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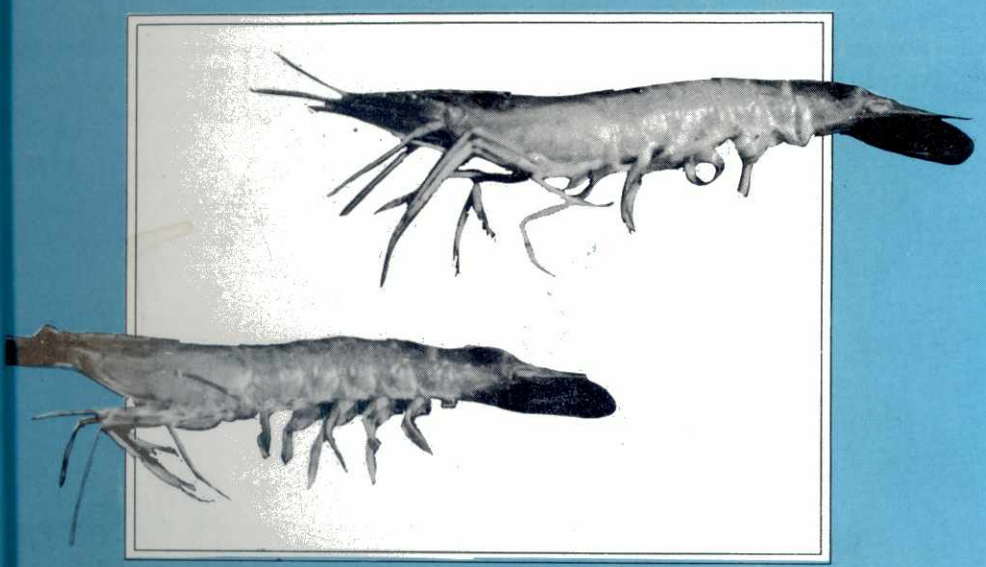

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Commercially Important Marine Bivalves of Sorsogon Bay Philippines*

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ABSTRACT

The species composition and distribution of marine bivalves in the Bay are presented, together with estimates on the growth, mortality and exploitation rate of two commercially important species, *Paphia undulata* and *Placuna placenta*.

Keywords: marine bivalve, Sorsogon Bay, species composition, species distribution, *Paphia undulata, Placuna placenta*

INTRODUCTION

Bivalves are important for their value as food and export commodity. The Philippines, famous for its molluscan fauna, has approximately 1,100 marine bivalve species widely distributed throughout the country's coastal areas. Some of the commercially important species are oyster (*Crassostrea* spp.), mussels (*Perna viridis* and *Modiolus* spp.), pearl oysters (MOP) (*Pinctada margeritifera* and *P. maxima*), windowpane shells or "kapis" (*Placuna placenta*), giant clams (*Tridacna* spp. and *Hippopus* spp.), scallops (*Amusium pleuronectes*), ark shells or cockles (*Anadara* spp.), venerid shells (*Paphia undulata* and *Katelysia* spp.), and angel wing shells (*Pholas orientalis*). Various species like the MOP are known pearl producers. Their shells are used in the manufacture of pearl buttons

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while some species are manufactured into fancy and decorative plates, ornaments and assorted shellcraft articles. Shellcraft is one of the country's leading dollar earners, with an estimated export value of P199 million in 1987. In a country where malnutrition is widespread, bivalves are the cheapest supplemental source of protein especially in areas where animal meat is scarce.

REVIEW OF RELATED LITERATURE

Bivalves are exploited extensively, yet research on these valuable resource are few and scattered. Most of the earlier works are taxonomic and anatomical studies on how to improve farming technologies of some of the culture species such as oysters, mussels, and to some extent, window-pane shells or kapis. The earlier works were published by Villaluz, et.al. (1951) and Ronquillo et al. (1951) on the culture of mussel and oyster, and Blanco (1958) on kapis farming. Recent researches include biology and culture of giant clams (Gomez, et.al., 1988), scallops (Llana, 1979), and kapis (Rosell, 1979).

Certain gaps on bivalve research had been identified during the seminar workshop on the status of Mollusc Resources in 1986. One of the gaps in research concerns the assessment of the country's bivalve resources and their regional distribution. To somehow fill this gap, a study was conducted to identify the commercially important marine bivalves of Sorsogon Bay, which is proved to be one of the richest fishing grounds for molluscs, especially bivalves. It was part of the project-assessment of invertebrate resources of Sorsogon Bay, with emphasis on shrimp stocks, which started in 1989. Interest in Sorsogon Bay was triggered by the results of the hydro-biological surveys conducted by Legasto and del Mundo (1976). During the initial survey period, it was noted that the fishermen in the Bay were involved in gathering and exporting blood clam *Anadara antiquata*. The industry existed until 1980. Also during this period, benthos samples obtained from the hydro-biological survey revealed the abundance of young Paphia undulata, representing 89% of the total bivalve biomass. The suceeding surveys likewise showed Paphia undulata as the dominant benthic organism, representing 94% of the bivalve biomass. Information and data presented here were the results of fishing observation, fish landing surveys and personal interview with fishermen in the Bay.

OBJECTIVES OF THE STUDY

The Sorsogon Bay study was an attempt to:

1. determine the species composition and distribution of bivalves in the Bay,
2. determine growth, mortality and exploitation rates of the abundant species,

3. determine the status of the bivalve fishery, and
4. provide planners and administrators options in formulating management and conservation measures.

METHODOLOGY

On-board observations and regular monthly surveys on fish landing centers were conducted. Yield estimates were based on total landing figures. Shell height measurements were recorded with the use of a caliper. Estimation of growth using length frequency analysis was undertaken and mortality and recruitment determined using the ELEFAN programs for analysis.

Paphia undulata was collected in Sorsogon Bay using compressor or capandra. Shell height measurement of samples was done in landing areas such as Rizal, Pier Site and Cambulaga, Sorsogon, in December 1988 and from August to October 1989. Shell height (SH) was measured in millimeter and the samples from four sampling dates was 2,697 (Table 1).

Placuna placenta was gathered using the same equipment used to collect P. undulata in the Bay, specifically in Castilla area, Pier, and Casiguran, Sorsogon proper, from April to June 1989. Shell collected from these areas were dead P. placenta. Table 2 shows the shell height of the 3,754 dead P. placenta.

Growth (Sh ∞ and K), mortality (M, F, and Z) and exploitation rate of Paphia undulata were obtained using the ELEFAN method. Initial values of Sh∞ and Z/K were estimated using the Weatherall method (ELEFAN II) (Weatherall, 1986 as modified by Pauly, 1986a) by plotting the SH - SH' against the SH' (cutoff shell height). The formula used:

$$SH - SH' = a + bSH$$

where $SH \infty = a/-b$

and $Z/K = (1+b)/ - b)$

SH is defined here as the mean shell height computed from SH' upward, in a given shell height frequency samples, in which SH' is the limit of the first shell height class used in computing the value of SH.

The values obtained served as initial values to facilitate the estimation of the parameters Sh ∞ and K of the von Bertalanffy growth formula through ELEFAN program (Pauly, 1982) for the samples of Paphia undulata. Weatherall method was also used to estimate the SH ∞ and K values for Placuna placenta.

Natural mortality (M) values were obtained using Pauly's empirical equation:

$$/Log10 = - 0.0066 - 0.279 \log10 SH \infty + 0.6543 \log10 K + 0.4634 \log10 T$$

where SH ∞ is the asymptotic shell height in mm, K is put on annual basis and T is the mean annual temperature set at 28°C in Sorsogon Bay.

Fishing mortality (F) was then computed as:

$$F = Z - M$$

while exploitation rate, i.e., the ratio of fishing mortality to total mortality was computed as:

$$E = F/Z$$

which allows the assessment of whether or not the stock is overfished, on the assumption that the optimal value of E is about equal to 0.5, based on the assumption that sustainable yield is optimized when F is about equal to M (Gulland, 1971).

Recruitment pattern was obtained using the appropriate routine of ELEFAN II program. Since shell height frequency data alone do not allow the estimation of to, the abscissa of recruitment pattern is not fixed in real time and is therefore labelled "1 year" (Pauly, 1982).

Fishermen were interviewed to obtain first-hand information on the bivalve fishery.

DESCRIPTION OF THE STUDY AREA

Sorsogon Bay is bounded by longitude 123°50'E and 124°10'E and latitude 12°50'N and 12°59'N. The Bay has an approximate area of 120 km^2. Its mouth opens to a narrow channel leading to Ticao Pass. It is generally shallow with depths ranging from 0.5 to 9 m (0.25 to 5 fathoms). The various river systems around the Bay drain flood waters during heavy downpours, thus contributing to the enrichment of the water. Mangroves are present along the coastline. Generally, the bottom of the Bay is characterized by very soft mud and accumulated silt. However, there are areas which have sandy bottom and some with coarser sediments (Fig. 1).

RESULTS AND DISCUSSION

Species composition

The commercially important species from the natural beds are Paphia undulata, Placuna placenta, Pinna bicolor and Anadara antiquata, while the artificially raised species are Crossostrea iredelei and Perna viridis. There are also less abundant species with less commercial value such as Plicatula plicata, Placuna ephippium, Saccostrea echinata, Isognomon isognomum, Pteria sp., Solen sp., and Anomalocardia squamosa.

Species succession of bivalves seems to exist in Sorsogon Bay. From 1975-1980, *Anadara antiquata* was the abundant species, with peak years 1977-1978. From 1981-1986, it was *Pinna*, with peak in 1984, *Paphia* in 1987 and *Placuna* in 1988.

Distribution

Paphia undulata are mostly concentrated on the eastern portion of the Bay from 2 to 4 fathoms although during the past decade it was observed to occur almost in all parts but in lesser volume (Fig. 2).

Placuna placenta also occur throughout the Bay before typhoon Sisang in 1987, but the tidal surge swept the dead kapis shells to gather abundantly in the northwestern portion and in the southeastern part of the Bay (Fig. 2).

The other bivalves which occur in much lesser volume are found all over the bay, like *Andara, Pinna and Isognomon*. *Solen* are usually found near mouths.

Growth, mortality and exploitation rates of abundant species

Paphia undulata

Table 3 shows the estimates on growth, mortality and exploitation rates of *Paphia undulat a*. SH ∞ and K (growth constant) has 44 mm and 1.8 year^{-1}. Figure 3 shows the growth curve of the species for four months and the catch curve is shown in Figure 4. Exploitation rates had a value of 0.434, indicating an almost optimal value (0.5) for the exploitation ratio.

The recruitment pattern shows that *P. undulata* has two pulses of annual recruitment (Fig. 5).

Placuna placenta

The parameters obtained for *Placuna placenta* are summarized in Table 4. SH ∞ = 131.64 and Z/K = 2.934, and the Weatherall plot is shown in Figure 6.

For now, it is impossible to separate the Z (total mortality) and K (growth constant) to compute the mortality, exploitation rate pattern and recruitment since information on growth parameters of this species are lacking. These results will serve as basic information for future use.

Status of the Bivalve Fishery

Andara antiquata

From 1975-1980 *A. antiquata* were gathered at depths ranging from two to four fathoms with the use of air compressor or "capandra". A fishermen could gather 1/2 sack of *Anadara* measuring 45-60 mm for five to eight hours underwater. These were sold to Chinese buyers who in turn sold the meat to exporters. Four fishermen could obtain an estimated yield of two sacks/boat, each sack weighing about 70-90 kg or an average weight of 80 kg. So the average yield was 1,600 kg for 8-12 boats per day. At present, the occurrence of blood clam is small compared to *Paphia*.

Pinna bicolor

P. bicolor found to be abundant in 1984 were gathered at two to three fathoms deep using air compressor. Shell height of gathered shells ranged from 230-310 mm. Bigger pen shells with bigger adductor muscles command a higher price in the local market. Adductor muscles measuring about 1 inch in diameter were sold at P80/kg (P40 for the smaller ones) while the meat (except the adductor muscles) were sold at P15/kg. For home consumption, they were cooked into adobo with curry powder. Production estimate was 500 kg/day.

Paphia undulata

Although young *Paphia undulata* was the most abundant species among the benthic organisms (89-94% of the bivalve biomass) during the 1975 and 1980 hydro-biological surveys, it was not until 1985 that the fishernmen noticed its abundance. From 1985 to present, *Paphia* is the most abundant species with peak yeild in 1987. This explains the booming of *Paphia* processing plant industry in Sorsogon Bay.

The *badoy* industry in Sorsogon Bay started in November 1986 when several exporting firms bought shells from the gatherers/divers. Shell gatherers/divers using air compressor handpicked the shells at depths ranging from three to six fathoms. In 1987, a diver could gather 20-30 kg of *Paphia* for an average gathering time of 4 hours. Operation usually started from 10 a.m. to 3 p.m. A banca carrying 5-7 divers could harvest 150 kg. There was an estimate of 528

bancas using air compressor all over the area surrounding the Bay. An average of 50 tons were gathered daily (pers. comm., a staff of San Miguel Bay Corporation, 1987). Operations ceased when there was a decline in catch in mid-1987.

In April 1988, the *badoy* industry again flourished. The price of 34-38 mm *Paphia* then was P13/kg. But in 1989, the price of 34 mm shells went down to P7-8/kg and the smaller ones cost P4.5-5.00/kg. There were about 40 bancas (three to five divers/banca) gathering the shells. Each diver usually performed 2 dives, each dive lasted for three hours producing 10-25 kg of shells or a daily production of two tons (pers. comm., Gary Macam, buyer, 1989). Gathering took place at the eastern portion of the Bay, specifically in Boton at two to four fathoms where *Paphia* population was concentrated. Gathering was year-round except during bad weather.

The *Paphia* industry had benefitted a great number of people in the community. Processing plants requiring personnel (men and women) were put up in Cambulaga, Pier Site and Rizal, all in the municipality of Sorsogon. There were about 100 persons per processing plant and operation usually started at 4 p.m. until midnight. The tricycle drivers were likewise benefitted since a unit could transport six to eight sacks per trip, each sack had a transport fee of P3.00.

Cultured Species

A. *Crassostrea iredelei* is being cultured at the BFAR Oyster Farm in Juban, Sorsogon, with a total area of 1.2 ha. Only 0.25 ha is being used for oyster culture using the hanging culture method. The area is composed of 15 plots at 2 m deep. During spawning, which occurs from March-June, spat collectors are set to catch the free swimming larvae. May is the peak month for spat collection. Oyster spats were collected in March this year (1989). The average weight per hanging is one kilogram. The farm has 12 thousand hangings, which yielded 12 oyster after an eight-month period (October 1989). In areas where there are no breeding stock of oysters, breeders are provided to be utilized as initial and breeding stock. In 1987, a total of 11 MT were harvested and 10 MT in 1988. The oysters produced in the farm are being utilized in the dispersal program of the Region. There are two private oyster farms in Juban with a total area of 7 ha. In 1987, the total production was 63 MT and in 1987, it was 55.2 MT. The produce are sold locally and transported to Manila.

B. *Perna viridis* is being cultured at the BFAR Mussels Farm in Castilla and in Cambulaga, Sorsogon. The stake-wigwam method using bamboo stakes is being used. The first spats came from Jiabong, Samar, in 1985. Record on production was not taken. In Castilla, the BFAR mussels farm operation started in January 1989 using *anahaw* trunk stakes. Sixty trunks of this type was set.

There were privately owned mussels farms in Juban-Casiguran waters, the biggest is 0.7 ha while the rest were 0.10-0.13 ha. Production data from both the government and the privately owned farms were not available.

Utilization

The meat of the six commercially important bivalves in the Bay are being utilized as food. They are good sources of protein, vitamins and minerals for humans as well as lower animals. They are prepared in various ways such as adobo, chowder, omelet, soup, *bagoong* (paste) and *patis* (sauce). They are mixed into animal feeds. Oyster juice was reported to have antiviral properties. In *Pinna bicolor*, the most expensive part is the adductor muscle, the selling price of which depends on the size of the adductor muscles. Bivalve meats are processed, chilled or frozen then graded according to size before they are exported.

Aside from the meat, shells of these bivalves are also of economic importance. The shell of the windowpane oyster, *Placuna placenta,* ranks first among the shells. It has long been utilized in the Philippines as window pane and was found to be much stronger than plate glass of 3 mm thickness. The windows of some of the old churches, convents, and residences in the country are proof of their durability. Also due to its translucent characteristics, it emits a soft, diffused light which is not glaring to the eyes. Its other uses are for shellcraft and shell art where it is made into screens, lamp shades, paneling, trays, bouquet of flowers and other novelties for the home and office. It is also used in the manufacture of pearl essence for pearl beads (Martin, 1953).

COMMENTS

- Species succession of bivalves existed in the Bay; first it was *Anadara antiquata*, then *Pinna bicolor,* followed by *Placuna placenta* and finally, *Paphia undulata*.

- *Placuna placenta* gathered from 1988-1989 were dead shells, which may be due to the tidal surge during typhoon Sisang in 1987 that swept the bottom of the Bay and buried the kapis in the mud at 0.5 m deep.

- The exploitation rate of *Paphia undulata* obtained through the ELEFAN method was 0.434, which is about equal to optimal value (0.5) and may indicate that the stock is nearly optimized.

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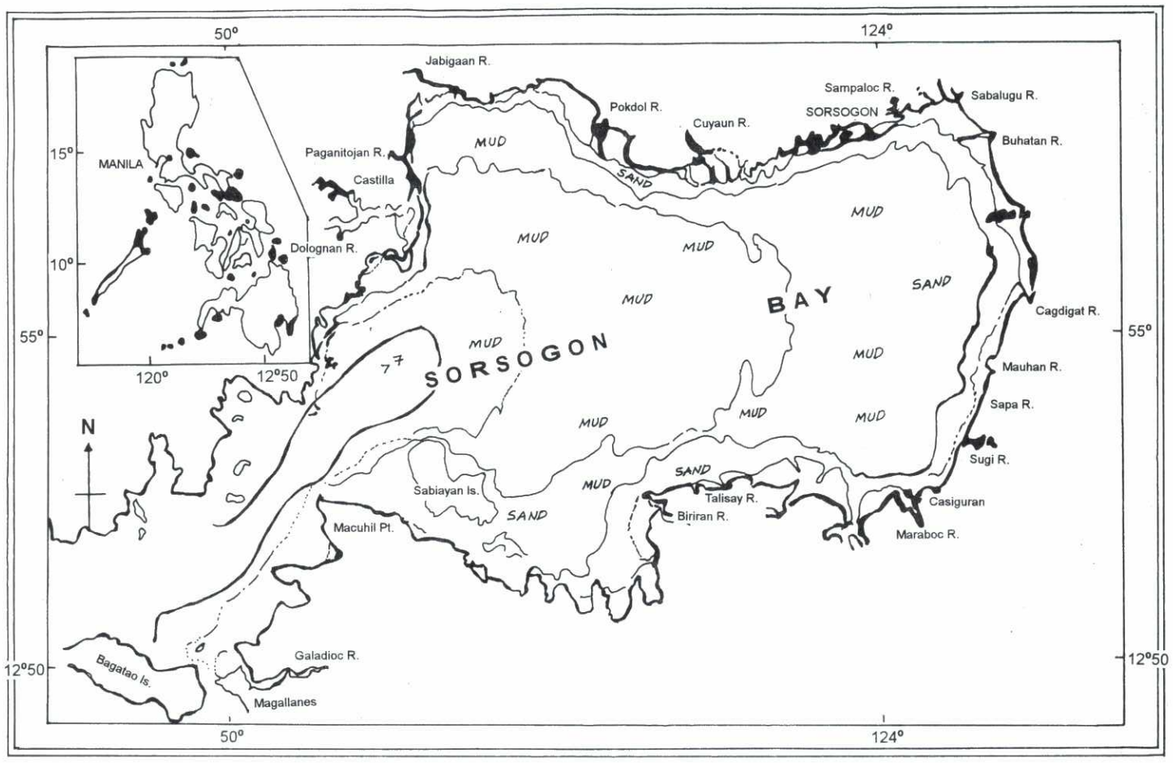


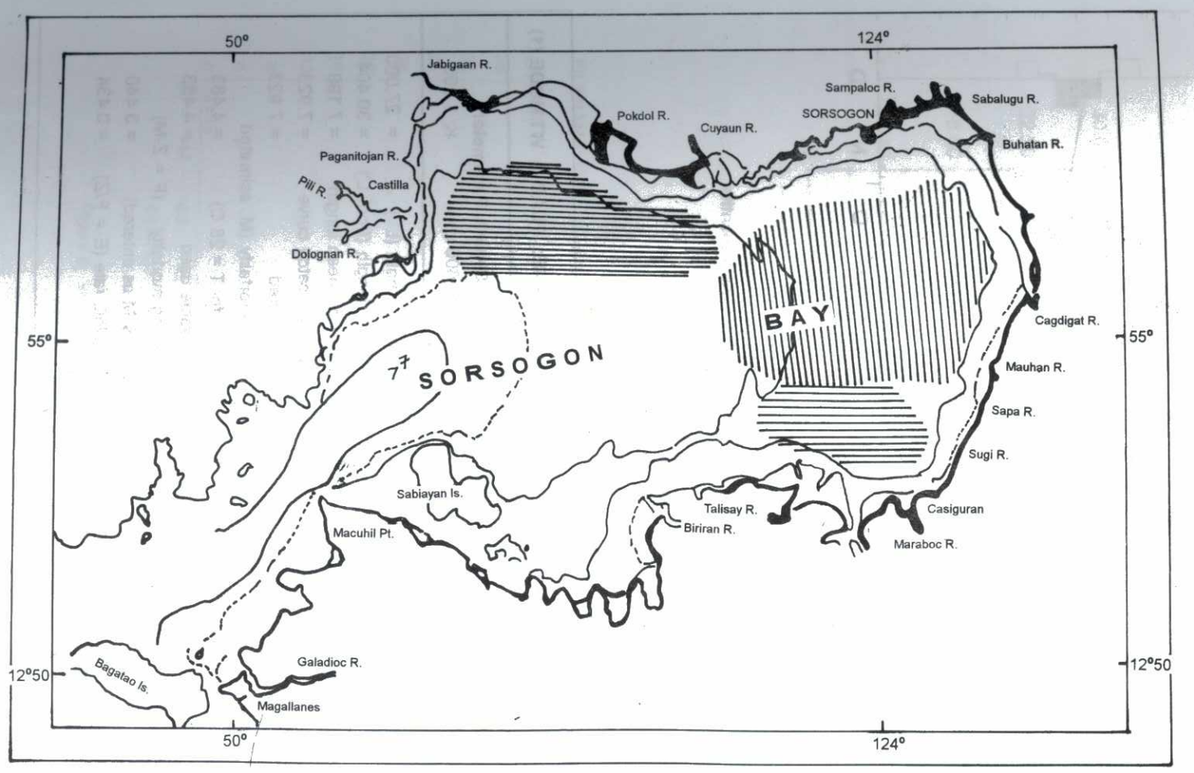


Figure 2 **Distribution of *Paphia undulata* (vertical line) and of *placuna placenta* (horizontal lines) in Sorsogon Bay, Philipppines, 1988-1989.**

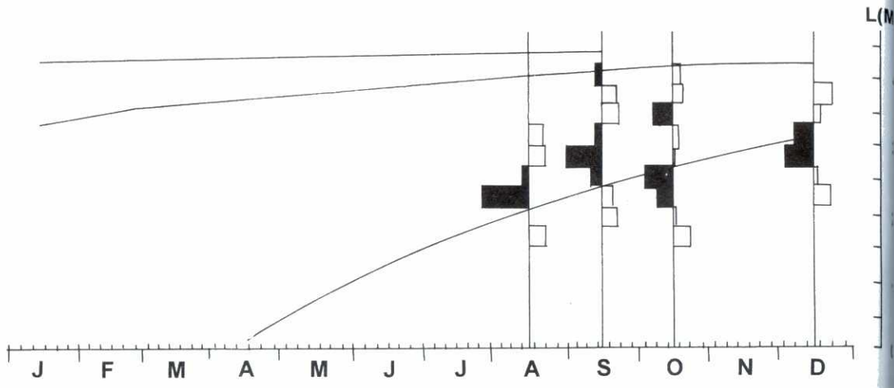
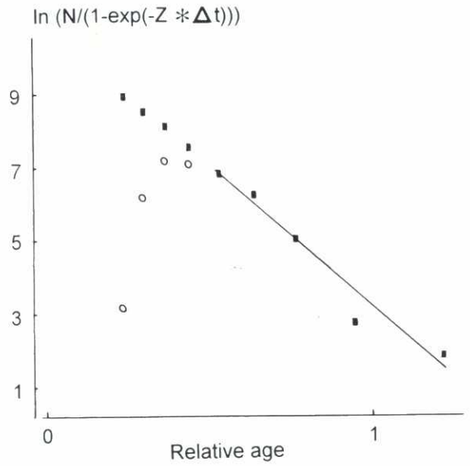


Figure 3. **Growth curve- *Paphia undulata* for 4 months.**

CATCH CURVE



FILENAME: PUAD WT.MODE (1)	
Growth Parameters	
Loo: 44.000 mm	K: 1.800
cutoff length (L')	= 27.000
mean length (from L')	= 30.404
Z from mean length	= 7.190
Z from catch curve	= 7.923
Z entered	= 7.923
nat. mortality (M, esimated for T = 28 C)	= 4.483
M value used	= 4.483
fishing mortality (F = Z-M) (Z & M as entered)	= 3.440
exploit. rate (E = F/Z)	= 0.434

Figure 4. **Catch curve - *Paphia undulata.***

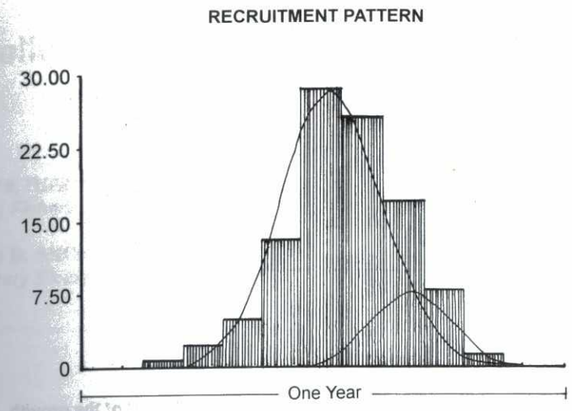


Figure 5. **Recruitment pattern- *Paphia undulata.***

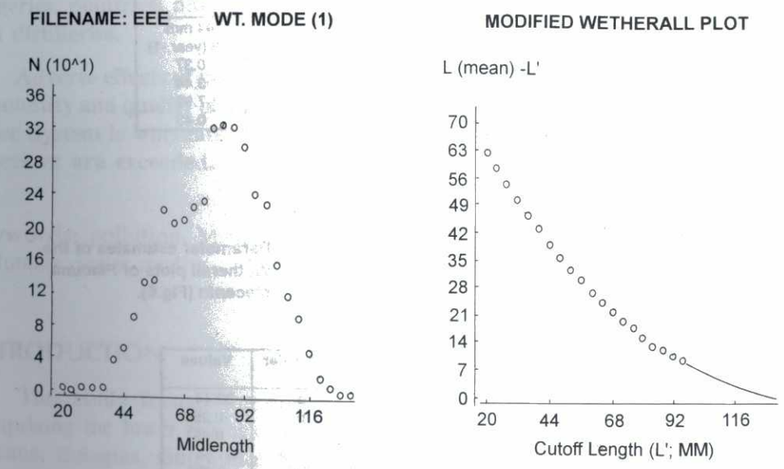


Figure 6. **Wetherall plots. *Placuna placenta.***

Table 1. **Shell height frequency of *Paphia undulata* in Sorsogon Bay.**

SH/Date	8/15/89	9/15/89	10/15/89	12/15/89
16.5	9.0		1.0	
19.5	133.0	4.5	70.0	
22.5	424.0	28.0	188.5	9.0
25.5	170.5	164.5	280.0	67.0
28.5	11.0	293.5	98.0	216.0
31.5	4.5	139.0	54.5	167.5
34.5		8.0	81.5	49.5
37.5		4.5	11.0	1.0
40.5		5.5	1.5	
43.5		1.5		
Sum	752.0	649.0	786.0	510.0

n = 2,697.00

Table 2. **Shell height frequency of *Placuna placenta* in Sorsogon Bay, 1988.**

SH/Date	4/15/89	5/15/89	6/15/89
22	1.6		0.8
26	1.0		0.2
30	1.6	0.4	0.4
34	2.6	0.6	0.8
38	3.2	0.0	0.8
42	24.8	6.4	7.2
46	36.2	7.0	8.4
50	64.8	14.0	15.6
54	89.6	22.0	22.4
58	89.6	25.6	22.4
62	149.6	30.4	43.2
66	140.6	28.0	36.0
70	128.0	39.6	42.8
74	116.0	54.0	55.6
78	108.8	60.0	66.4
82	163.2	109.6	49.6
86	145.8	128.2	52.6
90	144.4	138.0	40.4
94	138.4	135.4	24.6
98	107.2	116.8	16.8
102	107.2	113.6	5.6
106	87.4	68.0	2.6
110	72.4	47.6	0.8
114	57.2	35.0	
118	36.8	12.8	
122	15.2	4.0	
126	5.0	1.0	
130	0.8	0.4	
134		0.6	
Sum	2039.0	1199.0	516.0

n = 3,754.00

Table 3. **Summary of the growth (Shoo and K) mortality (Z, M, F) and exploitation rate of *Paphia undulata* gathered in Sorsogon Bay.**

Parameter	Values
Sh oo	44 mm
K	1.8 (year -1)
M	0.37
F	3.44
Z	7.92
E	0.43

Table 4. **Parameter estimates of the Wetherall plots of *Placuna placenta* (Fig.6).**

Parameter	Values
a	33.44
b	-0.254
r	0.991
SH oo	131.64
Z/K	2.936