Edible Molluscs, Crustaceans and Holothurians from North and South Bais Bays, Negros Oriental, Philippines*

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ABSTRACT. The standing stock, distribution and harvest of the common molluscan, crustacean and holothurian species occurring in North and South Bais Bays, southern Negros, Philippines were studied for 12 months from January through December 1982. Twenty-seven species of pelecypods and gastropods, several species of crustaceans in the families Gecarcinidae, Penaeidae, Portunidae and Grapsidae, and 16 species of holothurians were found to be harvested for food. Standing stock of pelecypods and gastropods in an area of approximately 267 ha was estimated to be about 33.5 tons (wet weight), exclusive of the mussel **Modiolus metcalfei** and the sea hare **Dolabella auricularia. Dolabella** had a standing stock of about 217 kg (wet weight) per ha in favorable areas of the bays. Standing stocks of crustaceans are unknown except for that of **Cardisoma carnifex,** estimated at 3300 adults and subadults per ha. Standing stock of five major species of holothurians was about 2.6 tons (wet weight) per ha in favorable habitats. Annual harvest in 1982 of molluscs, crabs, shrimps, holothurians and sea hare egg masses was estimated at about 16 tons, with a market value of ₱77,000. Although 26 species of algae occurred in the Bays, the basis for animal production was most likely the mangrove forest and seagrass bed.

North and South Bais Bays on southern Negros Island have long been sources of food molluscs, crustaceans and holothurians for local populations in Bais City and neighboring towns including Dumaguete City. Because of the concern that the marine productivity of the bays might be affected by such factors as unrestrained exploitation, destruction of their mangrove forests and pollution, this study was conducted. The data gathered could serve as a baseline for future studies of biological resources in the bays.

Previous studies of the Bais Bays have dealt with effects of pulp and paper mill effluent on certain benthos (Alcala and Ortega 1976), levels of mercury in sediments and shellfish (Lowrie et al. 1979), structure of intertidal macrobenthos (Maravilla 1975, Notosoedarmo 1979), effects of siltation on corals (Alcala 1977), ecology of certain economically important species (Alcala 1979, Calumpong 1979), ecology of seagrasses (Meñez, et al. 1983), distribution and density of plankton (Alcazar 1983) and growth, reproduction and mortality of the sea hare *Dolabella auricularia* (Pauly and Calumpong 1984). The present paper reports the various species of molluscs, crustaceans and holothurians harvested for food from the two bays, estimating their distributions and

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standing stocks and, where possible, the value in Philippine pesos of the harvests.

Methods and Materials

Data were gathered by direct observations, by interview with fishermen and by use of the transect-quadrat method. Transects were located in permanent stations and were laid out perpendicular to the shoreline.

Samples of organisms were collected from 1 m x 1 m quadrats to a depth of 10-15 cm, using a trowel. They were weighed after excess water was blotted, then fixed in formalin and preserved in alcohol. Sample specimens of molluscs and holothurians were sent to the Smithsonian Institution, Washington, D.C. for identification. Dr. David Pawson identified the holothurians and Dr. Joseph Rosewater the molluscs. Voucher specimens are deposited in the Silliman University Marine Laboratory and the U.S. National Museum, Smithsonian Institution. Dr. Ernani G. Meñez, Smithsonian Institution, kindly provided us a list of algae taken from South Bais Bay.

The study area was sampled eight times in one year, at intervals of 1.5 months from January through December 1982. The duration of every visit was two days. Our observations for molluscs and holothurians were generally made in an area of about 377 hectares, but data for crustaceans pertain to a much larger area. Standing stocks of molluscs and holothurians were determined in North Bais Bay (4 stations) and South Bais Bay (2 stations).

Water temperature, salinity and nature of substrate were recorded. Salinity was measured with a direct-reading salinometer.

The Study Area

North and South Bais Bays (Fig. 1) have a total area of about 50 km^2 (North Bay, 32 km^2; South Bay, 18 km^2), exclusive of the two large coral reef areas at the mouth of North Bais Bay. If these reefs are included, the total area would be about 64 km^2. The two bays varied in depth at mean low water from less than a fathom to 30 fathoms. Mangrove trees lined most of the landward margins; five species of seagrasses occupied some parts of the bays.

The two bays are separated by Daco Island, consisting of 237 ha of dry land, 146 m at its highest point, and a 206-ha Talabong mangrove forest. This forest, composed mainly of young trees of the genera

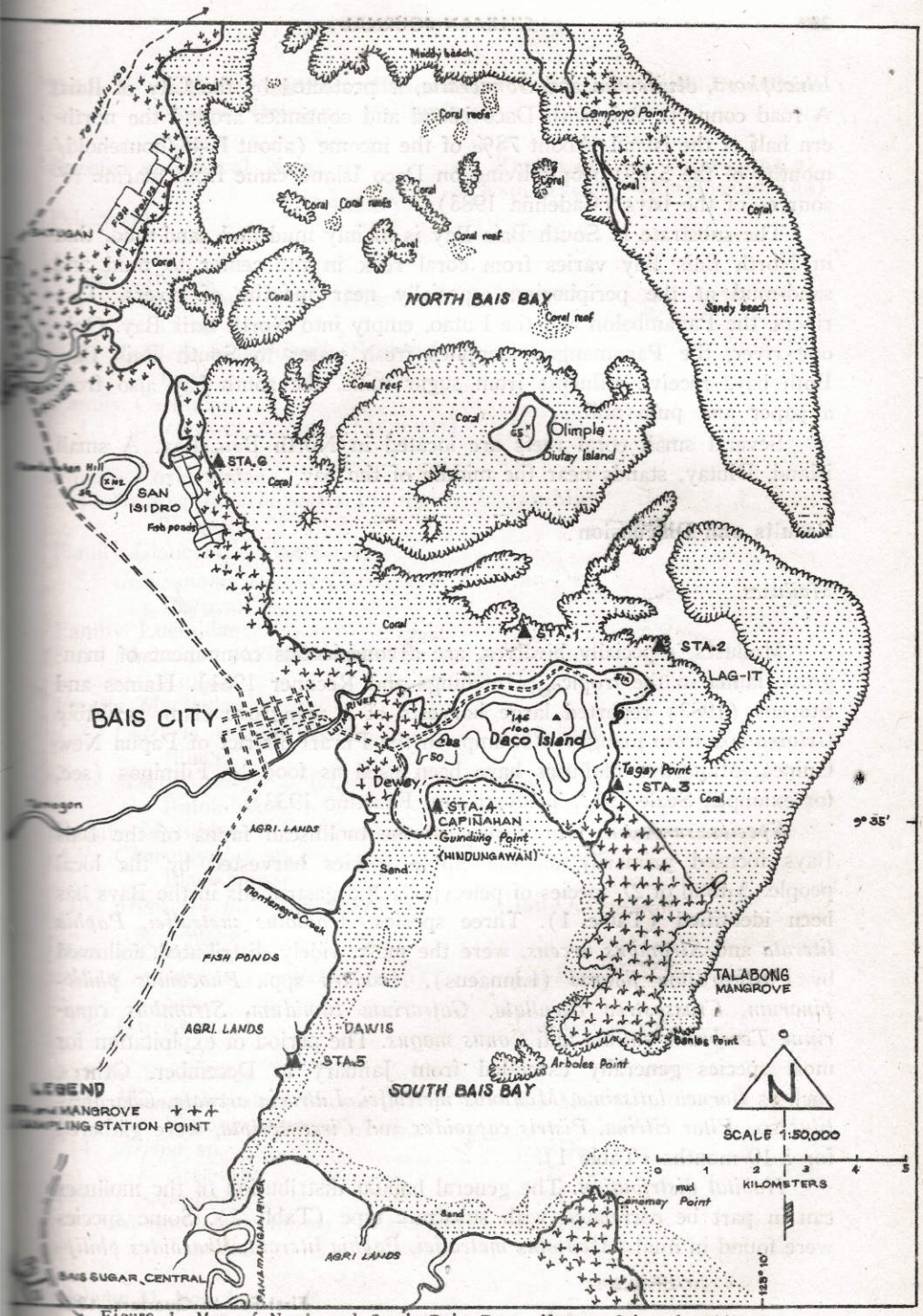

Figure 1. Map of North and South Bais Bays, Negros Oriental, Philippines

Rhizophora, Avicennia and *Sonneratia,* is protected by the City of Bais. A road connects Bais with Daco island and continues around the northern half of the island. About 78% of the income (about ₱348/household/month) of the 5,150 people living on Daco Island came from marine resources of the bays (Cadeliña 1983).

The substrate in South Bais Bay is mainly mud and sand-mud, that in North Bais Bay varies from coral rock in the center to mud and sand-mud at the peripheries, especially near mouths of rivers. Two rivers, the Panambalon and the Lutao, empty into North Bais Bay. Only one river, the Panamangan, supplies fresh water to South Bais Bay. Both bays receive effluents from sugar mills, the south bay also from a paper and pulp mill.

Several small coral reefs are located in North Bais Bay. A small island, Diutay, stands near the middle of the bay.

Results and Discussion

Molluscs.

Molluscs, especially bivalves, are a conspicuous component of mangrove fauna in the tropics (Hutchings and Rechner 1981). Haines and Stevens (1983) reported large harvests of a mangrove clam, probably *Geloina* sp., from mangrove swamps in the Purari district of Papua New Guinea. Mangrove molluscs have been used as food by Filipinos (see, for example, Seale 1912, Talavera and Faustino 1933).

Species surveyed. Our survey of the molluscan fauna of the Bais Bays focused primarily on the edible species harvested by the local people. A total of 27 species of pelecypods and gastropods in the Bays has been identified (Table 1). Three species, *Modiolus metcalfei, Paphia literata* and *Strombus urceus,* were the most widely distributed, followed by *Vasticardium flavum* (Linnaeus), *Anadara* spp., *Phocoides philippinarum, Crassostrea cucullata, Gafrarium tumidum, Strombus canarium, Terebralia sulcata* and *Conus magus.* The period of exploitation for most species generally extended from January to December. Others, such as *Barnea latissima, Modiolus metcalfei, Lutraria arcuata, Charomytilus* sp., *Pitar citrina, Pistris capsoides* and *Circe scripta,* were gathered for 5-10 months (Table 1).

Habitat distribution. The general habitat distribution of the molluscs can in part be correlated with substrate type (Table 2). Some species were found in mud (*Modiolus metcalfei, Paphia literata, Phacoides philip-*

Table 1. A list of edible molluscs from North and South Bais Bays, Negros Oriental, Philippines

Species and Local Name	Period of Exploitation	Approximate Distribution (ha)
Pelecypods		
Family Arcidae		
1. *Anadara antiquata* (Meuschen) Litub	Jan-Dec	10
2. *Anadara broughtonii* (Schrenck) Litub	Jan-Dec	10
Family Cardiidae		
3. *Vasticardium flavum* (Linnaeus) Litub	Jan-Dec	20
Family Corbiculidae		
4. *Geloina suborbicularis* Philippi Tuway	Jan-May	3
Family Glauconomyidae		
5. *Glauconome rugosa* (Reeve) Bayuyan	Jan-Dec	4
Family Lucinidae		
6. *Phacoides philippinarum* (Reeve) Embao	Jan-Dec	10
Family Mactridae		
7. *Lutraria arcuata* (Reeve) Bilaog	Jan-June	4
8. *Mactra antiquata* (Spengler) Bulok-bulok	June-Dec	2
Family Mytilidae		
9. *Charomytilus* sp. Black mussel	Feb-June	2
10. *Modiolus metcalfei* (Hanley) Tahong	Jan-Oct	50
Family Ostreidae		
11. *Crassostrea cucullata* (Born) Sisi	Jan-Dec	10
12. *Ostrea* sp. Kuya	Jan-May	5
Family Pholadidae		
13. *Barnea latissima* (Sowerby) Sugong-sugong	Jan-May	4
14. *Atrina* sp. Atsa-atsa	Jan-Dec	5
Family Sanguinolariidae		
15. *Sanguinolaria togata* (Deshayes) Tamislot	Jan-Dec	4

Table 2. Habitat distribution of edible molluscs in the Bais Bays (part of the habitat exposed at low tides)

Species	Distribution	Description of Habitat
Barnea latissima	Station 6	Sand and mud substrate; pure stands of *Thalassia*, salinity 33 ppt; temperature 30-31°C
Lutraria arcuata, Mactra antiquata	Station 6	As above
Paphia semirugata, Anadara sp., *Pitar citrina, Clauconome rugosa, Pistris capsoides, Solen* sp., *Circe scripta, Sanguinolaria togata*	Station 2	Sand and coral rubble substrate with little mud; seagrass bed composed of *Enhalus* and *Thalassia;* salinity 33 ppt; temperature 30-31°C
Modiolus metcalfei, Paphia literata, Phacoides philippinarum, Gafrarium tumidum, Ostrea sp., *Strombus canarum, Charomytilus* sp., *Telescopium telescopium, Terebralia sulcata*	Stations 4 and 5	Mud substrates near and in mangrove 0.5-1 m deep; seagrasses absent; salinity 28-32 ppt; temperature 29-30°C
Crassostrea cucullata	Stations 4 and 5	Attached to roots and trunks of mangrove trees; salinity 28-33 ppt
Geloina suborbicularis	Stations 4 and 5	Muddy canals in nipa groves; salinity 0-28 ppt
Conus magus, Vasticardium flavum, Strombus urceus, Atrina sp.	Stations 1, 2, 3	Sand and coral rubble substrate; seagrasses *Enhalus* and *Thalassia;* the the algae *Hydroclathrus* and *Gracilaria* also occurred at Station 3

pinarum, Gafrarium tumidum, Telescopium telescopium), while others (*Lutraria arcuata, Mactra antiquata, Pistris capsoides,* etc.) were found in mixtures of sand and mud or rubble and mud. Those species found in mud (substrate infauna) together with some species of oysters (substrate epifauna) attached to roots and lower trunks of mangrove trees might be considered truly mangrove species. The clam *Geloina suborbicularis* is especially adapted to cooler, less saline microhabitats in mangrove swamps, usually associated with *Nypa*. Other molluscan species inhabited seagrass beds having mostly sandy or sandy-muddy substrates (Stations 1, 2, 3 in Table 2).

Standing stocks. The standing stock of molluscs in three areas in the Bais Bay, as determined by the transect-quadrat method in January-March 1980, are summarized in Tables 3 anl 4. The mean number of individuals per 20 m^2 ranged from 26.5 to 39.7 and the mean wet weights from 137.1 to 351.2 g. The weight per hectare was 68.6 to 175.6 kg. Table 4 gives an idea of the mean number of individuals and their mean wet weights for seven common genera sampled at three stations.

A more thorough sampling at six stations, February-December 1982, gave comparable standing stock estimates on a 20 m^2 area basis—10.75 to 44 individuals weighing 139.58 to 496 g, except for larger numbers and greater wet weight for *Modiolus metcalfei* and *Paphia literata* at Station 5 (Table 5). *Modiolus metcalfei* grew large colonies at Station 5 from February to October 1982 and were totally harvested shortly after our sampling. Excluding the estimates for Station 5, the average estimated wet weights of the molluscs was 148 kg/hectare. On this basis the approximately 267 hectares of "shell" areas would have a standing stock of about 33,516 kg or 33.5 tons, exclusive of *Modiolus metcalfei.*

Economic value. The economic value of edible molluscs in the 267 hectares of "shell" area is not accurately known because of the difficulty of determining the harvest. Our earlier estimate of 2,000 kg wet weight per month or 24,000 kg in one year valued at ₱48,000 per year (Alcala 1979) is probably too high. The best estimate would be about 12,000 kg (12 tons) per year (exclusive of the harvest of the mussel *Modiolus metcalfei*), with an annual value of ₱24,000. The harvest of *Modiolus* by about 20 families appears to be substantial. For example, one family harvested 20 sacks weighing 500 kg during the 12 months in 1980, with a value of ₱1,000.

The sea hare *Dolabella auricularia* is important because of the edible egg masses it produces year round (Pauly and Calumpong 1984). It has

Table 3. Mean monthly standing stock of molluscs in the Bais Bays in 20 1-m² quadrats, January-March 1980, exclusive of the Sea Hare, Dolabella auricularia

	Okiot	Lag-it	Sanlagan
Mean no. of individuals	33.7	39.7	26.5
Mean wet weight (g)	137.1	139.4	351.2
Weight/hectare (kg)	68.6	69.7	175.6

Station: Species Sampled	Mean No. ± SD of Individuals per Sample	Mean Wet Weight per Sample (g)	Estimated No. of Individuals/ ha	Estimated Wet Weight/ha (kg)
1 *Vasticardium flavum* *Conus magus* *Paphia literata* *Strombus urceus* *Anadara antiquata* *Atrina* sp.	11.37 ± 8.35*	247.64 ± 267.70	11,370	247.6
2 *Strombus urceus* *Conus magus* *Anadara* sp. *Atrina* sp.	10.75 ± 5.82+	139.58 ± 56.02	5,375	69.8
3 *Strombus* sp. *Vasticardium flavum* *Anadara antiquata* *Atrina* sp. *Gafrarium tumidum*	12.62 ± 5.55*	122.73 ± 63.03	12,620	122.7
4 *Strombus canarium* *Strombus urceus* *Gafrarium tumidum*	12.38 ± 3.93*	154.05 + 36.24	12,380	154.0
5 *Modiulus metcalfei* *Paphia literata*	596.57 ±333.60#	2,783.8 ± 861.77	298,285	1,391.9
6 *Pitar citrina* *Pistris capsoides* *Solen* sp. *Circe scripta* *Sanguinolaria togata* *Glauconome rugosa*	21.63 ± 9.07*	146.16 ± 58.76	21,630	146.2

* 10 1-m² quadrats, or 10 m² total area sampled
\+ 20 1-m² quadrats, or 20 m² total area sampled
\# Sampling from February through October 1982

Table 6. List of crustaceans commonly found in the Bais Bays

Family Gecarcinidae

1. *Cardisoma carnifex* Herbst

Family Grapsidae

2. *Neoepisesarma mederi* (Milne-Edwards)
3. *Neosarmatium meinerti* (De Man)
4. *Varuna litterata* Fabricius

Family Ocypodidae

5. *Uca c. coarctata* (Milne-Edwards)
6. *Uca demani* Ortmann
7. *Uca d. dussumieri* (Milne-Edwards)
8. *Uca lactea annulipes* (Milne-Edwards)
9. *Uca lactea perplexa* (Milne-Edwards)
10. *Uca t. triangularis* (Milne-Edwards)
11. *Uca v. vocans* (Linnaeus)

Family Penaeidae

12. *Metapenaeus* spp.
13. *Penaeus* spp.

Family Portunidae

14. *Portunus* spp.
15. *Scylla serrata* Forskal

Family Thallasinidae

16. *Thallasina anomala* Herbst

Table 7. Edible holothurians in North and South Bais Bays, Negros Oriental, Philippines

Species	Local Name
1. *Actinopyga mauritana* (Quoy & Gaimard)	balat-sunlatan
2. *A. echinites* (Jaeger)	balat-tagukan
3. *Bohadschia marmorata* Jaeger	pisot
4. *B. argus* Jaeger	balat-hanginan
5. *Holothuria leucospilota* Brandt	batuli
6. *H. edulis* Lesson	balat-tagukan
7. *H. hilla* Lesson	balat-tagukan
8. *H. pulla* Selenka	balat-tagukan
9. *H. atra* Jaeger	balat-tagukan
10. *H. aculeata* Semper	balat-sus-an
11. *H. scabra* Jaeger	balat-bagisan
12. *H. fuscacinerea* Jaeger	balat-bagisan
13. *H. imitans* Ludwig	balat-bagisan
14. *H. impatiens* Forskal	balat-bagisan
15. *Stichopus variegatus* Semper	balat-bagisan
16. *Thelenota ananas* Jaeger	balat-monang

Economic value. Two crustacean families, the Penaeidae (prawns and shrimps) and Portunidae (crabs) were highly valued as food items. The mean monthly harvest of shrimps in the Bays was about 176 kg, which, if extrapolated for one year, could amount to about 2,111 kg, with a value of over ₱31,000. Crabs (*Portunus spp.* and *Scylla serrata*) were also highly desired food items. Only the catch of *Scylla serrata* was known. The mean monthly harvest of this crab was 196 kg, 2,356 kg in one year, valued at over ₱15,000 (Table 8). (The taxonomy of the genus *Scylla* is still in question. Most authors recognize only one species, but Estampador in 1949 tried to show that there were three species, based on adult coloration, differences in chromosome morphology and structure and in gametogenesis.)

It is known that penaeid shrimps are caught in large quantities in Philippine mangrove swamps. However, quantification of yields is lacking. Prawn production is dependent on intact mangrove forests, and destruction of these forests has resulted in reduced harvest (Krishnamurthy and Jeyaseelan 1980). A major reason for this reduction in yield is diminution of the food supply of the shrimps, as it is now well established that mangrove detritus serves as the energy base of food webs in mangrove swamps (see Odum and Heald 1975, Odum 1982, Odum et al. 1982).

Holothurians.

Sixteen species of edible sea cucumbers have been identified in the Bays (Table 7 and Fig. 2). They were distributed in an area of about 110 ha at the seaward (eastern) edge of Daco Island and in the Talabong mangrove forest. Here the substrate was predominantly sand mixed with coral rubble and the conspicuous plants were the seagrasses *Enhalus* and *Thalassia* and the algae *Hydroclathrus* and *Gracilaria.* These sea cucumbers are not strictly mangrove species, as all of them except *Holothuria pulla, H. aculeata, H. scabra, H. fuscocinerea* and *H. imitans* have also been reported from coral reefs (Clark 1976).

Standing stock. The mean density of five species, *Actinopyga mauritiana, A. echinites, Holothuria pulla, H. hilla* and *Bohadschia argus,* determined at Station 2 from February to December 1982 using the transect-quadrat method, was 6.75 ± 2.38 individuals or 3,375 individuals per hectare, with a mean wet weight of 541 kg. The mean density of another group of six species, *Holothuria leucospilota, H. aculeata, H. atra, H. edulis, Bohadschia marmorata* and *Thelenota ananas,* was sim-

Figure 2. A. Holothurians (*Bohadschia* and *Holothuria*) and

Table 9. Marine benthic algae found in the mangrove swamp at South Bais Bay

Rhodophyceae (red algae)

1. *Leveillea jungermannioides* (Martens & Hering) Harvey
2. *Amphiroa fragilissima* (Linnaeus) Lamouroux
3. *Tolypiocladia glomerulata* (C. Agardh) Schmitz
4. *Catenella caespitosa* (Withering) L. Irvine
5. *Acanthophora spicifera* (Forskal) Borgesen
6. *Gracilaria salicornia* (C. Agardh) Dawson
7. *Bostrychia tenella* (Lamouroux) J. Agardh
8. *Actinotrichia fragilis* (Forskal) Borgesen
9. *Laurencia papillosa* (Forskal) Greville

Clorophyceae (green algae)

10. *Boergesenia forbesii* (Harvey) Feldmann
11. *Neomeris vanbosseae* Howe
12. *Ulva reticulata* Forskal
13. *Caulerpa racemosa* (Forskal) J. Agardh
14. *Enteromorpha intestinalis* (Linnaeus) Nees
15. *Chaetomorpha crassa* (C. Agardh) Kutzing
16. *Udotea* sp.
17. *Avrainvillea* sp.
18. *Halimeda opuntia* (Linnaeus) Lamouroux
19. *Halimeda macroloba* Decaisne
20. *Chaetomorpha spiralis* Okamura
21. *Chaetomorpha linum* (Muller) Kutzing

Phaeophycease (brown algae)

22. *Hydroclathrus clathratus* (C. Agardh) M. A. Howe
23. *Padina tenuis Bory*
24. *Giffordia duchassaigniana* (Grunow) Taylor

Cyanophyceae (blue-green algae)

25. *Lyngbya majuscula* Gomont
26. *Brachytrichia* sp.

larly determined at Station 3 during the same period to be 39.75 ± 13.06 per 20 m² or 19, 875 individuals per hectare, with a wet weight of about 2.6 tons per hectare. These biomass estimates, though based on limited samples, indicate that the standing stock of edible holothurians in certain areas of the bays is substantial.

Harvest and economic value. It is very difficult to estimate the actual harvest of holothurians in the bays. Our preliminary data indicate that about 108 kg per month (1.3 tons per year) were gathered for local consumption, valued at about ₱2,800 per year (Table 8). To this amount must be added ₱9,000, the value of 600 kg of dried holothurians (*trepang* or *beche de mer*) sold by a trader in 1980. An unknown portion of the holothurian harvest came from deeper water and was not strictly part of the mangrove fauna. A *trepang* (dried sea cucumber) fishery has existed in the Philippines for some time (see, for example, Seale 1917).

Algae

Twenty-six species of marine benthic algae distributed in the four algal classes have been found in South Bais Bay by Dr. Ernani Meñez, Smithsonian Institution (Table 9). All of these species were attached to rocks or to sand-mud substrate, except for *Bostrychia tenella* and *Catenella caespitosa,* which were attached to mangrove roots, and a few others that were epiphytic on other algae.

Among the green algae, *Caulerpa racemosa* and *Enteromorpha intestinalis* would appear to have direct use to man, the former being used as salad and the latter serving as bait for rabbitfish (*Siganus*) traps.

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