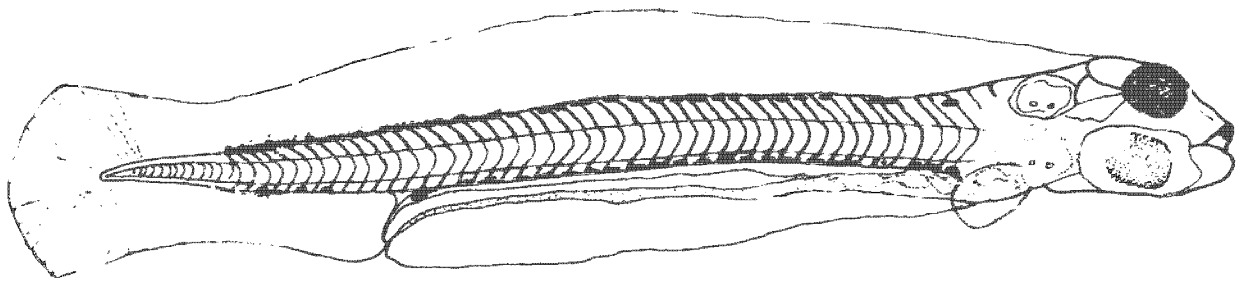

Fig. 61. Diagram of anaesthetized 2-day-old larva, 1025 hours, 29 March 1978, standard length 5.96 mm.

Four-day-old larvae (Fig. 62)

The mouth is functional, and oyster eggs and larvae, juvenile Brachionus plicatilis, and Chlorella sp. appear in the gut for the first time, with evidence of digestion at the posterior end near the anus. The fin fold is still wide and complete. Mesenchyme appears on the fin fold ventral to the notochord where caudal rays will later develop. The pigmentation pattern is similar to that of 2-day-old specimens except that the melanophores have become denser on the ventral part of the body. The larvae now perform darting movements in catching their prey. Heavy mortality, which began on the 3rd day after hatching at the time of yolk resorption, continued through the 4th day among the specimens under study.

Six-day-old larvae (Fig. 63)

The only visible difference from 4-day-old specimens is that the melanophores, scattered along the myomeres, have become denser along the ventral and dorsal edges of the myomeres near the tail.

Nine-day-old larvae (Fig. 64)

The rays of the caudal fin are outlined within the greatly reduced fin fold. The anlage of the dorsal fin has appeared. Melanophores now form a line along the ventral edges of the myomeres and along their dorsal edges immediately behind the anlage of the dorsal fin. At this stage the fish have formed a school with a positive rheotropic response to the current produced by the aerator. Phototaxis was positive at low light intensity, but became negative above a certain threshold.

Fourteen-day-old larvae (Fig. 65)

The depth of the body has increased, and a remnant of the preanal fin fold can still be observed. The rays of the caudal, dorsal, and anal fins are differentiating, and the hind margin of the caudal fin has begun to fork. The melanophores are now situated along the dorsal and ventral surfaces of the body, and pigmentation at the ventral side of the caudal peduncle is becoming denser.

Twenty-one-day-old larvae (Fig. 66)

The myomeres in front of the anus have been reduced from 33 to 32. The heart and liver are prominent. The preanal fin fold is partially retained. The melanophores form a row along the dorsal side of the body from the 5th myomere to the anterior base of the dorsal fin.

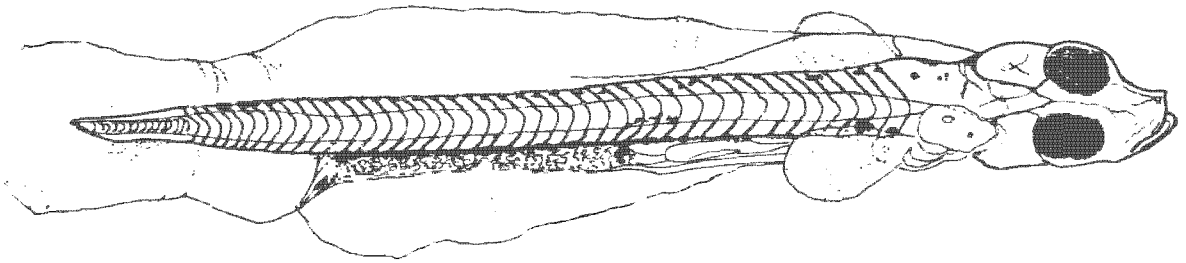

Fig. 62. Diagram of anaesthetized 4-day-old larva, 1036 hours, 31 March 1978, standard length 4.92 mm.

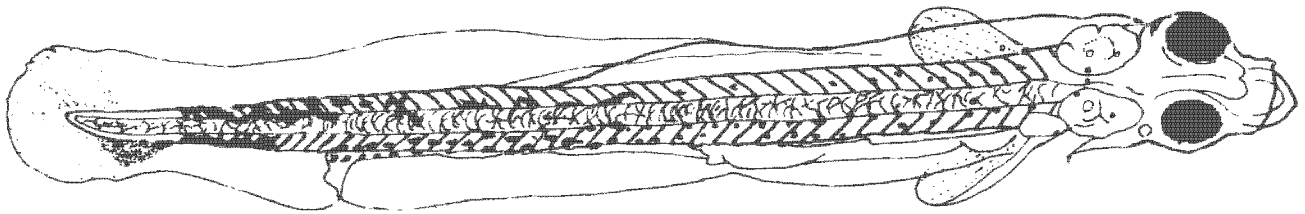

Fig. 63. Diagram of anaesthetized 6-day-old larva, 1050 hours, 2 April 1978, standard length 5.86 mm.

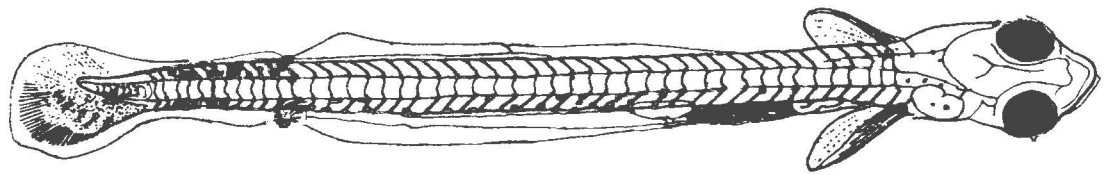

Fig. 64. Diagram of anaesthetized 9-day-old larva, 1015 hours, 5 April 1978, standard length 6.85 mm.

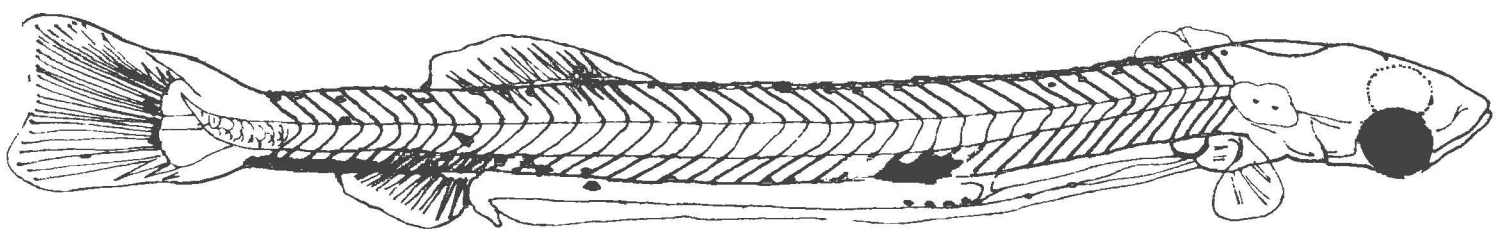

Fig. 65. Diagram of anaesthetized 14-day-old larva, 1045 hours, 10 April 1978, standard length 8.61 mm.

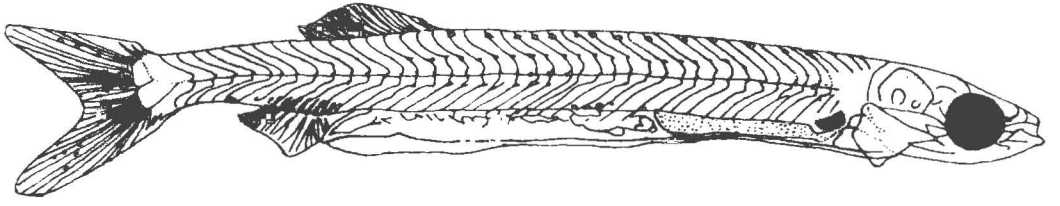

Fig. 66. Diagram of anaesthetized 21-day-old larva, 1100 hours, 17 April 1978.

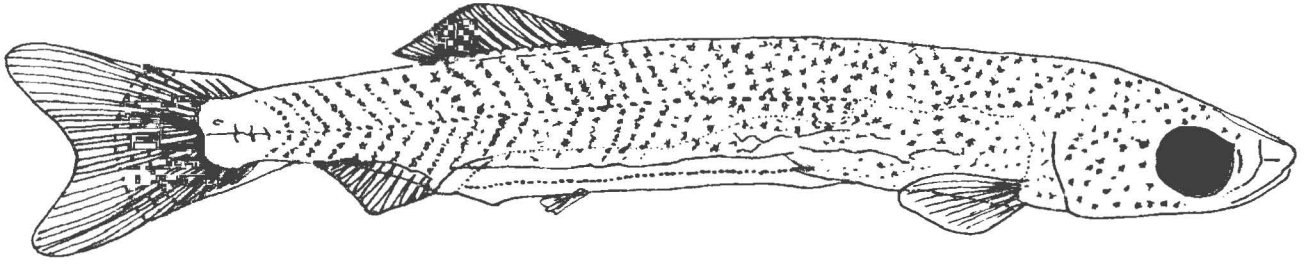

Fig. 67. Diagram of anaesthetized 28-day-old larva, 1400 hours, 24 April 1978.

Twenty-eight and thirty-one day-old larvae (Figs. 67-68)

At this age the young fish are already in their juvenile period of development. The body has become thicker. With the replacement of the anal fin fold by developing ventral fins, all the fins have differentiated. The anterior half of the body is dotted with stellate chromatophores, while melanophores are developed on the myosepta outlining the myomeres on the posterior half of the body. The body is opaque and of a silvery colour on the ventral side.

The young fish are now very swift swimmers and are extremely difficult to catch by scoop net. Particles of bottom debris from the tank were found in the intestines, although the fish were amply provided with minced fish as food.

Thirty-five-day-old juvenile milkfish (Figs. 69-70)

The body is fusiform, much like the adult. Adipose eyelids are present at the anterior and posterior margin of the eyes. Pigmentation is more profuse. The body colour is silvery ventrally and greenish on the dorsal side. Except for a lack of scales all the external characteristics of the adult are present at this stage.

Wild larvae (Figs. 68,71) were collected from the seashore on 18 May 1977 and 18 April 1978. They had morphological features similar to the 21-day-old laboratory specimens. However, these wild fish were, with the exception of darkly pigmented eyes, almost devoid of pigmentation. Benthic and planktonic organisms were observed in the hindgut. Wild juveniles captured on 13 May 1977, and reared in captivity until 22 May were, except for their almost complete lack of body pigmentation, morphologically similar to 35-day-old juveniles (Fig. 69).

3.6.2 Bone ossification (from stained specimens)

The stages of ossification of bones in milkfish, as indicated by examination of specimens reared to 1, 2, 4, 6, 9, 14, 21, 28, and 35 days of age in 1978, are described below and summarized in Table 7. Wild larvae captured at the shore on 18 April 1978 were also examined. Their exact age was not known, but their preserved total lengths ranged from 12.7 to 14.9 mm. Milkfish embryos 2 days old showed no sign of ossification.

Pectoral fins and pectoral girdle

The first body structure to start ossifying was the cleithrum. It had begun ossification in the 4-day-old specimens, and had become fully ossified at 6 days. The postcleithrum was first observed at 21 days and had become prominent, together with the cleithrum, at 28 days. The

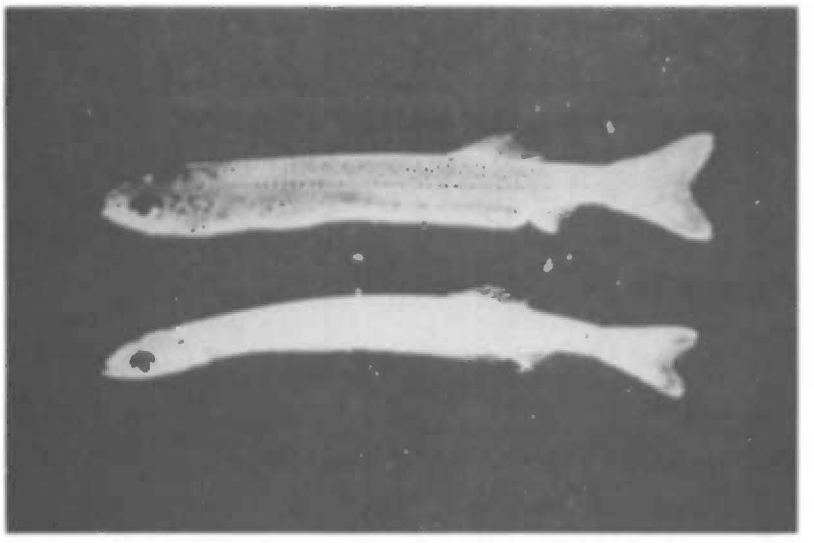

Fig. 68. Anaesthetized: 31-day-old juvenile, 18 May 1977, total length 14.13 mm (top); newly captured wild juvenile, 18 May 1977, of similar length (bottom).

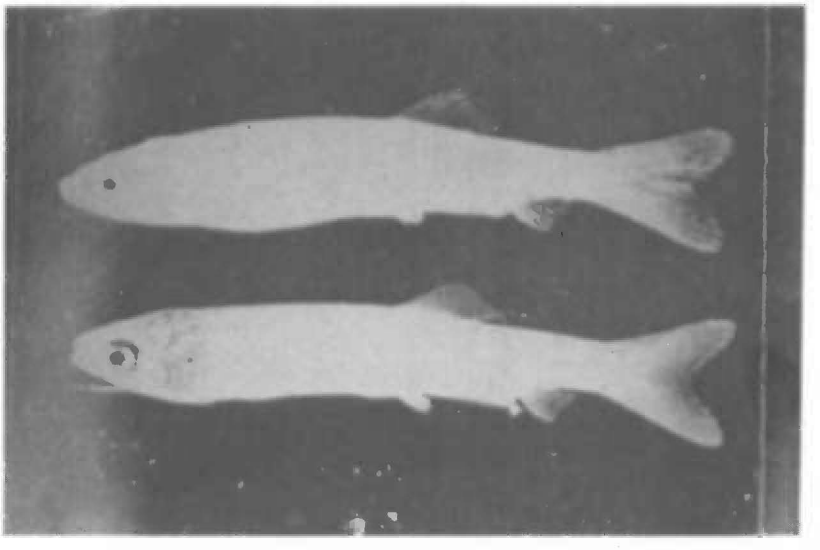

Fig. 69. Anaesthetized: 35-day-old juvenile, 22 May 1977, total length 22.6 mm (bottom); wild shore caught juvenile of similar length captured 9 days previously and reared in captivity (top).

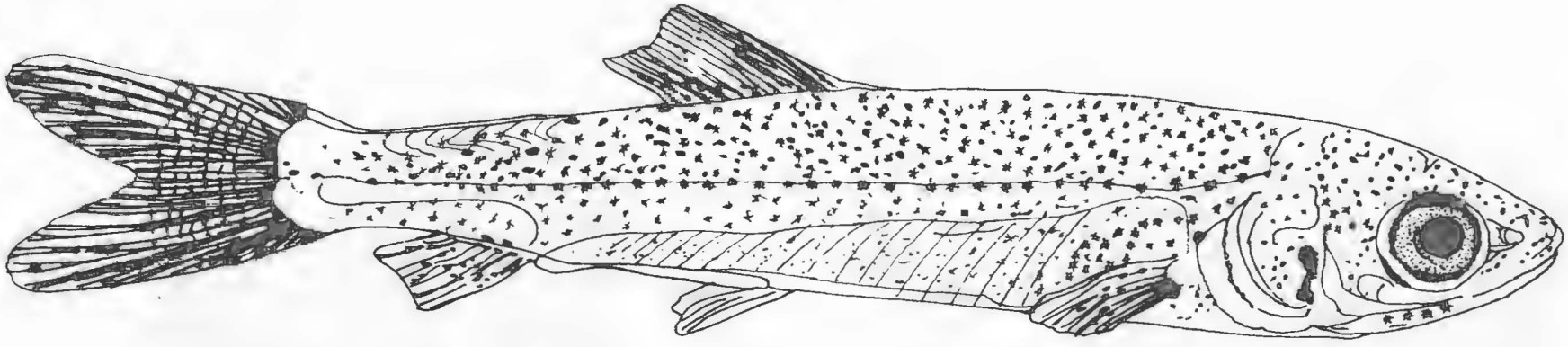

Fig. 70. Diagram of anaesthetized 35-day-old juvenile, 1330 hours, 1 May 1978, standard length 20.60 mm.

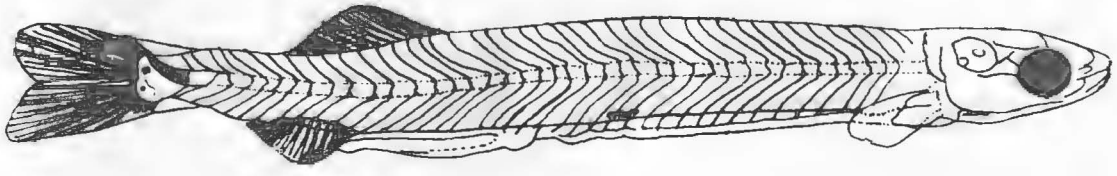

Fig. 71. Diagram of anaesthetized, newly captured wild larva, 18 April 1978.

Table 7. Sequence of ossification of the bones in milkfish. Age is in days after hatching.

U = unbranched rays; B = branched rays.

Age	Number of rays in fins					No. of hypural plates	Other bone structures
	Pectoral	Ventral	Dorsal	Anal	Caudal		
4							Cleithrum in process of ossification.
6							Cleithrum fully ossified.
9					10-12		
14	3-4		6-8	5-6	20-22	4	
21	4-5		11-13	7-8	20-26	6	Basioccipital appeared.
28	6-8	5-7	14-16	7-8	28-32	6	Parasphenoid, opercular, frontal and branchiostegals developed. Haemal and neural processes appeared. Pleural ribs developing.
35	1 U, 9-10 B	1 U, 8-10 B	4-6 U, 11-13 B*	2-4 U, 8 B*	9-12 U, 19 B 9-11 U*	6	Most of the cranial skeleton developed. Vertebral column fully formed.
Wild fry			11-15	7-8	19-25	6	Basioccipital and parasphenoid developed.

*Full complement

coracoid bone had appeared in juveniles of 35 days.

Ossification of pectoral fin rays was first observed in a group of 3 or 4 rays in the 14-day-old larvae. At 21 days 4 or 5 rays showed ossification, and at 28 days 6 to 8 rays did. The rays of 35-day-old juveniles were fully ossified and segmented, each fin having 9 or 10 branched rays and 1 unbranched ray.

Newly-caught larvae from the wild showed no sign of ossification of the pectoral fins (as distinct from the girdle).

Caudal or tail fin

The first fin rays to differentiate in milkfish larvae were those of the caudal fin. Ossification had started in 9-day-old larvae, which had 10 to 12 principal rays already formed, although still unbranched and unsegmented. Ossification began just below the tip of the notochord, which was beginning to turn up.

The 14-day-old larvae had a full complement of 19 principal rays and 1 to 3 procurrent or secondary rays, all rays being segmented but unbranched. During the process of ossification the tip of the notochord turned dorsad, pulling the rays up toward a horizontal position and aligning their midline with the body's midline, so that the homocercal shape of the fin had begun to form. There are initially 4 hypural plates, the upper two being associated with 11 principal rays of the dorsal lobe of the caudal fin, and the lower two with the 8 principal rays of the ventral lobe.

In 21-day-old larvae the caudal fin had an additional 2 or 3 ventral and 2 or 3 dorsal secondary rays, bringing the total number to between 20 and 26. The ventral secondary rays exhibited a growing association with the developing haemal process of the penultimate vertebra. The other two hypural plates had appeared, completing the series of 6 plates. In the dorsal half of the fin the 10 principal rays had become associated with the upper 3 hypurals, and the 9 principal rays in the lower half with the lower 3 hypurals.

In the 28-day-old juvenile milkfish the 19 principal rays of the caudal fin were branched. The neural and haemal processes of the penultimate vertebra were modified to support the 5-7 dorsal and 5-6 ventral secondary rays. At 35 days the full complement of 9-12 dorsal and 9-11 ventral secondary rays of the caudal fin was present.

Shore-caught wild larvae had an ossification pattern with the caudal fin and supporting skeleton similar to that of 21-day-old reared specimens.

Dorsal fin

In 14-day-old larvae 6 to 8 unsegmented rays of the dorsal fin had appeared in the region between the 27th and 33rd myomeres. At 21 days the number of rays had increased to between 11 and 13, all being segmented and the last ray divided.

Juvenile milkfish 28 days old had 14 to 16 dorsal rays. The 11 to 13 principal rays were still unbranched and could not be distinguished from the secondary rays. The dorsal fin had moved forward so that the first ray was aligned with the 24th or 25th vertebra. The 14 supporting pterygiophores had made their appearance under the rays. A one-to-one relationship between pterygiophores and fin rays was observed in specimens with 14 rays.

At 35 days the rays were completely differentiated, there being 11-13 principal rays and 4-6 secondary rays. The principal rays had become branched and the pterygiophores were better developed.

In shore-caught wild larvae the ossification pattern was similar to that of 21-day-old reared specimens, although in some of them 14 to 16 rays were counted.

Anal fin

The first rays of the anal fin to appear were a group of six, starting behind the anus and extending to the 38th myomere in the 14-day-old larvae. In 21-day-old specimens the full complement of 7 or 8 segmented principal rays was present, but they were still unbranched. The last ray was already divided. An additional 1 or 2 rays were formed anteriorly, so that the first group of rays was shifted back.

No additional anal rays appeared in the 28-day-old juveniles. However, the rays were in process of branching, and the 7 opposed pterygiophores were being formed. At 35 days the final number of rays was present, with the addition of 3 or 4 unbranched secondary rays. The principal rays were fully branched and the pterygiophores better developed.

Shore-caught wild larvae had an anal-fin ossification pattern similar to that of 21-day-old reared larvae.

Pelvic or ventral fins, and pelvic girdle

The last of the fins to develop were the pelvic or ventral fins. A group of 5 rays was first observed, together with the basipterygium, in

juveniles 28 days old. Ossification of the rays progressed rapidly, and the full complement was present at 35 days. The specimens examined had 8 to 10 branched principal rays and 1 spine-like soft ray.

Vertebral column

The vertebral column of the milkfish examined consisted of 43 or 44 vertebrae, except for one with 38 vertebrae.

All the centra of the vertebral column of 21-day-old specimens appeared to be fully ossified. However, the haemal and neural process of the penultimate and the preceding four vertebral centra were still in the process of ossification. Ossification of each centrum began along the dorsal and ventral margins, and progressed inward to meet at the midline.

In 28-day-old juveniles the neural and haemal spines of all vertebrae were fully formed and directed slightly backward. Several pleural ribs were evident, although not yet attached to their bases on the vertebrae. At 35 days the pleural ribs were fully formed, and the neural and haemal spines were better developed. In addition, the transverse processes, epipleurals, and the intermuscular bones had appeared.

Wild shore-caught larvae mostly had vertebral centra fully ossified, but the haemal and neural processes, and in some smaller specimens even the centra of the penultimate and preceding 4 vertebrae, were still undeveloped.

Cranial skeleton

The basioccipital is the only part of the head skeleton that was ossified in 21-day-old larvae. At 28 days the branciostegal rays, the parasphenoid, and the opercular bones were ossified, as well as an unidentified structure above the eye, presumably the frontal bone. The gill rakers were evident in specimens stained with alizarin. At 35 days the supraoccipital, frontal, nasal metapterygoid, premaxilla, dentary, alisphenoid, and suboperculum had appeared.

Cranial development in wild shore-caught larvae was similar to that of 21-day-old reared larvae, except that the parasphenoid bone was also present.

3.6.1 Position of the anus and dorsal fin

The position of both the anus and dorsal fin moves relatively nearer

the head during development. In newly-hatched larvae the anus is situated at the ventral side of the 34th myomere, but has shifted to the 33rd myomere in the one-day-old fish. It remains in that position until the 9th day after hatching, but has reached its final position below the 32nd myomere in 14-day-old larvae.

The first apparent dorsal fin ray is present above the 27th to 29th myomere in 14-day-old larvae. Although there is no change in position in 21-day-old specimens, it has shifted to the 24th or 25th vertebrae in the 28-day-old juveniles. The final position above the 20th vertebra occurs in the 35-day-old specimens.

4.0 Related Studies

4.1 Changes in length and weight of milkfish fry preserved in formalin

Kumagai and Castillo (1978) found differences in the shrinkage in length and in loss of wet weight of milkfish fry preserved in 5 or 10% seawater formalin and in 5 or 10% freshwater formalin. In all studies reported herein on preserved eggs, larvae, and fry, the materials were preserved in 5% seawater formalin for a minimum of one week prior to being measured or three weeks prior to being weighed.

4.2 Salinity preference of milkfish fry

Over 75% of the milkfish fry collected on Panay Island come from Antique Province on the west coast of the island (Villaluz, 1975). This province also contains the greatest number of streams and rivers per kilometer of coastline, and the best collecting grounds are adjacent to the mouths of these freshwater sources. Although there are a few locations on other islands where milkfish fry enter river-lake systems and spend their first year or two in the lake, this does not appear to occur on Panay. The fry that are not captured near shore soon go out to sea and are seldom seen again until they return as spawning adults.

Juario et al. (1976, 1977) performed experiments to determine the salinity preference of newly captured fry and possible changes in their preference from time of capture to 3 weeks postcapture. Results from these preliminary experiments were inconclusive, but indicate that all fry, regardless of whether or not they had been acclimatized to 3, 10, 20 or 32 ppt salinity following capture, showed a preference for 32 ppt and that this preference did not change with age.

4.3 Ecological studies of the Batbatan Island spawning ground

Having confirmed that the waters off the approximately 1.5-km long east coast of Batbatan Island (Fig. 5) contained a milkfish spawning ground, a program was initiated to document the hydroclimatic conditions and to attempt qualitative and quantitative plankton surveys of the area. Four sampling stations (stations 1, 2, 3 and 5 of Fig. 72) were located along the 25-m depth contour and one station (station 4) located in the prevailing current northeast of the island. Horizontal 10-minute surface plankton tows at a speed of 1.5 knots were made through each station. It was later learned that, because of high winds and heavy swells, it was difficult and often unsafe to sample station 5; this station was abandoned. For similar reasons station 4 could not be sampled on a regular basis.

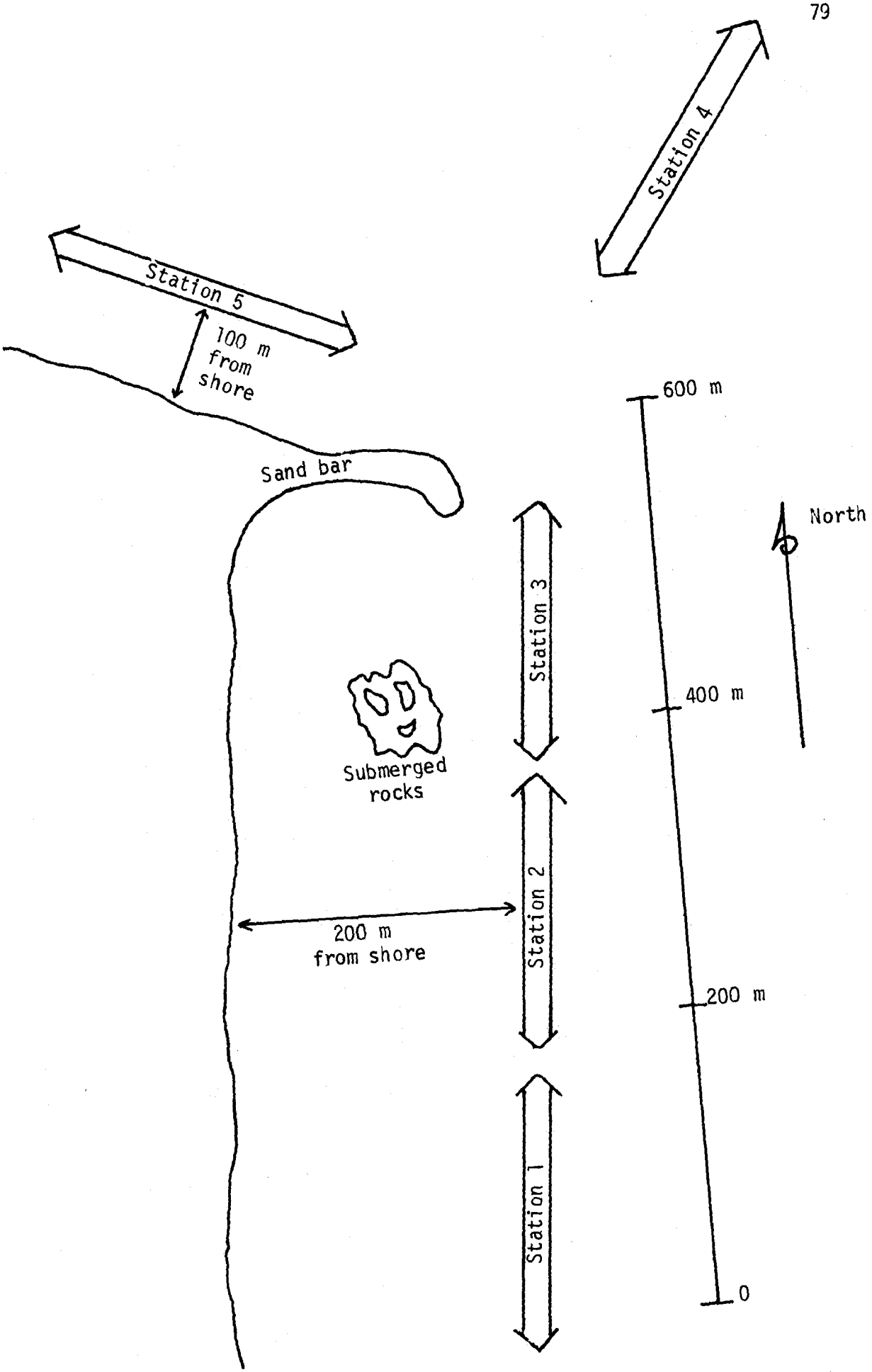

Fig. 72. Location of five sampling stations off the East coast of Batbatan Island.

To aid in identification, a provisional key to pelagic fish eggs was prepared by Kumagai (see Appendix A). From 2 July 1977 to 20 April 1978, stations 1 to 3 were sampled 64 times for phyto- and zooplankton by Silverio and Marfil (see Appendix C), and from 4 October 1977 to 20 April 1978, 45 times specifically for pelagic fish eggs by Bombeo, Castillo, and Unalayao (see Appendix B).

Thirty-four genera of phytoplankton and 42 genera of invertebrate zooplankton were recognized. The diatoms Chaetoceras and Rhizosolenia predominated in the phytoplankton taken by the nets, although with somewhat different seasonal abundance. Also common at one time or another were dinoflagellates of the genera Ceratium, Ceratocorys, Peridinium, and Ornithocercus. The dominant zooplankton genera were the copepods Calanus, Eucalanus, Rhincalanus, Copilla, Sapphirina, Centropages, Euchaeta, Corycaeus, and Oithona, the pelagic shrimp Lucifer, and the arrow-worm Sagitta. Whereas phytoplankton tended to be most abundant in morning samples, zooplankters were usually taken in largest numbers in afternoon and night samples.

The ichthyoplankton study yielded 24 spherical egg types and one spindle egg type. Three of the spherical egg types were identified as Oxyporamphus sp., Mugil sp., and Chanos chanos, while the spindle egg type and resulting larva were similar, but not identical, to those of Stolephorus sp. Two unidentified spherical type eggs were abundant throughout the period, while the spindle type was present in large numbers during October and early November, and from mid-February to mid-April. Milkfish eggs were present in small numbers during March and April.

4.4 Bibliographies

Three bibliographies were prepared: the milkfish by D.C. Ramsingh and W.E. Vanstone (1976, unpublished); the rabbit fishes, family Siganidae by W.E. Vanstone (1978, unpublished); and egg incubation and larval rearing of marine teleosts by C.G. Barlow (1978, unpublished). These will be published separately.

4.5 Spawning and larval rearing of fishes other than milkfish

All personnel assigned to the team had little, if any, experience in handling adult fin fish and none had experience in spawning, incubation, or larval rearing. Also, in view of the fact that the peak of the milkfish breeding season is of limited duration at Pandan (March to May), the Project was designed to train people during the off season. To this end rabbit fishes (Siganus canaliculatus, S. guttatus, S. lineatus, S. spinus, S. vermiculatus and S. virgatus) were captured, maintained as brood stock, routinely spawned, and the larvae reared to the fry stage. Silversides, Preneus pinquis, were captured along the shore throughout the year and would normally spawn naturally the same evening in spawning tanks, after which the larvae were reared. Sexually mature halfbeak, Hemeramphus far, were captured by fishermen during their spawning migration. Personnel from the Project stripped and fertilized this species on the beach and incubated the eggs at the laboratory. After one week's incubation, which is longer than normal for most tropical fishes, the larvae would hatch and were then reared to the fry stage.

Acknowledgements

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Appendix A

PROVISIONAL KEYS TO PELAGIC FISH EGGS PRESERVED IN FORMALIN

by S. Kumagai

A. Agglutinated pelagic eggs

a. Eggs in a gelantinous ribbon

1. The ribbon big, 30 cm wide and 500 cm long. Eggs 1.3-1.8 mm in diameter with a single OG (oil globule) . . . . . Lophius

2. The ribbon small, 6-10 cm wide and 38-76 cm long, fine hexagonal network on the surface of ribbon. Eggs 0.53-0.79 mm in diameter, without OG . . . . . Pterophryne & Antennarius

b. Eggs in a balloon

1. Balloons in a pair, 10 x 20 cm. Eggs 0.81-0.83 mm in diameter, with a single OG . . . . . Pterois

2. Balloon not paired, various size up to 8 cm . . . . . .

. . . . some species of Carapidae, Scorpaenidae & Brotulidae

B. Isolated pelagic eggs

a. Elongated eggs

1. Spindle-shaped, 0.50-0.61 x 1.31-1.66 mm, with a single OG . . . . . Callyodon

2. Oval, 0.53-0.82 x 1.00-1.71 mm, with a single OG, yolk segmented . . . . . Stolephorus spp.

3. Oval, 0.5-0.8 x 0.98-2.25 mm, without OG, yolk segmented

3.1 Chorion with a knob at one end . . . . Stolephorus spp.

3.2 Chorion without a knob . . . . Stolephorus & Engraulis

b. Round eggs

1. Chorion with some structure

1.1 Tiny projections (each consisting of three planes) distributed over chorion. 1.2-1.33 mm in diameter, with a single or 2-10 OG. . . . . Myctophidae

1.2 Short spinules (0.07-0.12 mm) distributed over chorion. 1.7-2.1 mm in diameter, no OG . . . . . Oxyphorhamphus micropterus

1.3 A warty projection on chorion. Diameter 0.97-1.40 mm, with a single or numerous OG, yolk not segmented . . . . . Bothidae

1.4 A comfit-like gelatinous coat covering chorion. Outer diameter 1.3-1.8 mm, inner diameter 0.87-1.17 mm, with a single OG, yolk segmented . . . Maulolicus japonicus

1.5 A smooth gelatinous coat covering chorion

1.5.1 With a single OG, yolk segmented. Outer diameter 1.77-2.48 mm, inner diameter 1.47-1.85 mm . . . . . Ilisha elongata

1.5.2 With several OG, yolk segmented, Outer diameter 2.0 mm, inner diameter 1.5-1.6 mm . . . Alosa spp.

1.6 A fine network of hexagonal meshes on chorion

1.6.1 With a single OG, yolk not segmented. Diameter of egg 1.16-1.26 mm, diameter of mesh 0.016-0.03 mm . . . . . Pleuronichthys cornutus

1.6.2 With many OG

1.6.2.1 Diameter of egg 1.6-1.65 mm, 7-19 OG, diameter of mesh 0.015 mm . . . . . Chirocentrus hypselosoma

1.6.2.2 Diameter of egg 1.45-1.80 mm, 80 OG or more, diameter of mesh 0.14-0.24 mm . . . . . Aesopia cornuta

1.6.2.3 Diameter of egg 0.85-0.90 mm, 5-15 OG . . . . . Cynoglossidae

1.6.3 Without any OG, yolk not segmented

1.6.3.1 Diameter of egg 1.09-1.22 mm, diameter of mesh 0.05 mm . . . . . .Synodontidae

1.6.3.2 Diameter of egg 0.64-0.73 mm, diameter of mesh 0.010-0.025 mm . . . . Callionymus

1.7 Chorion consisting of two layers of membrane

1.7.1 With a single OG, yolk segmented

1.7.1.1 Space between two membranes wide, diameter of eggs 1.06-1.14 mm . . . . Hilsa Kelee

1.7.1.2 Space between two membranes narrow, diameter of egg 1.1-1.2 mm..Sardinella brachysoma

1.7.2 Without any OG

1.7.2.1 Diameter 2.04-2.12 mm, yolk segmented . . . . . .Chauliodus sloani

1.7.2.2 Diameter 1.50-1.70 mm, yolk not segmented . . . . . Fistularia villosa

2. Chorion without special structure

2.1 Perivitelline space wide (yolk diameter 80% or less of egg (diameter), yolk segmented

2.1.1 Smaller than 2 mm in diameter

2.1.1.1 With a single OG . . . . . .Clupeidae

2.1.1.2 Without OG . . . .Sardinella leiogaster

2.1.2 Bigger than 2 mm in diameter . . . . . .Anguillida

2.2 Perivitelline space narrow

2.2.1 With a single OG

2.2.1.1 Diameter of egg 1.55-2.04 mm, diameter of OG 0.4-0.65 mm, yolk not segmented.

2.2.1.1.1 Myotomes of embryo more than 100 . . . . . Trichiurus spp.

2.2.1.1.2 Myotomes of embryo about 50 . . . . . .Scomberomorus niphonius

2.2.1.2 Diameter of egg 1.30-1.60 mm, diameter of OG 0.3-0.35 mm, yolk segmented . . . . . Coryphaena hippurus

2.2.1.3 Diameter of egg 1.1-1.3 mm

2.2.1.3.1 Yolk segmented, diameter of OG 0.2-0.33 mm . . .Seriola sp., Labracoglossa sp., etc.

2.2.1.3.2 Yolk not segmented

2.2.1.3.2.1 Diameter of OG 0.31-0.53 mm

2.2.1.3.2.1.1 Myotomes of embryo more than 30 . . . . Scomberomorus commersoni, S. Kuhli

2.2.1.3.2.1.2 Myotomes of embryo less than 30 . . . . . .Scianidae

2.2.1.3.2.2 Diameter of OG 0.21-0.30 mm . . . . . .Scorpaenidae, Triglidae

2.2.1.4 Diameter of egg 0.95-1.1 mm

2.2.1.4.1 Yolk segmented. . . . . .?

2.2.1.4.2 Yolk not segmented . . . . . Scomber, Auxis, etc

2.2.1.5 Diameter of egg 0.75-0.95 mm

2.2.1.5.1 Yolk segmented . . . . .Carangidae, Mullidae, Oplegnathidae, Pomadasyidae, etc

2.2.1.5.2 Yolk not segmented . . Sparidae, Lethrinididae, Lutjanidae, Platycephalyidae, etc.

2.2.1.6 Diameter of egg 0.55-0.75 mm

2.2.1.6.1 Yolk segmented . . . . .Sphyranidae, Sillaginidae, Gerridae, etc

2.2.1.6.2 Yolk not segmented . . . . Labridae, Scaridae, Leiognathidae

2.2.2 With many OG

2.2.2.1 Diameter of egg 1.6-2.4 mm

2.2.2.1.1 Yolk not segmented, OG more than 100

2.2.2.1.2 Yolk not segmented

2.2.2.1.2.1 OG 6-35, distributed contagiously . . . . . .Ostraciontina

2.2.2.1.2.2 OG 50-100, distributed evenly . . . . . Zebrias sp.

2.2.2.2 Diameter of egg 1.15-1.55 mm

2.2.2.2.1 Yolk segmented, with 3-20 OG. . . . . Setipinna taty

2.2.2.2.2 Yolk not segmented, with 10-45 OG. . . . . Trachinicae, Cynoglossidae

2.2.2.3 Diameter of egg 0.95-1.1 mm

2.2.2.3.1 Yolk segmented . . . . Coilia mystus

2.2.2.3.2 Yolk not segmented

2.2.2.4 Diameter of egg 0.75-0.95 mm

2.2.2.4.1 Yolk segmented . . . . Cynoglossidae

2.2.2.4.2 Yolk not segmented . . . Cynoglossus robustus, etc

2.2.2.5 Diameter of egg 0.65-0.75 mm . . . . . .Cynoglossidae

2.2.3 Without OG

2.2.3.1 Diameter of egg 1.8-2.3 mm, yolk not segmented . . . . . .*Trachipterus* sp., *Fistularia petimba*

2.2.3.2 Diameter of egg 1.56-1.63 mm, yolk not segmented . . . . . .*Verasper variegatus*

2.2.3.3 Diameter of egg 1.10-1.49 mm

2.2.3.3.1 Yolk segmented, diameter of egg 1.10-1.32 mm

2.2.3.3.1.1 Myotomes in newly hatched larvae more than 50 . . . *Etrumeus micropus*

2.2.3.3.1.2 Myotomes in newly hatched larvae 33-35+ 8-10 . . . *Chanos chanos*

2.2.3.3.2 Yolk not segmented

2.2.3.3.2.1 Myotomes of embryo less than 30, diameter of egg 1.31-1.49 mm . . . . . *Inimicus* sp.

2.2.3.3.2.2 Myotomes of embryo more than 30, diameter of egg 1.20-1.33 mm . . . . . .*Saurida elongata*

2.2.3.4 Diameter of egg 0.8-1.1 mm, yolk not segmented

2.2.3.4.1 Myotomes of embryo less than 30 . . . . . .Scorpaenidae

2.2.3.4.2 Myotomes of embryo more than 30. . . . . *Saurida* sp.

2.2.3.5 Diameter of egg about 0.78 mm, myotomes of newly hatched larvae 24 . . . . . *Triacanthus breviorstris*

2.2.3.6 Egg somewhat oval in shape, 0.88 x 1.07 to 0.63 x 0.73 mm . . . . . .Scorpaenidae

Note 1. For decisive identification of fish eggs, it is essential to observe the following in addition to the characteristics used in the keys: (a) Behaviour of pigment cells during development of eggs; (b) the shape of yolk and the position of oil globule in a newly hatched larva; (c) the number of myotomes and the position of anus in a newly hatched larva; (d) the nature of fin fold and the distribution of pigment cells. Needless to say, all these cannot be observed with preserved specimens.

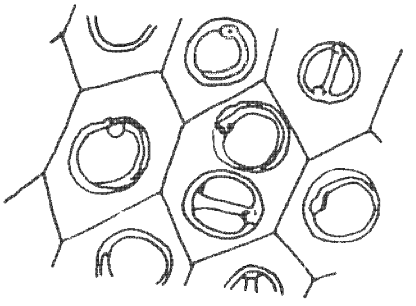
Note 2. Eggs have been studied with only a limited number of species so far, and with a bulk of species the nature of eggs remains unknown. Most species are expected to spawn eggs that have a single oil globule and are 0.8-1.2 mm in diameter, without any special structure on chorion, viz. eggs of "B-b-2.2.1.3 to 2.2.1.5" in the keys.

Note 3. After preservation, segmentation of yolk is clearly recognizable only in eggs of clupeiods and Anguillida. In other species it may be often impossible to determine whether the yolk is segmented unless we tear the egg membrane and crush the yolk with a pin.

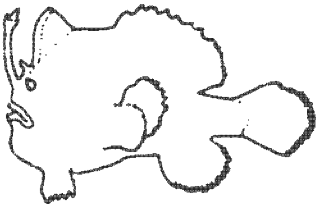
Note 4. "The number of myotomes" in the key refers to that in a rather developed stage of embryo.

A. Agglutinated Eggs

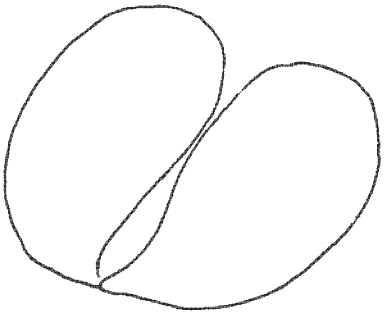
a. Eggs in gelatinous ribbon

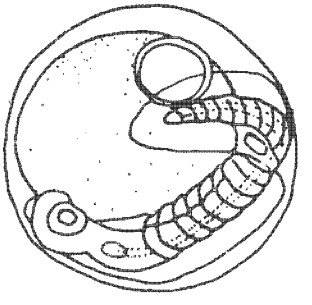


Antennarius

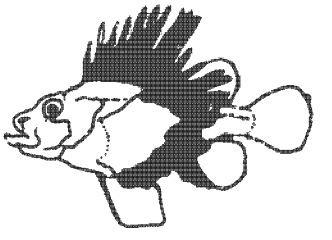


b. Eggs in a balloon

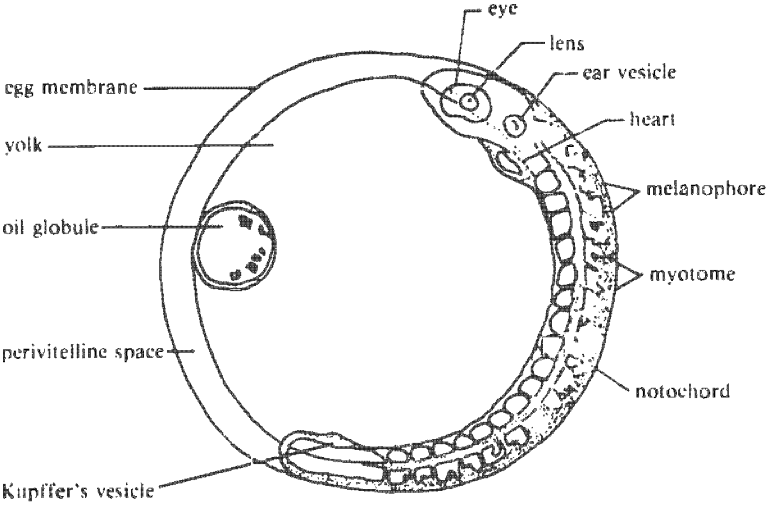




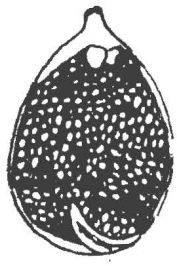
Pterois

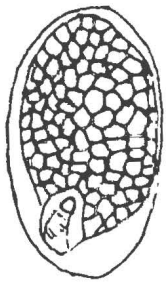


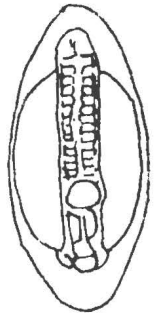
B. Isolated Eggs



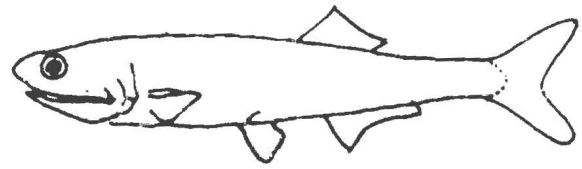
a. Elongated eggs



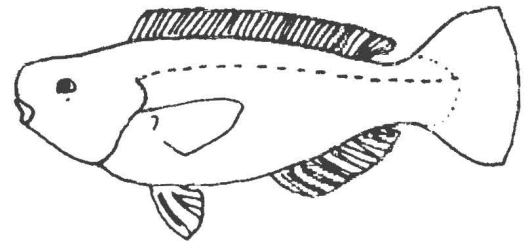




Stolephorus

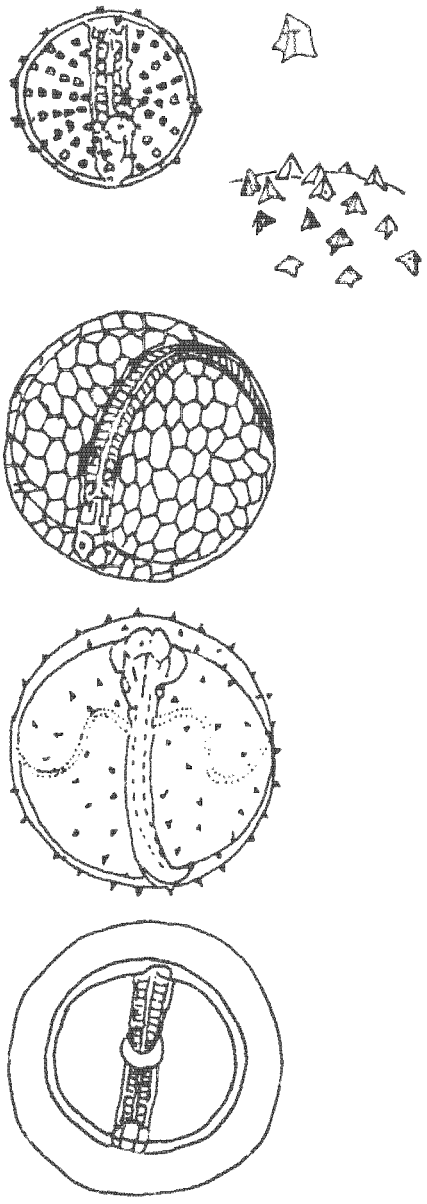


Callyodon ovifrons

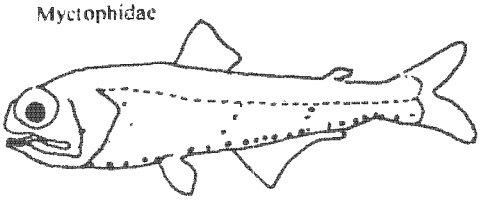


b. Round eggs

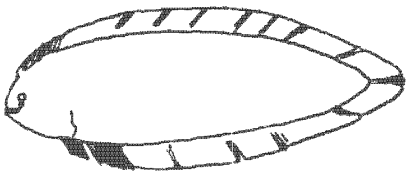
1. Chorion with some structure



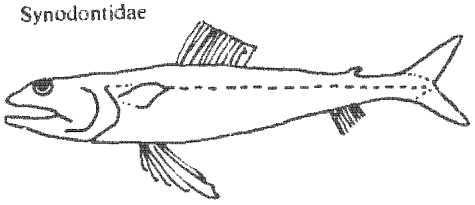
Myctophidae



Cynoglossidae

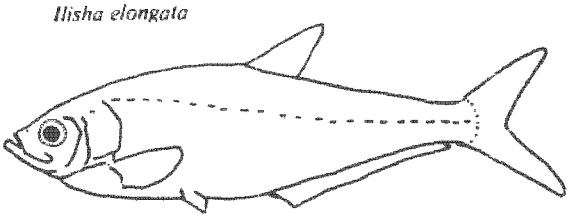


Synodontidae

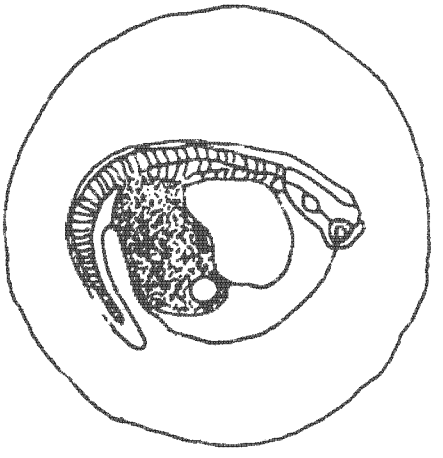


Oxyphorhamphus

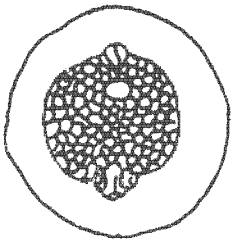
Ilisha elongata



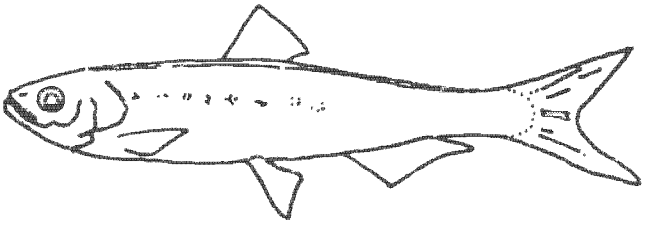
2. Chorion without special structure
   2.1 Perivitelline space wide



Anguillida

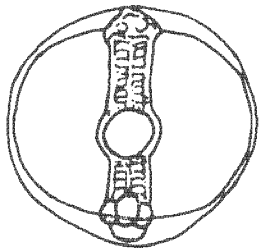


Sardinopus melanogaster

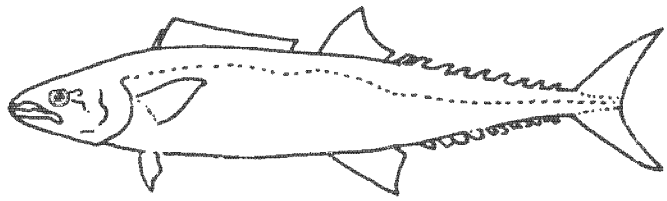


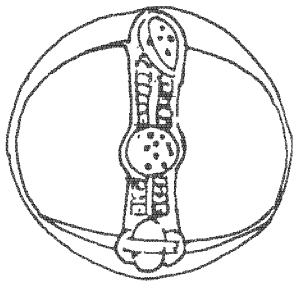
2.2 Perivitelline space narrow

2.2.1 Single oil globule

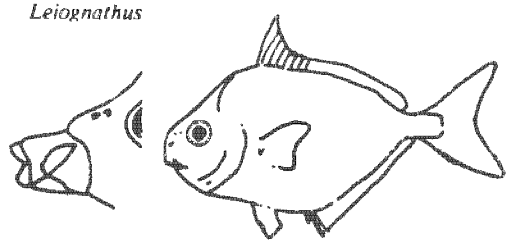


Scomberomorus niphonius

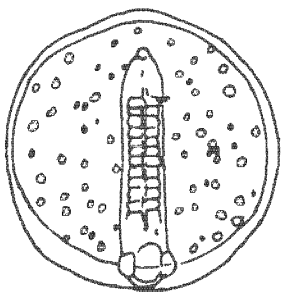




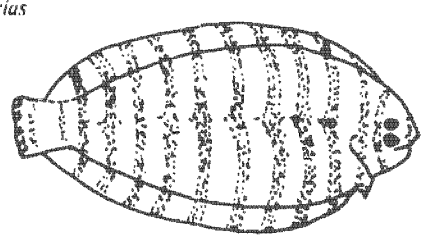
Leiognathus

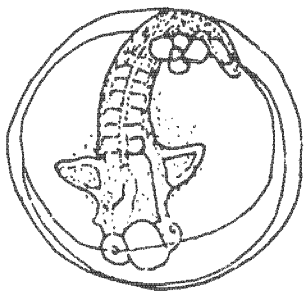


2.2.2 Many oil globules

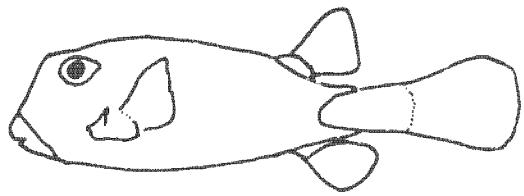


Zebrias



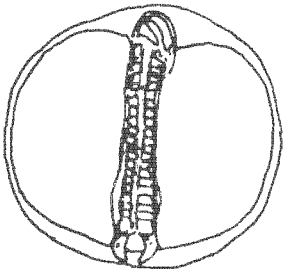


Ostraciontina

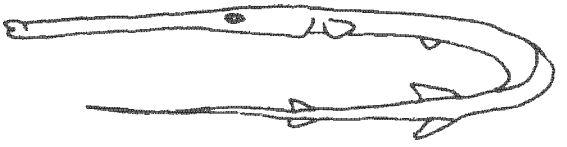


2.2.3 No oil globule

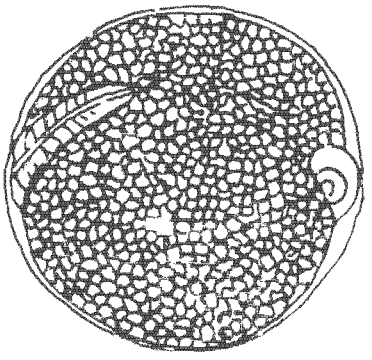
2.2.3.1 Yolk not segmented



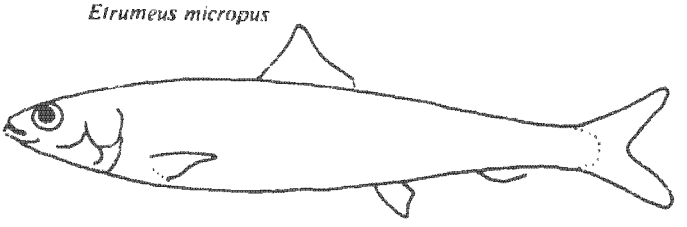
Fistularia petimba



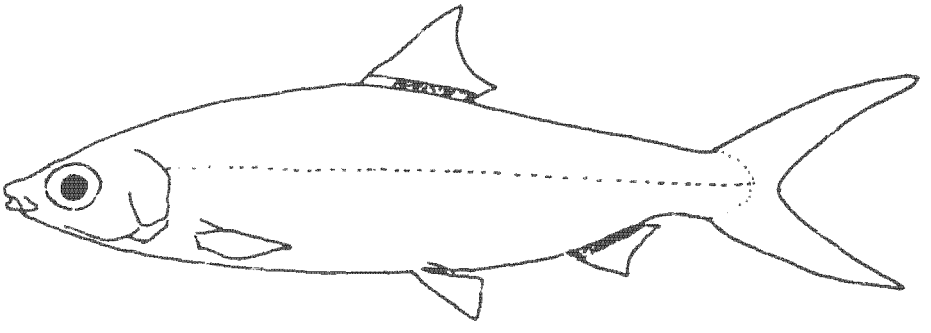
2.2.3.3.1 Yolk segmented



Etrumeus micropus



Chanos chanos



Appendix B

ICHTHYOPLANKTON STUDY OF THE MILKFISH SPAWNING GROUND OFF THE EAST COAST OF BATBATAN ISLAND

by

R.E. Bombeo, A. Castillo Jr. and G. Unlayao

Abstract

A qualitative study of fish eggs from the surface waters off the eastern coast of Batbatan Island from 4 October 1977 to 20 April 1978 yielded 25 types of pelagic eggs. Of these, 24 were spherical, while one type was spindle shaped. Eight types were successfully incubated, but no larvae survived to the fry stage. Identification as to genus was made in two cases: Spherical types J and V were identified as Oxyporamphus sp. and Mugil sp., respectively. Milkfish (Chanos chanos) eggs were identified as to genus and spiner. The spindle type egg and resulting larva were similar, but not identical, to those of Stolephorus sp.

A concurrent quantitative study showed spherical type eggs A and B and the spindle type egg to be the most abundant. Spherical type eggs A and B were numerous throughout the study period, while the spindle type was present in large numbers during October and early November and from mid-February to mid-April. Milkfish eggs were present in small numbers during March and April.

Introduction

The waters over the 1.0- to 1.5-km long narrow shelf off the eastern coast of Batbatan Island are to date the only confirmed spawning ground for the milkfish, Chanos chanos. As a separate study to that of Silverio and Marfil (Appendix C), who investigated the distribution and abundance of phytoplankton and zooplankton at the spawning ground between July 1977 and April 1978, it was decided to initiate qualitative and quantitative investigations of fish eggs occurring therein.

Methods

Weather permitting, air temperature, water temperature and salinity were determined and surface plankton tows were made every 4 days between 1000 and 1100 hours, from 4 October 1977 to 20 April 1978, at each of the 4 stations described by Silverio and Marfil. Tows were limited to a single 10-minute tow at 1.5 knots at each station.

Two identical nets, made of nylon grid gauze, type GG 38, with the following specifications were used: mouth diameter 0.75 mm or 0.44 mm^2 in area; net length 1.93 mm; mesh aperture 500 μm. A Rigosha flowmeter was mounted in the mouth of one net whose contents were to be used for quantitative analysis. Flow rates were calculated by the method of King and Denmond (1953). No flowmeter was attached to the second net whose contents were to be used for qualitative analysis.

At the conclusion of each tow the nets were hauled simultaneously. The tied end of the net used for quantitative analysis was loosened and the contents were washed down into a plastic bucket containing seawater. The zooplankton washed out from the net were transferred to a 0.30-mm mouth diameter auxiliary net with an attached plankton bucket and all organisms were flushed into the bucket. The contents of the plankton bucket were then transferred to a 250-ml screwcapped plastic bottle where the organisms were preserved in 10% seawater formalin for a minimum of 7 days before sorting and counting. The organisms collected in the net for qualitative analysis at each station were pooled in a plastic bucket containing seawater which was continuously aerated and transported to the laboratory. The trip from Batbatan Island to the laboratory at Mag-aba took approximately 2 hours.

On the arrival at the laboratory the live samples were concentrated by straining through a fine mesh net and were then transferred to a beaker for easy sorting of the eggs from associated zooplankters. With the use of a small dropper each type of egg was separated on a Petri dish for examination under a stereo microscope provided with an eyepiece micrometer. Each type of egg was measured and external features were examined; the number of oil globules and their size were determined, and the depth and width of yolk were measured. Where possible the myotomes in developing embryos were counted. Diagrams were made of each egg type which were coded alphabetically. Representative eggs of each type were preserved in 10% seawater formalin as reference material after sorting and counting the mixed eggs obtained during the quantitative part of the study. Attempts were made to incubate the remaining number of the more predominate egg types and to rear the resultant larvae to the fry stage to further identify them.

Eggs were incubated in glass aquaria or 1 x 1 x 1m diameter fiberglass tanks containing seawater that had been aged at ambient temperature for 4-7 days. The water in each incubator was continuously aerated. Temperature during incubation and larval rearing ranged from 26 to 27°C and salinity ranged from 28 to 32 ppt. Resulting larvae were supplied daily with Chlorella, Brachionus plicatilis, and oyster egg and larvae. Prior to daily feeding, the tank walls were sponged down and then three-quarters of the water in each tank siphoned off and replaced with new aged seawater. Representative larvae from each type of egg that hatched were measured, drawn to scale, and described.

Results and Dimension

Air temperature at the 4 stations ranged from 26.0 to 31.0°C throughout the sampling period, while surface water temperatures and salinity ranged from 25.6 to 30.4°C and from 32.4 to 36.0 ppt, respectively (Table B-1).

Twenty-four types of spherical eggs were collected during the study and were designated as spherical types A to W and milkfish (Figs. B-1, 3-4, 7-15, 17-21, 23-28, 30, and 32-33), all different in one or more of the following features: egg diameter, yolk diameter and appearance; size and number of oil globules; and external structures on the chorion. One type of spindle shaped egg was collected (Figs. B-35-38).

Spherical type eggs A, B, J, O, U, V and milkfish and spindle type eggs were successfully incubated, with hatching of most types occurring the day of collection or early the following day (Figs. B-2, 5-6, 22, 29, 31, 34, and 39). Hatching of spherical type J occurred after 7 days incubation (Fig. B-16). Attempts to incubate spherical type W eggs and all attempts to rear larvae from any egg type were unsuccessful.

Spherical type J eggs (Fig. B-15) were identified as flyingfish, Oxporamphus sp. They are characterized by the short spinules, evenly distributed on the chorion, their large size, and the absence of oil globules (Appendix A). The larva is diagrammed in Fig. B-16.

Spherical type V eggs and resultant larvae (Figs. B-30-31) were identified as Mugil sp. The eggs and larvae were identical to those obtained from sexually mature mullet captured near the laboratory and spawned in captivity (unpublished).

Milkfish, Chanos chanos, were easily identified by their size, their finely segmented yolk, the absence of oil globules, and their yellowish colour. The eggs and resultant larvae (Figs. B-33-34) were identical to those described by Vanstone et al. (1977).

Spindle shaped eggs and resultant larvae (Figs. B-35-39) are believed to belong to the genus Stolephorus. Several types of elongated eggs collected from the Java Sea have been described by Delsman (1931) with most belonging to the genera Stolephorus and Engraulis. The larvae agree with Delsman's description of Stolephorus larvae, except in the number of preanal and postanal myotomes. Delsman reported 12+17 myotomes, whereas the specimens now described contain 11+16.

Spherical type A and B eggs were present in very large numbers throughout the study period (Table B-2), type B being more plentiful than type A. Spindle type eggs were present in large numbers during October and November and during February, March, and April. Spherical types C to J, M, O, S, and W were occasionally present in small numbers, while types Q, R, and V were present in large numbers during March and April. A small number of milkfish eggs (Table B-3) were also obtained in March and April. Although type specimens of spherical types K, L, N, P, T, and U were collected and described in the qualitative portion of this investigation, none were recognized during sorting the preserved eggs for quantitative analysis.

References

Delsman, H.C. 1931. Fish eggs and larvae from the Java Sea: 17- The genus Stolephorus. Treubia, 13, 217-243.

King, J.E., and Demond, J. 1953. Zooplankton abundance in the central Pacific. Fisheries Bulletin, U.S. Fish and Wildlife Service, 82(54), 111-142.

Vanstone, W.E., Tiro, L.B. Jr., Villaluz, A.C., Ramsingh, D.C., Kumagai, S., Dulduco, P.J., Barnes, M.M.L., and Dueñas, C.E. 1977. Breeding and larval rearing of the milkfish Chanos chanos (Pisces: Chanidae). Aquaculture Department, Southeast Fisheries Development Center, Technical Report No. 3. pp. 3-17.

Table B-1. Air temperatures and surface water temperatures and salinities at the 4 stations located in the spawning grounds off Batbatan Island 1977/78. Station 4 could not be sampled consistently.

Station	Date/Time 1977	Air Temp. °C	Water Temp. °C	Water Salinity, ppt	Date/Time 1977	Air Temp. °C	Water Temp. °C	Water Salinity, ppt
1	4/10/1154	28.3	29.2	34.0	17/11/1110	27.4	29.1	35.0
2	1133	28.3	29.2	34.0	1050	28.0	29.0	35.0
3	1120	28.2	29.1	35.0	1035	28.0	29.0	35.0
4	1105	28.2	29.1	34.0	1012	26.6	28.5	34.0
1	8/10/1105	27.6	29.0	33.0	21/11/1050	26.4	28.5	36.0
2	1120	30.4	29.8	34.0	1035	26.4	28.5	36.0
3	1136	28.2	29.6	35.0	1022	27.2	28.0	35.0
4	1152	30.4	29.8	34.0	1010	26.0	28.2	35.0
1	12/10/1135	30.2	27.8	34.0	29/11/1055	29.3	29.0	36.0
2	1120	30.2	27.4	34.0	1040	27.6	28.8	36.0
3	1105	30.1	29.9	34.0	1025	26.6	28.8	36.0
4	1050	30.1	29.9	35.0				
1	16/10/1048	28.4	29.6	34.0	4/12/1039	27.6	28.9	34.0
2	1104	29.1	30.0	36.0	1025	27.5	28.2	34.0
3	1119	27.0	29.4	35.0	1012	27.5	28.2	34.0
4	1134	28.3	29.3	34.0	0959	27.0	28.1	35.0
1	20/10/1032	27.0	29.0	36.0	7/12/1038	27.8	28.6	35.0
2	1211	27.0	28.0	35.0	1025	28.6	28.5	35.0
3	1225	26.0	28.4	35.0	1012	28.8	28.5	35.0
4	1015	26.4	28.3	35.0				
1	1/11/1131	27.3	29.3	34.0	11/12/1113	29.0	29.0	35.0
2	1116	27.0	29.1	34.0	1101	29.0	29.0	35.0
3	1100	29.0	29.4	34.0	1049	29.0	28.6	34.0
4	1045	28.1	29.0	34.0	1037	30.0	28.6	34.0
1	5/11/1150	27.6	29.0	34.0	14/12/1050	30.0	28.3	35.0
2	1134	27.6	28.9	34.0	1035	30.0	28.3	35.0
3	1120	28.0	28.9	34.0	1020	29.5	28.3	35.0
4	1104	27.0	28.4	35.0				
1	9/11/1050	26.0	28.0	33.0	18/12/1048	28.6	28.8	34.0
2	1038	26.0	28.0	33.0	1035	28.5	28.8	34.0
3	1025	26.0	28.4	33.0	1022	28.6	28.8	35.0
4	1010	27.0	28.1	33.0	1009	29.4	28.8	34.0
1	13/11/1120	26.3	27.6	33.0	23/12/1100	28.8	29.6	35.0
2	1100	26.3	27.6	33.0	1047	28.5	28.8	35.0
3	1045	26.3	27.6	33.0	1030	28.5	28.8	35.0
4	1030	26.5	28.0	34.0				

Table B-1. (Cont'd.)

Station	Date/Time 1977/78	Air Temp. °C	Water Temp. °C	Water Salinity, ppt	Date/Time 1978	Air Temp. °C	Water Temp. °C	Water Salinity, ppt
1	27/12/1055	29.0	28.8	34.0	1/2/1105	27.0	27.2	35.0
2	1041	29.8	28.8	35.0	1053	27.0	27.0	35.0
3	1030	29.4	28.2	35.0	1040	27.0	27.0	35.0
1	31/12/1055	29.0	28.0	35.0	5/2/1118	27.0	26.9	35.0
2	1040	29.0	28.0	35.0	1051	26.3	26.9	35.0
3	1025	29.0	28.0	35.0	1040	26.3	26.9	35.0
4	1010	29.8	28.0	34.5				
1	4/1/1125	28.0	28.2	35.0	9/2/1100	28.9	27.1	35.0
2	1110	28.0	28.2	35.0	1047	28.7	27.1	35.0
3	1055	28.0	28.0	35.0	1035	28.0	27.0	35.0
1	8/1/1040	26.2	28.0	34.0	13/2/1017	27.0	25.6	
2	1023	26.0	27.8	34.0	1005	26.5	25.6	
3	1010	26.0	27.8	34.0	0950	26.5	25.6	
1	12/1/1125	28.0	27.8	35.0	17/2/1010	29.0	27.0	34.0
2	1108	28.0	27.8	35.0	0958	29.0	27.0	34.0
3	1055	28.0	27.8	35.0	0945	28.5	27.0	35.0
1	16/1/1043	29.8	27.5	35.0	21/2/1050	27.4	26.0	
2	1032	29.0	27.2	35.0	1035	27.4	26.0	
3	1020	28.5	21.0	35.0	1023	27.0	25.8	
1	20/1/1052	28.0	27.6	35.0	25/2/1029	29.0	27.0	34.0
2	1039	28.0	27.6	36.0	1018	29.0	27.0	34.0
3	1027	28.0	27.6	36.0	1005	29.0	27.0	34.0
4	1005	28.2	27.6	36.0				
1	24/1/1035	26.5	27.0	35.0	1/3/1105	28.0	28.0	
2	1023	27.5	27.0	34.0	1052	28.0	28.0	
3	1010	26.5	27.0	35.0	1040	28.0	28.0	
1	28/1/1135	26.0	27.0		5/3/1055	29.0	28.2	34.0
2	1120	26.0	27.0		1043	29.0	28.2	34.0
3	1105	26.0	27.4		1030	29.0	28.2	34.0
4	1050	28.0	27.0		1018	29.0	28.2	

Table B-1 (Cont'd.)

Station	Date/Time 1978	Air Temp. °C	Water Temp. °C	Water Salinity, ppt	Date/Time 1978	Air Temp. °C	Water Temp. °C	Water Salinity, ppt
1	9/3/1058	29.8	28.6		3/4/1045	30.2	28.1	
2	1040	30.0	28.5		1033	30.2	28.0	
3	1028	30.2	28.6		1020	30.2	28.0	
4	1015	30.2	28.4		1005	30.0	27.9	
1	13/3/1030	30.7	27.1	35.0	8/4/1043	28.6	28.2	
2	1017	30.7	27.0	33.0	1031	28.5	28.2	
3	1005	30.7	27.0	35.0	1019	28.4	28.0	
4					1008	28.2	27.8	
1	17/3/1030	30.2	28.2		12/4/1112	28.2	28.2	
2	1017	30.1	28.0		1100	28.2	28.3	
3	1004	28.8	27.7		1045	28.2	28.3	
4	0948	28.8	27.5		1025	28.2	28.4	
1	21/3/1032	30.8	27.4	35.0	16/4/1045	31.0	28.8	
2	1020	30.8	27.4	35.0	1031	31.0	28.8	
3	1007	30.8	27.4	34.0	1019	30.0	28.9	
4					1005	30.0	28.9	
1	25/3/1033	29.8	28.2		20/4/1030	29.8	27.9	
2	1019	29.8	28.0		1017	29.8	27.9	
3	1006	29.8	28.0		1005	30.0	28.0	
4	0950	29.8	27.8					
1	30/3/1104	30.2	27.9					
2	1051	30.2	27.8					
3	1038	31.0	28.1					
4	1025	31.0	27.9					

Table B-2. Number of pelagic fish eggs by type per 100 mm^3 collected during 10-minute surface plankton tows of the 4 stations located on the spawning ground off Batbatan Island 1977/78. Station 4 could not be sampled consistently. Blanks in the table mean that no eggs of that type were collected in the net used for quantitative analysis at that time at that station.

Date/Time 1977	Station	Spherical Type A	B	C	D	E	F	G	H	I	J	K
4/10/1154	1	1677	617	18								
1133	2	1462	167	31								
1125	3	2110	1079	67								
1110	4	5485	647	38								
8/10/1110	1											
1125	2											
1136	3											
1152	4											
12/10/1135	1	120	2356									
1125	2	13										
1110	3	558	2928									
1055	4	69	2342									
16/10/1048	1	6875	3119									
1109	2	2050	12496									
1119	3	7227	36379									
1134	4	3313	14696									
20/10/1032	1	824	2696									
1211	2	13462	11148									
1225	3	712	3349									
1015	4	362	793									
1/11/1131	1	527	1003		170							
1116	2	1224	2170		186							
1111	3	986	4365		307							
1045	4	1115	6572		489							
5/11/1150	1	5294	1663					84	50			
1134	2	16123	1562					12				
1120	3	1171	395					28				
1104	4	4425	1042					51				
9/11/1050	1	1818	19667									
1038	2	41937	4406									
1025	3	1364	25519									
1010	4	38000	31122									

Table B-2 (Cont'd.)

Date/Time 1977	Station	Spherical Type L	M	N	O	P	Q	R	S	T	U	V	W	Spindle Type
4/10/1154	1													92
1133	2													731
1125	3													520
1110	4													711
8/10/1110	1													
1125	2													
1136	3													
1152	4													
12/10/1135	1													2658
1125	2													67
1110	3													2262
1055	4													377
16/10/1048	1													6969
1109	2													2368
1119	3													1333
1134	4													1398
20/10/1032	1													1292
1211	2													307
1225	3													623
1015	4													413
1/11/1131	1													34
1116	2													31
1111	3													80
1045	4													229
5/11/1150	1													
1134	2													12
1120	3													
1104	4													
9/11/1050	1													47
1038	2													31
1025	3													
1010	4													103

Table B-2 (Cont'd.)

Date/Time 1977	Station	Spherical Type A	B	C	D	E	F	G	H	I	J	K
13/11/1120	1	52885	78671			189						
1100	2	14338	28323			88						
1045	3	27641	52150									
1030	4	1927	4043			86						
17/11/1110	1	113	146			65						
1050	2	123	216									
1035	3	344	1034									
1010	4	255	3827									
21/11/1050	1	212	636							424		
1035	2		604									
1022	3											
1010	4		344							344		
29/11/1055	1	1603	961			320						
1040	2	5055	4758									
1025	3	10117	5245									
4/12/1039	1	285	571									
1023	2	1904										
1012	3	1060	424									
0959	4	2206	6620									
7/12/1038	1	373	2987									
1025	2		4668									
1012	3		2408									
11/12/1113	1		1274									
1101	2		5980									
1049	3	617	5868									
1037	4	248	4968									
14/12/1050	1		2650									
1035	2	863										
1020	3	1872	4816									
18/12/1048	1	20732	6434									
1035	2	3722	10490									
1022	3	561										
1009	4	9445	43933									
23/12/1100	1		4982									
1047	2		3125									
1032	3		3488									

Table B-2 (Cont'd.)

Date/Time 1977	Station	Spherical Type L	M	N	O	P	Q	R	S	T	U	V	W	Spindle Type
13/11/1120	1													
1100	2													
1045	3													
1030	4													
17/11/1110	1													32
1050	2													
1035	3													
1010	4													
21/11/1050	1													
1035	2													
1022	3													
1010	4													
29/11/1055	1													
1040	2													297
1025	3													
4/12/1039	1													
1023	2													
1012	3													
0959	4													
7/12/1038	1													
1025	2													
1012	3													
11/12/1113	1													
1101	2													
1049	3													
1037	4													
14/12/1050	1													
1035	2													
1020	3													
18/12/1048	1													
1035	2													358
1022	3													
1009	4													
23/12/1100	1													
1047	2													
1032	3													

Table B-2 (Cont'd.)

Date/Time 1978	Station	Spherical Type A	B	C	D	E	F	G	H	I	J	K
4/1/1125	1	1122	6058									
1110	2	650	3035									
1055	3	623	2493									
8/1/1040	1	23333	5897									
1023	2	820	1435									
1010	3	1498	2996				166					
12/1/1125	1		1294									
1108	2		1063									
1055	3											
16/1/1043	1	13430	8759									
1032	2	7797	13574									
1020	3	12500	7857									
20/1/1052	1	2601	650									
1039	2	1391	5565									
1027	3		1500									
1005	4	1111	740									
24/1/1035	1											
1023	2		388									
1010	3	361	361									
28/1/1135	1	1846	7384									
1120	2	5810	23887									
1105	3	1176	4117									
1050	4	3380	7887									
1/2/1105	1	29396	27936									
1053	2	11250	15000									
1040	3	21621	44684									
5/2/1118	1	8363	8727									
1051	2	6206	7586									
1040	3	21250	11250									
9/2/1100	1	2666	2133									
1047	2	3607	2823									
1035	3	1252	3131									
13/2/1017	1		1172									
1005	2		11888									
0950	3		2352									

Table B-2 (Cont'd.)

Date/Time 1978	Station	Spherical Type L	M	N	O	P	Q	R	S	T	U	V	W	Spindle Type
4/1/1125	1													
1110	2													
1055	3													
8/1/1040	1													
1023	2													
1010	3													
12/1/1125	1													
1108	2													
1055	3													
16/1/1043	1													
1032	2													
1020	3													
20/1/1052	1													
1039	2		495											
1027	3													
1005	4													
24/1/1035	1													
1023	2													
1010	3													
28/1/1135	1													
1120	2													
1105	3													
1050	4													
1/2/1105	1													
1053	2													
1040	3													
5/2/1118	1													
1050	2													
1049	3													
9/2/1100	1													
1047	2													
1035	3													
13/2/1017	1													
1005	2													213
0950	3													

Table B-2 (Cont'd.)

Date/Time 1978	Station	Spherical Type A	B	C	D	E	F	G	H	I	J	K
17/2/1010	1	2119	4788							1059		
0958	2	1509	5735									
0945	3	11707	21463									
21/2/1050	1	6917										
1035	2	1972										
1023	3	838	419									
25/2/1029	1	31725	17766									
1018	2	32608	65217									
1005	3	33783	91216									
1/3/1105	1	7874										
1052	2	5102										
1040	3	7512										
5/3/1055	1											
1043	2	44117									1633	
1030	3	39087										
1018	4	136518	37542									
9/3/1055	1	27316										
1040	2	48383									1178	
1028	3	16969										
1015	4	30573				1175						
13/3/1030	1	5773	6976	1154							1154	
1017	2	12658	25316									
1004	3	7256	1451									
17/3/1030	1	8139	2325									
1017	2		4962									
1004	3	2728										
0948	4	1475	4427									
21/3/1032	1		30995									
1020	2		76954									
1007	3		7716									
25/3/1033	1		99370									
1019	2		73295									
1006	3		22673									
0950	4	2468	6215									

Table B-2 (Cont'd.)

Date/Time 1978	Station	Spherical Type L	M	N	O	P	Q	R	S	T	U	V	W	Spindle Type
17/2/1010	1													1059
0958	2													
0945	3													
21/2/1050	1													2960
1035	2													1315
1023	3													
25/2/1029	1													
1018	2													
1005	3													3378
1/3/1105	1													
1052	2													
1040	3													
5/3/1055	1							1508						
1043	2													
1030	3				3412									
1018	4													
9/3/1055	1				2845									
1040	2				1178									2356
1028	3													
1015	4													7055
13/3/1030	1													11547
1017	2													1582
1004	3													13062
17/3/1030	1											13953	2325	
1017	2											4962	3722	3722
1004	3											2728		8185
0948	4											7256		
21/3/1032	1							3874				1937	193	
1020	2											22276	2025	
1007	3											13503		
25/3/1033	1											13249		
1019	2											19120		3186
1006	3											5966		2983
0950	4													

Table B-2 (Cont'd.)

Date/Time 1978	Station	Spherical Type A	B	C	D	E	F	G	H	I	J	K
30/3/1104	1		97210									
1059	2		23489									
1038	3	9535	33375									
1025	4	33227	86680									
3/4/1045	1	6468	16817									
1033	2	2695	28301									
1020	3	8150	30750									
1008	4	33426	43175									
8/4/1058	1	1616	3233									
1041	2		1295									
1029	3		9584									
1018	4	49295	25352									
12/4/1112	1											
1100	2	8608										
1045	3	1392	6963									
1025	4	17123	33029									
16/4/1045	1		7132									
1032	2											
1019	3											
1005	4	4549	18198			1516						
20/4/1030	1	62240	21438									
1017	2	35211	24590									
1005	3	52228	20020								8704	

Table B-2 (Cont'd.)

Date/Time 1978	Station	Spherical Type L	M	N	O	P	Q	R	S	T	U	V	W	Spindle Type
30/3/1104	1						50718							
1059	2						26845					3355		
1038	3						4767		1589					3178
1025	4						15891							15891
3/4/1045	1											1293		10349
1033	2													13477
1020	3											4920		2460
1008	4													5571
8/4/1058	1													
1041	2													
1029	3													
1018	4													
12/4/1112	1						7246	2898						
1100	2						5738							
1045	3						4178							
1025	4							1223						
16/4/1045	1													2377
1031	2							239117						3065
1019	3							7497						2142
1005	4													3033
20/4/1030	1													
1017	2													
1005	3													

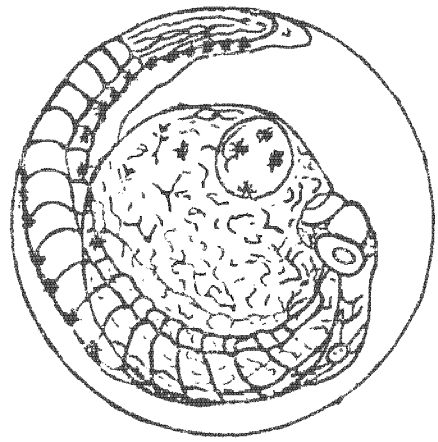
Table B-3. Number of milkfish eggs collected in 10-minute surface plankton tows for 4 stations located on the spawning grounds off the east coast of Batbatan Island during March and April 1978. Two identical nets were towed simultaneously. The net for quantitative analysis was fitted with a flowmeter, while the net for qualitative analysis was not.

Date/Time	Station	Quantitative		Qualitative
		No. of eggs	Volume of water through net, m^3	No. of eggs
21/3/1032	1	1	51.6	1
30/3/1038	3	1	62.9	1
3/4/1008	4			3
4/4/1020	3			2
1010	4			6
5/4/1020	4			4
20/4/1025	1	1	14.5	
1017	2	2	28.4	1

Figs. B-1 - B-39. Description of the 25 types of eggs collected from the spawning ground located off the east coast of Batbatan Island between October 1977 and April 1978 and of the larvae hatched from 8 types.

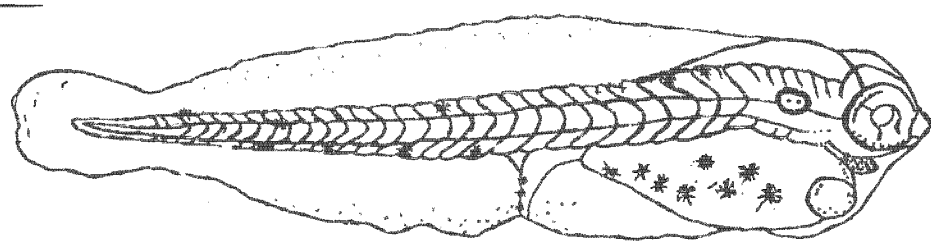
A type spherical egg and larva (Figs. B-1 and B-2).

Fig. B-1



Egg diameter 0.82-0.83 mm (range of 2 eggs); yolk length 0.62-0.63 mm; one yellowish oil globule with 4 dark brown stellate pigment cells and diameter of 0.16-0.18 mm; egg membrane globular, smooth and transparent; yolk very finely segmented with 6 dark brown stellate pigment cells; late embryo (Fig. B-1) had several dark brown stellate pigment cells extending from head to caudal region along both dorsal and ventral part of body; eye cap distinct; otocysts developed; heart distinct and fin folds developing.

Fig. B-2



One-day-old larva (Fig. B-2) had: standard length 2.69 mm; preanal length 1.09 mm; yolk length 0.54 mm; oil globule in anterior portion of yolk with diameter 0.16 mm; number of myotomes 11+18; black spots along margin of fin folds and on ventral edge of eye cap; dark brown stellate pigment cells on yolk and scattered along dorsal and ventral portions of myotomes; fin fold continuous; almost vertical anal pore; and statocyst with 2 distinct otoliths.

B type spherical eggs and larvae (Figs. B-3 - B-6)

Fig. B-3

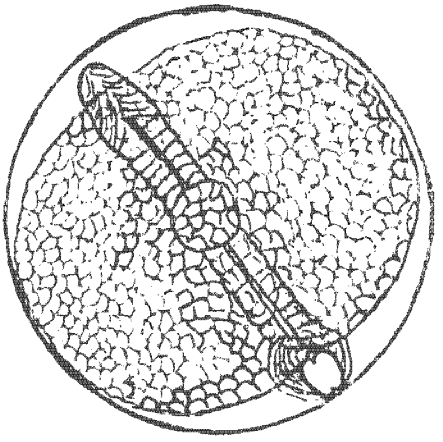
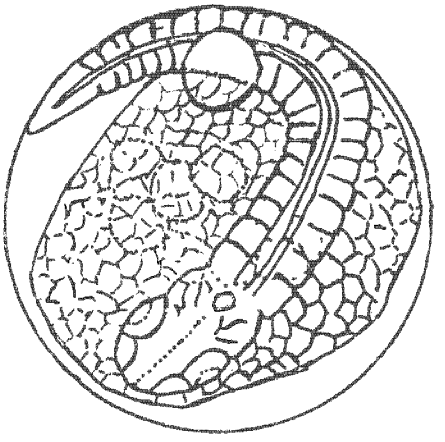
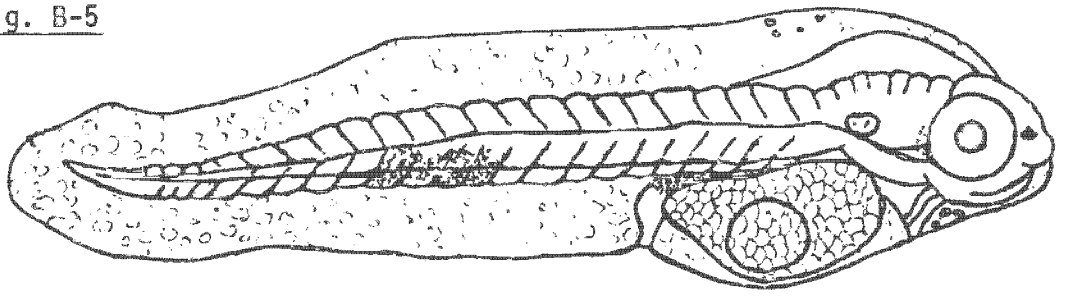


Fig. B-4



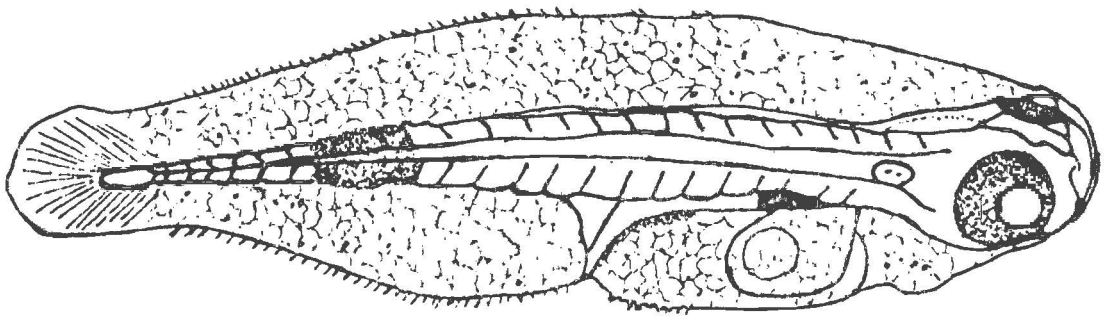
Egg diameter 0.58-0.63 mm; yolk diameter 0.42-0.44 mm; vitelline space wider near the head and tail regions of the early embryo (Fig. B-3); one yellowish oil globule without pigment cells; egg membrane globular, smooth and transparent; yolk finely segmented; 15 to 16 myotomes visible in the early embryo, 20 to 25 in the late embryo (Fig. B-4) (it hatched 5 minutes after being drawn); the late embryo had eight irregular shaped transparent bubblelike structures forming a chain within the yolk.

Fig. B-5



Newly hatched larva (Fig. B-5) had: standard length 1.72 mm; preanal length 0.76 mm; head length 0.18 mm; yolk length and depth 0.46 and 0.20 mm, respectively; oil globule diameter 0.12 mm; number of myotomes 5+18; spot of black pigment between anterior of eye cap and snout; spots of brown pigment immediately posterior to eye cap; streak of brown pigment between dorsal-posterior portion of yolk and alimentary canal; band of brown pigment on ventral portion of 6th to 10th post anal myotomes; unpigmented oil globule on ventral side of yolk; continuous fin fold with bubblelike structure throughout; vertical anal canal, unpigmented eyes; non-functional mouth; finely segmented yolk; and distinct otocysts.

Fig. B-6



One-day-old larva (Fig. B-6) had: standard length 1.80 mm; preanal length 0.80 mm; head length 0.20 mm; yolk length and depth 0.30 and 0.13 mm, respectively; globule diameter 0.06 mm; streak of brown pigment between dorsal posterior portion of yolk and alimentary canal; vertical band of brown pigment on the dorsal and ventral portions of the 6th to 10th post anal myotomes; oil globule reduced to half the diameter of this in day-zero larva and location changed to posterior portion of yolk; fin fold continuous with spring structures along its edge; eye cap slightly pigmented; and mouth not functional.

C type spherical eggs (Figs. B-7 and B-8)

Fig. B-7

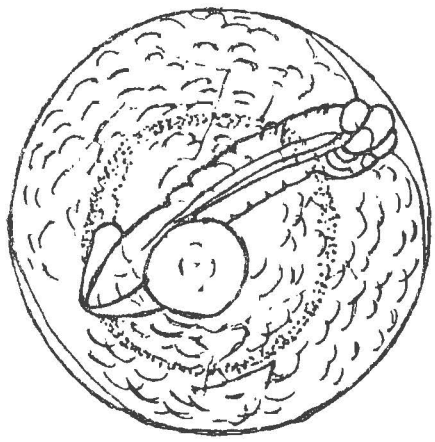
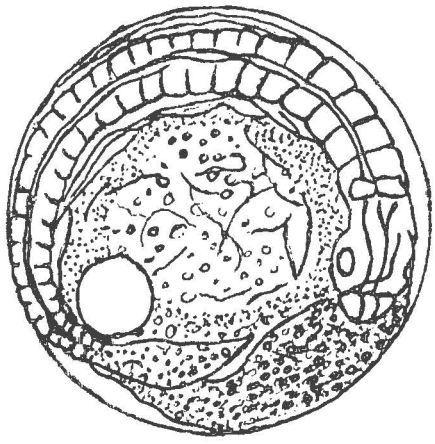


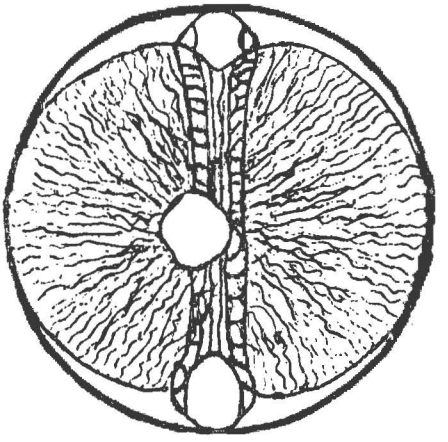
Fig. B-8



Egg diameter 1.28-1.43 mm (range of 3 eggs); yolk diameter 1.13 mm in early embryo (Fig. B-7), 0.82 mm in more fully developed embryo (Fig. B-8); one yellowish oil globule 0.25-0.28 mm; egg membrane globular; yolk coarsely segmented; and 20-25 myotomes present in late embryo.

D type spherical egg (Fig. B-9)

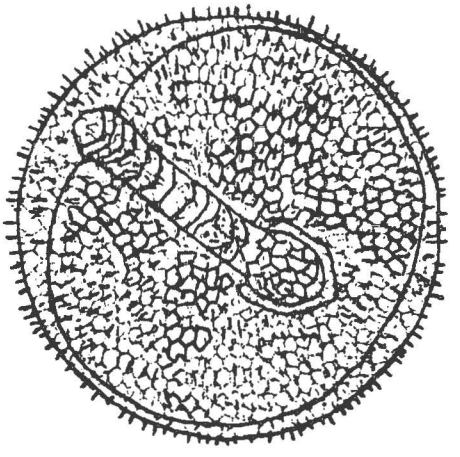
Fig. B-9



Egg diameter 0.48-0.50 mm (range of 3 eggs); yolk diameter 0.36-0.40 mm; one yellowish oil globule with diameter 0.12-0.12 mm; egg membrane smooth and transparent; yolk finely segmented; and developing embryo unpigmented with 10-15 myotomes and developing head parts and eye caps.

E type spherical egg (Fig. B-10)

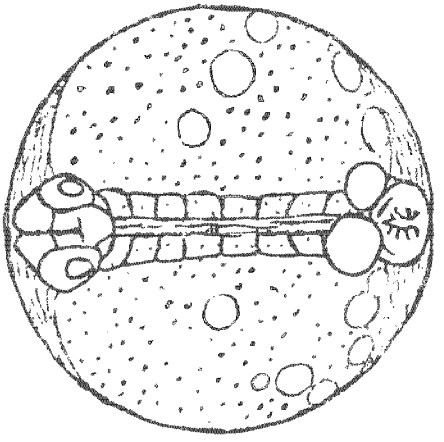
Fig. B-10



Egg diameter 1.14 mm; yolk diameter 1.00 mm; no oil globules; and egg membrane with hexagonal segmentation and uniformally distributed short hair-like protrusions.

F type spherical egg (Fig. B-11)

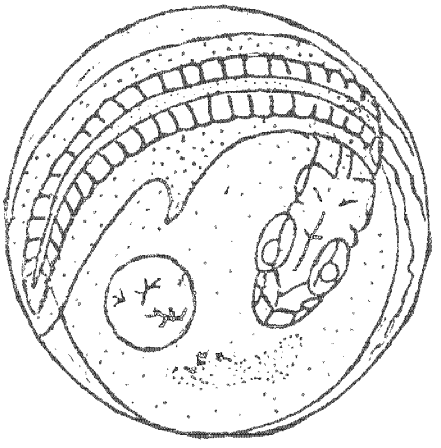
Fig. B-11



Egg diameter 1.06 mm; yolk diameter 0.84 mm; 14 pale yellow oil globules ranging in size from 0.03 to 0.11 mm; egg membrane finely segmented; dots of black pigment uniformally distributed on surface of yolk sac; and 8-10 myotomes present in developing embryo.

G type spherical egg (Fig. B-12)

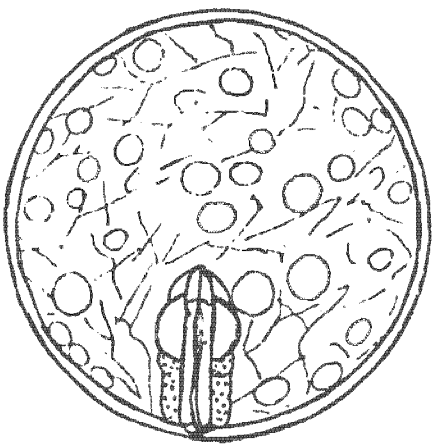
Fig. B-12



Egg diameter 1.69 mm; yolk diameter 1.44 mm; single colourless oil globule with 4 stellate pigment cells and diameter of 0.32 mm; egg membrane slightly segmented; and numerous black spots distributed in yolk membrane.

H type spherical egg (Fig. B-13)

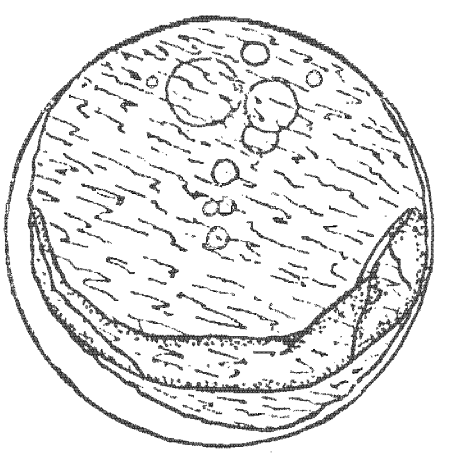
Fig. B-13



Egg diameter 2.0 mm; yolk diameter 1.80 mm; more than 30 yellowish, randomly distributed, oil globules; egg membrane globular and transparent; and yolk oddly segmented giving it an opaque appearance.

I type spherical egg (Fig. B-14)

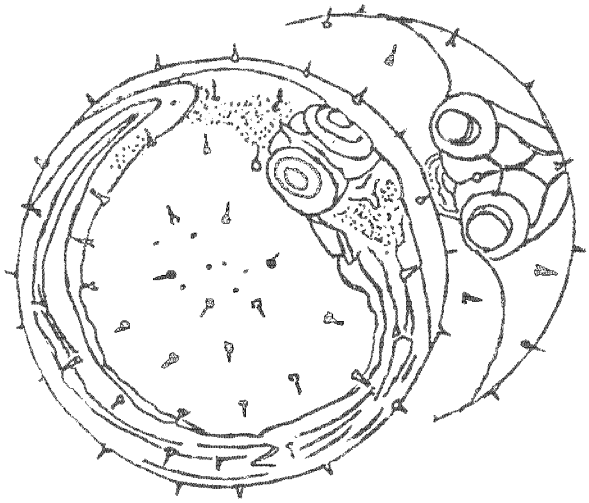
Fig. B-14



Egg diameter 1.44 mm; yolk diameter 1.22 mm; 10 yellowish oil globules with the largest having a diameter of 0.20 mm; egg membrane transparent; and yolk finely segmented.

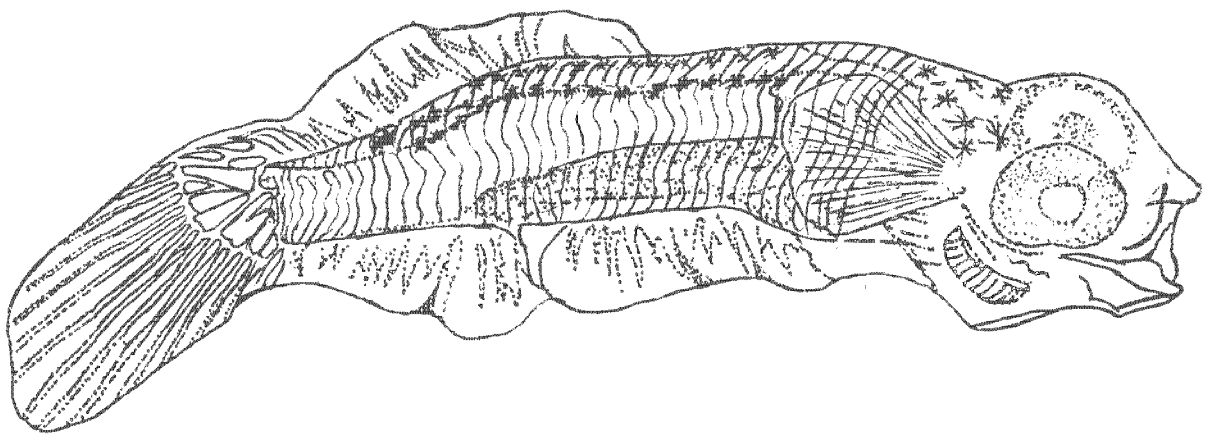
J type spherical egg and larva Oxyporamphur sp. (Figs. B-15 and B-16)

Fig. B-15



Egg diameter 2.08 mm (mean of 7 eggs); yolk diameter 1.75mm: no oil globule; egg membrane transparent with spiny protrusions uniformally distributed over its surface; perivitelline space narrow; yolk transparent and small granules within it appeared to be passing through the mouth of the embryo at stage illustrated in Fig. B-15 and circulating through its body.

Fig. B-16



One-day-old larva (Fig. B-16) had: total length 4.84 mm; standard length 4.00 mm; preanal length 2.76 mm; head length 1.25 mm; approximately 50 myotomes; black stellate pigment cells on head dorsal and posterior to the eyes and extending along dorsal myotomes; a black band along ventral myotomes from head to postanal region; eyes pigmented; mouth functional; gill slit and first gill raker developed; yolk fully resorbed; and anal pore vertical to body.

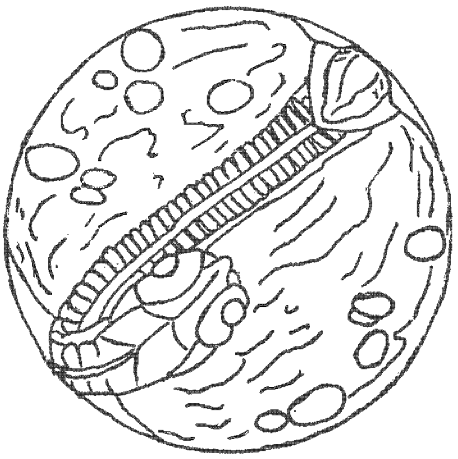
K type spherical egg (Fig. B-17)

Fig. B-17

Egg diameter 1.38 (average of 2 eggs); yolk diameter 1.02 mm; 2 yellowish oil globules with the largest having a diameter of 0.34 mm and 7 stellate pigment cells; egg membrane globular and transparent; yolk segmented containing several small bubblelike structures; vitelline space narrow and the developing embryo (Fig. B-17) had a row of melanophores on each side of its body.

L type spherical egg (Fig. B-18)

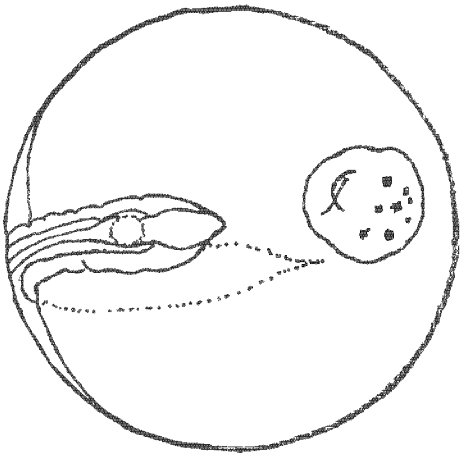
Fig. B-18



Egg diameter 1.28 mm; yolk diameter 1.12 mm; 13 or more oil globules with the largest having a diameter of 0.12 mm; egg membrane smooth and transparent; yolk very large with very slight segmentation; and the developing embryo (Fig. B-18) had 30 myotomes.

M type spherical egg (Fig. B-19)

Fig. B-19



Egg diameter 1.64 mm; yolk diameter 1.56 mm; one yellowish oil globule with a diameter of 0.40 mm and a few red spots on one side of it; and yolk slightly opaque.

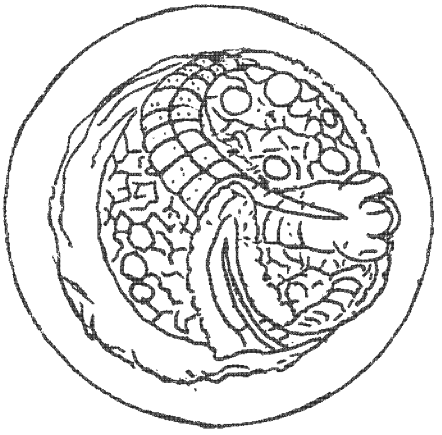
N type spherical egg (Fig. B-20)

Fig. B-20

Egg diameter 2.19 mm; yolk diameter 1.75 mm; no oil globules; egg membrane smooth and transparent; black stellate pigment cells evenly distributed on yolk surface; and late embryo (Fig. B-20) contains numerous very fine myotomes and a few black stellate pigment cells on its head.

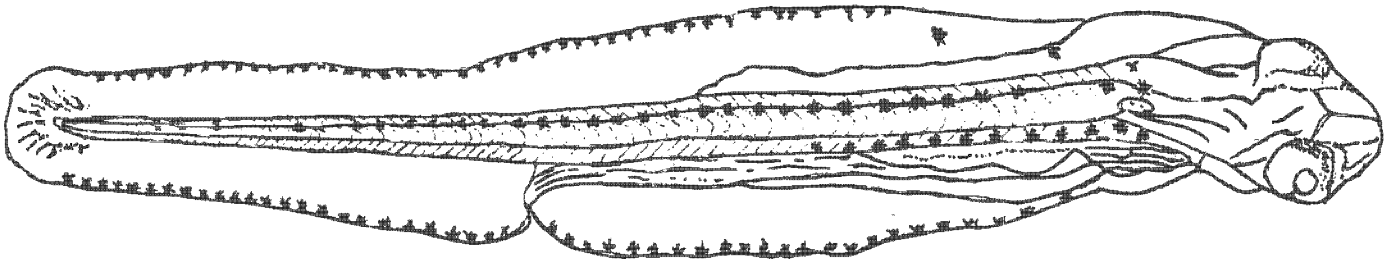
O type spherical egg and larva (Figs. B-21 and B-22)

Fig. B-21



Egg diameter 1.30 mm (average of 5 eggs); yolk diameter 0.91 mm; average number of oil globules 7; egg membrane slightly segmented and smooth; and the late embryo (Fig. B-21) had black spots along the outside edge of the fin fold and along each side of the body.

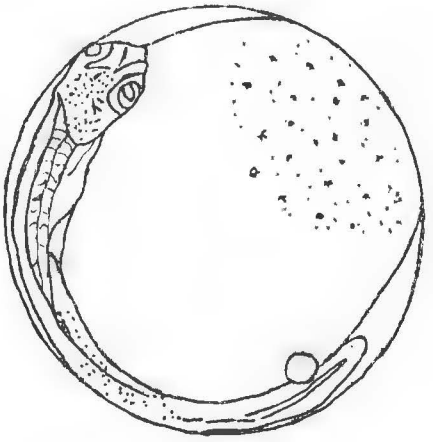
Fig. B-22



One-day-old larva (Fig. B-22) had: total length 6.00 mm; standard length 5.63 mm; preanal length 3.69 mm; head length 0.38 mm; number of myotomes 35 to 40 + 40 to 45; yolk resorbed; black stellate pigment cells along edges of dorsal and ventral fin folds; 2 large black stellate pigment cells in centre of anterior portion of dorsal fin fold; a chain of black stellate pigment cells along the dorsal myotomes from the statocyst to the caudal region and a second chain along the ventral myotomes from the statocyst to the 17th preanal myotome; statocyst with 2 distinct otoliths; partially pigmented eyes; and developing gut with anal pore diagonal to body.

P type spherical egg (Fig. B-23)

Fig. B-23



Egg diameter 2.80 mm; yolk length 2.00 mm; yolk depth 2.44 mm; one yellowish oil globule with diameter of 0.16 mm; egg membrane smooth and transparent; yolk yellowish with several black pigment cells on its ventral surface; and the developing embryo (Fig. B-23) is pale yellow with numerous small black spots on its head and along its back.

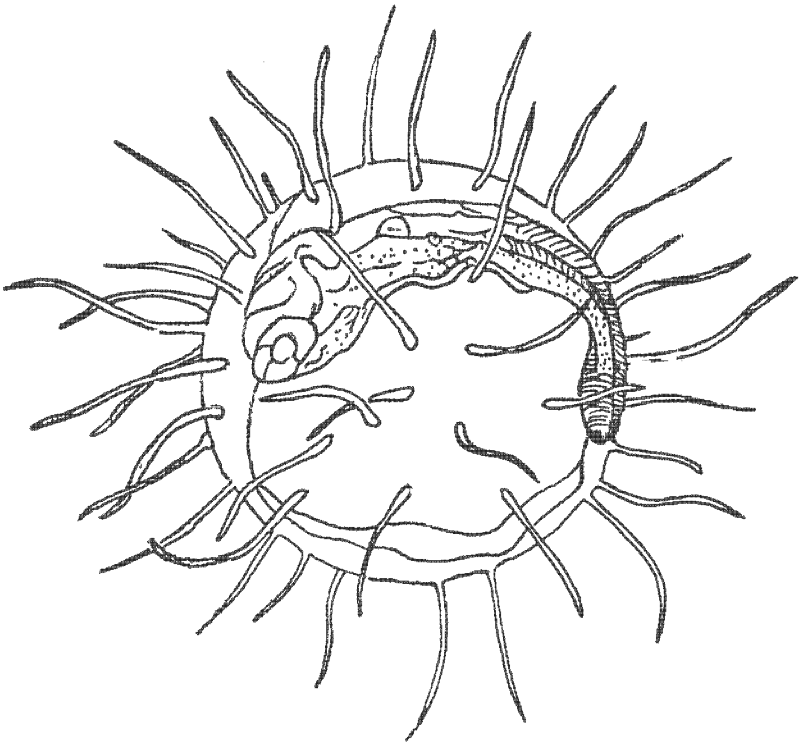
Q type spherical egg (Fig. B-24)

Fig. B-24

Egg diameter 0.79 mm; yolk diameter 0.72 mm; no oil globules; narrow vitelline space; egg membrane smooth and transparent; and yolk made up of very small yellowish granules.

R type spherical egg (Fig. B-25)

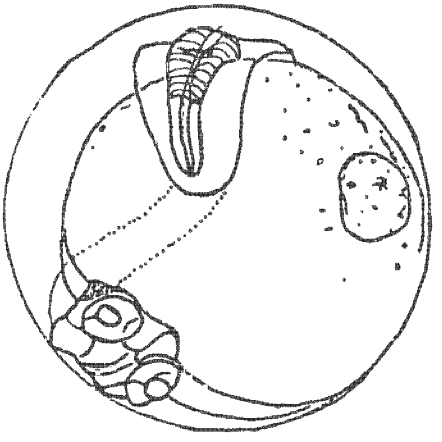
Fig. B-25



Egg diameter 1.96 mm; yolk length 1.72 mm; yolk depth 1.76 mm; no oil globules; egg membrane transparent with numerous evenly distributed protrusions of average length 0.44 mm; and the developing larva (Fig. B-25) contained numerous very narrow myotomes with red pigment cells on the ventral myotomes.

S type spherical egg (Fig. B-26)

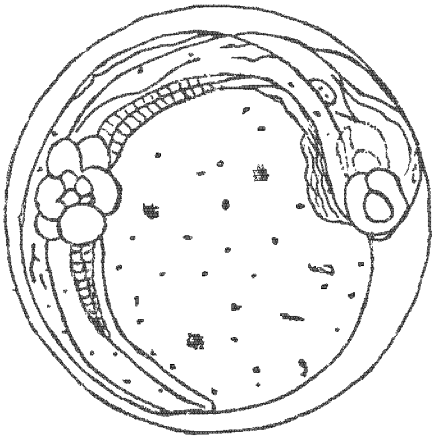
Fig. B-26



Egg diameter 1.27 mm; yolk length 1.03 mm; yolk depth 1.08 mm; one oil globule with diameter of 0.25 mm; and dark red stellate pigment cells and spots; egg membrane smooth and transparent; and yolk contains numerous very small bubblelike structures.

T type spherical egg (Fig. B-27)

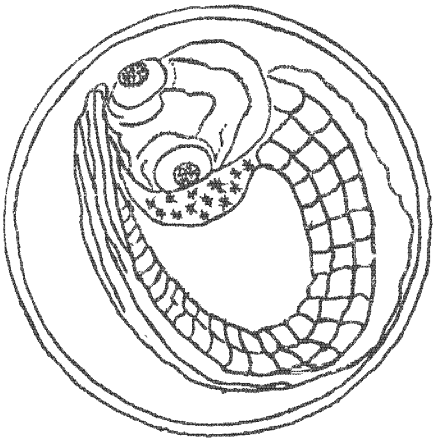
Fig. B-27



Egg diameter 1.42 mm; yolk length 1.22 mm; yolk depth 1.33 mm; 7 or more oil globules which are clumped together with the largest having a diameter of 0.12 mm; and yolk contains numerous evenly distributed red spots and a few red stellate pigment cells.

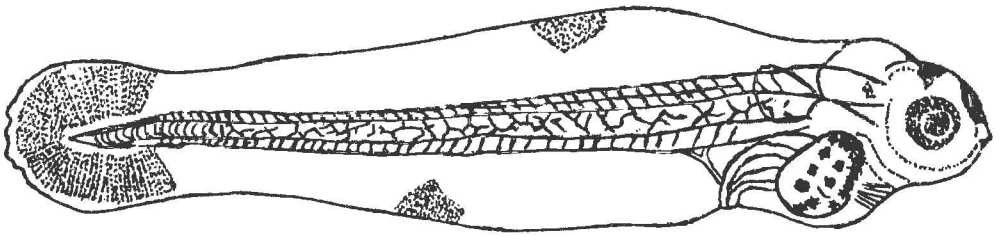
U type spherical egg and larva (Figs. B-28 and B-29)

Fig. B-28



Egg diameter 1.32 mm; yolk almost completely utilized by developing embryo, diameter 0.40 mm; no oil globules; dark brown stellate pigment cells on yolk; egg membrane smooth and transparent; and ready to hatch embryo (Fig. B-28) had a yellowish head with eye lens partially pigmented.

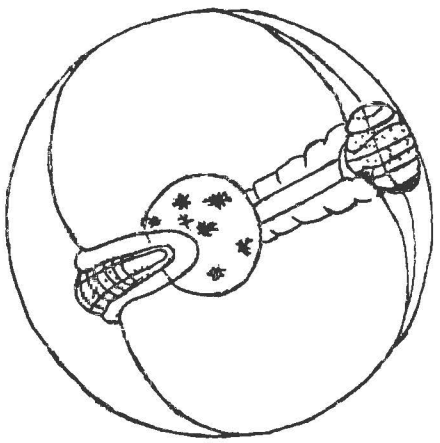
Fig. B-29



One-day-old larva (Fig. B-29) had: total length 3.68 mm; standard length 3.56 mm; preanal length 1.04 mm; head length 0.68 mm; yolk diameter 0.32 mm; number of myotomes 0+43 to 45; head yellowish with numerous black spots on dorsal portion and near the snout; patches of yellowish pigment in the middorsal, midventral and caudal portions of the fin fold; black spots and stellate pigment cells on the nearly resorbed yolk sac; mouth functional; eyes pigmented; buds of pectoral fins present; and anal canal almost vertical.

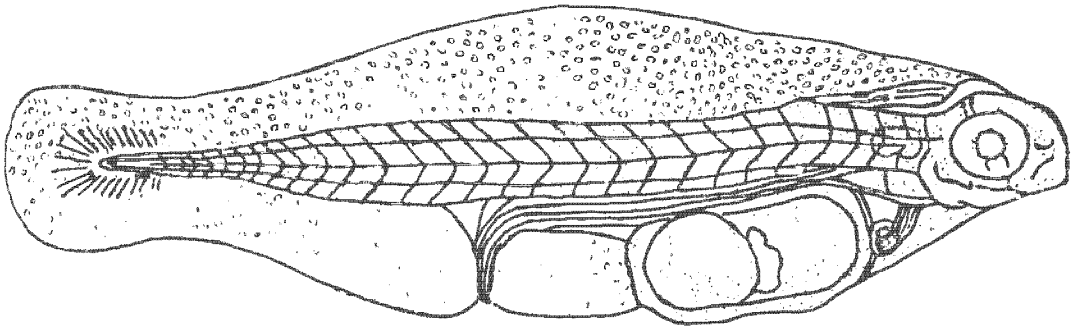
V type spherical egg and larva, Mugil sp. (Figs. B-30 and B-31)

Fig. B-30



Egg diameter 0.85 mm; yolk length 0.72 mm; yolk depth 0.80 mm; one bright yellow oil globule with diameter of 0.31 mm containing 5 black stellate pigment cells; and the developing embryo (Fig. B-30) had dark spots on its head and tail.

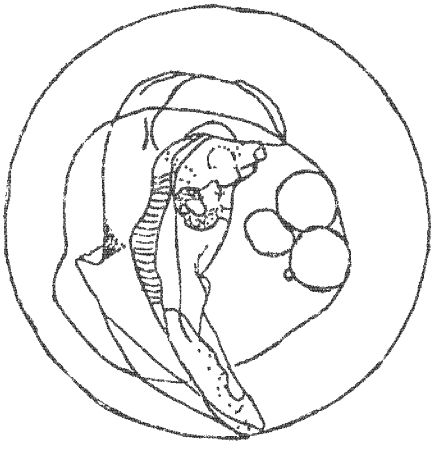
Fig. B-31



One-day-old larva (Fig. B-31) had: total length 2.62 mm; standard length 2.38 mm; preanal length 1.35 mm; yolk length 0.59 mm; oil globule in posterior portion of yolk with diameter 0.30 mm; number of myotomes 12+16; brownish pigmentation from snout to 8th post anal myotome with no pigmentation in the 9th to 16th post anal myotome; fin fold continuous with numerous bubblelike inclusions; and anal canal vertical to body.

W type spherical egg (Fig. B-32)

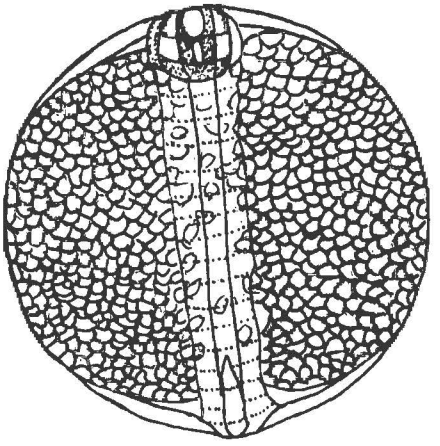
Fig. B-32



Egg diameter 1.28 mm; irregularly shaped clear yolk with a length and depth 0.88 and 0.92 mm, respectively; 4 oil globules with the largest having a diameter of 0.20 mm; and egg membrane smooth and transparent.

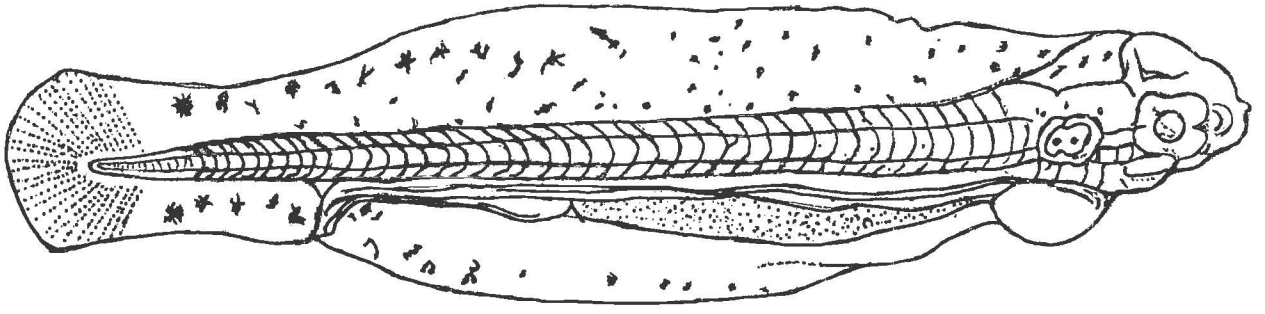
Milkfish egg and larva, Chanos chanos (Figs. B-33 and B-34)

Fig. B-33



Egg diameter 1.22 mm; yolk length 0.94 mm; yolk width 1.00 mm; no oil globules; very narrow perivitelline space; egg membrane smooth and transparent; and very finely segmented yellowish yolk.

Fig. B-34



One-day-old larva (Fig. B-34) had: standard length 5.42 mm; preanal length 4.32 mm; yolk length 3.23 mm; yolk depth 0.14 mm; number of myotomes 33+11; black stellate pigment cells scattered throughout posterior half of dorsal fin fold, the post anal portion of the ventral fin fold and the posterior portion of the preanal ventral fin fold; spots of black pigment on the posterior portion of the head and a few along the body with several distributed throughout the fin folds; statocysts have two distinct otoliths; anus diagonal to the body; and smooth not functional.

Spindle type egg and larva, Stolephorus sp. (Figs. B-35 - B-39)

Fig. B-35

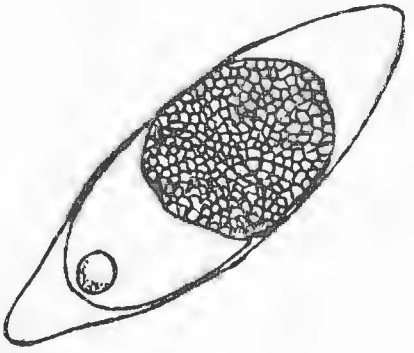


Fig. B-36

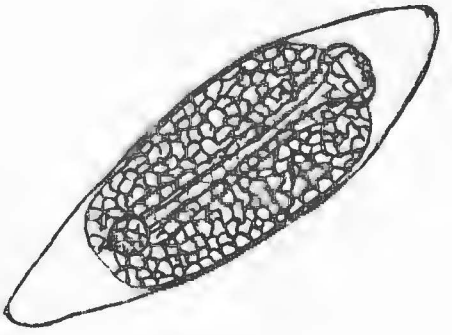


Fig. B-37

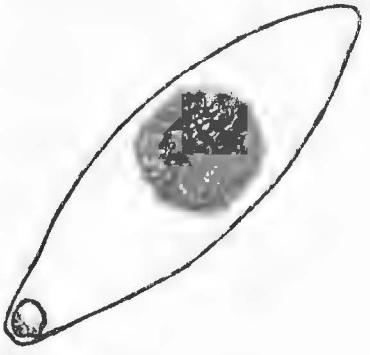
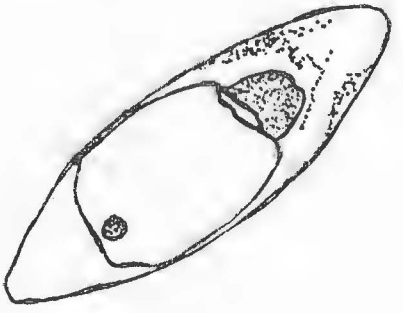
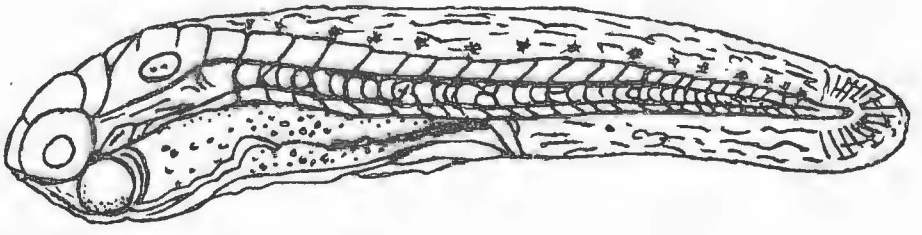


Fig. B-38



Egg length 1.45 to 1.60 mm; egg width 0.50 to 0.51 mm; yolk length 0.81 mm (Figs. B-35, B-36 and B-38) but completely filled egg membrane during early blastula stage (Fig. B-37); yolk width 0.49 to 0.50 mm; egg membrane smooth and transparent; and yolk segmented with one yellowish oil globule with a diameter of 0.08 mm.

Fig. B-39



Newly hatched larva (Fig. B-39) had: standard length 1.89 mm; preanal length 0.95 mm; yolk length 0.68 mm; yolk depth 0.18 mm; unpigmented oil globule in anterior portion of yolk with diameter of 0.11 mm; number of myotomes 11+16; brown stellate pigment cells in dorsal fin fold adjacent to embryo extending from 3rd myotome to tail region; and statocyst containing 2 otoliths located in the 1st dorsal myotome.

Appendix C

PHYTOPLANKTON/ZOOPLANKTON STUDY OF THE MILKFISH SPAWNING GROUND OFF THE EAST COAST OF BATBATAN ISLAND

by

Christopher M. Silverio and Emiliano N. Marfil Jr.

Abstract

A study of the plankton off the eastern coast of Batbatan Island from 2 July 1977 to 20 April 1978 yielded 42 genera of zooplankton and 34 genera of phytoplankton. The degree of abundance of the plankton varied throughout the 10-month period.

Diatoms were the commonest group in the phytoplankton. Chaetoceros and Rhizosolenia predominated throughout the study period. Chaetoceros were abundant during September, early October, mid-January, and February, while Rhizosolenia had peaks in October and February. Dinoflagellates of the genera Ceratium, Ceratocorys, Peridinium, and Orinthocercus were very common in Batbatan waters. The commonest genera of zooplankton were Calanus, Sagitta, Eucalanus, Rhincalanus, Copilla, Sapphirina, Centropages, Enchaeta, Corycaeus, Oithona, and Lucifer.

The diurnal abundance of phytoplankton in the nets usually occurred during the morning sampling, whereas zooplankton were commonest in the afternoon and night samples.

Introduction

To date, the only confirmed spawning ground for milkfish is located off the eastern coast of Batbatan Island located at 11°25.7 N Latitude and 121°55 E Longitude. This island (Fig. C-1) is about 4.4 km from east to west and 1.5 km from north to south and is surrounded by water more than 200 m deep. It was decided to make a qualitative and quantitative analysis of zooplankton and phytoplankton occurring near the spawning ground, because some of these organisms must serve as feed for larval milkfish.

Similar studies on plankton have been conducted in other parts of the Philippines. Bersamine (1957) investigated the fluctuations in the planktonic population of the estuaries of Navotas and Malabon. Tan et al. (1970) surveyed the distribution of zooplankton in the waters east of the Philippines. Results of a qualitative study of some phytoplankters from Sulu, Naawan, Misamis Oriental and Tigbauan and Iloilo coastal areas were published in 1975 (Mindanao State University, 1975).

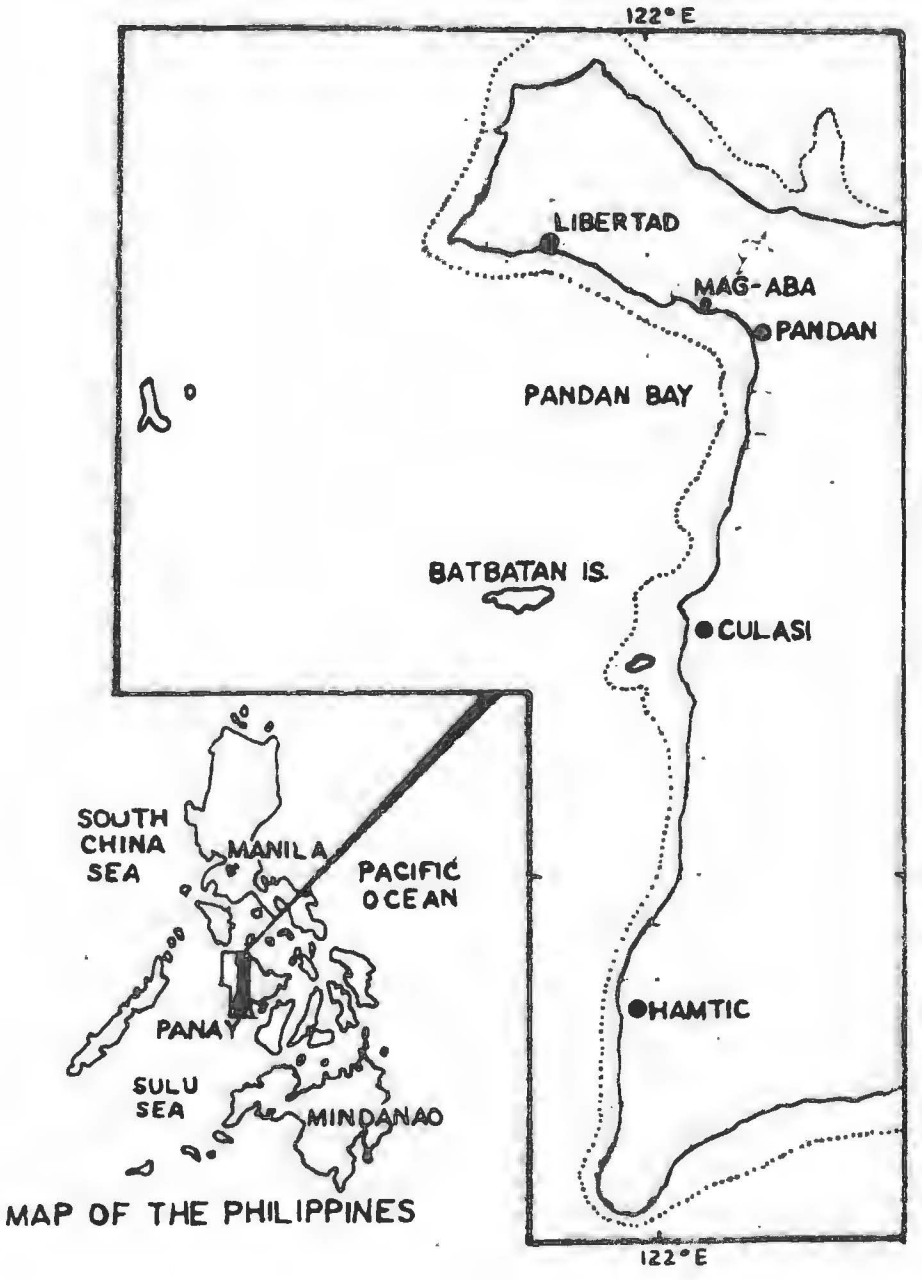


Fig. C-1. The western coast of Panay island, Republic of the Philippines, including the shoreline of Antique province, where this study was conducted.

Elsewhere, Chua and Chong (1975) and Tham et al. (1970) have studied plankton distribution in the Straits of Malacca and in Singapore waters. King and Demond (1953) made a comprehensive study of zooplankton abundance in the central Pacific. During 1955-1956, Nakamura (1956) made an extensive survey on the abundance and distribution of zooplankton in Hawaiian waters.

Zooplankton is an essential food for many marine vertebrates. Chua and Chong (1975) reported that the areas of pelagic fish abundance appear to coincide with the areas of high standing crops of zooplankton during the southwest monsoon in the Straits of Malacca, notably in the region between Pulau Jarak and One Fathom Bank. Ryther (1956) reported evidence that juveniles of the Peruvian anchovy feed on the zooplankton even though the adults are predominantly, if not exclusively, herbivorous. Stomach contents of small gobies taken in mid-water in the coastal waters of southwest Africa revealed the presence of chain-forming diatomes of the genus Fragillaria (Barber and Haedrich 1952 as quoted by Ryther 1956). Schuster (1960) reported that milkfish are generally plankton feeders, whether in the sea, in estuarine water, or in ponds.

Methods

Sampling Procedure

Five collecting stations (Fig. C-2) were established along the southeastern coast of Batbatan Island. The location of the station was based primarily on the high frequency of milkfish eggs and other fish eggs that had been collected in the area (Kumagai, Castillo and Banada 1976). Stations 1, 2, 3 and 5 were located approximately along the 25-m water depth contour and one station (station 4) in the prevailing current northeast of the island. It was later learned that, because of winds and heavy swells along the coral reef, it was difficult and often not safe to sample station 5 and this station was abandoned. For similar reasons station 4 could not be sampled on a regular basis.

Surface plankton tows were made every 8 days at every station, weather permitting. Tows were made at 0830, 1500, and 2000 hours. Sampling was limited to a single tow of each net at each station.

Two types of plankton nets were used for the sampling: (1) For collecting phytoplankton, a Kitahara surface plankton net of Japanese standard NXX13, made of nylon bolting cloth, with the following specifications: mouth diameter, 0.30 m; length, 1.30 m; and mesh aperture 94 μm; and (2) for zooplankton and egg sampling, a nylon grid gauze type GG38 net with the following specifications: mouth diameter, 0.75 m or 0.44 m^2 in area; net length 1.93 m; and mesh aperture, 500 μm. A calibrated flowmeter, TSK 4-hands type, (King and Demond, 1953) was mounted

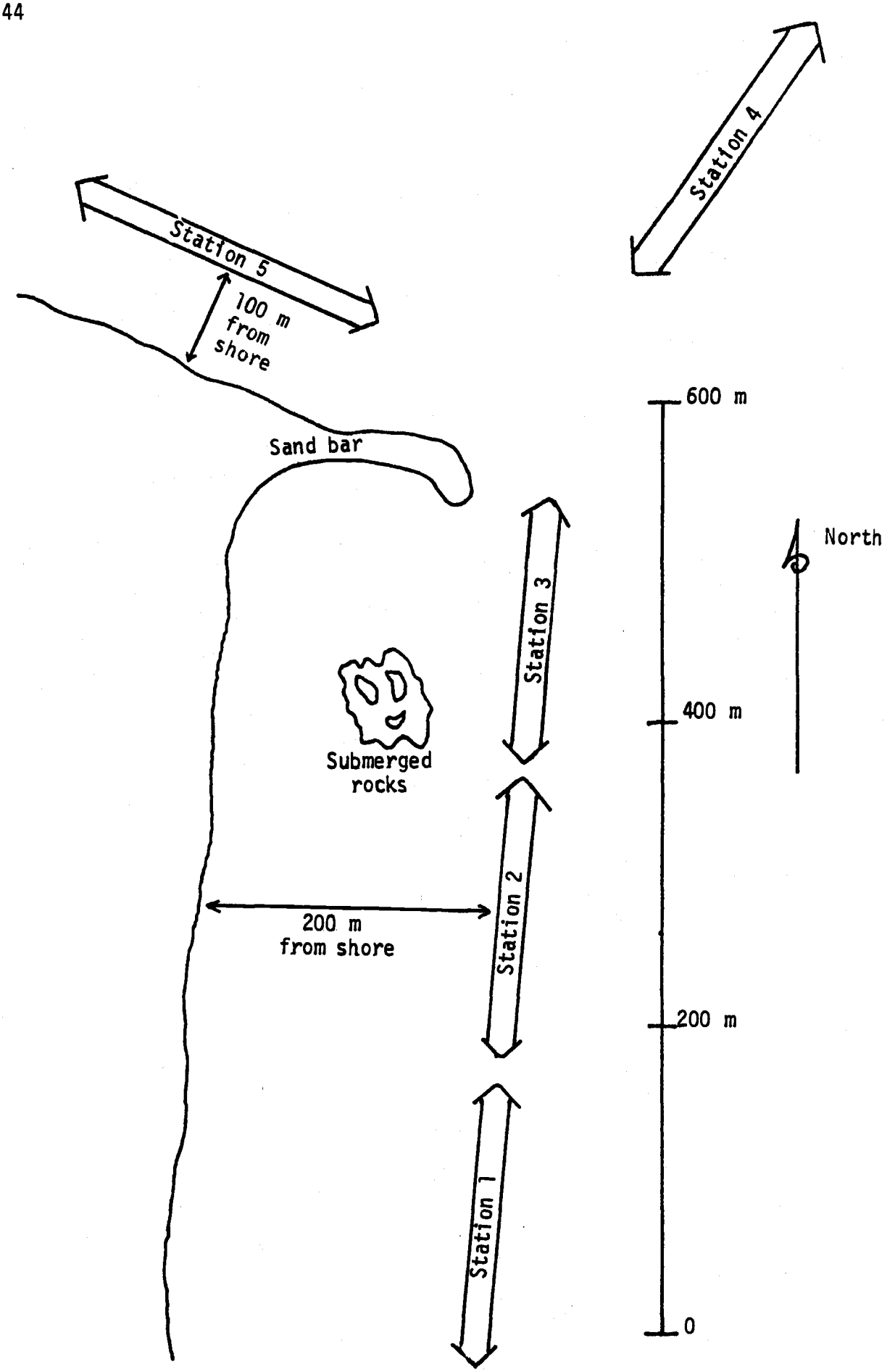


Fig. C-2. Location of five sampling stations off the East coast of Batbatan Island.

in the mouth of each net to measure the volume of water filtering through the net. The nets were released and towed simultaneously along the surface. Horizontal tows were made for 10 minutes at 1.5 knots. At the conclusion of each tow, the nets were hauled simultaneously. The tied end of the zooplankton net was loosened and the contents washed down into a plastic bucket filled with seawater. The zooplankters washed out from the net were transferred to a 0.30-m mouth diameter auxiliary net with an attached plankton bucket. Backwashing the auxiliary net flushed all the organisms into the plankton bucket. The contents of the plankton bucket were then transferred to a 250-ml screwcapped plastic bottle containing 10% seawater formalin solution. The phytoplankters were similarly concentrated and preserved.

Treatment of Samples

The samples brought to the laboratory were transferred to 250-ml specimen bottles and identified to genus using keys and illustrations by Shirota (1966), Yamaji (1966), Newell (1963), and McConnaughy (1970). Their abundance was then estimated using an Olympus microscope, a stereo dissecting microscope, a pipette for transferring concentrate, and two types of divided glass slide chambers, as described by Welch (1948).

A vernier caliper was used to obtain accurate measurements of counting cells and then cell capacity was computed. Counting cells of 75 x 25 x 1 mm and 12 x 10 x 3 mm were used for phytoplankton and zooplankton counts, respectively.

The total volume of original plankton was measured by using a 250-ml graduated cylinder. Prior to the aliquot count, the concentrate bottle was gently inverted several times to provide thorough mixing and even distribution of organisms and a 1-ml sub-sample immediately obtained and transferred to the counting cell. Prior to counting, the filled chambers were allowed to stand for 1-2 minutes to give enough time for cells to settle down. Counting was done by slowly moving the counting cell to the different visual fields in the chamber and an individual count was made of all the organisms according to their genus by applying the tally method. Two 8-key laboratory counters were used to facilitate the counting of very dense phytoplankton and zooplankton. Five samples of 1 ml aliquot each were taken from every specimen bottle to determine the species present and the quantity of each.

RESULTS AND DISCUSSION

Plankton study along the eastern coast of Batbatan Island was from July 1977 to April 1978. Thirty-four cruises were made. The 8-day sampling interval was modified when inclement weather affected the operation. During the month of September only two samplings were conducted, on September 5 and September 25. High waves usually made it impossible to make tows at night during the months of August, October, November, January, February, and March.

The first month of the study was devoted to the qualitative analysis of plankton. Quantitative results of the plankton abundance were calculated based on the 250-ml sample collected and from the total volume of water filtered through the net during sampling.

Phytoplankton Abundance

The main bulk of phytoplankton collected off the eastern coast of Batbatan Island consisted of diatoms, dinoflagellates, and blue-green algae. Nanoplankton was not considered because the nets used did not retain it. Diatoms were by far the most common group found in the area (Table C-1).

From the 10 months of study on plankton, 34 genera of phytoplankton were identified. Nineteen genera of diatoms belonging to phylum Chrysophyta were recorded. The most common genera were Rhizosolenia, Chaetoceros, Thalassionema, Bacteriastrum, and Climacodium. The dinoflagellates (phylum Pyrrophyta) comprised 14 genera, four of which, Ceratium, Orinthocercus, Peridinium, and Ceratocorys, commonly occurred in the vicinity. The blue-green algae comprised a single genus, Trichodesmium.

The phytoplankton population in the sampling area is dominated by the diatoms, although during the middle part of June a large number of Trichodesmium were observed and collected. Tham et al. (1970) observed large patches of Trichodesmium erythraem between June and August of certain years along the Strait of Singapore. Likewise, Chua and Chong (1975) recorded their abundance in certain areas of the Straits of Malacca.

Other diatoms found in Batbatan waters are similar to the genera reported by Patten (1962), Tham et al. (1970), and Chua and Chong (1975). The most abundant and very common genera were Chaetoceros and Rhizosolenia; Chaetoceros, being most abundant during September, early October, mid-January, and February. On the other hand, Rhizosolenia was also observed to be especially abundant in the plankton in October and February. Although Coscinodiscus was usually present in good numbers, there were two occasions (late September and January) when the population reached its highest density. Occasional blooms of genus Climacodium were also observed during the months of January and February. Thalassionema showed its maximum abundance during the latter part of September, early October, and January. Nitschia bloomed in mid-February but was practically absent in other months (January and April) of the year. Likewise, the genus Asterionella predominated from mid-January to mid-February. Other genera, such as Biddulphia, Cerataulina, Fragillaria, Isthmia, Lauderia, Navicula, Planktoniella, Pleurosigma, Streptotheca, Thalassiothrix, and Skeletonema appeared sporadically in the plankton and were relatively few in number.

Four genera of dinoflagellates, e.g. Ceratium, Ceratocorys, Perindinium, and Orinthocercus, were commonly found in the waters of Batbatan Island. Among the four genera, Ceratium predominated during the early part of August, late September, early October, mid-January, and February. Orinthocercus was very common during the months of July, August, September, October, November, and December; whereas, the genera Perindinum and Ceratocorys appeared throughout the 10-month period in relatively fair numbers. Pyrocystis, Globigerina, Palachroma, Dinophysis, and Triposolenia were absent at certain months of the year and when present had a low density count.

It was observed that the major abundance of these organisms occurred during the morning and afternoon samplings, and numbers were low during the night. The penetration of sufficient amount of light through the surface may be the cause of the increase in the numbers of organisms during certain times of the day (Parson et al. 1966, Sverdrup 1953).

The variations in the population density of the organisms may be attributed to the effect of the environmental factors prevailing in the area. Tidal action and upwelling may contribute to the high cell counts of some organisms (Chua and Chong 1975). Sudden increases in the phytoplankton density can be limited in time and quantity by the grazing of herbivorous plankton animals (Harvey et al. 1935, Chua and Chong 1975). Steele (1959) pointed out also the possibility that plants are not neutrally buoyant and by sinking will leave the euphotic zone where photosynthesis exceeds respiration. There is also the fact that nutrients are not plentiful and as the plants remove the nutrients the resulting low concentrations may limit further growth. Physical barriers (e.g. coral reefs and a sand bar) in the sampling area partially separate the water masses. This explains the absence of some organisms at some stations (Chua and Chong 1975).

Water Temperatures and Salinities

There was only a slight range of variation in the water temperatures gathered throughout the 10-month period (Table C-2). Tham et al. (1970) ruled out the significance of temperature on plankton density.

Water salinity varied slightly from time to time (Table C-2). The absence of estuaries and sewage effluent along the coast of the island may influence the range of variation in salinity. Lowered surface salinity usually occurred during the rainy season, when frequent rainfalls diluted the surface water. Chua and Chong (1975) reported that some phytoplankters (e.g. Ditylum, Bacillaria, Nitshia, and Rhizosolenia) thrive best in waters that have lower salinity. Tham et al. (1970) observed that genus Lauderia find the lower salinity in the Ponggol-estuary more favourable for growth.

Zooplankton Abundance

During the 10 months of this study 42 genera of zooplankton were encountered (Table C-3). These did not include crab zoeae, marine Foliosa, schizopods, or fish eggs and larvae, although these were included in the quantitative analysis. Out of 42 genera, 24 belonged to the Phylum Arthropoda, 8 to Mollusca, 4 to Coelenterata, 2 each to Annelida and Chaetognatha, and 1 each to Ctenophora and Hemichordata.

The results of one date (27 April 1978) showed that there is a large difference between the quantity of zooplankton collected during the afternoon and night, as compared with the morning. Most of the densities were lowest at about noon. This phenomenon may result from movement of the zooplankton toward the surface during twilight and temporary withdrawal near midday (Nakamura 1956).

The most common genera observed in almost all the stations were Calanus, Sagitta, Eucalanus, Rhincalanus, Copilla, Sapphirina, Centropages, Euchaeta, Corycaeus, Oithona, Oncaea, Lensia, Atlanta, Conchoecia, and Lucifer. On all the sampling operations done from July to April, these genera were found to be present in all the aliquot samples, and usually were more numerous than other zooplankters.

These zooplankters were present in the area the whole year. The highest counts obtained were as follows: Calanus - February; Sagitta - April; Eucalanus - January; Rhincalanus - December; Copilla - July; Sapphirina - February; Centropages - February; Euchaeta - September; Corycaeus - January; Oithona - October; Oncaea - October; Lensia - July; Atlanta - July and April; Conchoecia - September; and Lucifer - November.

It was evident that Calanus, Sapphirina, and Centropages have a period of abundance during the month of February, while Sagitta, Euchaeta, and Conchoecia have their peak in September. Eucalanus and Corycaeus were most numerous in January; Rhincalanus' highest count was in the month of December. Copilla, Lensia, and Atlanta's highest counts were in July; and Oithona and Lucifer's peak seasons were during the months of October and November, respectively.

Hyperina, Bolinopsis, Acartia, and Creseis appeared to be relatively high during the month of November to April. The month of April was observed to have the highest count for these zooplankters.

Although Streetsia, Pronimopsis, Hyperioides, Pronima, Gnathia, Parascelus, Balanus, Cypridina, Euchirella, Balanoglossus, Fritillaria, Sagitella, Tomopteris, marine Foliosa, Liriope, Euclio, and Creseis were observed together with the other zooplankton, they were never in large numbers, and some of these zooplankters, such as Streetsia, Pronimopsis, Hyperioides, Pronima, Gnathia, Balonoglossus, Tomopteris, marine Foliosa, and Euclio, were very rare in the samples.

The pelagic tunicates were common but in small numbers. The common forms were Oikopleura and Salpa. These pelagic Tunicates were observed during the mid-part of November to April, but never in large numbers. Doliolium was occasionally observed from early July to April, but appeared to be very rare. Thaliaceans, which were represented by Thalia and Salpa, were also fairly common during mid-July, early September, the latter part of October, although they were occasionally observed during November, March, and April.

From July to April, crab zoeae and schizopods were very common at all stations. Their peaks of abundance were during July, January, February, and April. It was noted that most of the schizopods collected were in their reproductive stage, since most of them contained young in the abdominal cavity.

The density of fish eggs in the samples was very great and they could be found in almost all the stations. High counts were during July, October, January, March (as the peak), and April. Chanos eggs occurred in very small numbers in March and April 1978. These were collected at station 4 during the morning sampling of March 5, at station 1 in the afternoon of March 12, and at stations 2 and 3 in the afternoon of April 27.

Fish larvae were present in most of the samples, but they were usually in small numbers. However, in April they were abundant and the highest number of counts for larvae were obtained during that month. It is likely that hatching of eggs occurs in the area. Kumagai, Castillo and Bañada (1978) confirmed that Batbatan Island is one of the spawning grounds of milkfish and this may be also true of other pelagic fishes that migrate to the area for spawning.

The abundance of zooplankton in this vicinity may perhaps be attributed to the occurrence of upwelling and mixing of water in the area, as discussed by Tan et al. (1970).

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Table C-1. Number of phytoplankters by genus per 100 m^3 collected during 10-minute surface plankton tows of the 4 stations located on the spawning grounds off Batbatan Island 1977/78. Station 4 was not sampled consistently. Blanks in the table mean that no phytoplankton of that genus was collected at that time at that station.

Date/Time 1977	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
2/7/1020	1						3568
1045	2						6968
1057	3						4116
1110	4						8750
7/7/0956	1						9225
1010	2						12544
0940	3						10807
0928	4						3691
7/7/1319	1						5080
1347	2				231		3704
1303	3						7503
1250	4						2489
13/7/1106	1						18234
1040	2				553		17136
1025	3						45454
1010	4						26444
13/7/1608	1		526				15263
1540	2						44000
1521	3						48580
1510	4			500			44000
13/7/2107	1						11522
2040	2						34505
2015	3						39556
2028	4						39526
25/7/1143	1			182	3101		33381
1106	2		204		1628		54131
1051	3				1240		95238
1037	4				330		35443
8/8/1014	1						82018
1044	2			754	262		81952
1029	3			2843			105643
1012	4						10573
8/8/1600	1			1052			61842
1540	2						36842
1525	3						56842
1510	4						58684

Table C-1 (Cont'd.)

Date/Time 1977	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
15/8/0955	1						10096
0935	2		820		3690		70931
0920	3		672				25314
0905	4		7068		3029		36752
23/8/1005	1		1948	2922	10226	730	23861
0950	2			1988			23111
0935	3		727	3394			32735
0920	4		814	2035			29711
5/9/1015	1			370	8741		40370
1030	2			578			13107
1042	3			556			30370
1100	4						78488
5/9/1508	1						19246
1526	2						25293
1543	3			334	334		19205
1606	4			1654			14061
5/9/1911	1						12076
1929	2		195	1559			25526
1915	3			385	1348		20031
2017	4			696			27159
25/9/1510	1			16590			57780
1535	2			16587			98798
1600	3			6445			98633
1615	4			9950			128823
25/9/2015	1			15656			80658
2000	2			12910			135040
1945	3			17004			123887
1930	4			11969			112877
26/9/0851	1			35995			18293
0914	2			89662			19831
0930	3			187778			25111
0950	4			77742			40980
3/10/1610	1		782	10759	4108		58294
1630	2		1068	11325	1068		148290
1655	3			8324	1742		139179
1707	4			11494	3512		176245

Table C-1 (Cont'd.)

Date/Time 1977	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
3/10/2058	1			12068			177872
2115	2			2935			164797
2131	3			1235			285597
4/10/1006	1			8897	791		244958
0937	2			3426			320362
0923	3			4124			318778
0843	4			1064			252235
11/10/1536	1						41515
1521	2				1160		38500
1505	3						29035
12/10/0919	1				641		70085
0844	2						47647
0835	3						54430
0804	4		4526	590	787		49784
19/10/1600	1		5291				39242
1620	2		5533		4427		33865
1640	3		639		426		19370
1700	4						52632
20/10/0837	1		700				32444
0903	2						27060
0930	3			814			39276
0942	4			593			36773
							32927
4/11/1717	1				179		27143
1700	2						7414
1639	3		200				47600
1620	4		2477		885		49009
5/11/1028	1		9107		714		23214
1006	2		192				25962
0945	3		227		909		28864
1059	4		12679		9464	3393	38571
12/11/1505	1		8761		1496	214	11538
1520	2	912	4790		684		10493
1535	3	893			357		5897

Table C-1 (Cont'd.)

Date/Time 1977	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
12/11/1944	1	2119					9838
1929	2	2123	150		354		10616
1913	3	1563	1215			174	9722
13/11/1000	1	185	1481				7593
0946	2	175	20687		175	175	4558
0933	3	181	4341		543		4161
0915	4	769	1923		384		4423
20/11/1655	1	583					96210
1643	2	506	1688		169		8609
1623	3				169		5394
1608	4	160					12970
20/11/2005	1	1412			235		22599
1950	2	696	557	139	278		13641
1935	3	775	517				16529
21/11/0935	1	233					7129
0918	2						8155
0905	3	431	2146				6028
0845	4		5112				3920
28/11/1704	1	672	1008				19825
1648	2	936	1873		936		19663
1635	3		513				15657
1620	4	928			193		11767
28/11/2042	1		379		759		15175
2028	2		1268				10396
2015	3		1537		256		7172
29/11/0941	1		1150				11103
0928	2	347	350				14600
0915	3	784	3527				7053
6/12/1647	1	500			242		19641
1633	2	500			245		28620
1621	3	731					14133
1608	4			230	1613		15070

Table C-1 (Cont'd.)

Date/Time 1977/78	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
6/12/2102	1						15182
2048	2	1048		262			31710
2036	3	1490		596			38141
7/12/0900	1	1277			213		28085
0848	2	1185		592	1629		16736
0836	3	988	1383		1383		24111
13/12/1714	1	1378	2165	394	2559		27756
1702	2	563	2065		1877		16892
1650	3	1160		928	2319		35250
14/12/1130	1	1596		639	5747		27458
1127	2	686	457		1828	914	17367
1115	3	3831	2235	1277	7663	1596	47254
22/12/1743	1	480					15782
1725	2	594	594				22727
1710	3	1310	14151	262	1834		38522
23/12/1000	1	782			2347	1565	46557
0945	2	263	1053	263	1842		30526
0930	3		467		467		4669
7/1/1630	1				688		6281
1615	2	666					8278
1600	3		210				2732
8/1/0945	1	9119	9119				6345
0930	2	1144					11723
0915	3						701
15/1/1657	1	607	1821		191821		145179
1643	2		9576		2573	1144	12586
1630	3		8102		41701	3151	13661
1615	4		1256		1884		10678

Table C-1 (Cont'd.)

Date/Time 1978	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
16/1/0945	1	639	2554		3831	4151	16283
0930	2		27439	678	9827	12872	25068
0925	3		24359	427	7265	6838	21154
0912	4	635	4759		5393	10470	26967
23/1/1624	1	923617	23383	81839	81839		14451
1609	2		66640	139338	90872	110258	48465
1556	3		128162	33228	37975	180380	33228
24/1/0924	1	1678	186	373		2051	9322
0912	2	756	756			567	3590
0859	3	1218				1462	1990
31/1/1610	1	666	41555		6222	3778	8444
1557	2	212	60104		5097	2434	10407
1545	3	220	78263		6393	2205	14771
1/2/0919	1	877	98080		11034	7346	22477
0907	2		35125		3708	6705	7879
0854	3		102003		2188	3506	9563
8/2/1545	1	1212	8485		12930	23840	22627
1528	2		3443		657	657	657
1515	3	795	16688		4370	166880	15826
9/2/0938	1	508		671782	254	113392	25388
0925	2	280	1881	71543	2825	102497	147579
0912	3	664	45111	18008	2014	10755	18268
16/2/1623	1			208780		8584	6878
1611	2		92593		910	11536	10625
1559	3		2102	64103		64103	64103
17/2/0841	1		7812	735630		210924	2577
0848	2		104390			10580	10490
0906	3			61224		4015	1045

Table C-1 (Cont'd.)

Date/Time 1978	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
24/2/1650	1					9760	59524
1638	2					47770	95541
1625	3		554	50847	278	2223	4446
25/2/0936	1			1412		1412	2825
0919	2			5226	1742	1742	5226
0912	3			5848		1462	1462
4/3/1625	1		1613	1613			3226
1612	2		1355	1355		1660	1450
1600	3			1393		1393	2786
5/3/0949	1			10606		4545	3030
0937	2			38526		12845	3211
0924	3			3171	3171	3171	12684
0910	4			8368			4184
12/3/1556	1		1450				1240
1608	2		4149			2075	2075
1621	3						7692
13/3/0933	1		1524	7622			1524
0920	2						2505
0908	3	1351		1351			2702
20/3/1628	1						4968
1616	2	1601	1601				3201
1604	3	1182					2364
21/3/0939	1		2556				2556
0926	2	3018	2315				2315
0912	3				1510		3020
29/3/1543	1	5620					62479
1528	2		9944				26518
1510	3	4167	2083				30555

Table C-1 (Cont'd.)

Date/Time 1978	Station	Amphi-solenia	Asterio-nella	Bacter-iastrum	Biddul-phia	Cera-taulina	Ceratium
30/3/0958	1	5097					73054
0945	2	5779					49699
0933	3		3821				30569
7/4/1619	1	1071	1250		15000		5893
1606	2	806			2419		3710
1553	3	1428			238		5357
7/4/2007	1				645		3556
1955	2	2400	600		400		4600
1945	3				526		15526
8/4/0910	1	500			500		9334
0858	2	1200					12200
0845	3	2778			930		14260
15/4/1605	1		5000		1071		10357
1550	2		3965		517		8448
1537	3	625	5000		833		6272
15/4/2018	1						18056
2005	2		1316				11579
1950	3		9722				9167
16/4/0930	1		2206				7647
0915	2						8077
0900	3						9500
19/4/1610	1						6207
1557	2	1250			750		12750
1545	3				625		4063
19/4/2032	1						20333
2020	2						5250
2007	3		2727				10682
20/4/0936	1						6875
0924	2	1000	19333				19000
0906	3			1875			15313

Table C-1 (Cont'd.)

Date/Time 1977	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
2/7/1020	1	254					
1045	2	1310					
1057	3	1067					
1110	4	250	250	250			
7/7/0956	1	1435					
1010	2	3136			448		
0940	3	4053					
0928	4	369					
7/7/1319	1	1474		164			
1347	2	1157					
1303	3	2714					
1250	4	933					
13/7/1106	1	5294	7176				
1040	2	3316	829		553		
1025	3	5909	2450				
1010	4	10000	3778		666		
13/7/ 1608	1	526	1053				
1540	2	5000	500				
1521	3	3821	2580				
1510	4	4000	6000				
13/7/2107	1	412	823				
2040	2	3105	1380				
2015	3	3781	1454				
2028	4	3462	8078	577			
25/7/1143	1	1642	2188		364		34475
1106	2	2035	14448	407			27676
1051	3	4464	11656	744			35466
1037	4	2967	13353	330	1978		19947
8/8/1014	1	3943	7361	788	1052		4468
1044	2	5275	19781	1130	754		754
1029	3	11154	24934				
1012	4						
8/8/1600	1	1316	9474		3158		
1540	2	2368	8947		6052		
1525	3	4636	11316		3158		
1510	4	1052	8158	526	2368		

Table C-1 (Cont'd.)

Date/Time 1977	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
15/8/0955	1	606	750				
0935	2	3485	820				
0920	3	3360	672	672			
0905	4	3836	352				
23/8/1005	1	1461	18504		2678		
0950	2	3479	21117	994	3231		
0935	3	5092	71290	970	1212		
0920	4	3256	49654	1018	3256		
5/9/1015	1	8988	1481		2037		
1030	2	9444	2698		1156		
1042	3	10740	3704				
1100	4	9811	1509		2075		
5/9/1508	1	4762	595		992		
1526	2	3800	5076				
1543	3	2004	501		334		
1606	4	3000	8065		560		
5/9/1911	1	1081	37851				
1929	2	2923	40140				
1915	3	1733	11750			7019	
2017	4	1600	25940			2263	
25/9/1510	1		359700				86400
1535	2	1923	712800				570200
1600	3	1367	149414				660352
1615	4	1571	272832				581014
25/9/2015	1	396	641102				115933
2000	2	2500	585100				286900
1945	3	3036	482600				526518
1930	4	3921	387330				864837
26/9/0851	1	6884	736035				700629
0914	2		979536				750211
0930	3	8888	1434222				540000
0950	4	5424	707915				859783
3/10/1610	1	2152	260182		2152		3717
1630	2	2137	228632		7051		1282
1655	3	2701	200155		5226		
1707	4	5747	379310		9579		

Table C-1 (Cont'd.)

Date/Time 1977	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
3/10/2058	1	3914	338878		2609		15003
2115	2	6403	201441		3469		20277
2131	3	3704	55967		3704		67078
4/10/1008	1	4547	156386		6129		
0937	2	2937	79540		2447		
0923	3	1698	33236		3154		
0843	4	1490	14899				
11/10/1536	1	3422	228				
1521	2	2087					
1505	3	3658	686		914		
12/10/0919	1	3846	4274		3846		
0844	2	3858	2701		2508		
0835	3		1502				563
0804	4	3542	3148		2361		
							188
19/10/1600	1	1543	7937				
1620	2		3320		1992		
1640	3						
1700	4	615600					
20/10/0837	1		2888		4444		
0903	2	410			4100		
0930	3	1018	1221				
0942	4	593	3163	593	2372		2175
4/11/1717	1	893					
1700	2	172					
1639	3	2400		200	200		
1620	4	2123			177		
5/11/1028	1	714		357	357		
1006	2	577			192		
0945	3	682	682	681			
1059	4		900		714		
12/11/1505	1				2778		
1520	2		228		1825		
1535	3	179		179	536		

Table C-1 (Cont'd.)

Date/Time 1977	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
12/11/1944	1				1543		
1929	2		177	531	1238		
1913	3	174	868	174	1736		
13/11/1000	1		741	556	741		
0946	2			526			
0933	3	181	181	543	724		
0915	4	4423	577	192	385		
20/11/1655	1	146					
1643	2	338					
1623	3			674	337		
1608	4	162		486			
20/11/2005	1	471	2354	1177	1412		
1950	2		3480	835	1253		
1935	3	258	258	258	1033		
21/11/0935	1	932		233	233		
0918	2			233	699		
0905	3			1005			
0845	4	170		852			
28/11/1704	1	1344	336		1344		
1648	2	312	312	312	936		
1635	3	1540			1283		
1620	4	579			579		
28/11/2042	1			379	1517		
2028	2	761			1775		
2015	3	1025	512	256	2305		
29/11/0941	1	383	2680	766	1531		
0928	2		1389		2083		
0915	3	588	392	392	1176		
6/12/1647	1	2425	2910		1940		
1633	2		2202	734	4403		
1621	3	731	1218	187	1949		
1608	4	1382	230	230	2073		

Table C-1 (Cont'd.)

Date/Time 1977/78	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Concino-discus
6/12/2102	1	3554	4689	362	989		
2048	2	3669	5765	262	1310		
2036	3	4470	13409	596	2384		
7/12/0900	1	1702	8936		5319		
0848	2	1481	6517		5628		
0836	3	988	11462		2767		
13/12/1714	1	1181	26772		4134		
1702	2	1126	8446	563	938		
1650	3	1160	18553	232	5798		
14/12/1130	1	958	51505		2554		
1127	2	914	27194		2742		
1115	3	2235	119412		7344		
22/12/1743	1	804	1980		2240		
1725	2	1040	2525	149	2080		
1710	3	786	4193		4455		1048
23/12/1000	1	2347	21518	391	5086		
0945	2	1579	8947		3947		
0930	3		5369				
7/1/1630	1	445			688		4844
1615	2			666			13934
1600	3			731	341		9458
8/1/0945	1		9119		9119		8516
0930	2		1716		858		121867
0915	3						86827
15/1/1657	1		33517		1518		13657
1643	2		283507		3717		148583
1630	3	1051	45127	701	2803		16562
1615	4	628	17537		1256		11432

Table C-1 (Cont'd.)

Date/Time 1978	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
16/1/0945	1		56513	639	6066		26820
0930	2		184959	2033	6436		38957
0925	3		116669	1282	4915		23932
0912	4	317			5076		33629
							29903
23/1/1624	1		3904910	5846	122759		111068
1609	2		3743942	6058	84814		151454
1556	3		82607	4747	47468		94937
24/1/0924	1		5220	373	2424		15474
0912	2		945	567	756		9070
0859	3	244	244	731	1706		34600
31/1/1610	1	444	1556	4667	2000		31333
1557	2		1327	2434	3319		37832
1545	3	220	1764	3968	4630		44974
1/2/0919	1		3678	5313	61539		726743
0907	2		23598	1348	1318		45485
0854	3		8925	2550	1475		40501
8/2/1545	1	1212	113138	1212	8485		29092
1528	2	459	16470	7819	6958		12196
1515	3		535625	3576	18675		24417
9/2/0938	1	762	465182	1777	111694		23103
0925	2		752486	470	7054		23985
0912	3	664	35183	693	13462		13027
16/2/1623	1		839101		6878		3439
1611	2		555555	1821	11536		93593
1559	3		256410		3153		5254
17/2/0841	1		1024674	234	132804		101555
0848	2		692308		10490		10490
0906	3		409796		2007		4015

Table C-1 (Cont'd.)

Date/Time 1978	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
24/2/1650	1		178571	59524	976		4879
1638	2		95541				
1625	3		101095		556		16949
25/2/0936	1		2825		1412		2825
0919	2		8741	1742			1742
0912	3		7340				1462
4/3/1625	1		3226		1613		1613
1612	2		13550		1355		1355
1600	3		6963		1393		2786
5/3/0949	1		51515		1515		1515
0937	2		80283		3211		3211
0924	3		22198				3171
0910	4		25105		4184		
12/3/1556	1		1240		1240		
1608	2		6224				2075
1621	3		7692		3846		3346
13/3/0933	1		3048	1524	1524		
0920	2	1250	1250	1250	1250		
0908	3	1351	1351	1351			1351
20/3/1628	1				1651		1651
1616	2		1601	1601			1601
1604	3			1182	2364		1182
21/3/0939	1		2556	2556	2556		5113
0926	2	2315			2315		2315
0912	3		1510		1510		1510
29/3/1543	1			2434	15417		8926
1528	2				6630		
1510	3			2083	25694		

Table C-1 (Cont'd.)

Date/Time 1978	Station	Cera-tocorys	Chaeto-ceros	Clado-pyxis	Clima-codium	Condon-nelopsis	Coscino-discus
30/3/0958	1	2548	4247	3398	16989		
0945	2	5779			26583		3467
0933	3				16240		
0920	4		1984	13889	15873		
7/4/1619	1	714		1607	1429		536
1606	2		645		5645		
1553	3	714	357	833	3929		1310
7/4/2007	1				1865		
1955	2				1400		
1945	3			1053	3948		526
8/4/0910	1	500		2833	1333		500
0858	2	600		1000	1800		800
0845	3	1296		741	935		
15/4/1605	1	1071	714				
1550	2	1034		1034			
1537	3		417		833		
15/4/2018	1	3057	833	556	833		
2005	2	1842	789	789	1316		
1950	3	556	1111		833		
16/4/0930	1	3677	588				
0915	2	1538					
0900	3	1000		750			
19/4/1610	1						
1557	2			750			
1545	3				469		
19/4/2032	1	1333		667			667
2020	2						
2007	3	455	1136				
20/4/0936	1		2188	1875	1250		
0924	2		2333	1677	1333		
0906	3	938	7182	1250			

Table C-1 (Cont'd.)

Date/Time 1977	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
2/7/1020	1						
1045	2						1130
1057	3						
1110	4						
7/7/0956	1	1435					
1010	2	672	448				
0940	3	2702	340				
0928	4	184	369				
1319	1	492	164				
1347	2		463				
1303	3	1437	160				
1250	4		311				
13/7/1106	1	882	294				
1040	2	1405	553				
1025	3	1364	454				
1010	4	2222	444				
13/7/1608	1			526			
1540	2						
1521	3						
1510	4	500		500			
13/7/2107	1			540			
2040	2	345		690			
2015	3			1745			
2028	4		288	288			
25/7/1143	1	7296	2006	182			
1106	2	611	611	2035			
1051	3			3968			
1037	4			989			
8/8/1014	1		2628	1314			
1044	2		476	2826			
1029	3	437	1200	3718			
1012	4		1830				
8/8/1600	1	1052					
1540	2	526					
1525	3	1578					
1510	4	1316					

Table C-1 (Cont'd.)

Date/Time 1977	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
15/8/0955	1		2423				
0935	2		1230	820			
0920	3		1568				
0905	4		3433				
23/8/1005	1	730	1948	1461			
0950	2	497					
0935	3	727					
0920	4	1018	1832				
5/9/1015	1	370	185				
1030	2	771	185				
1042	3						
1100	4	3584	1509				
5/9/1508	1	992					
1526	2	544					
1543	3						
1606	4			207			
5/9/1911	1						
1929	2		200				
1915	3	385	385				
2017	4	378					
25/9/1510	1	572					
1535	2						
1600	3			781			
1615	4			524			
25/9/2015	1	793		793			
2000	2	820		1230			
1945	3	1012		1215			
1930	4						
26/9/0851	1						
0914	2						
0930	3			900			
0950	4						
3/10/1610	1		2543	1174			
1630	2		855				
1655	3						
1707	4			1277			

Table C-1 (Cont'd.)

Date/Time 1977	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
3/10/2058	1			1957			
2115	2			1334			
2131	3			1646			
	4						
4/10/1008	1			2372			
0937	2		1470	734			
0923	3						
0843	4			851			
11/10/1536	1	1141		456			
1521	2						
1505	3						
12/10/0919	1		855				
0844	2						
0835	3						
0804	4						
19/10/1600	1		882	1323			
1620	2		1107				
1640	3	639					
1700	4						
20/10/0837	1						
0903	2						
0930	3						
0942	4			1000			
4/11/1717	1	179		357			
1700	2		172				
1639	3	600		600			
1620	4	177	354	885			
5/11/1028	1		1071	893			
1006	2			192			
0945	3			681			
1059	4		2500	179			
12/11/1505	1			1709			
1520	2			1370		684	
1535	3			715			

Table C-1 (Cont'd.)

Date/Time 1977	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
12/11/1944	1			3472			
1929	2	177		3540		531	
1913	3			2800		347	
13/11/1000	1		185	926		1481	
0946	2		175	900		900	
0933	3		362	1100		543	
0915	4			577		192	
20/11/1655	1			729			
1643	2	506		844			
1623	3	169		337			
1608	4	324		1300			
20/11/2005	1	471		1883			
1950	2	140		1253			
1935	3	258		258			
21/11/0935	1	233		1400			
0918	2	233		233			
0905	3						
0845	4	170		511			
28/11/1704	1		336	1008			
1648	2			1248			
1635	3						
1620	4						
28/11/2042	1			1138			
2028	2	254	254	761			
2015	3						
29/11/0941	1		383	1914			
0928	2	347	2083				
0915	3		600	200			
6/12/1647	1			1212			
1633	2			1223			
1621	3			1218			
1608	4			230			

Table C-1 (Cont'd.)

Date/Time 1977/78	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
6/12/2102	1						
2048	2			2360			
2036	3			1490			
7/12/0900	1	426		1500			
0848	2	296		1481			
0836	3			1186			
13/12/1714	1			984		1181	
1702	2						
1650	3			730		464	
14/12/1130	1		639	639		2874	
1127	2		229	229		229	
1115	3					962	
22/12/1743	1						
1725	2			2674			
1710	3	262	524	4193			
23/12/1000	1	782		3912			
0945	2	263		2632			
0930	3						
7/1/1630	1			445			
1615	2	333	333				
1600	3						
8/1/0945	1						
0930	2						
0915	3						
15/1/1657	1		304	304			
1643	2		286		2023	853	
1630	3			4350	701		
1615	4			314	1570	1570	

Table C-1 (Cont'd.)

Date/Time 1978	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
16/1/0945	1			958	319	1916	
0930	2		678	3049			
0925	3		426	1923		2778	
0912	4		1269	3490	1269	317	
23/1/1624	1			11691		116913	
1609	2			18174		169628	
1556	3			33228			
24/1/0924	1			559		1119	
0912	2					378	
0859	3					731	
31/1/1610	1		1556	8222			
1557	2		885	8628	1106		212
1545	3		882	17416	661	882	
1/2/0919	1		2013	15138	4415	409	
0907	2		337	16518		337	
0854	3		638	15301	319	638	
8/2/1545	1		808	1416	2020	8889	
1528	2			459	3755	2074	
1515	3			1576		17086	
9/2/0938	1			3048		77772	
0925	2			2822		11704	
0912	3			233		2490	
16/2/1623	1			144805			
1611	2			2125		4854	
1559	3			1051	1051	3153	
17/2/0841	1			93744		54684	
0848	2			10490			10490
0906	3						

Table C-1 (Cont'd.)

Date/Time 1978	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
24/2/1650	1						
1638	2						
1625	3			278			30898
25/2/0936	1						
0919	2						
0912	3		1462	2924			
4/3/1625	1			1613			1613
1612	2		1355	1355			
1600	3			1393	1393		
5/3/0949	1		1515	1515			
0937	2						
0924	3						
0910	4						
12/3/1556	1			1240			2481
1608	2			2075			
1621	3						
13/3/0933	1			1524			
0920	2						
0908	3		1351	1351			
20/3/1628	1			2302			4968
1616	2	1601					1601
1604	3	1182		1182			
21/3/0939	1						
0926	2			2315			
0912	3	1510					
29/3/1543	1	1623		11360			
1528	2	1989					
1510	3	2083		1389			

Table C-1 (Cont'd.)

Date/Time 1978	Station	Dino-physis	Fragi-llaria	Globi-gerina	Isthmia	Lauderia	Navicula
30/3/0958	1						
0945	2			4623			
0933	3		2866	9553	5732		
0920	4			3306			
7/4/1619	1			345			
1606	2		476	484			
1553	3	238		476			
7/4/2007	1			345			
1955	2	400		400			
1945	3			263			
8/4/0910	1			667			
0858	2			600			
0845	3	556	556				
15/4/1605	1						
1550	2	1379		345			
1537	3		1042				
15/4/2018	1			833			
2005	2			789			
1950	3			2500			
16/4/0930	1		588				
0915	2	1154		1538			
0900	3						
19/4/1610	1			1034			
1557	2						
1545	3			938			
19/4/2032	1			1000			
2020	2						
2007	3						
20/4/0936	1						
0924	2						
0906	3						

Table C-1 (Cont'd.)

Date/Time 1977	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
2/7/1020	1	3058	254		254		4077
1045	2	9416			1883		3766
1057	3	5183	152		610		1372
1110	4	4750	500		1250		1000
7/7/0956	1		11275		5125		
1010	2	448	11424		2688		
0940	3		2702		1351		
0928	4		1107		369		
7/7/1319	1		9505		6719		
1347	2		3009		4398		
1303	3	160	19476		1596		
1250	4		4667		1556		
13/7/1106	1	2353	17646		4118		
1040	2	553	15754		3040		
1025	3	4091	65908	454	16363		454
1010	4	666	32666	1111	8666		222
13/7/1608	1	2894	2632		3421		526
1540	2	4000	10500		14500		
1521	3	4912	12554		10916		
1510	4	4500	8000		13750		
13/7/2107	1	3292	1646		823		
2040	2	6556	5866	345	5866		
2015	3	4654	8434	291	10180		
2028	4	6347	13848		8366		
25/7/1143	1	5290	8391	364	3283		
1106	2	3663	8343	407	5494		
1051	3	7888	11904		4216		
1037	4	4286	4946	164	3956		
8/8/1014	1	5783	13670	262	4732		
1044	2	9420	24868		3202		
1029	3	7854	35214		16285		
1012	4	3050	3660		2633		
8/8/1600	1	5789	30789	1052	5000		
1540	2	3421	22631		5526		
1525	3	5000	34736		7368		
1510	4	5000	23158		5000		

Table C-1 (Cont'd.)

Date/Time 1977	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
15/8/0955	1	808	6260		4038		
0935	2	5330	35465		12095		
0920	3	2912	13441	1120	12097		
0905	4	4644	20598	808	7471		
23/8/1005	1	2191	13650		3408		
0950	2	2982	10188	1242	3479		
0935	3	5334	13336		2667		
0920	4	2849	6105	611	3460		
5/9/1015	1	1666	26111	370	16666		
1030	2	386	6654	771	7517		
1042	3	2222	14259	2222	7037		
1100	4	3018	33206	3207	30942		
5/9/1508	1	1786	10516		11111		1587
1526	2	3263	10333	3082	10900		362
1543	3	1170	9018	1837	4843		167
1606	4	414	8065	827	2700		
5/9/1911	1	1600	7210	541	3785		
1929	2	3313	15004	1754	8000		200
1915	3	2700	10978	1733	6550		
2017	4	3134	8357	1741	6100		
25/9/1510	1	6865	7818		5150		
1535	2	14183	10337		5530		
1600	3	1000	1855		4883		
1615	4	19900	4200		4453		
25/9/2015	1	22000	3171		4558		
2000	2	28074	4508		5123		
1945	3	16400	3239		6883		
1930	4	16508	2064		2700		
26/9/0851	1	9048	1180		7081		
0914	2	1154			4430		
0930	3	2000			1333		
0950	4	3415	2812	200	219		
3/10/1610	1	11541	12128		2543		
1630	2	12820	3632		3205		
1655	3	8904	2710		2904		
1707	4	15645	10856		2874		

Table C-1 (Cont'd)

Date/Time 1977	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
3/10/2058	1	10111	9132		981		
2115	2	17343	9605		2935		
2131	3	23045	1649		4938		
4/10/1008	1	7117	19178		4152		
0937	2	13480	19100		2936		
0923	3	3882	24988		5095		
0843	4	6386	15326		1277		
11/10/1536	1	3193	6615	684	10948		
1521	2		4174		14378		
1505	3	3200	4801		13946		
12/10/0919	1	17094	11111		6624		
0844	2	7137	6752		10224		
0835	3	12575	3003		6381		
0804	4		4526		11940		
19/10/1600	1	2205	1323		14110		
1620	2	7525	221		7968		
1640	3	1915			1500		
1700	4		975		9016		
20/10/0837	1	2900	70000		6222		
0903	2	1230	410		2665		
0930	3	2849	814		3256		
0942	4	2570	791		5733		
4/11/1717	1	3900	357	179	4300		179
1700	2	500	400		172		
1639	3	5000	1800	400	9000		
1620	4	4100	1100		7200		
5/11/1028	1	357	1400	200	3400		200
1006	2	1500	1500		6000		192
0945	3	500	227		4300		
1059	4	1300	1300	500	6100		1300
							131
12/11/1505	1	2100			1100		
1520	2	500	228		3000	500	228
1535	3	179	715		1100		

Table C-1 (Cont'd.)

Date/Time 1977	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
12/11/1944	1	200	600		2100	800	
1929	2	177			1300	500	
1913	3	174	174		1400	700	
13/11/1000	1	185	926		4500	600	
0946	2	700		400	1700	2100	175
0933	3	174	174		1400	700	
0915	4		577		400	2300	600
20/11/1655	1	146	900		1000		
1643	2		800		1200	200	
1623	3		500		1300	169	
1608	4		162		2300		
20/11/2005	1	200	1412	471	4800		
1950	2	300	400	139	2200		
1935	3		258	258	2900		
21/11/0935	1	500		233	2100		
0918	2	233	700		1200		
0905	3		1200		1005		
0845	4		400		400		
28/11/1704	1	1300		672	3000		300
1648	2	600	312		4700		
1635	3	1800	800		2300		
1620	4	800	928		1900		
28/11/2042	1	3400	1517		4600		
2028	2	2300	1775		2300		
2015	3	256	512		1600		
29/11/0941	1	383	766		1531		
0928	2	1700	350		2400		
0915	3	1000	200		1176		
6/12/1647	1	500	2910		3600		
1633	2	500	1700		3900		
1621	3		1218		2200	300	
1608	4		900		2800	500	

Table C-1 (Cont'd.)

Date/Time 1977/78	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
6/12/2102	1	505			897		
2048	2	800	262		1048		
2036	3		3000		1800	596	
7/12/0900	1		1100		5100	1702	
0848	2		1600		1800	200	
0836	3		400		2767		
13/12/1714	1		1600		1800	1800	
1702	2		800		1500	2400	
1650	3				3700	1400	
14/12/1130	1	1000			5100	4800	
1127	2		914		1828	2100	
1115	3		1277		3200	3800	
22/12/1743	1				2580		
1725	2		1040		3900	200	
1710	3		524		2400	262	262
23/12/1000	1				4300	400	
0945	2		1100		2900	800	
0930	3		467		700		
7/1/1630	1				6886		4315
1615	2			333	3332	6664	
1600	3					3753	
8/1/0945	1		6076		12118		
0930	2		858			858	
0915	3				2701		
15/1/1657	1				1821	3304	
1643	2				29854		
1630	3		701		1401		
1615	4				1256	314	

Table C-1 (Cont'd.)

Date/Time 1978	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
16/1/0945	1		319		1596	1277	
0930	2				2033	678	
0925	3				1068	426	
0912	4				3173	952	
23/1/1624	1				40920	5846	
1609	2				54523		
1556	3				9494		
24/1/0924	1				2424	1491	
0912	2				2100	600	
0859	3					731	
31/1/1610	1				3600	1111	
1557	2				2212	2434	
1545	3		220		2900	1102	
1/2/0919	1	216			8173	4067	817
0907	2	337			1656	2240	
0854	3	954				1913	
8/2/1545	1	1212			6069		
1528	2	7819			1527		
1515	3		796		1192	1192	
9/2/0938	1				4007	254	
0925	2				1881		
0912	3				1629		
16/2/1623	1				1720		
1611	2	92593			2429		
1559	3	128205			64103		
17/2/0841	1	696570			70309		
0848	2	31469					
0906	3				1004		

Table C-1 (Cont'd.)

Date/Time 1978	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
24/2/1650	1						
1638	2	47770			47770		
1625	3	16949			556		
25/2/0936	1	1412					
0919	2	1742					
0912	3	1462					
4/3/1625	1	1613					1613
1612	2	1355					
1600	3	2786					1393
5/3/0949	1	1515					
0937	2						
0924	3				6342		
0910	4				4184		
12/3/1556	1	3722					1240
1608	2				2075		
1621	3	3846			3846		
13/3/0933	1				1524		
0920	2	1250			1250		
0908	3				1351		
20/3/1628	1						
1616	2				1601		
1604	3				2364		
21/3/0939	1	5113					
0926	2				2315		
0912	3	1510			1510		
29/3/1543	1				54365		
1528	2				1326		
1510	3				2778		

Table C-1 (Cont'd.)

Date/Time 1978	Station	Nitschia	Orintho-cercus	Pala-chroma	Peri-dinium	Plankto-niella	Pleuro-sigma
30/3/0958	1		3398		18688		
0945	2				4623		
0933	3				19106		
0920	4				3968		
7/4/1619	1			357	3571		
1606	2		806		4032		
1553	3				2738		
7/4/2007	1				895		
1955	2		600		1800		
1945	3				1579		
8/4/0910	1		500		5333		
0858	2		800		8000		
0845	3				5000		
15/4/1605	1				11428		
1550	2				8448		517
1537	3				3125		
15/4/2018	1		556		14322		
2005	2				3421		
1950	3				2500		
16/4/0930	1		1029		3971		1029
0915	2				18462		
0900	3		750		7250		
19/4/1610	1				3621		
1557	2				5500		
1545	3				2031		
19/4/2032	1		1000		3000		
2020	2		500				
2007	3				909		
20/4/0936	1				1563		
0924	2		1333		2000		
0906	3						

Table C-1. (Cont'd)

Date/Time 1977	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
2/7/1020	1		510				
1045	2		376				
1027	3		152				
1110	4		750				
7/7/0956	1						
1010	2		224				
0940	3		338				
0928	4						
7/7/1319	1		492				
1347	2		1157				
1303	3		319				
1250	4		622				
13/7/1106	1		2647				
1040	2		3593				
1025	3		1818				
1010	4		2888				
13/7/1608	1						526
1540	2		1000				
1521	3						
1510	4		13000				500
13/7/2107	1		2058				1234
2040	2		3450				
2015	3		1163				
2028	4		2885				
25/7/1143	1		730				
1106	2		3663				
1051	3		992				248
1037	4		989				
8/8/1014	1		17087				8938
1044	2		10926				8478
1029	3		16185				49212
1012	4		2440				
8/8/1600	1		13947				9211
1540	2		15263				13158
1525	3		9211				14474
1510	4		11316				7105

Table C-1 (Cont'd)

Date/Time 1977	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
15/8/0955	1		7380				
0935	2						1025
0920	3		5376				896
0905	4		4038				2019
23/8/1005	1		10470				11931
0950	2		8201				21620
0935	3		10669				26912
0920	4		10989				30932
5/9/1015	1		1851				
1030	2		3084				
1042	3		4814				
1100	4		4905				
5/9/1508	1		2778				
1526	2		1300				
1543	3		1170				
1606	4		5170				
5/9/1911	1		11900				1082
1929	2		21240				7210
1915	3		10600				2504
2017	4		20543				4004
25/9/1510	1		1716				783753
1535	2		2163				1064663
1600	3		2734				423828
1615	4		524				290113
25/9/2015	1		2973				900912
2000	2		2254				901640
1945	3		2227				677732
1930	4		2485				579850
26/9/0851	1		4721				436371
0914	2		1900				10763
0930	3		4444				874222
0950	4		2411				347127
3/10/1610	1		90962				35798
1630	2		143600				818376
1655	3		99700				35617
1707	4		137612				104406

Table C-1 (Cont'd.)

Date/Time 1977	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
3/10/2058	1		128180				58382
2115	2		89114				62433
2131	3		9465				24280
4/10/1008	1		2617438				34400
0937	2		176946				28634
0923	3		427220				15526
0843	4		42571				6386
11/10/1536	1		5474				684
1521	2		5334				
1505	3		2286				
12/10/0919	1		36752				4060
0844	2		28164				578
0835	3		17267				938
0804	4		24793				
19/10/1600	1		12125				4200
1620	2		8632				7525
1640	3		5321				3406
1700	4		6578				7310
20/10/0837	1		20444				4900
0903	2		11275				2870
0930	3		7733				3053
0942	4		10083				4547
4/11/1717	1		1607				
1700	2		1034				
1639	3		1600				
1620	4		531				
5/11/1028	1		3035				357
1006	2		4038				385
0945	3		4100				227
1059	4		2857				900
12/11/1505	1		9200				1923
1520	2	68	8667				3200
1535	3		1430				715

Table C-1 (Cont'd.)

Date/Time 1977	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
12/11/1944	1	2315	4050				578
1929	2	885	5662				2477
1913	3	347	5382				2800
13/11/1000	1	1111	117				556
0946	2	701	5435			351	1600
0933	3	904	3075				3075
0915	4	1538	2500				1538
20/11/1655	1	146	1500				
1643	2	675	1519				
1623	3	169	337				
1608	4		486				
20/11/2005	1	471	8475				471
1950	2	557	5300	278			1113
1935	3	775	2841				775
21/11/0935	1		1400	233			
0918	2	233	1165				
0905	3	146	281				146
0845	4	511	341	170			
28/11/1704	1	336	4032				
1648	2		1248	624		312	
1635	3		513	513			
1620	4		578			578	
28/11/2042	1		5690			1900	758
2028	2		2282				254
2015	3		2050			256	512
29/11/0941	1	383	3063			766	1531
0928	2		2800			700	
0915	3	600	3527			600	
6/12/1647	1		4850			242	1455
1633	2	500	7100	245		734	1567
1621	3		354	487		487	
1608	4	230	2073	230		461	230

Table C-1 (Cont'd.)

Date/Time 1977-78	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
6/12/2102	1		8652				
2048	2		7075			524	1834
2036	3		11025	894		1200	6257
7/12/0900	1	426	19800	213		638	8936
0848	2	1333	10515	600		1925	4300
0836	3	790	11660	400			5731
13/12/1714	1	590	20700	984		787	37800
1702	2	751	12762	375		751	26652
1650	3	464	19017				88822
14/12/1130	1	1916	43423			319	74713
1127	2	914	33364				52559
1115	3	1600	87164	958		639	204662
22/12/1743	1	304	2118	178			804
1725	2	742	3119	148		446	594
1710	3	786	20702	524			2621
23/12/1000	1	2347	19171			1174	15649
0945	2	1315	13421			263	8200
0930	3		9804			700	
7/1/1630	1	1580	3240			1480	4005
1615	2	2333	2338			1000	6564
1600	3	3261	11892				630
8/1/0945	1		110018				2428
0930	2	2573				6358	1430
0915	3						
15/1/1657	1		141876				12447
1643	2		11437			286	18586
1630	3		17714				15763
1615	4		10678			314	6881

Table C-1 (Cont'd.)

Date/Time 1978	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
16/1/0945	1		29693	319		1916	40868
0930	2					6097	81301
0925	3					4274	49787
0912	4	952	50127			4442	57107
23/1/1624	1		2618962		81839	52611	175370
1609	2		2526252		115105	42407	193861
1556	3	14241	659810		18987	56962	66456
24/1/0924	1	746	16033	373	373	6339	2424
0912	2	1133	4000	200	200	6045	945
0859	3	1216	7310	244		17100	1500
31/1/1610	1	900	18444		444	4000	14222
1557	2	1327	30752			4425	27700
1545	3	900	30423	441		7937	29541
1/2/0919	1	2452	49040			11443	51920
0907	2	1348	25959			9776	43488
0854	3	956	14112			5150	30800
8/2/1545	1	404	235165		404	7677	5253
1528	2		43725			657	5637
1515	3	5679	856669	7794	7794	15099	3179
9/2/0938	1	3300	61655			10917	4316
0925	2	1881	461777			31408	13285
0912	3	693	177777		6698	2129	4634
16/2/1623	1		419500			1720	10318
1611	2	910	185185			1214	13352
1559	3		256110			2102	25221
17/2/0841	1	7912	925722		10624	23435	270800
0848	2		20979				31469
0906	3		183678				30111

Table C-1 (Cont'd.)

Date/Time 1978	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
24/2/1650	1		178571			59524	59524
1638	2		238853				47770
1625	3		67797		278		10949
25/2/0936	1		16949				2825
0919	2		15679				
0912	3		20468				462
4/3/1625	1		20968				
1612	2		17615				1355
1600	3		15320				1393
5/3/0949	1		39394				3030
0937	2		57803				3211
0924	3		50737				3171
0910	4		33473	4184			4184
12/3/1556	1		1240				
1608	2		8299				
1621	3		15385				
13/3/0933	1		3048				
0920	2						
0908	3		2702				
20/3/1628	1		1651				
1616	2		3201				1601
1604	3		2364				
21/3/0939	1		5113				1556
0926	2		4630				2315
0912	3		3020				1510
29/3/1543	1		17040				
1528	2		9281				
1510	3						

Table C-1 (Cont'd.)

Date/Time 1978	Station	Pyro-cystis	Rhizoso-lenia	Sagena	Skeleto-nema	Strepto-theca	Thalas-sionema
30/3/0958	1						
0945	2	3467	18493				
0933	3		4776				
0920	4						
7/4/1619	1		714	536			
1606	2		645				
1553	3	357	1191	357			
7/4/2007	1						
1955	2		1600				
1945	3	789	789				
8/4/0910	1		333	167			500
0858	2		1200				
0845	3	1111	930				
15/4/1605	1	1786					
1550	2		2586				
1537	3		1667				
15/4/2018	1		8055				
2005	2		2895				789
1950	3		8611				
16/4/0930	1		3235				
0915	2		6923				
0900	3		13250				
19/4/1610	1		1034				
1557	2	1000					
1545	3						
19/4/2032	1			1000			
2020	2						
2007	3		682				
20/4/0936	1	1563	1563				
0924	2		1333				
0906	3		4375	1250			2500

Table C-1 (Cont'd.)

Date/Time 1977	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
2/7/1020	1			19622	
1045	2				
1057	3				
1110	4			5250	250
7/7/0956	1				
1010	2				
0940	3				
0928	4				
7/7/1319	1				
1347	2				
1303	3				
1250	4				
13/7/1106	1				
1040	2				
1025	3				454
1010	4				444
13/7/1608	1				789
1540	2		3000		1000
1521	3				546
1510	4				
13/72107	1			65432	
2040	2				
2015	3				
2028	4				866
25/7/1143	1			819203	364
1106	2		611		407
1051	3				
1037	4	330			
8/8/1014	1	1052		1570977	
1044	2			666164	
1029	3	4811			1094
1012	4				
8/8/1600	1			876052	
1540	2				
1525	3				789
1510	4				

Table C-1 (Cont'd.)

Date/Time 1977	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
15/8/0955	1				
0935	2				
0920	3				
0905	4				
23/8/1005	1				
0950	2				
0935	3	2910			
0920	4	4070			
5/9/1015	1				370
1030	2				
1042	3				185
1100	4				
5/9/1508	1				
1526	2				
1543	3				
1606	4				207
5/9/1911	1	8800			
1929	2	5261			200
1915	3	770			
2017	4	2960			
25/9/1510	1	77613			200
1535	2	98317			
1600	3	25200			390
1615	4	48442			524
25/9/2015	1	68800			
2000	2	46926			1020
1945	3	52024			405
1930	4	47670			413
26/9/0851	1	61600			
0914	2	153000			
0930	3	139333			
0950	4	51828			
3/10/1610	1		978		391
1630	2		2137		
1655	3		774	194	
1707	4		958		

Table C-1 (Cont'd.)

Date/Time 1977	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
3/10/2058	1		325		1631
2115	2				
2131	3				
4/10/1008	1				
0937	2				
0923	3				485
0843	4				
11/10/1536	1	456			5474
1521	2				4406
1505	3				4572
12/10/0919	1				641
0844	2				
0835	3				375
0804	4	984			787
19/10/1600	1				2646
1620	2	1550			
1640	3				
1700	4				302880
20/10/0837	1	700			444
0903	2				1435
0930	3				1221
0942	4				593
4/11/1717	1				714
1700	2	172			
639	3				1200
1620	4				885
5/11/1028	1				1071
1006	2				1346
0945	3				1136
1059	4		1071		900
12/11/1505	1	541			855
1520	2				228
1535	3				357

Table C-1 (Cont'd.)

Date/Time 1977	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
12/11/1944	1	192			578
1929	2	708			885
1913	3	521			1245
13/11/1000	1				
0946	2	351			900
0933	3	543	181		543
0915	4				962
20/11/1655	1				1020
1643	2				1013
1623	3				674
1608	4				811
20/11/2005	1				706
1950	2				859
1935	3	258			1291
21/11/0935	1	233			233
0918	2				233
0905	3				861
0845	4				170
28/11/1704	1			336	
1648	2				
1635	3				513
1620	4	579		386	193
28/11/2042	1				379
2028	2				254
2015	3				512
29/11/0941	1	383			
0928	2	800			
0915	3				200
6/12/1647	1				
1633	2				
1621	3				244
1608	4	230			

Table C-1 (Cont'd.)

Date/Time 1977/78	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
6/12/2102	1				
2048	2				
2036	3				596
7/12/0900	1				
0848	2				
0836	3	1976			
13/12/1714	1				400
1702	2	938			375
1650	3	1400			
14/12/1130	1	1916			639
1127	2	2285			
1115	3				
22/12/1743	1				
1725	2				300
1710	3				
23/12/1000	1				782
0945	2				
0930	3				
7/1/1630	1				
1615	2				
1600	3				
8/1/0945	1				
0930	2				
0915	3				
15/1/1657	1	9911			607
1643	2				
1630	3				
1615	4				

Table C-1 (Cont'd.)

Date/Time 1978	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
16/1/0945	1				
0930	2	678			678
0925	3	426			426
0912	4				
23/1/1624	1				
1609	2				
1556	3				
24/1/0924	1				200
0912	2				400
0859	3				1000
31/1/1610	1	1600		700	
1557	2	1327			212
1545	3			700	
1/2/0919	1			2412	2860
0907	2	2697			337
0854	3		319		638
8/2/1545	1				
1528	2				
1515	3				
9/2/0938	1				
0925	2				
0912	3				
16/2/1623	1				
1611	2	2125			
1559	3				
17/2/0841	1				
0848	2	10490			
0906	3				

Table C-1 (Cont'd.)

Date/Time 1978	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
24/2/1650	1				
1638	2				
1625	3				
25/2/0936	1				
0919	2				
0912	3				
4/3/1625	1				
1612	2				
1600	3				
5/3/0949	1	2702			
0937	2	2500			
0924	3				
0910	4				
12/3/1556	1				
1608	2				
1621	3				
13/3/0933	1	1250			
0920	2				
0908	3	1351			
20/3/1628	1	1651			
1616	2				
1604	3				
21/3/0939	1				
0926	2				
0912	3				
29/3/1543	1				
1528	2				
1510	3				2083

Table C-1 (Cont'd.)

Date/Time 1978	Station	Thalassio-thrix	Tricera-tium	Tricho-desmium	Tripo-solenia
30/3/0958	1				6796
0945	2				
0933	3				
0920	4				
7/4/1619	1				
1606	2				
1553	3				238
7/4/2007	1				
1955	2				600
1945	3				
8/4/0910	1				1000
0858	2				1200
0845	3				741
15/4/1605	1				
1550	2				
1537	3				
15/4/2018	1				
2005	2				
1950	3				
16/4/0930	1				
0915	2				
0900	3				
19/4/1610	1				
1557	2				
1545	3				
19/4/2032	1				
2020	2				
2007	3				
20/4/0936	1				628
0924	2				805
0906	3				

Table C-2. Surface water temperatures and salinities of the 4 stations located on the spawning grounds off Batbatan Island 1977/78. Station 4 was not sampled consistently.

Station	Date/Time 1977	Water Temp. °C	Water Salinity ppt	Date/Time 1977	Water Temp. °C	Water Salinity ppt
1	2/7/1020	28.0	35.0	15/8/0955	28.3	33.5
2	1045	29.5	35.0	0935	28.8	33.4
3	1057	30.0	34.1	0920	28.7	33.8
4	1110	29.9	34.6	0905	29.0	33.5
1	7/7/0956	29.6	34.4	23/8/1005	29.0	33.5
2	1010	29.8	34.6	0950	29.2	33.8
3	0940	29.8	34.2	0935	28.8	33.4
4	0928	29.0	34.4	0920	28.3	33.5
1	7/7/1319	29.8	34.4	5/9/1015	28.4	33.3
2	1347	29.8	34.5	1030	28.5	33.6
3	1303	29.6	34.2	1042	28.5	33.7
4	1250	30.0	34.5	1100	28.6	33.7
1	13/7/1106	29.4	33.6	5/9/1508	29.0	33.6
2	1040	29.6	34.1	1526	28.7	33.2
3	1025	29.1	34.2	1543	29.2	33.4
4	1010	29.5	34.0	1606	28.4	33.8
1	13/7/1608	29.8	34.1	5/9/1911	28.5	33.5
2	1540	29.9	34.0	1929	28.5	33.4
3	1521	29.8	34.2	1915	28.5	33.4
4	1510	30.3	34.0	2017	28.5	33.4
1	13/7/2107	29.0	34.3	25/9/1510	28.4	33.2
2	2040	29.0	34.2	1535	27.9	33.6
3	2015	29.1	33.7	1600	28.2	33.0
4	2028	29.6	34.1	1615	28.3	33.6
1	25/7/1143	28.9	33.7	25/9/2015	28.7	33.4
2	1106	29.0	33.0	2000	28.9	33.3
3	1051	28.9	34.0	1945	28.0	33.4
4	1037	29.1	33.2	1930	28.0	33.7
1	8/8/1014	29.3	33.6	26/9/0851	30.0	34.2
2	1044	28.9	34.0	0914	29.8	34.6
3	1029	28.9	34.0	0930	30.0	34.5
4	1012	29.0	34.2	0950	30.1	34.5
1	8/8/1600	29.9	34.0	3/10/1610	29.3	34.3
2	1540	29.8	34.0	1630	27.5	34.1
3	1525	29.8	34.2	1655	27.5	34.0
4	1510	30.3	34.0	1707	27.5	34.1

Table C-2 (Cont'd.)

Station	Date/Time 1977	Water Temp. °C	Water Salinity ppt	Date/Time 1977	Water Temp. °C	Water Salinity ppt
1	3/10/2058	27.3	34.1	12/11/1944	28.0	34.7
2	2115	27.5	34.1	1929	28.0	34.5
3	2131	27.5	34.1	1913	28.0	34.5
1	4/10/1008	28.5	34.0	13/11/1000	28.2	34.2
2	0937	29.5	34.2	0946	28.5	34.2
3	0923	28.5	34.2	0933	28.2	34.2
4	0843	28.5	34.0	0915	28.5	34.3
1	11/10/1536	27.6	34.3	20/11/1655	28.0	34.0
2	1521	27.6	34.0	1643	28.2	35.0
3	1505	27.5	34.2	1623	28.5	34.4
4				1608	28.0	34.2
1	12/10/0919	27.5	34.3	20/11/2005	28.0	35.0
2	0844	27.5	34.2	1950	28.0	34.5
3	0835	27.5	34.3	1935	28.0	34.5
4	0804	27.5	34.0			
1	19/10/1600	28.1	34.6	21/11/0935	28.5	34.2
2	1620	28.4	34.7	0918	28.5	34.2
3	1640	28.3	34.6	0905	28.0	34.2
4	1700	28.5	35.0	0845	28.2	34.5
1	20/10/0837	29.0	35.0	28/11/1704	29.0	35.1
2	0903	28.7	34.7	1648	29.0	35.1
3	0930	28.7	34.4	1635	29.0	35.1
4	0942	28.6	35.0	1620	29.0	35.1
1	4/11/1717	27.5	34.4	28/11/2042	29.0	35.0
2	1700	27.5	33.0	2028	29.0	35.0
3	1639	27.6	34.0	2015	29.0	35.0
4	1620	26.8	33.0			
1	5/11/1028	29.5	33.3	29/11/0941	28.2	35.0
2	1006	29.3	33.1	0928	28.2	34.0
3	0945	29.5	33.3	0915	28.6	35.0
4	1059	28.4	33.2			
1	12/11/1505	28.0	34.0	6/12/1647	28.3	34.4
2	1520	29.0	35.0	1633	28.2	34.4
3	1535	28.0	34.4	1621	28.5	35.0
4						

Table C-2 (Cont'd.)

Station	Date/Time 1977/78	Water Temp. °C	Water Salinity ppt	Date/Time 1978	Water Temp. °C	Water Salinity ppt
1	6/12/2102	28.2	34.7	24/1/0924	26.8	35.2
2	2048	28.2	34.4	0912	26.5	35.0
3	2036	28.3	35.0	0859	26.2	35.0
1	7/12/0900	28.5	34.7	31/1/1610	27.0	35.4
2	0848	28.8	35.0	1557	27.0	35.5
3	0836	28.5	35.0	1545	27.0	35.1
1	13/12/1714	28.5	34.6	1/2/0919	26.5	34.5
2	1702	28.2	35.5	0907	26.5	35.3
3	1650	28.5	34.6	0854	27.0	35.0
1	14/12/1130	28.8	36.0	8/2/1545	27.0	35.1
2	1127	29.0	35.0	1528	27.2	35.0
3	1115	28.5	34.7	1515	27.0	35.3
1	22/12/1743	27.3	35.5	9/2/0938	27.0	35.0
2	1725	27.0	35.4	0925	27.0	35.0
3	1710	27.0	35.3	0912	27.0	34.5
1	23/12/1000	28.0	36.6	16/2/1623	27.0	34.1
2	0945	28.0	36.4	1611	27.0	34.2
3	0930	27.5	36.5	1559	27.0	34.2
1	7/1/1630	27.8	34.7	17/2/0841	27.0	34.4
2	1615	27.5	35.1	0848	27.0	34.4
3	1600	28.0	35.5	0906	27.0	34.5
1	8/1/0945	27.0	35.1	24/2/1650	27.0	34.5
2	0930	27.0	35.1	1638	26.8	34.3
3	0915	27.2	35.0	1625	27.0	34.5
1	15/1/1657	27.5	35.0	25/2/0936	27.0	34.3
2	1643	27.5	35.1	0919	26.0	34.4
3	1630	27.5	35.0	0912	27.0	34.3
4	1615	28.5	35.0			
1	16/1/0945	27.0	35.1	4/3/1625	27.5	34.2
2	0930	27.0	35.1	1612	27.5	35.0
3	0925	27.0	35.3	1600	27.5	34.4
4	0912	27.0	35.1			
1	23/1/1624	26.8	35.0	5/3/0949	28.0	34.3
2	1609	26.8	34.5	0937	28.0	34.4
3	1556	26.8	35.0	0924	27.5	34.3
4				0910	27.5	34.3

Table C-2 (Cont'd.)

Station	Date/Time 1978	Water Temp. °C	Water Salinity ppt	Date/Time 1978	Water Temp. °C	Water Salinity ppt
1	12/3/1556	27.5	34.5	8/4/0910	27.0	35.3
2	1608	27.3	35.0	0858	27.0	35.0
3	1621	27.3	35.0	0845	27.0	35.5
1	13/3/0933	27.0	35.1	15/4/1605	30.0	32.4
2	0920	26.7	33.3	1550	30.0	34.5
3	0908	27.1	35.2	1537	30.0	34.4
1	20/3/1628	29.0	34.3	15/4/2018	28.0	34.4
2	1616	29.0	35.0	2005	28.0	34.4
3	1604	29.0	34.4	1950	29.0	34.1
1	21/3/0939	27.3	34.8	16/4/0930	29.0	34.5
2	0926	27.4	34.5	0915	29.0	34.5
3	0912	27.4	34.3	0900	29.0	34.5
1	29/3/1543	29.0	35.3	19/4/1610	28.5	34.6
2	1528	29.0	35.3	1557	28.5	34.7
3	1510	29.0	35.3	1545	28.6	34.6
1	30/3/0958	27.8	31.0	19/4/2032	28.3	34.5
2	0945	27.7	31.0	2020	28.3	34.5
3	0933	27.7	31.3	2007	28.3	34.5
4	0920	27.7	31.0			
1	7/4/1619	28.2	34.4	20/4/0936	27.8	34.5
2	1606	28.0	34.3	0924	27.6	34.5
3	1553	28.0	34.4	0906	28.0	34.6
1	7/4/2007	27.0	35.3			
2	1995	27.2	35.2			
3	1945	27.5	35.4			

Table C-3. Number of zooplankters by genera or types per 100 m^3 collected during 10 minute surface plankton tows of the 4 stations located on the spawning grounds off Batbatan Island 1977/78. Station 4 was not sampled consistently. Blanks in the table mean that no zooplankton of that genus or type were collected at that time at that station.

Date/Time 1977	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Belanus
2/7/1020	1			46	138		
1045	2			68	442		
1057	3			2	192		
1110	4				141		
7/7/0956	1			120	403		
1010	2			234	1289		
0940	3			396	274		
0928	4			300	300		
7/7/1319	1			102	153		
1347	2			112	617		
1303	3			118	100		29
1250	4			63	411		
13/7/1106	1				159		
1040	2			550	250		100
1025	3			81	573		
1010	4				100		100
13/7/1608	1			436	100		
1540	2			137	45		
1521	3			49	99		
1510	4			355	45		45
13/7/2107	1			298	223		
2040	2			375	250		
2015	3			312	260		
2028	4				210		104
25/7/1143	1				459		
1106	2			119	39		
1051	3				86		
1037	4			86	43		
8/8/1014	1			95	190		
1044	2			170	238		
1029	3			196	151		
1012	4			209			
8/8/1600	1	47		94	94		
1540	2				408		
1525	3			39	315		
1510	4						

Table C-3 (Cont'd.)

Date/Time 1977	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
15/8/0955	1				181		
0935	2				185		37
0920	3			40	121		
0905	4						
23/8/1005	1	88		219	132		
0950	2				133		
0935	3			44	44		
0920	4			147	147		
5/9/1015	1			97	195		
1030	2			590	347		
1042	3			60			
1100	4			179	36		
5/9/1508	1			409	492		
1526	2			267	167		
1543	3			61	491		
1606	4			34	203		34
5/9/1911	1				199		33
1929	2		127	85	551		42
1915	3				269		38
2017	4				263		76
25/9/1510	1				749		
1535	2			43	431		
1600	3			106	176		
1615	4				38		
25/9/2015	1				393		36
2000	2			37	147		74
1945	3	182		37	365		
1930	4	148			296		
26/9/0851	1				177		
0914	2				114		
0930	3			40	40		
0950	4				36		
3/10/1610	1			35	35		
1630	2			76	423		
1655	3			200	69		
1707	4			57	57		

Table C-3 (Cont'd.)

Date/Time 1977	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
3/10/2058	1			176	117		
2115	2						
2131	3				173		
4/10/1008	1				35		
0937	2				88		
0923	3				826		
0843	4				153		
11/10/1536	1				164		
1521	2				42		
1505	3				82		
12/10/0919	1		38		38		
0844	2				35		
0835	3				169		
0804	4			34			
19/10/1600	1			238			
1620	2				80		40
1640	3			191	114		
1700	4			44	44		
20/10/0837	1				160		40
0903	2			74			37
0930	3			620			
0942	4			1170	71	35	
4/11/1717	1			32			
1700	2				95		
1639	3				71		
1620	4		32	64	96		64
5/11/1028	1				32		
1006	2						35
0945	3					41	
1059	4				32		
12/11/1505	1				38		
1520	2						
1535	3				64		32

Table C-3 (Cont'd.)

Date/Time 1977	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
12/11/1944	1					35	35
1929	2				223	32	159
1913	3				62		
13/11/1000	1				367	100	33
0946	2				95	32	
0933	3				64		
0915	4						
20/11/1655	1		79		183		
1643	2		90		182		
1623	3				303		
1608	4				117	29	
20/11/2005	1		42		42		42
1950	2		25		200		25
1935	3				327		
21/11/0935	1				126		
0918	2		42		336		
0905	3				311		
0845	4				62		
28/11/1704	1				60	181	
1648	2				224	56	
1635	3				278		
1620	4				278		
28/11/2042	1				68		
2028	2						
2015	3				148		
29/11/0941	1						
0928	2			250	126		63
0915	3				35	35	
6/12/1647	1		43				
1633	2						
1621	3				219		
1608	4						

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
6/12/2102	1		49		392		
2048	2		141	94			
2036	3		53				
7/12/0900	1		38		38	77	
0848	2			27	27		
0836	3						
13/12/1714	1				35		
1702	2		34		68		
1650	3			42	42		
14/12/1130	1		172			230	
1127	2		41			41	41
1115	3				115	115	
22/12/1743	1						37
1725	2						
1710	3		94	47		47	
23/12/1000	1				141		
0945	2		48				
0930	3		210		546		
7/1/1630	1		57				57
1615	2						61
1600	3						38
8/1/0945	1		55		55		55
0930	2		52				
0915	3		64				128
15/1/1657	1		60			60	
1643	2						
1630	3				513	128	
1615	4		57		386		

Table C-3 (Cont'd.)

Date/Time 1978	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
16/1/0945	1					57	
0930	2				121		
0925	3				269		
0912	4						
23/1/1624	1		175		245		
1609	2	945					
1556	3	114					
24/1/0924	1				67		
0912	2						
0859	3		131				
31/1/1610	1	280			240		
1557	2	80		40			40
1545	3	40	40				
1/2/0919	1						
0907	2				53		
0854	3		50				
8/2/1545	1	823					127
1528	2	64			1154		
1515	3				625		
9/2/0938	1				200		
0925	2				482		
0912	3		36		36		
16/2/1623	1	63					
1611	2						48
1559	3	192			38		38
17/2/0841	1	189					
0848	2						
0906	3				368		

Table C-3 (Cont'd.)

Date/Time 1978	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
24/2/1650	1	700					
1638	2	287					
1625	3	244					
25/2/0936	1	102			154		51
0919	2						
0912	3	606			158		
4/3/1625	1						29
1612	2						
1600	3	75					
5/3/0949	1	27	27		190		
0937	2		17	34	17		
0924	3	505			1197		
0910	4				83		167
12/3/1556	1	67	37		22		
1608	2	75					
1621	3	205					
13/3/0933	1	27					
0920	2				23		23
0908	3	291			98		
20/3/1628	1	89			30		
1616	2				201		
1604	3	21			255		
21/3/0939	1	550			413		
0926	2	167			458		
0912	3	82			516		
29/3/1543	1	205			58		
1528	2	120			263		
1510	3	167			63		
30/3/0958	1				92		92
0945	2	792			250		42
0933	3	138					69
0920	4	16			49		

Table C-3 (Cont'd.)

Date/Time 1978	Station	Acartia	Agalma	Asterias	Atlanta	Balano-glossus	Balanus
7/4/1619	1	460			131		360
1606	2	1265					
1553	3	252			63		
7/4/2007	1	2105			175		
1955	2	851					35
1945	3	143					333
8/4/0910	1	370			370		122
0858	2	816			603		248
0845	3	200	33		267		
15/4/1605	1			137	480		
1550	2	247			401		
1537	3			75	301		
15/4/2018	1	441		200	245		
2005	2	1200			250		
1950	3	250					
16/4/0930	1	516		160	240		
0915	2	141			563		
0900	3	275			275		
19/4/1610	1	188					
1557	2	491					
1545	3	83					
19/4/2032	1						
2020	2						
2007	3				163		
20/4/0936	1						
0924	2						
0906	3	168					

Table C-3 (Cont'd.)

Date/Time 1977	Station	Basia	Boli-nopsis	Calanus	Centro-pages	Copilla	Con-choecia
2/7/1020	1			22798		596	
1045	2			3220		440	102
1057	3			3489		164	54
1110	4			896			
7/7/0956	1	120		8508		564	645
1010	2	78		8320		156	1132
0940	3			4695		60	91
0928	4		3	1033		166	3
7/7/1319	1	51	204	5255		765	204
1347	2	168	280	12921		505	617
1303	3	325	59	2159		295	325
1250	4	601	63	6898		601	506
13/7/1106	1	159		1648		159	212
1040	2	250	550	4900		900	100
1025	3	1639	901	12950		3442	163
1010	4	280	120	3680		1280	100
13/7/1608	1	145	145	7669		2524	242
1540	2	91	45	4954		2568	91
1521	3			9207		1881	99
1510	4	225	135	2567		1126	
13/7/2107	1	373	74	8955		373	3880
2040	2	375		3437		200	1875
2015	3	208	260	4114		885	2345
2028	4	159	151	5789		157	1263
25/7/1143	1	287		1264			
1106	2	238		351		119	
1051	3	86	43	1206		129	
1037	4	646		1767		388	
8/8/1014	1		47	5714			
1044	2			3503			
1029	3			3503			
1012	4		34	559		69	
8/8/1600	1			3160		47	47
1540	2	34	34	3197		34	
1525	3			4921		79	39
1510	4		36	992			73

Table C-3 (Cont'd.)

Date/Time 1977	Station	Basia	Bolinopsis	Calanus	Centropages	Copilla	Conchoecia
15/8/0955	1			10434		579	435
0935	2			2962		407	222
0920	3	40		6129		968	282
0905	4	145		797		145	
23/8/1005	1			1535		263	
0950	2			6607		267	133
0935	3	44		4166		88	175
0920	4	74		2719			
5/9/1015	1	162	32	1849	32	129	195
1030	2	521		694		35	173
1042	3			91			303
1100	4	107		268		143	321
5/9/1508	1	697		4017	41	287	2292
1526	2	233		3299		233	799
1543	3	460		4324		307	8036
1606	4	135	34	1892		439	169
5/9/1911	1	99		1467		67	267
1929	2	467		4489		339	2330
1915	3	308		3653		231	2614
2017	4	142		3458		76	677
25/9/1510	1	68		20544	137		753
1535	2	259		13490		43	819
1600	3	35		8767			
1615	4	38	76	3458	38		
25/9/2015	1	143		9213	214	72	393
2000	2		37	8158	37	37	110
1945	3	146		7626	474		255
1930	4	148		6702	148		222
26/9/0851	1	35		7728		35	70
0914	2			8721			76
0930	3	40		840			120
0950	4	36	145	1811		36	217
3/10/1610	1			2535		35	141
1630	2			15691			76
1655	3		139	18738		244	314
1707	4	172		19597	57	114	287

Table C-3 (Cont'd.)

Date/Time 1977	Station	Basia	Boli-nopsis	Calanus	Centro-pages	Copilla	Con-choecia
3/10/2058	1	59		10231	59		176
2115	2	48		21840			384
2131	3	75		1872			
4/10/1008	1			1206		35	35
0937	2	88		3903	44	88	175
0923	3	86	174	11346	609	130	
0843	4	153	153	2136	76		38
11/10/1536	1	41		3197		410	205
1521	2	83		4207		333	292
1505	3	123		6763	1107	246	123
12/10/0919	1	154		4883		269	38
0844	2	104		9652	1007	382	
0835	3	101	68	6319	34		68
0804	4	142		6808	284	71	71
19/10/1600	1	159		2024		159	40
1620	2	40		2580		159	318
1640	3			954		572	
1700	4			3771	132	614	
20/10/0837	1	200		2440	1080	1480	
0903	2	257	74	257	110	74	37
0930	3	73		365	219	36	36
0942	4	283		355		213	71
4/11/1717	1	162		1168	130		32
1700	2	95		1329	190	601	
1639	3	143		1143	250	571	71
1620	4	318		2643	32	637	
5/11/1028	1	389		422		325	129
1006	2	407		556	35	174	70
0945	3	533		1558	205	205	492
1059	4	129		1806	290	161	129
12/11/1505	1	115		3500		192	231
1520	2	205		14551	861	1640	1148
1535	3	97		10900	451	1322	290

Table C-3 (Cont'd.)

Date/Time 1977	Station	Basia	Bolinopsis	Calanus	Centropages	Copilla	Conchoecia
12/11/1944	1	174		2708	35	243	283
1929	2	159		2038	255	320	287
1913	3	250		2500		625	94
13/11/1000	1	170		5570		1000	300
0946	2	200		2405	190		348
0933	3	97		1233		357	32
0915	4	336		1007	168	235	34
20/11/1655	1	26		7878	79	157	3300
1643	2	121		7848	394	91	1757
1623	3	30		7100	424		1939
1608	4			1751	263	29	234
20/11/2005	1	42		1652	170	254	212
1950	2	100		1507	25	151	201
1935	3	47		2900			888
21/11/0935	1			1638		126	
0918	2	42		2521	337	210	84
0905	3	26	26	3030	129	26	104
0845	4	92		2607	153	92	245
28/11/1704	1	241		783	91	61	482
1648	2	674		3651	169	1685	449
1635	3	278		3518	324	417	463
1620	4	35		3750	487		521
28/11/2042	1			1027	137	616	68
2028	2	46		1744	229	506	275
2015	3	50		2700	400	500	100
29/11/0941	1	208		420		69	
0928	2	62		937	312	62	
0915	3	142		1100	1028	284	177
6/12/1647	1	351		4385	877	526	1842
1633	2	309	44	6901	1637	700	2345
1621	3			7060		1009	3070
1608	4	123		7200		500	2991

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Basia	Bolinopsis	Calanus	Centropages	Copilla	Conchoecia
6/12/2102	1	392		7695	588		1127
2048	2	94		2500		519	236
2036	3	53		2144			322
7/12/0900	1	192		654	38	423	
0848	2	401		1336	294	134	187
0836	3	214		1214	71	393	393
13/12/1714	1	496		2729	35		106
1702	2	237		7907	1014	2264	473
1650	3	33		12496	416	1958	
14/12/1130	1	747		5632	172	345	575
1127	2	413		1570	207	41	537
1115	3	632		4483	1322	460	402
22/12/1743	1	150		2208	187	64	449
1725	2	321		2299	454	180	80
1710	3	94		2122		188	
23/12/1000	1	282		915		140	
0945	2	476		1619		286	
0930	3	462		9200	1764	966	
7/1/1630	1	632		2874	57	345	230
1615	2	549		6646		671	488
1600	3	115		7844	154	307	961
8/1/0945	1	222		3108	278	56	100
0930	2	314		3300	105		105
0915	3	577		1859	64	64	64
15/1/1657	1	1055		4222	612	56	556
1643	2	474		18157	1000		105
1630	3	897		42883	4167	897	321
1615	4	862	57				

Table C-3 (Cont'd.)

Date/Time 1978	Station	Basia	Boli-nopsis	Calanus	Centro-pages	Copilla	Con-choecia
16/1/0910	1	300		7126	230	57	230
0930	2	305		4756		183	
0925	3	307		4642	2269	192	192
0912	4	1092		3078	287	575	172
23/1/1624	1	737	35	6702		211	
1609	2	175		5597	1272		400
1556	3	85		5071	313	256	
24/1/0924	1			3858	503	134	
0912	2	136	34	5272		204	170
0859	3	219	44	2192	132	44	395
31/1/1610	1	120		760		160	
1557	2	320		320			40
1545	3	40		159			
1/2/0919	1	64		7243		64	192
0907	2	353		138	106	160	
0854	3	150		6050	350		
8/2/1545	1	443		5170		2848	
1528	2	320		31836			
1515	3	312		23188	188	3438	
9/2/0938	1	240		20640	600		240
0925	2	370		21218	296		185
0912	3	510		10107	547		
16/2/1623	1	190		5949	380	1012	316
1611	2	48		1143	94		48
1559	3	154		5230	192	761	
17/2/0841	1	188		4386	472		94
0848	2	112		5448	225	500	
0906	3						

Table C-3 (Cont'd.)

Date/Time 1978	Station	Basia	Boli-nopsis	Calanus	Centro-pages	Copilla	Con-choecia
24/2/1650	1	800	54	9677	1900	1989	54
1638	2			9827	517	3390	
1625	3	305		3505		1554	3505
25/2/0936	1	408		13877	255	1071	
0919	2	139		97722	139	1389	
0912	3	79		2342	26	394	
4/3/1625	1	29		665	116	173	56
1612	2	44		24		49	24
1600	3	100		250		50	625
5/3/0949	1	244		652	81		54
0937	2	35		623			86
0924	3			4201	558	452	2047
0910	4	583		5583	700		83
12/3/1556	1	89		1875	156	246	89
1608	2	112		2201	410	373	74
1621	3	411		3014		548	
13/3/0933	1	192		275			
0920	2			856	44	113	90
0908	3	24		2136	315	291	218
20/3/1628	1			565		387	
1616	2	28		1293		373	56
1604	3	21		1319		383	64
21/3/0939	1			10871	1924	413	1009
0926	2			9292	750	417	750
0912	3	27		6168	652	244	896
29/3/1543	1	234		1929	58	526	555
1528	2			1029	48	48	167
1510	3	21		7761	230	84	21
30/3/0958	1	31		429	92	31	92
0945	2	42		2292	125	208	417
0933	3	34		896	103	172	
0920	4	81		623	81	131	

Table C-3 (Cont'd.)

Date/Time 1978	Station	Basia	Boli-nopsis	Calanus	Centro-pages	Copilla	Con-choecia
7/4/1619	1	105		4770	105	425	360
1606	2	2941	59	4677	118	235	412
1553	3			7161	273	610	273
7/4/2007	1			10613	1228	1140	351
1955	2	248		5461	106	567	
1945	3	191		9700		95	143
8/4/0910	1			6778	400		274
0858	2			10400	284	851	400
0845	3	33		11100	133	1266	400
15/4/1605	1		1850	19246	205	342	
1550	2		247	7252	123	93	
1537	3		301	1842			
15/4/2018	1		490	3480			200
2005	2	100	1650	8250	200		150
1950	3		400	7600	450	500	
16/4/0930	1	80	317	6310	160	119	80
0915	2		211	8310		352	141
0900	3		700	7523		4600	230
19/4/1610	1	63	313	4781	63	250	63
1557	2		982	10357		134	
1545	3	56	56	12640		528	56
19/4/2032	1			1234			
2020	2			1343			
2007	3		122	7724	370	244	
20/4/0936	1		170	739		284	
0924	2			1700		417	
0906	3			6011	450	393	
	4						

Table C-3 (Cont'd.)

Date/Time 1977	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
2/7/1020	1	46				459	
1045	2	237				678	
1057	3	219				549	
1110	4	94	47			141	
7/7/0956	1	282	403		80	725	
1010	2	117	78		39	5468	
0940	3	150	60		120	274	
0928	4	266	233		100	133	
7/7/1319	1	561	204		51	4234	
1347	2	617	505		112	8988	
1303	3	266			118	5798	
1250	4	316	63		31	917	
13/7/1106	1	537					
1040	2	1850	100		350		
1025	3	1803	245		81	327	
1010	4	640	160		200	120	
13/7/1608	1	679	97		194	485	
1540	2	1605	183		183	275	
1521	3	891	99		99	693	
1510	4	450	360		540	270	
13/7/2107	1	447	149		597		
2040	2	312	62	6875	375	937	
2015	3				781	625	
2028	4	52	105	105	105	105	
25/7/1143	1	862	114			3850	
1106	2	555			79	555	
1051	3	431			86	172	
1037	4	345	43		259	215	
8/8/1014	1				47		
1044	2	34					
1029	3	39			39		
1012	4	279			34	34	
		24					
8/8/1600	1	2027					
1540	2	2585	68		34	34	
1525	3	4252			39		
1510	4	955	36		36		

Table C-3 (Cont'd.)

Date/Time 1977	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
15/8/0955	1	1413	72			942	
0935	2	1592				592	
0920	3	1048				40	
0905	4	254			36		
23/8/1005	1	132	88		88		
0950	2	1518				133	
0935	3	482	88			438	
0920	4	74	37			220	
5/9/1015	1	487			97	519	
1030	2	624			69		
1042	3	60					
1100	4	72			107		
5/9/1508	1	943	41		409	819	
1526	2	799			167	133	
1543	3	1411	30		153	429	
1606	4	372	68		101	203	
5/9/1911	1	33	167	99	67	33	
1929	2	636	169		85	42	
1915	3	1307		38		38	
2017	4	38	107		107	107	
25/9/1510	1	2568	719		137	137	
1535	2	4396	345		172	345	
1600	3	1232	352			387	
1615	4	263	142				
25/9/2015	1	214	107	36		72	
2000	2	37	184			110	
1945	3	182	255		72		
1930	4	555	518	37	37		
26/9/0851	1	3049	177	12		35	496
0914	2	341	189				
0930	3	360	40			40	
0950	4	471	145		72	36	435
						25	165
3/10/1610	1	528					
1630	2	2422	76				
1655	3	1188	69		69		
1707	4	2528			690		

Table C-3 (Cont'd.)

Date/Time 1977	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
3/10/2058	1	2234	118	118	118		
2115	2	1296	48	96	96		48
2131	3	2836		299	223		
4/10/1008	1	390	35				
0937	2	1359	132		44	44	263
0923	3	3478	174		43	43	652
0843	4	2365	38		153		
11/10/1536	1	697	41		41	2295	410
1521	2	917	200		83	2124	458
1505	3	902	82		82	410	451
12/10/0919	1	807				423	2038
0844	2	694	174		35	694	5000
0835	3	135	34			304	2095
0804	4	532	70		355	709	2270
			69				
19/10/1600	1	400	40		80	476	80
1620	2	1627	40		238	476	159
1640	3	382	38	76	76	267	191
1700	4	789		44	263		219
20/10/0837	1	960			320	2960	2560
0903	2	110	40		37	370	
0930	3	401			36		109
0943	4	532	35		35	213	
4/11/1717	1	324			64	454	64
1700	2	348			95	253	95
1639	3	536	36		71	464	179
1620	4	6305			223		382
5/11/1028	1	324			64	2596	292
1006	2	625			140	1771	68
0945	3	328			164	3853	
1059	4	129	32		32	1419	1032
12/11/1505	1	384			77	1230	884
1520	2	943			451	2664	
1535	3	387			193	1064	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-ianus	Euchi-rella
12/11/1944	1	69	139		104	1590	104
1929	2	159	191		32	191	
1913	3	188			31	781	312
13/11/1000	1	4		70	66		400
0946	2	285				1392	474
0933	3	324			32	649	162
0915	4	168	34			436	
20/11/1655	1	1021		26		2094	370
1643	2	636	60	273	30	3900	576
1623	3	576	60	242		2700	1667
1608	4	613		58	29	4087	409
20/11/2005	1	212			42	4788	127
1950	2	75				2813	25
1935	3	187		374	92	5233	187
21/11/0935	1	126	42			2142	
0918	2	126	42			3151	672
0905	3	26	77			910	233
0845	4	245	859	31		1901	215
28/11/1704	1	482				2048	
1648	2		56			2752	674
1635	3	741	46			5462	370
1620	4	382	35	69	34	7881	1295
28/11/2042	1			68		3151	68
2028	2	596		138		2844	321
2015	3	500		1000	50	1535	594
29/11/0941	1	278		69		347	
0928	2	186	62			1062	250
0915	3	354	142			2162	354
6/12/1647	1	526	300		44	5174	307
1633	2	1200	200			6900	
1621	3	482	263	44	44		701
1608	4	826				4378	207

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
6/12/2102	1	1127		196		7155	686
2048	2	141				1273	94
2036	3	482	214			1822	
7/12/0900	1	346	38			884	38
0848	2	454	106			1283	134
0836	3	321	143			714	321
13/12/1714	1	815		35		106	532
1702	2	1622	372	34		980	574
1650	3	1041	250			541	1749
14/12/1130	1	919				2529	402
1127	2	786			41	2231	165
1115	3	287	115			1092	287
22/12/1743	1	786			112	861	1010
1725	2	721		110	110	1337	1443
1710	3	47		47	141	556	
23/12/1000	1	915			70	2113	
0945	2	809	48			1238	96
0930	3	1386	168	126	210	1050	1176
7/1/1630	1	977	57	104	163	19540	402
1615	2	853	305	60	60	813	729
1600	3	1576		346		23147	3883
8/1/0945	1	167		222	56	4388	
0930	2		157	52	157	6753	104
0915	3	769	192		64		128
15/1/1657	1	2277		55	1167	3499	333
1643	2	3842	318		104	2889	1263
1630	3	7692	385	192	64	5192	2628
1615	4	4598	402	172	57	2298	3103

Table C-3 (Cont'd.)

Date/Time 1978	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
16/1/0910	1	2356	57		402	7758	632
0930	2	3841	183	61	793	5365	976
0925	3	2422	76		154	4652	
0912	4	3275	344		229	4425	1092
23/1/1624	1	1298				6667	1017
1609	2	981	218	327		8579	509
1556	3	598			85	2564	142
24/1/0924	1	738				1610	805
0912	2	612				2007	1122
0859	3	920	86			1403	745
31/1/1610	1	80			160	7080	40
1557	2				40	5200	
1545	3	158			40	794	
1/2/0919	1	833		64	256	1987	
0907	2	319		213	106	4362	
0854	3	400		150	50	5900	
8/2/1545	1	2088			63	15822	
1528	2	2371			64	7115	513
1515	3	3312	313		130	7813	
9/2/0938	1	960				3200	4000
0925	2	1444				3036	
0912	3	1751			36	3102	36
16/2/1623	1	759			190	8987	
1611	2	84				1810	
1559	3	154				2269	
17/2/0841	1	1320			519	12733	
0848	2	674				11178	
0906	3	2059			37	21909	

Table C-3 (Cont'd.)

Date/Time 1978	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
24/2/1650	1	968	161		107	5053	54
1638	2	2356			114	2759	1379
1625	3	1494	274			518	
25/2/0936	1	561			51	3469	
0919	2	764	69		138	2222	
0912	3	158		26	79	631	
4/3/1625	1	345				636	231
1612	2	171			24	293	
1600	3	100		50	25	350	75
5/3/0949	1	136	27	27		27	82
0937	2	190				52	329
0924	3	1383	346	346	27	479	425
0910	4	1667		83	500	833	417
12/3/1556	1	647	45			1116	117
1608	2	935	149			2886	112
1621	3	1301	68		68	1781	616
13/3/0933	1	110	54	82	27	467	82
0920	2	338		22	23	1396	293
0908	3	291		24		2014	
20/3/1628	1	149		58	29	179	
1616	2	86	29	29	86	230	373
1604	3	255		43	21	128	638
21/3/0939	1	1651	138			734	
0926	2	1666	83		42	875	
0912	3	1141	27	54		1114	
29/3/1543	1	877	175			2192	
1528	2	72		96		120	
1510	3	460		21	21	397	711
30/3/0958	1	92			61	245	1104
0945	2	875		42	42	2167	41
0933	3	241	34	68	34	345	103
0920	4	213	16	66		475	

Table C-3 (Cont'd.)

Date/Time 1978	Station	Cory-caeus	Creseis	Cypri-dina	Dolio-lum	Euca-lanus	Euchi-rella
7/4/1619	1	621	261		131	4150	
1606	2	882	2941		118	2853	88
1553	3	756	200	21	84	1428	63
7/4/2007	1	8771	526	440		5877	
1955	2	603			106	4149	
1945	3	952	238			3810	
8/4/0910	1	610	213			2164	
0858	2	745	500			2553	
0845	3	1967	133	33		1433	
15/4/1605	1	753	1918			205	137
1550	2	494	895	62		154	154
1537	3	75	163				
15/4/2018	1		196		245	686	
2005	2	1200	600			2400	
1950	3	700	350		100	2700	
16/4/0930	1	675	1468			1400	80
0915	2	352	1620			563	
0900	3	963	2156		184	917	
19/4/1610	1	344	156			1344	
1557	2	4464			90	1071	
1545	3	167	56			1139	
19/4/2032	1			123		185	
2020	2	93	232		139	93	
2007	3	325	285			163	
20/4/0936	1	284	114			3807	
0924	2	1071				4821	
0906	3	1517				14832	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Euchaeta	Euclio	Fritil-laria	Gnathia	Hyperia	Hyperi-oides
2/7/1020	1						
1045	2					34	
1057	3					27	
1110	4						
7/7/0956	1					403	
1010	2		39			234	
0940	3						
0928	4					100	
13/7/1319	1						
1347	2					280	
1303	3					29	
1250	4					31	
13/7/1106	1						
1040	2						
1025	3					163	
1010	4		40				
13/7/1608	1					145	
1540	2						
1521	3					49	
1510	4						
13/7/2107	1		74				
2040	2					687	
2015	3					468	
2028	4					947	
25/7/1143	1						
1106	2						
1051	3						
1037	4						
8/8/1014	1					47	
1044	2					578	
1029	3					196	
1012	4					34	
8/8/1600	1					94	
1540	2					136	
1525	3					236	
1510	4						

Table C-3 (Cont'd.)

Date/Time 1977	Station	Euchaeta	Euclio	Fritil-laria	Gnathia	Hyperia	Hyperi-oides
15/8/0955	1					145	
0935	2					74	
0920	3		40				
0905	4						
23/8/1005	1				88	175	
0950	2					223	
0935	3					263	
0920	4					184	
5/9/1015	1	32		32		32	
1030	2			35			
1042	3						
1100	4	214				36	
5/9/1508	1	369	41	123		41	
1526	2	267		299			
1543	3	64	30	61		92	30
1606	4	34				34	10
5/9/1911	1					67	
1929	2	254	212			424	
1915	3		38	115		77	
2017	4	38	142			38	
25/9/1510	1	8799	34				
1535	2	5172					
1600	3	387					
1615	4	38		178			
25/9/2015	1	3214	36			107	
2000	2	441		110		74	
1945	3	292				72	
1930	4	296	74	518		111	
26/9/0851	1					35	
0914	2						
0930	3						
0950	4		36				
3/10/1610	1	35					
1630	2	15					
1655	3	104				104	
1707	4					57	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Euchaeta	Euclio	Fritil-laria	Gnathia	Hyperia	Hyperi-oides
3/10/2058	1	176	59			176	
2115	2	48			48	48	48
2131	3				75	142	223
4/10/1008	1					35	
0937	2				44		
0923	3				43	86	
0843	4			76			
11/10/1536	1		42	82		41	
1521	2					83	
1505	3				123	287	
12/10/0919	1		38	77	38		
0844	2			173		69	
0835	3			102		203	
0804	4			71		35	
19/10/1600	1		40	40			
1620	2		238	40	40		
1640	3		76				
1700	4			44			
20/10/0837	1				40		
0903	2					74	
0930	3		109				
0942	4			35			
4/11/1717	1			32	32	130	
1700	2			95			
1639	3			107	36		
1620	4			64		32	
5/11/1028	1			32			
1006	2	2900	35	140		41	
0945	3			41			
1059	4			64			
12/11/1505	1						
1520	2	36				123	
1535	3	2773		32			

Table C-3 (Cont'd.)

Date/Time 1977	Station	Euchaeta	Euclio	Fritil-laria	Gnathia	Hyperia	Hyperi-oides
12/11/1944	1		35			278	
1929	2		96			160	
1913	3					281	
13/11/1000	1		70			233	
0946	2		62				31
0933	3		64		130		
0915	4		34	68		34	
20/11/1655	1		79		30	419	
1643	2					181	
1623	3					5000	
1608	4				58	58	
20/11/2005	1						
1950	2					175	
1935	3				92	467	
21/11/0935	1						
0918	2					252	
0905	3	207				260	
0845	4		276			62	
28/11/1704	1						
1648	2					168	
1635	3					370	
1620	4		34			521	
28/11/2042	1				68	273	
2028	2				45	183	
2015	3					300	
29/11/0941	1						
0928	2						
0915	3					142	
6/12/1647	1		44		307	701	
1633	2					400	
1621	3				44	350	
1608	4		41		124	537	

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Euchaeta	Euclio	Fritil-laria	Gnathia	Hyperia	Hyperi-oides
6/12/2102	1					294	
2048	2					141	
2036	3				54	214	
7/12/0900	1		77		77		
0848	2		52			134	
0836	3		35			35	
13/12/1714	1					35	
1702	2						
1650	3		82		42	250	
14/12/1130	1				57	57	
1127	2				41	81	
1115	3						
22/12/1743	1				309	112	
1725	2		26		26		
1710	3		41		188	47	
23/12/1000	1			70	70	211	
0945	2			142		96	
0930	3			168	379	168	
7/1/1630	1					230	
1615	2		61			914	
1600	3				38	769	
8/1/0945	1			110		1165	
0930	2					575	
0915	3				64		
15/1/1657	1				56	56	
1643	2				157	114	
1630	3				64	255	
1615	4					172	

Table C-3 (Cont'd.)

Date/Time 1978	Station	Euchaeta	Euclio	Fritillaria	Gnathia	Hyperia	Hyperioides
16/1/0910	1		61			172	
0930	2					243	
0925	3					422	
0912	4				172		
23/1/1624	1		35			211	
1609	2	1017	109			472	
1556	3	400				370	
24/1/0924	1					805	201
0912	2					850	815
0859	3					44	
31/1/1610	1	520	80				
1557	2	40					
1545	3	40					
1/2/0919	1	128		128		384	
0907	2	53	106			353	
0854	3	300				350	
8/2/1545	1	1265				190	
1528	2	4230				3781	
1515	3	2625				2812	
9/2/0938	1	1840				920	
0925	2	2035				1035	
0912	3	1495				365	
16/2/1623	1	959				63	
1611	2	102					
1559	3	1039				75	69
17/2/0841	1	282					
0848	2	280	224			449	
0906	3	1433				330	72

Table C-3 (Cont'd.)

Date/Time 1978	Station	Euchaeta	Euclio	Fritillaria	Gnathia	Hyperia	Hyperioides
24/2/1650	1	2365				106	
1638	2	114				229	
1625	3	2011		425		914	
25/2/0936	1	663				102	
0919	2	139				139	
0912	3	184				132	
4/3/1625	1	116					
1612	2						
1600	3	25			25	50	
5/3/0949	1						
0937	2						
0924	3	1250				159	
0910	4					147	333
12/3/1556	1	179					
1608	2	485	37				
1621	3						
13/3/0933	1	54				27	
0920	2	68				68	
0908	3	947				24	
20/3/1628	1	58				29	
1616	2	230				29	
1604	3	21					
21/3/0939	1	5137					
0926	2	4334				42	
0912	3	3043				82	
29/3/1543	1	877				29	
1528	2	120				24	
1510	3	753				21	
30/3/0958	1	31					
0945	2	958					
0933	3	138				34	
0920	4	361					

Table C-3 (Cont'd.)

Date/Time 1978	Station	Euchaeta	Euclio	Fritillaria	Gnathia	Hyperia	Hyperioides
7/4/1619	1	327	100				
1606	2	941		324		29	59
1553	3	2142					
7/4/2007	1	8771	263		175	800	
1955	2	390		390		213	106
1945	3	952		238		95	
8/4/0910	1	762					
0858	2	1454					
0845	3	2634					
15/4/1605	1	342			205	274	
1550	2	340				494	123
1537	3				75		
15/4/2018	1	50			147		
2005	2	12500				450	150
1950	3	900			450	1550	200
16/4/0930	1	1270					
0915	2	352			282		
0950	3	370					
19/4/1610	1	94					
1557	2					268	
1545	3	111					
19/4/2032	1						
2020	2					139	
2007	3	570				81	
20/4/0936	1						
0924	2					417	
0906	3	1067					

Table C-3 (Cont'd.)

Date/Time 1977	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
2/7/1020	1	2569		46			2064
1045	2	3220					272
1057	3	1181		82		54	851
1110	4	4716					94
7/7/0956	1	4158		322		201	1290
1010	2	2968		39		78	468
0940	3	6128		60		91	670
0928	4	3033		66		100	1100
7/7/1319	1	6377				408	408
1347	2	5224				224	1123
1303	3	3195				88	88
1250	4	4050				94	126
13/7/1106	1	2021				53	319
1040	2	3700				350	1150
1025	3	3360				163	573
1010	4	1040				40	240
13/7/1608	1	3106				194	48
1540	2	5779				275	
1521	3	2970				149	594
1510	4	5270		45		180	45
13/7/2107	1	1716		223		373	
2040	2	9062		125			
2015	3	2760		156			
2028	4	1315		421			52
25/7/1143	1	4597				57	57
1106	2	1150				119	39
1051	3	1422				172	43
1037	4	2801				172	43
8/8/1014	1	1904		142		47	47
1044	2	612		68		34	102
1029	3	590				118	
1012	4	279					
8/8/1600	1	424				94	47
1540	2	510		102		68	102
1525	3	945				118	79
1510	4	478				73	36

Table C-3 (Cont'd.)

Date/Time 1977	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
15/8/0955	1	978		72		72	181
0935	2	2037				111	111
0920	3	1371				40	
0905	4	399					36
23/8/1005	1	1096					88
0950	2	1830				45	223
0935	3	2806					88
0920	4	625		37			37
5/9/1015	1	1623		32		32	487
1030	2	590				35	5173
1042	3	121				30	30
1100	4	964				36	
5/9/1508	1	2951		41		82	656
1526	2	5399		67		99	1067
1543	3	2975				123	337
1606	4	1419					68
5/9/1911	1	933		67			67
1929	2	1313		254			127
1915	3	1922		38			269
2017	4	1729		76		187	154
25/9/1510	1	959		34			548
1535	2	1164				259	517
1600	3	1373		282			35
1615	4	5638				76	38
25/9/2015	1	2321		179		107	107
2000	2	2719		37		74	
1945	3	2079		72		37	
1930	4	2703		148		148	74
26/9/0851	1	461		35			213
0914	2	151				76	76
0930	3	200					40
0950	4	326					36
3/10/1610	1						457
1630	2	76		499		38	1154
1655	3	174		244		34	2132
1707	4	517		114			229

Table C-3 (Cont'd.)

Date/Time 1977	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
3/10/2058	1	176		59			2293
2115	2	912		384		96	3120
2131	3	746				148	3283
4/10/1008	1	70		177		142	957
0937	2	833				965	2368
0923	3	478		43		782	5260
0843	4	1297		76		114	2022
11/10/1536	1	369		738	1107		164
1521	2	750	41	1250	1700	333	200
1505	3	451		410	41	164	123
12/10/0919	1	1230		231	269		77
0844	2	1354	139	139	104		64
0835	3	169	405	102			
0804	4	1063	567	213	35		461
19/10/1600	1	714	40		80	80	
1620	2	278			198	159	40
1640	3	229	38		229	38	
1700	4	132			43		13
20/10/0837	1	1040	280			40	230
0903	2	221	74				74
0930	3	109			73	73	
0942	4	71	35	71		71	35
4/11/1717	1	1266		227			
1700	2	854		62			95
1639	3	1428		36	214		36
1620	4	892	32	32			96
5/11/1028	1	519	97	129	129		32
1006	2	481	34				
0945	3	902		80	123	328	80
1059	4	355	161	32			
12/11/1505	1	270	77		1270	192	77
1520	2	205	328		861		123
1535	3	225	742	64	97		97

Table C-3 (Cont'd.)

Date/Time 1977	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
12/11/1944	1	208	283	283	347		
1929	2	191	670	223	605		
1913	3	812	281	62	437		
13/11/1000	1	1167	600		233		
0946	2	443	158		760	601	
0933	3	324	162	32	584	195	
0915	4	671	201	135	268		
20/11/1655	1	1020	157	942			
1643	2	939		2100			30
1623	3	576	30	6605			60
1608	4	438	29	1343			
20/11/2005	1	254	42	1524			42
1950	2	376	25	703	25	25	
1935	3	374	47	9064		47	
21/11/0935	1	672		294	42		42
0918	2	800	420	210	294	42	
0905	3	466	233	1036	52		
0845	4	1288	276	30	123	24	
28/11/1704	1	181		60	1265	181	60
1648	2	1741	200	281		225	225
1635	3	1574	278	370		46	
1620	4	764	660	34		69	104
28/11/2042	1	342		205	1164	205	68
2028	2	413	46	321	826	229	95
2015	3	200	50	50	446		
29/11/0941	1	208	69			139	139
0928	2	312				62	875
0915	3	284		35	106	142	
6/12/1647	1	1228	219	614		263	43
1633	2	2124	133	442			
1621	3	965		395			
1608	4	1364				82	41

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
6/12/2102	1	2989	49	98			98
2048	2	1038		47			141
2036	3		53	214			53
7/12/0900	1	731		38	115	192	
0848	2	642	80			187	26
0836	3	1107	179	107	35	107	
13/12/1714	1	1134	35		248	70	70
1702	2	1757	135			278	101
1650	3	1499	167	82			292
14/12/1130	1	2126	287			977	57
1127	2	1488	123	41		247	
1115	3	1724	57	57	57	115	57
22/12/1743	1	1272				674	
1725	2	1230		241		134	
1710	3	424	47	141			283
23/12/1000	1	2042	140	70	70	423	70
0945	2	1524	381	428		142	
0930	3	1764	336	84		42	160
7/1/1630	1	862		3506		574	
1615	2	2073		671	366	305	
1600	3	1194				384	38
8/1/0945	1	667		4000			
0930	2	628	52	1623		262	52
0915	3	1474	192	321		321	128
15/1/1657	1	1778	390		1167	110	
1643	2	3105	210	52	1751		737
1630	3	4038	128	128	2244	256	5128
1615	4	4195			3276		575

Table C-3 (Cont'd.)

Date/Time 1978	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
16/1/0910	1	1780	172		1667		
0930	2	1402	183		2987	761	
0925	3	1576	115			153	
0912	4	1782			1782	632	
23/1/1624	1	2500		772		211	211
1609	2	1418		545		327	218
1556	3	684		57	370	314	200
24/1/0924	1	168		1712			101
0912	2	408		4081			170
0859	3	1009	44		44	263	263
31/1/1610	1	400		120		120	
1557	2	360		40	40	200	
1545	3	79	40			79	
1/2/0919	1	385	256	769	4872	192	
0907	2	798	319		1223		
0854	3	700	50	250	300	150	
8/2/1545	1	3671			190	1392	63
1528	2	2115		769			1538
1515	3	2312		437			2312
9/2/0938	1	960		40			200
0925	2	1000		556	111	518	1000
0912	3	1095	36	219		292	
16/2/1623	1	1013	126			126	63
1611	2	238				238	48
1559	3	500	115	192		115	38
17/2/0841	1	1037		236		1085	50
0848	2	1236	112			168	
0906	3	1544		441			

Table C-3 (Cont'd.)

Date/Time 1976	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
24/2/1650	1	323			1452		
1638	2	57		57	57	287	229
1625	3	122					91
25/2/0936	1	1327	357		867	51	102
0919	2	1319	347	139	833	278	208
0912	3	237	105	52	52	52	105
4/3/1625	1	231				56	231
1612	2	73				48	24
1600	3	525	25	25	25	25	50
5/3/0949	1	408		109	679		299
0937	2	363		52			86
0924	3	1340	52			52	1303
0910	4	1667	83			500	2000
12/3/1556	1	870				45	357
1608	2	1268	37			37	300
1621	3	1233	68			68	411
13/3/0933	1	522				137	54
0920	2	113	45	45			
0908	3	121	24			48	73
20/3/1628	1	357		58			89
1616	2	661		804		29	86
1604	3	362	21	894			192
21/3/0939	1	1009	183			90	1881
0926	2	875	208	125		83	708
0912	3	598	54	109			679
29/3/1543	1	1374	58	29	58	117	497
1528	2	144		24			24
1510	3	167		40			251
30/3/0958	1	429	61				61
0945	2	250		42		125	375
0933	3	276	34	68		138	368
0920	4	328	66		16	49	262

Table C-3 (Cont'd.)

Date/Time 1978	Station	Lensia	Liriope	Lucifer	Oiko-pleura	Oithona	Oncaea
7/4/1619	1	1340	230	131	105	131	131
1606	2	882	235	59	765	147	
1653	3	168		105		126	1008
7/4/2007	1	3333	175	800	2544		526
1955	2	1600	284	1500	11700	319	213
1945	3	2571		333	381	238	700
8/4/0910	1	1067			364		640
0858	2	1312			248		674
0845	3	900	167		833	167	970
15/4/1605	1	960			548	205	548
1550	2	960	123	247	62		463
1537	3	38					
15/4/2018	1	931	200	147	735	196	50
2005	2	1850	450	300			650
1950	3	1800			150		200
16/4/0930	1	476	240				2262
0915	2	915	352	141			5634
0900	3	826			138		5275
19/4/1610	1	1313					250
1557	2	1116	134	402		178	
1545	3	1250		111	56	111	1167
19/4/2032	1	680		185	1481		
2020	2	741			741		46
2007	3	772			325		772
20/4/0936	1	4944	114	682	400	170	
0924	2	1428		600	600	357	
0906	3	2584	168			112	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
2/7/1020	1					504	779
1045	2					1190	1428
1057	3					137	1208
1110	4					47	141
7/7/0956	1	725				725	10846
1010	2	664				6835	21523
0940	3	150				150	5609
0928	4	266				766	8400
7/7/1319	1	357				1020	5102
1347	2	112				617	19157
1303	3	532					5473
1250	4	158				759	2563
13/7/1106	1	212				53	425
1040	2	250				450	2600
1025	3	573				1885	9015
1010	4	200				560	1200
13/7/1608	1	436				582	7475
1540	2	137				642	5642
1521	3	49				792	9554
1510	4	270				315	3963
13/7/2107	1	1492				74	5746
2040	2	812				62	4500
2015	3	1093				208	7708
2028	4	1105				210	5736
25/7/1143	1					114	6436
1106	2	79				357	3253
1051	3	301				317	1982
1037	4	43				948	5129
8/8/1014	1					95	6000
1044	2	68				34	4930
1029	3					39	314
1012	4	34				454	209
8/8/1600	1	47				129	1556
1540	2	68					1939
1525	3						1889
1510	4						808

Table C-3 (Cont'd.)

Date/Time 1977	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
15/8/0955	1					579	14311
0935	2					667	8295
0920	3					444	2016
0905	4	108				36	435
23/8/1005	1					263	1754
0950	2					759	8705
0935	3					745	7191
0920	4					184	1543
5/9/1015	1	259				162	1038
1030	2	312				35	833
1042	3	91					303
1100	4	143					2321
5/9/1508	1	123		41		738	10698
1526	2					33	2266
1543	3	92				276	5153
1606	4					34	4290
5/9/1911	1	267				67	4299
1929	2	42		127		1059	7923
1915	3	38		38			3076
2017	4	107				178	4811
25/9/1510	1	68				137	2465
1535	2	129					1638
1600	3					35	1162
1615	4						865
25/9/2015	1	321					3499
2000	2	110					3344
1945	3	146					4533
1930	4	74				37	3296
26/9/0851	1	35				744	1418
0914	2	76					1174
0930	3	160				120	1120
0950	4					326	797
3/10/1610	1					281	2183
1630	2					192	1884
1655	3					104	4929
1707	4						6494

Table C-3 (Cont'd.)

Date/Time 1977	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
3/10/2058	1	59					3000
2115	2					48	2256
2131	3					74	2388
4/10/1008	1						5071
0937	2	175				351	2412
0923	3	130				391	2087
0843	4	229					1068
11/10/1536	1	246				656	5534
1521	2	1083				1208	6705
1505	3					80	2295
12/10/0919	1	38				231	2153
0844	2	34				486	2986
0835	3	33				777	5136
0804	4					603	7588
19/10/1600	1	238				400	1508
1620	2	159				913	1072
1640	3	191				153	2976
1700	4	44				132	3376
20/10/0837	1	40				1880	4280
0903	2	74				37	3750
0930	3	620					2116
0942	4					35	2269
4/11/1717	1	32				32	2856
1700	2	32				190	3164
1639	3					321	3785
1620	4					700	1369
5/11/1028	1	649				227	3018
1006	2	521				70	2812
0945	3	328				370	2951
1059	4					258	1258
12/11/1505	1	38				115	6575
1520	2	123				246	10043
1535	3					161	6482

Table C-3 (Cont'd.)

Date/Time 1977	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
12/11/1944	1	34				451	5520
1929	2	96				700	5638
1913	3	62				594	3406
13/11/1000	1	300				3100	6600
0946	2	162				1600	4050
0933	3	97				876	3115
0915	4					1208	2214
20/11/1655	1	26				26	1727
1643	2					60	1485
1623	3					91	4484
1608	4	88	29			146	1927
20/11/2005	1					42	3813
1950	2					175	2236
1935	3						2710
21/11/0935	1	126				168	11511
0918	2					336	8100
0905	3	26				129	7407
0845	4	31				92	3742
28/11/1704	1	120					7108
1648	2	112			56	1067	6740
1635	3	46			185	694	1221
1620	4	34	34			660	9583
28/11/2042	1	274	68			479	8013
2028	2					90	5000
2015	3					148	3514
29/11/0941	1					69	4375
0928	2	186				62	1750
0915	3	142				142	2836
6/12/1647	1		43			6183	10700
1633	2					10706	18713
1621	3		44			5306	11313
1608	4	41				6405	10578

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
6/12/2102	1					5000	10586
2048	2	47				1462	4008
2036	3	482				911	2252
7/12/0900	1	269				346	3910
0848	2	80				508	3127
0836	3	143				500	2928
13/12/1714	1					70	3935
1702	2					1216	3467
1650	3						6000
14/12/1130	1					2241	11724
1127	2					2149	9421
1115	3					3333	13218
22/12/1743	1	112				1010	3742
1725	2	134				1016	3154
1710	3					47	2640
23/12/1000	1					1056	11901
0945	2	48				809	9000
0930	3		42			1680	6932
7/1/1630	1	229				5977	7069
1615	2	120				7255	9146
1600	3					2884	7075
8/1/0945	1	110				1222	12776
0930	2		52			1204	14501
0915	3					897	9358
15/1/1657	1	110				1278	3700
1643	2	52				2368	15473
1630	3		64			2628	18653
1615	4	57			57	3621	11322

Table C-3 (Cont'd.)

Date/Time 1978	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
16/1/0910	1	57				3563	12068
0930	2					2805	6524
0925	3					1230	7113
0912	4	57				2069	6954
23/1/1624	1					5228	8492
1609	2	109				4435	9196
1556	3			28		1054	3704
24/1/0924	1	34			66	134	1254
0912	2					918	13842
0859	3					658	2719
31/1/1610	1	40				720	11560
1557	2					720	2040
1545	3	40				198	476
1/2/0919	1					1474	11474
0907	2					1382	9787
0854	3					1350	9350
8/2/1545	1					2785	14620
1528	2		64			1154	20256
1515	3					1750	14625
9/2/0938	1					400	14440
0925	2					518	12035
0912	3					912	10838
16/2/1623	1					4100	21582
1611	2					286	7333
1559	3	38				2269	11423
17/2/0841	1					2877	24617
0848	2					2191	15896
0906	3					3345	111175

Table C-3 (Cont'd.)

Date/Time 1978	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
24/2/1650	1			54		1452	12257
1638	2					1149	11264
1625	3						7590
25/2/0936	1		51			2653	12450
0919	2					2500	10902
0912	3					658	4657
4/3/1625	1	29				318	5722
1612	2	48					1268
1600	3					75	3900
5/3/0949	1					136	1032
0937	2					52	1713
0924	3					452	9493
0910	4	83				500	12500
12/3/1556	1					156	3214
1608	2					187	7350
1621	3	68				411	4931
13/3/0933	1	54				27	4038
0920	2	22				68	5517
0908	3	24				291	3811
20/3/1628	1					119	9374
1616	2					56	9050
1604	3						5980
21/3/0939	1					458	8165
0926	2	42				42	6709
0912	3	27				136	7445
29/3/1543	1					234	7337
1528	2					72	407
1510	3					40	3452
30/3/0958	1	31				31	5245
0945	2					292	7042
0933	3	68				172	5379
0920	4	16				49	2147

Table C-3 (Cont'd.)

Date/Time 1978	Station	Ophio-trix	Para-scelus	Pronim-opsis	Pronima	Rhin-calanus	Sagitta
7/4/1619	1	105		163		425	11402
1606	2	88				88	10600
1553	3					294	6825
7/4/2007	1	263				1754	16753
1955	2	426				142	8800
1945	3	143		190			17500
8/4/0910	1						12162
0858	2						15106
0845	3					300	9632
15/4/1605	1					342	5342
1550	2		154			185	4320
1537	3						3760
15/4/2018	1	343				147	294
2005	2		100			300	5600
1950	3					200	2650
16/4/0930	1					240	11150
0915	2	141				422	14370
0900	3	92					9724
19/4/1610	1	219				156	4531
1557	2						6741
1545	3					83	4084
19/4/2032	1						3210
2020	2	93					5278
2007	3					81	3658
20/4/0936	1	170				170	12444
0924	2	120				120	13700
0906	3	337			56	674	7921

Table C-3 (Cont'd.)

Date/Time 1977	Station	Sagi-tella	Salpa	Sapphi-rina	Street-sia	Thalia	Tomop-teris
2/7/1020	1			183			
1045	2			782			
1057	3			549			
1110	4			47			
7/7/0956	1			362			
1010	2			156			39
0940	3	91		150			
0928	4	266		1400			
7/7/1319	1			255			
1347	2	56		1132			112
1303	3	29		295			
1250	4			601			
13/7/1106	1			159			
1040	2			1000			50
1025	3			1393			
1010	4			120			
13/7/1608	1			1019			
1540	2			825		91	
1521	3			643			
1510	4			90		450	
13/7/2107	1			746			
2040	2	62		125			
2015	3	156		572			52
2028	4			210		105	
25/7/1143	1			114			
1106	2	39		119			
1051	3	129					
1037	4	43		172		43	
8/8/1014	1	47					
1044	2	68		68			
1029	3	78					
1012	4						
8/8/1600	1						
1540	2	34		102			
1525	3	39		39			39
1510	4			73		36	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Sagitella	Salpa	Sapphirina	Streetsia	Thalia	Tomopteris
15/8/0955	1	36		1196			
0935	2			1666			
0920	3			40			
0905	4	36					
23/8/1005	1			44			
0950	2			134			45
0935	3	132		44			
0920	4			37			
5/9/1015	1			97		32	
1030	2	35		35		35	
1042	3					30	
1100	4			36			
5/9/1508	1	41		328		41	
1526	2	67		233			
1543	3	30		552			
1606	4			68			
5/9/1911	1		199	67			
1929	2		424	424		85	85
1915	3	154		308			
2017	4	38	107	76		142	
25/9/1510	1	34		238			
1535	2	43		560			43
1600	3	35		35			
1615	4						
25/9/2015	1			107			
2000	2			74			
1945	3	37					
1930	4						
26/9/0851	1						
0914	2						
0930	3						
0950	4			36			
3/10/1610	1			35		35	
1630	2		38	192		76	
1655	3	34		314			
1707	4			57		172	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Sagitella	Salpa	Sapphirina	Streetsia	Thalia	Tomopteris
3/10/2058	1			59		235	
2115	2		48	192		96	
2131	3	75	142	75			
4/10/1008	1		35				35
0937	2						
0923	3	44		391		130	44
0843	4		114			267	
11/10/1536	1	41		615		123	
1521	2	200		625		83	
1505	3	41		1558		82	
12/10/0919	1			269		38	
0844	2			104		139	
0835	3			237			
0804	4	106		213			
19/10/1600	1			198		80	
1620	2			278		318	
1640	3			420		76	
1700	4			395		44	
20/10/0837	1			840			
0903	2			331	110	147	
0930	3			36		36	
0942	4		35	71		106	
4/11/1717	1				32	64	
1700	2	32	62	253		95	
1639	3	36		536		179	36
1620	4		96	318		637	
5/11/1028	1			227		97	
1006	2					104	
0945	3			372			
1059	4			258		32	
12/11/1505	1			115			
1520	2			328	41		
1535	3			355			

Table C-3 (Cont'd.)

Date/Time 1977	Station	Sagitella	Salpa	Sapphirina	Streetsia	Thalia	Tomopteris
12/11/1944	1			243		35	35
1929	2			159		382	
1913	3			375		375	31
13/11/1000	1			1733		33	
0946	2			538			
0933	3			552		65	
0915	4			370			
20/11/1655	1	26		3350			
1643	2	91		1182			
1623	3	121		1636			60
1608	4	30					
20/11/2005	1			84			
1950	2	150		75		75	25
1935	3	187		140		192	192
21/11/0935	1			42			
0918	2			126			42
0905	3			155			26
0845	4			276			
28/11/1704	1			301			60
1648	2			786		56	56
1635	3	93		1065		46	
1620	4			417		139	347
28/11/2042	1	68		68		205	
2028	2			229			
2015	3			200		50	
29/11/0941	1			69			
0928	2			312			
0915	3			142		35	
6/12/1647	1			1929		132	86
1633	2			4114		177	221
1621	3			2105		86	
1608	4			2727			

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Sagi-tella	Salpa	Sapphi-rina	Street-sia	Thalia	Tomop-teris
6/12/2102	1			1960		98	98
2048	2			1368		189	
2036	3			804			
7/12/0900	1			115		269	
0848	2	27		160			
0836	3			286		107	
13/12/1714	1			461		284	
1702	2			1521			
1650	3			1957			82
14/12/1130	1			1092			57
1127	2	82		578			
1115	3			402		57	
22/12/1743	1			524		449	
1725	2			481		134	
1710	3	47		1132		94	
23/12/1000	1			634			
0945	2			98		48	48
0930	3			882		420	
7/1/1630	1		57	459			104
1615	2			1219			122
1600	3			1730			176
8/1/0945	1	56		278			56
0930	2	105	52	314			
0915	3	128	64	192			
15/1/1657	1			333		400	
1643	2			1000			114
1630	3			1282			64
1615	4		172	345			

Table C-3 (Cont'd.)

Date/Time 1978	Station	Sagi-tella	Salpa	Sapphi-rina	Street-sia	Thalia	Tomop-teris
16/1/0910	1		287	690			
0930	2		121	732			
0925	3	38		692			
0912	4		57	344			57
23/1/1624	1		281	772		316	70
1609	2		872	190			109
1556	3	57		712	28	200	
24/1/0924	1	168		403			66
0912	2	34		646			102
0859	3		44	438		44	86
31/1/1610	1	40	40	160			
1557	2			160			
1545	3			436			
1/2/0919	1		64	256			
0907	2		53	585			
0854	3			250			
8/2/1545	1			2025			
1528	2			2436	64	64	
1515	3	62		2312			
9/2/0938	1			840			40
0925	2	222		1740	74		
0912	3	255		803		109	
16/2/1623	1			1456			
1611	2			84			48
1559	3	75	38	1385	75		38
17/2/0841	1	47		377			47
0848	2			449			
0906	3			2132			

Table C-3 (Cont'd.)

Date/Time 1978	Station	Sagitella	Salpa	Sapphirina	Streetsia	Thalia	Tomopteris
24/2/1650	1	54	54	1989			
1638	2	152		1321			
1625	3			3048			
25/2/0936	1			561		51	
0919	2			555			
0912	3	26		368			
4/3/1625	1		29	87			
1612	2			73			
1600	3	75		600	25		50
5/3/0949	1			109			
0937	2			104			
0924	3	52		931			
0910	4	83		250			
12/3/1556	1			268			
1608	2	37		300			
1621	3			205			
13/3/0933	1	82	27	27			
0920	2			135			
0908	3			170			
20/3/1628	1			387			
1616	2	29		144			
1604	3						21
21/3/0939	1						
0926	2	83		292			
0912	3	27		326		27	
29/3/1543	1		205	409		87	
1528	2	23	24	335			
1510	3			377			21
30/3/0958	1			123		31	
0945	2			750	42		
0933	3		34				
0920	4			164			

Table C-3 (Cont'd.)

Date/Time 1978	Station	Sagitella	Salpa	Sapphirina	Streetsia	Thalia	Tomopteris
7/4/1619	1		105	784		131	33
1606	2		118	1300		265	
1553	3		63	1450		105	105
7/4/2007	1		87	3772			
1955	2		213	1135		180	213
1945	3		238	1952			
8/4/0910	1	91		2042			
0858	2	177		2305			
0845	3	33		1800	66	167	66
15/4/1605	1			960			
1550	2	62		370			300
1537	3						
15/4/2018	1						441
2005	2			750			100
1950	3	50	50	750			50
16/4/0930	1	119		357			
1915	2	138		493			
0900	3			780			
19/4/1610	1		94	281		94	
1557	2		90	90		90	
1545	3			700			
19/4/2032	1						
2020	2						
2007	3	81	122	4100			
20/4/0936	1		227			114	
0924	2		357	1200		178	60
0906	3		393	786		281	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish	
					Eggs	Larvae
2/7/1020	1	119		46	1513	
1045	2			169	918	34
1057	3	137		274	82	
1110	4	141			943	
7/7/0956	1			282	5645	
1010	2	39		1523	5898	
0940	3	91		150	8018	91
0928	4	400		133	6433	
7/7/1319	1	255		306	1581	
1347	2	56		4213	505	
1303	3	236		532	7899	
1250	4	31		759	1265	
13/7/1106	1	106		319	957	
1040	2	250		750	1550	
1025	3	737		2868	655	
1010	4	100		520	600	
13/7/1608	1	145		388	1019	
1540	2	321		275	2018	
1521	3	49		643	742	
1510	4			315	1030	
13/7/2107	1	2089		10597	8955	
2040	2	2687		6812	13750	62
2015	3	3750		3593	5781	52
2028	4	10421		3684	7947	
25/7/1143	1			172	6551	
1106	2				4206	
1051	3				2112	
1037	4			86	3534	
8/8/1014	1	238		47	4142	
1044	2	272		204	1598	
1029	3	157		39	1929	
1012	4	34			4125	
8/8/1600	1	94			1509	
1540	2			34	884	
1525	3	39			315	
1510	4			147	698	

Table C-3 (Cont'd.)

Date/Time 1977	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish Eggs	Fish Larvae
15/8/0955	1	253		1123	1123	
0935	2	111		570	2518	
0920	3			202	887	
0905	4			36	906	
23/8/1005	1	702		351	2587	88
0950	2			89	2678	
0935	3	44		88	1666	
0920	4	74		147	1470	
5/9/1015	1	65		97	487	
1030	2				486	
1042	3				1242	
1100	4			36	214	
5/9/1508	1			123	1394	
1526	2			99	799	
1543	3	30		675	1288	
1606	4			34	135	
5/9/1911	1			999	767	
1929	2	296		2585	4322	
1915	3	1038	77	2422	2653	
2017	4			1353	226	
25/9/1510	1	103		856	171	
1535	2	43		517	172	
1600	3	282		246	70	
1615	4	38		264	38	
25/9/2015	1	3785		786	321	
2000	2	220		331	551	
1945	3	584		1131	365	
1930	4	111		815	296	
26/9/0851	1	248		319	248	
0914	2				492	
0930	3	80			224	
0950	4	289		72	906	
3/10/1610	1			70	176	
1630	2			308	576	115
1655	3	280		69	1118	69
1707	4			114	1552	

Table C-3 (Cont'd).

Date/Time 1977	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish Eggs	Fish Larvae
3/10/2058	1	1940		2175	5527	59
2115	2	1152		5376	3456	
2131	3	448		3358	2164	
4/10/1008	1			70	1064	
0937	2	43		44	2324	
0923	3	565		782	1826	
0843	4			114	7973	
11/10/1536	1	41	41		2664	328
1521	2	42	42			42
1505	3	205		123	1148	123
12/10/0919	1	77		115	654	
0844	2			243	312	
0835	3			135	135	68
0804	4		35	213	1631	
19/10/1600	1		40	198	1191	
1620	2	40		516	1985	
1640	3			458	2290	
1700	4			219	702	132
20/10/0837	1			80	1040	40
0903	2			74	1103	
0930	3	36		73	1241	
0942	4			35	1170	
4/11/1717	1	97	32		3242	
1700	2			32	253	
1639	3		35	250	143	
1620	4			32	414	127
5/11/1028	1			32	519	
1006	2	70			660	
0945	3	41		451	492	
1059	4				161	
12/11/1505	1		38	158	500	38
1520	2			902	281	
1535	3			225	322	32

Table C-3 (Cont'd.)

Date/Time 1977	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish	
					Eggs	Larvae
12/11/1944	1			600	1493	
1929	2	159		637	2070	
1913	3	62		688	3312	62
13/11/1000	1			400	6000	
0946	2		31	31	1519	62
0933	3			130	649	
0915	4			302	436	
20/11/1655	1	707		602		200
1643	2	424		727	152	91
1623	3	212	30	2818	182	515
1608	4	117		263		
20/11/2005	1	678	42	1271		84
1950	2	75		829	100	226
1935	3	46	46	2336	140	46
21/11/0935	1			588		42
0918	2		42	630	84	84
0905	3		26	673		260
0845	4			306	62	
28/11/1704	1	60		904	361	
1648	2			1741	281	112
1635	3	93		3425	370	93
1620	4	139	35	1700	208	68
28/11/2042	1	273		959	616	342
2028	2	734		1835	1376	138
2015	3	1138		2722	891	100
29/11/0941	1				625	
0928	2				625	
0915	3	35		248	567	70
6/12/1647	1			2500	263	
1633	2	177		4026		
1621	3	263		333	1096	219
1608	4			3223	537	289

Table C-3 (Cont'd.)

Date/Time 1977/78	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish	
					Eggs	Larvae
6/12/2102	1	147		3675	1127	490
2048	2			660	519	
2036	3			324	5200	116
7/12/0900	1		38	115	500	38
0848	2		27	454	214	106
0836	3			536	321	
13/12/1714	1	106		603		
1702	2	135		372	338	
1650	3	42		958	1416	82
14/12/1130	1			230	287	287
1127	2			289	123	41
1115	3	114		862	402	230
22/12/1743	1	37		1534	486	187
1725	2			1390	1283	
1710	3	141		802	2735	
23/12/1000	1			423	1338	70
0945	2	48		286	333	48
0930	3			1008	714	42
7/1/1630	1				169	163
1615	2	61		9877	1463	183
1600	3	38		923	1230	307
8/1/0945	1			3000	333	390
0930	2			1466	157	157
0915	3			256	385	64
15/1/1657	1	56		400	13500	
1643	2	114		1210	6473	53
1630	3			1538	3333	
1615	4	287		919	5345	

Table C-3 (Cont'd.)

Date/Time 1978	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish Eggs	Fish Larvae
16/1/0910	1	632		1379	3161	115
0930	2	243		1341	2622	
0925	3	500		1038	1384	38
0912	4	229		402	3850	
23/1/1624	1			1825	2211	
1609	2			1890	1890	175
1556	3			626	1767	
24/1/0924	1			2348	134	705
0912	2	68	102	3231		714
0859	3				175	44
31/1/1610	1	120		400	2560	80
1557	2	120		80	80	
1545	3	119		40	1468	
1/2/0919	1	384		961	577	
0907	2			319	957	53
0854	3	250		350	350	
8/2/1545	1	63		1076	3924	
1528	2	64		4231	1410	448
1515	3	313		1688	1187	313
9/2/0938	1	280		1440	720	120
0925	2			2007	259	74
0912	3	36			803	292
16/2/1623	1			2532	1519	
1611	2			1238	1238	47
1559	3	75		1231	1385	192
17/2/0841	1	424		2500	707	283
0848	2	224		3426	674	786
0906	3	515		3566	331	515

Table C-3 (Cont'd.)

Date/Time 1978	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish	
					Eggs	Larvae
24/2/1650	1			2042	1452	429
1638	2	114		1264	1207	460
1625	3			671	1250	
25/2/0936	1			816	714	51
0919	2	69		347	1111	208
0912	3			210	394	79
4/3/1625	1	29		260	11011	29
1612	2	585		244	7927	24
1600	3	775		475	3475	
5/3/0949	1	27		54	14916	
0937	2			104	6436	
0924	3	1861		877	4068	292
0910	4	1583		700	26166	
12/3/1556	1	22		67	558	22
1608	2	410		261	1418	
1621	3			205	2671	
13/3/0933	1	27		54	1236	27
0920	2	158		293	540	45
0908	3	24		97	485	48
20/3/1628	1	119		89	1428	58
1616	2	144		316	1494	115
1604	3			447	553	212
21/3/0939	1			872	780	
0926	2			833	417	
0912	3	54		1195	300	136
29/3/1543	1	29		380	3890	58
1528	2	72		72	1292	24
1510	3	146		648	1611	42
30/3/0958	1			400	583	
0945	2			833	417	125
0933	3	34		517	896	
0920	4	32		98	426	32

Table C-3 (Cont'd.)

Date/Time 1978	Station	Crab Zoea	Marine Foliosa	Schi-zopod	Fish	
					Eggs	Larvae
7/4/1619	1		105	200	950	105
1606	2			471	765	382
1553	3			441	231	168
7/4/2007	1	3508		1930	3070	1052
1955	2	816		1312	1214	284
1945	3	762	143	2620	2200	191
8/4/0910	1			244		91
0858	2			426		3546
0845	3	200		433		200
15/4/1605	1		68	205	2603	
1550	2	2315		6758	2345	62
1537	3				800	
19/4/2018	1	98		245		147
2005	2	2800		10150	3950	150
1950	3	5750		9050	8300	350
16/4/0930	1	80		119	80	
0915	2	211		704	493	70
0900	3		92	46	413	
19/4/1610	1			375	470	
1557	2			714	625	134
1545	3			278	722	333
19/4/2032	1				123	
2020	2			700	1300	
2007	3			490	203	81
20/4/0936	1			909	4318	
0924	2		120	300	1607	
0906	3			281	337	450

Appendix D

Personnel

The laboratory site at Mag-aba, Pandan, was geographically very isolated. The closest marketplace was at Kalibo, 65 km away on the northern coast of Panay Island. The 200-km road from Iloilo on the south eastern coast to Mag-aba crossed 25 rivers. At the start of the project, in 1975, only six of these rivers had bridges and vehicles had to wait until low tide before fording them. Owing to flash floods during the rainy season, these rivers frequently could not be crossed even at low tide.

All personnel working at Mag-aba volunteered to join the project and all worked as a team. The research results are the product of a community effort. The team members are listed below, those who were members for more than two years being marked by an asterisk. We apologize if some names have been inadvertently omitted.

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