Spot assessment of the marine invertebrate resources of Baybay waters

Bernardita P. Germano and Gloriosa C. Guinocor
Department of Plant Protection, Visayas State College of Agriculture
Baybay, Leyte 6521-A, Philippines

ABSTRACT

The marine macrobenthic invertebrate resources of Baybay were assessed using the transect-quadrat method. Two samplings in 23 stations over an area of 2300 m^2 yielded a mean macroinvertebrate density of 117 individuals/100 m^2. A total of 142 invertebrate species belonging to 72 families in 16 classes in 7 phyla were identified. The three most dominant species are the barnacle *Balanus* sp. and the gastropods *Nerita odonta* and *Clypeomorus bifasciata bifasciata*. Gastropoda is the most dominant and most ubiquitous taxon. The commercially important genera *Haliotis* and *Tridacna* are also found in the area.

Highest and lowest mean density were observed in Bunga and Kilim, respectively. Species diversity was highest in Plaridel and lowest in San Agustin. The mean species diversity of Baybay is lower than of the neighboring Cuatro Islas and Camotes Islands.

Siltation appears to be a major macroinvertebrate density-controlling factor in Baybay waters. Thus, vigilance against slash-and-burn agriculture and the removal of rocks and boulders from major rivers should be increased. The pattern of diversity is probably imposed by bottom topography and the practice of beach seining.

The trial mariculture of *Haliotis* and *Tridacna* in the southern stations is recommended to possibly increase local seed stocks of these species and introduce a potential source of alternative livelihood for small-scale fishermen. Further, it is recommended that some portion on beach-seined areas (stations from Baybay wharf to Marcos) be reserved for rehabilitation of vegetation so as to have a source of recruits for the exploited sites.

Keywords: *Marine invertebrates, Baybay waters, density, species diversity, siltation, bottom topography, beach seining*

INTRODUCTION

The coast of Baybay has 60 major and minor rivers and streams that empty into the marine environment. These channels may contribute not only freshwater but also agricultural wastes, household wastes and silt to the marine waters of Baybay. Like in most coastal areas in the Philippines, various fishing activities (both destructive and nondestructive) are also being undertaken. How inputs from the land and various fishing activities have affected the marine invertebrate fauna over the years is not known as no baseline data is available, hence this study.

The steady growth in population with the attendant problems of food and income shortage has led to the increasing importance of marine invertebrates as potential food and income sources. Information gathered in this study will thus be useful for future conservation and management of the marine invertebrate resources in the area.

Specifically, this study can serve as reference for efforts aimed at increasing productivity and biodiversity. This investigation must also be done to assess the impact of industrialization on Baybay waters considering that it is contignous with the waters of Isabel where PASAR Smeltering, Lepanto Mining and Philphos Fertilizer Corporation are dumping their wastes. Site-specific recommendations for improving diversity and productivity are made. To possibly partly address the small-scale fisherman's problem of food and income shortage, local species of mariculture potential are also identified.

OBJECTIVES OF THE STUDY

- To collect and identify the marine invertebrate fauna of Baybay waters.
- To determine and compare the density/abundance of the invertebrates in different sampling stations.
- To determine and compare species diversity of the different sampling stations and of Baybay as a whole with that of neighboring islands.
- To relate density/abundance and species diversity with some physico-chemical parameters.
- To identify local species with mariculture potential.

MATERIALS AND METHODS

Twenty-three sampling stations were established in the coastal waters of Baybay (eastern Camotes Sea). The 23 stations represent 23 locations in the 19 coastal barangays (including Baybay town proper) of Baybay. The hydrographic and topographic characteristics of the different stations are described in a separate paper. All stations were sampled for macroinvertebrates (corals are treated in a separate paper) twice from May 1991 to June 1992.

Sampling was done using the transect-quadrat method. A calibrated 100 m transect was laid perpendicular to the shoreline starting from the water edge. Sampling depth was down to approximately 5 meters. A 1 x 1 m quadrat was laid every 10 m along the transect. All readily visible macroinvertebrates within the quadrat were individually identified and counted. This resulted in a predominantly epibenthic assemblage but included a few endobenthic species which could be readily discerned by their traces. Samples of specimens that could not be identified on the spot were collected and labelled for later identification. Identification of the different invertebrates is based mainly on external characters. However, internal characters and microscopic deposits, if any, were examined if external characters were insufficient for proper identification. Taxonomic works on invertebrates from different parts of the Philippines and those covering the Indo-Pacific basin were consulted (see references). Verification and identification of some unidentified specimens were done by cross-checking with systematized collections at the University of San Carlos Biological Museum and by specialists from the Philippine National Museum.

The density (no. of individuals per 100 m^2) of each species was determined using the mean density of the two samplings in each station. Percent dominance of each species was computed as follows (Pichon 1978):

$$\text{Dominance (\%)} = \frac{\text{density of a species}}{\text{total density per station}} \times 100$$

Percent dominance of each species in the entire study area was also determined.

Species diversity of each station was computed using the Shannon-Wiener diversity index (Pielou 1978) as follows:

$$H' = -\sum_{i=1}^{s} p_i \, ln \, p_i$$

where H' is the Shannon-Wiener diversity index, *s* is the total number of species in each station, and p_i is the density of a species divided by the total density per station.

Frequency of occurrence of the different species was computed as follows:

$$\text{Frequency (\%)} = \frac{\text{\# of stations species is present}}{\text{total \# of stations established}} \times 100$$

The physico-chemical characteristics of selected stations along Baybay waters as noted in a separate study were correlated with density and diversity using microstat program. These include temperature, salinity, dissolved oxygen, water transparency and sedimentation rate. The substrate type in each station and the number of tributaries present in each station were also noted.

Any seasonality in the community structure of macroinvertebrates is not studied nor reflected in this paper.

RESULTS

Two samplings in all 23 stations in Baybay yielded a total of 5,384 individuals or a mean density of 117 individuals/100 m². A total of 142 species of macroinvertebrates were identified (Table 1) as belonging to 72 families in 16 classes in 7 phyla. About 20 species have remained unidentified. These consist mostly of sponges, crabs and tubeworms.

The 15 most dominant species in the study area are presented in Table 2 and their distribution is shown in Fig. 1. The barnacle *Balanus* sp. dominated the study area followed by the gastropods *Nerita odonta* and *Clypeomorus bifasciata bifasciata*. The gastropods were the most abundant group. The 15 most dominant species constitute 75.42% of the macroinvertebrate fauna by abundance. Of the 15 most dominant species, *Clypeomorus bifasciata bifasciata* was the most ubiquitous being found in 17 out of 23 stations. The nine most ubiquitous species (frequency>30%) are shown in Table 3.

Of the 23 stations established (Fig. 1), Bunga had the highest mean density while Kilim had the lowest (Fig. 2). Species diversity was highest in Plaridel and lowest in San Agustin (Fig. 3). Compared with some areas in the Camotes Islands and Cuatro Islas, the mean diversity of macroinvertebrates in Baybay is relatively lower (Table 4).

The physico-chemical characteristics of the different stations as obtained in a separate study are presented in Figs. 4 and 5. Physico-chemical data for the 23 sampling stations were obtained from six hydrographic stations. The 23 stations were grouped on the basis of topographic proximity and similarity as follows:

Hydrographic Stations		
Caridad	Baybay	
Hilapnitan	Punta	
ViSCA	Plaridel	
Invertebrate Stations		
Maybog Caridad	Sta. Cruz Kiga Brandy Is. Baybay Hipusngo Palhi	Bitanhuan Maslog Plaridel
Hilapnitan Bunga San Agustin		
Marcos Pangasugan ViSCA Gabas Kilim	Sabang Jaena Punta Maitum	

Table 1. Macroinvertebrates of Baybay waters.

DEMOSPONGIA
- *Leiodermatium* sp.
- Black tubular sponge
- Brown sponge
- Encrusting lavender sponge
- Encrusting orange sponge
- Green tubular sponge
- Yellow sponge

RHIZOPODEA
- *Marginopora* sp.
- *Calcarina* sp.

ANTHOZOA
- *Stylatula* sp.

HYDROZOA
- *Hydrallmania* sp.

SCYPHOZOA
- *Cassiopea frondosa*

POLYCHAETA
- *Eurythoe complanata*
- *Eupolymnia* sp.
- White sabellid
- Worm with tube of pebbles

ECHINOIDEA
- *Prionocidaris verticillata*
- *Diadema setosum*
- *Echinothrix calamaris*
- *Tripneustes gratilla*
- *Echinometra oblonga*
- *Echinocardium cordatum*
- *Salmacis spheroides*

HOLOTHUROIDEA
- *Actinopyga echinites*
- *Bohadschia marmorata*
- *Bohadschia* sp.
- *Holothuria scabra*
- *Holothuria* sp.
- *Holothuria (Thymocyscia) hilla*
- *Opheodesoma grisea*
- *Stichopus variegatus*
- *Synapta* sp.

OPHIUROIDEA
- *Ophiocoma erinaceus*
- *Ophiocoma* sp.
- *Ophiomastix annulosa*
- *Ophioracnella* sp.
- *Ophiolepis* sp.
- *Macrophiothrix longipeda*

STELLEROIDEA
- *Acanthaster planci*
- *Archaster typicus*
- *Linckia laevigata*
- *Culcita novae-guineae*
- *Oreaster nodosus*
- *Oreaster* sp.

BIVALVIA
- *Barbatia decussata*
- *Anadara maculosa*
- *Laevicardium flavum*
- *Arcinella thaanumi*
- *Chama isotoma*
- *Lima* sp.
- *Modiolus (M.) modiolus*
- *Septifer bilocularis*
- *Crassostrea* sp.
- *Atrina tuberculosa*
- *Plana semicostata*
- *Pinctada* sp.
- *Callista erycina*
- *Circe (Circe) scripta*
- *Gafrarium pectinatum*
- *Venus puerpuera*

GASTROPODA
- *Umbonium* sp.
- *Acmaea limatula*
- *Acmaea persona*
- *Acmaea pygmaea*
- *Acmaea saccharina*
- *Acmaea* sp.
- *Calpurnus verrucosus*
- *Angaria delphinus*
- *Dolabella* sp.
- *Architectonica perspectiva*
- *Cantharus erythreus*
- *Cantharus rubiginosus*
- *Cantharus* sp.
- *Bursa granularis*
- *Bursa margariticola*
- *Clypeomorus batillariaeformis*
- *Clypeomorus bifasciata bif.*
- *Conus planorbis*
- *Conus* sp.
- *Conus stercusmuscarum*
- *Cypraea annulus*
- *Cypraea arabica*
- *Cypraea pallida*
- *Cypraea* sp.
- *Cypraea tigris*
- *Patelloida striata*
- *Haliotis asinina*
- *Haliotis varia*
- *Littorina scabra*
- *Mitra eremitarum*
- *Strigatella paupercula*
- *Vexillum rugosum*
- *Chicoreus brunneus*
- *Hexaplex chicoreus*
- *Morula fiscella*
- *Morula margariticola*
- *Morula* sp. 1
- *Morula squamata*
- *Murex* sp.
- *Purpura panama*
- *Nassarius (Hebra) subspinosus*
- *Polinices mammatus*
- *Nerita albicilla*
- *Nerita odonta*
- *Nerita* sp. 1 (olive green)
- *Nerita* sp.2 (yellow)
- *Nerita versicolor*
- *Oliva elegans*
- *Oliva miniacea*
- *Oliva reticulata*
- *Oliva* sp.
- *Pyrene testudinaria*
- *Cerithium bifasciatum*
- *Cerithium nodulosum*
- *Cerithium obeliscus*
- *Engina alveola*
- *Stomatella planulata*
- *Strombus aurisdianae*
- *Strombus canarium*
- *Strombus labiatus*
- *Strombus lentiginosus*
- *Strombus mutabilis*
- *Strombus* sp.
- *Terebra annulus*
- *Terebra arenatus*
- *Terebra dimidiata*
- *Terebralia sulcata*
- *Euchelus atratus*
- *Monodonta labio*
- *Niso goniostoma*
- *Tectus fenestratus*
- *Trochus laciniatus*
- *Trochus niloticus*
- *Turbo cinereus*
- *Turbo* sp.
- *Turritella terebra*
- *Vasum turbinellum*
- *Drupa* sp.
- Black dotted sea slug

POLYPLACOPHORA
- *Tonicia truncata*
- *Chiton* sp.

SCAPHOPODA
- *Dentalium elephantinum*
- *Dentalium lubricatum*
- *Dentalium* sp.

CIRRIPEDIA
- *Balanus* sp.

MALACOSTRACA
- *Calappa hepatica*
- *Pagurus* sp.
- *Pseudosquilla ciliata*
- *Charybdis hongkongensis*
- *Charybdis* sp.
- *Thalamita crenata*
- Big-pincered brown crab
- Crab with long antennae

Table 2. Fifteen most dominant macrobenthic invertebrate species in Baybay waters.

SPECIES	DOMINANCE (%)	CLASS
Balanus sp.	29.13	Cirripedia
Nerita odonta	8.58	Gastropoda
Clypeomorus bifasciata bif.	7.62	Gastropoda
Echinocardium cordatum	5.91	Echinoidea
Pagurus sp.	4.29	Malacostraca
Nerita albicilla	3.83	Gastropoda
Trochus laciniatus	3.34	Gastropoda
Turbo cinereus	2.53	Gastropoda
Nassarius (Hebra) subspinosus	2.01	Gastropoda
Morula margariticola	1.71	Gastropoda
Engina alveola	1.58	Gastropoda
Niso goniostoma	1.47	Gastropoda
Chiton sp.	1.17	Polyplacophora
Acmaea pygmaea	1.15	Gastropoda
Cerithium bifasciatum	1.10	Gastropoda
TOTAL	75.42	

Table 3. The most obiquitous macrobenthic invertebrate species in Baybay waters (frequency > 30%).

SPECIES	FREQUENCY %	CLASS
Clypeomorus bifasciata bif.	73.9	Gastropoda
Tube worm	56.5	Polychaeta
Moruia margariticola	47.8	Gastropoda
Pagurus sp.	43.5	Malacostraca
Nerita albicilla	43.5	Gastropoda
Nerita odonta	39.1	Gastropoda
Acmaea pygmaea	34.8	Gastropoda
Chiton sp.	34.8	Polyplacophora
Turbo clinereus	34.8	Gastropoda

Table 4. Mean diversity of Baybay waters and neighboring islands (data obtained from an unpublished report).

AREA	MEAN DIVERSITY ± S.D.
Baybay (different stations)	2.0693 ± 0.6401
Didio, Cuatro Islas (diff. times)	2.7065 ± 0.3895
Apid, Cuatro Islas (diff. times)	2.8015 ± 0.6008
Muabog, Camotes Islands (diff. times)	2.9960 ± 0.1361
San Francisco, Camotes Island (diff. times)	2.5705 ± 0.1285

Legend:
1. *Balanus* sp.
2. *Nerita odonta*
3. *Clypeomorus bifasciata bif*
4. *Echinocardium cordatum*
5. *Pagurus* sp.
6. *Nerita albicilla*
7. *Trochus laciniatus*
8. *Turbo cinereus*
9. *Nassarius (Hebra) subspinosus*
10. *Morula margariticola*
11. *Engina alveola*
12. *Niso goniostoma*
13. *Chiton* sp.
14. *Acmaea pygmaea*
15. *Cerithium bifasciatum*

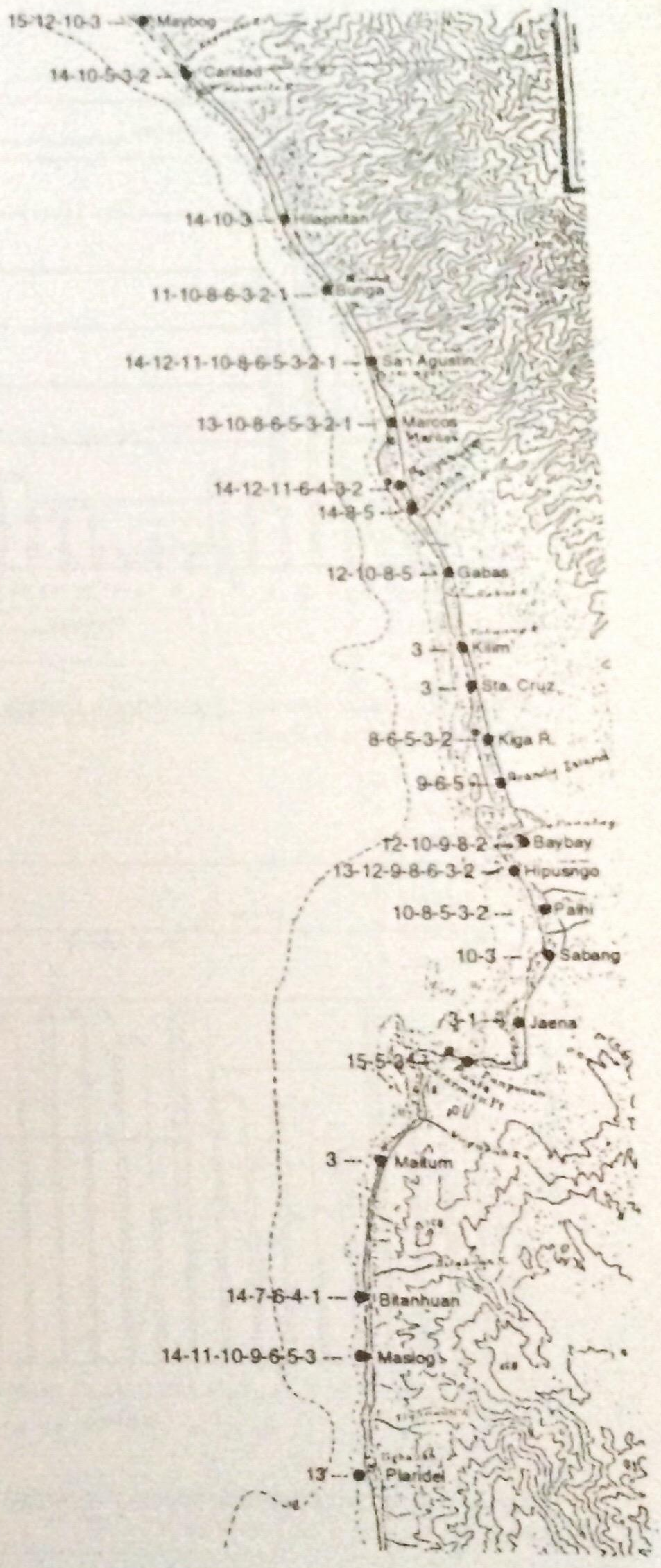

Figure 1. Map of the study area showing the 23 sampling stations and the distribution of the 15 most dominant macroinvertebrates.

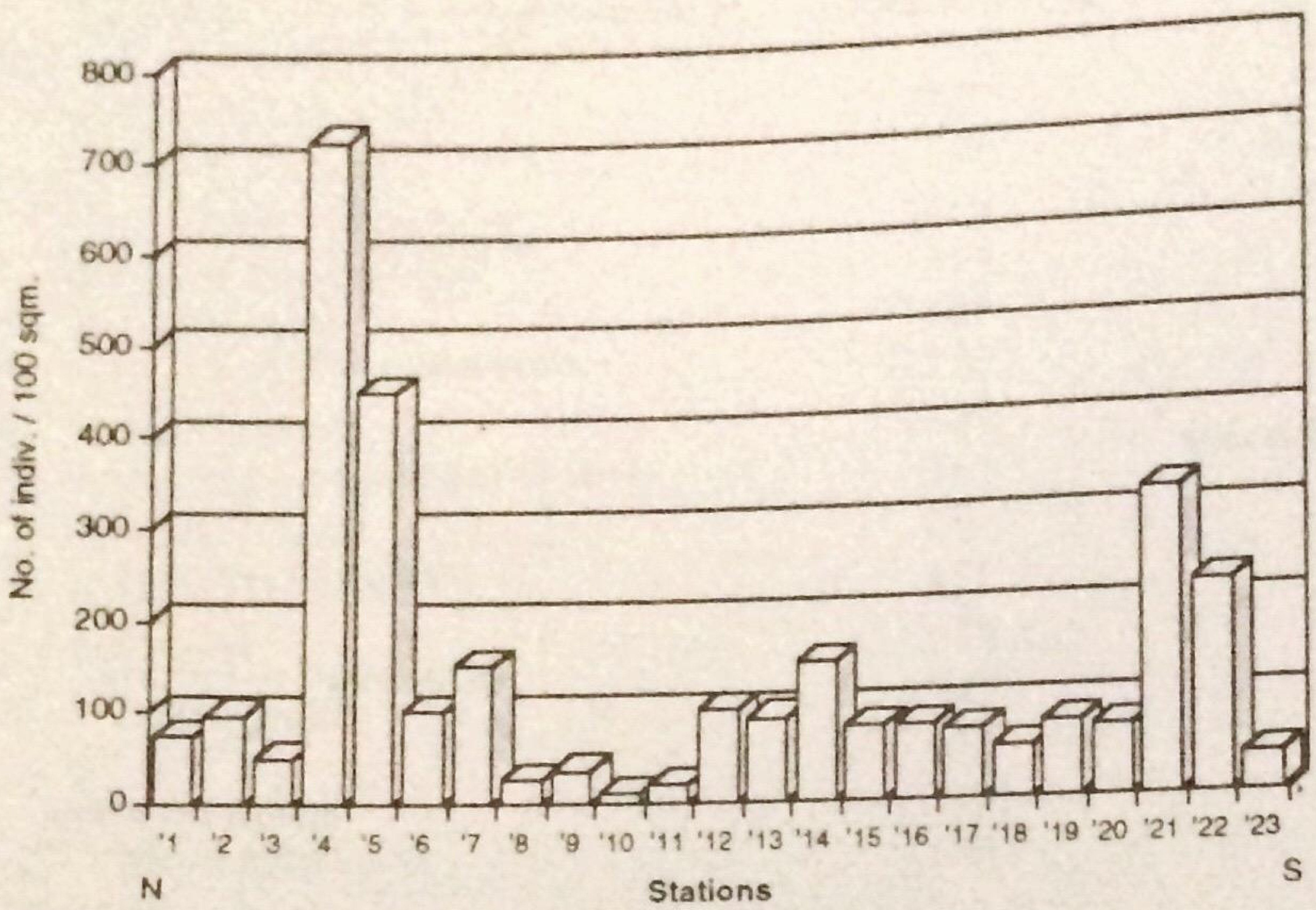

Figure 2. Macrobenthic invertebrate density (mean of 2 transects) of different stations in Baybay.

Stations:

1. Maybog
2. Caridad
3. Hilapnitan
4. Bunga
5. San Augstin
6. Marcos
7. Pangasugan
8. ViSCA
9. Gabas
10. Kilim
11. Sta. Cruz
12. Kiga
13. Brandy Is.
14. Baybay
15. Hipusngo
16. Palhi
17. Sabang
18. Jaena
19. Punta
20. Maitum
21. Bitanhuan
22. Maslog
23. Plaridel

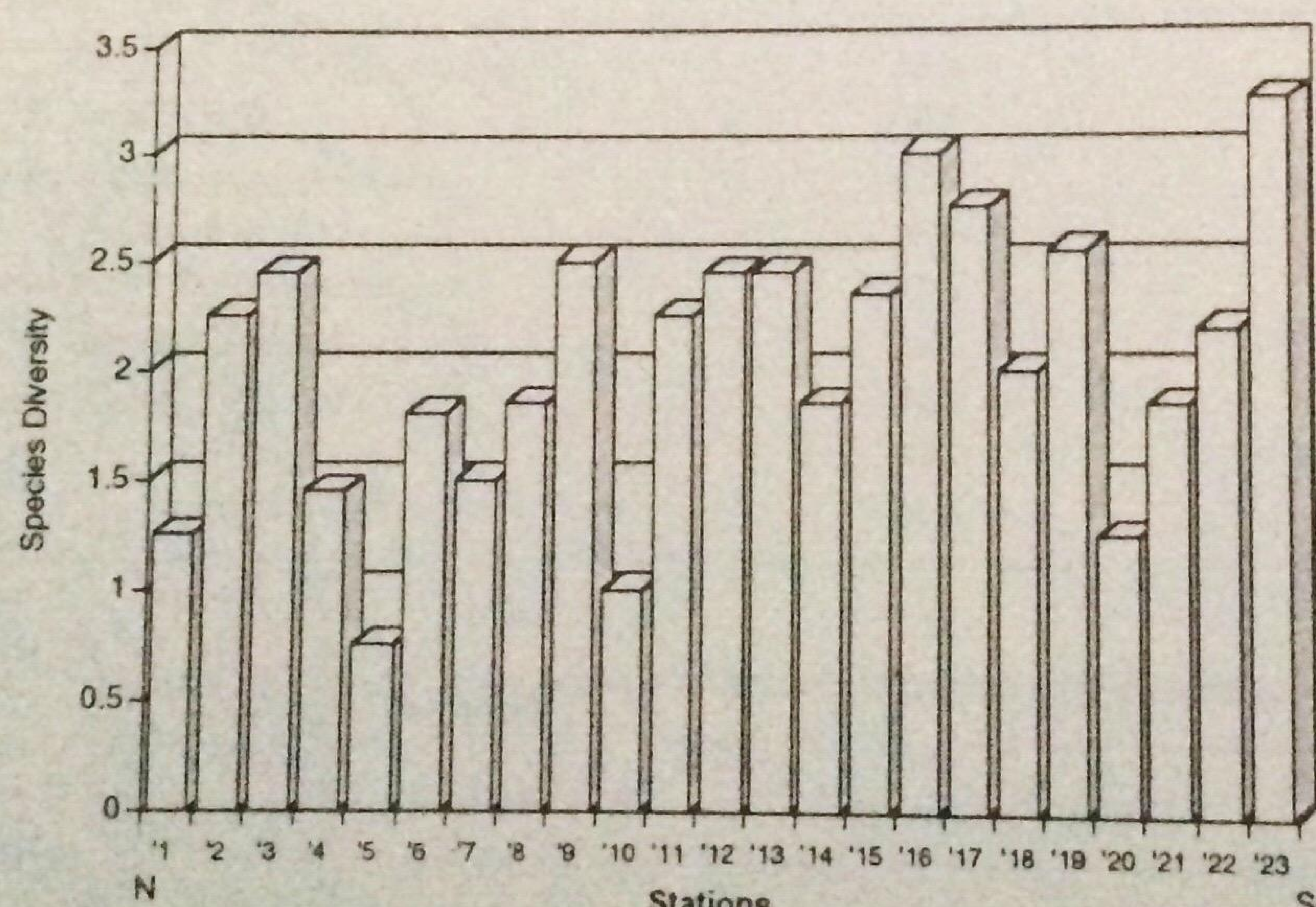

Figure 3. Macroinvertebrate species diversity of different stations in Baybay.

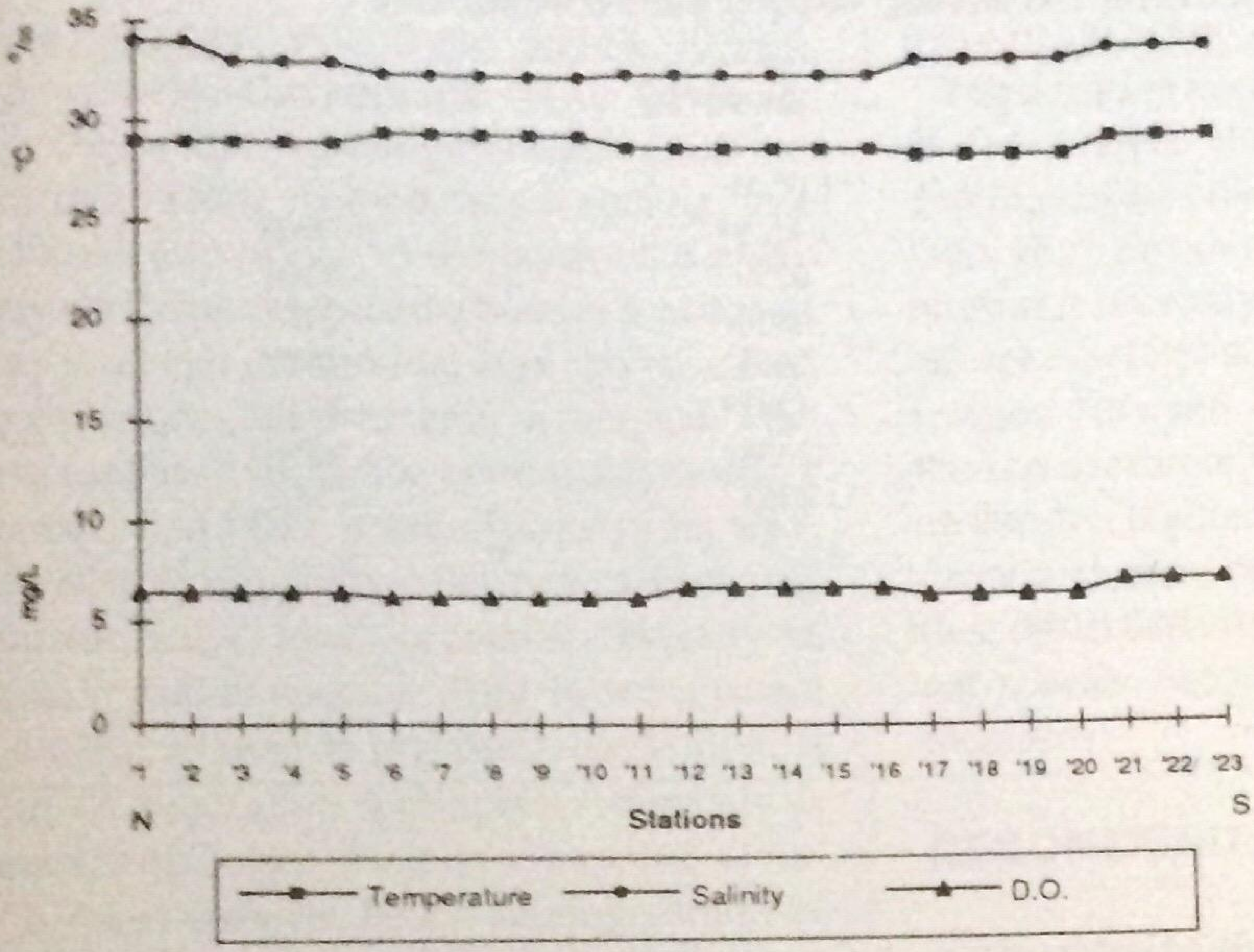

Figure 4. Mean temperature, salinity and dissolved oxygen content of different stations in Baybay.

Stations:
1. Maybog
2. Caridad
3. Hilapnitan
4. Bunga
5. San Agustin
6. Marcos
7. Pangasugan
8. ViSCA
9. Gabas
10. Kilim
11. Sta. Cruz
12. Kiga
13. Brandy Is.
14. Baybay
15. Hipusngo
16. Palhi
17. Sabang
18. Jaena
19. Punta
20. Maitum
21. Bitanhuan
22. Maslog
23. Plaridel

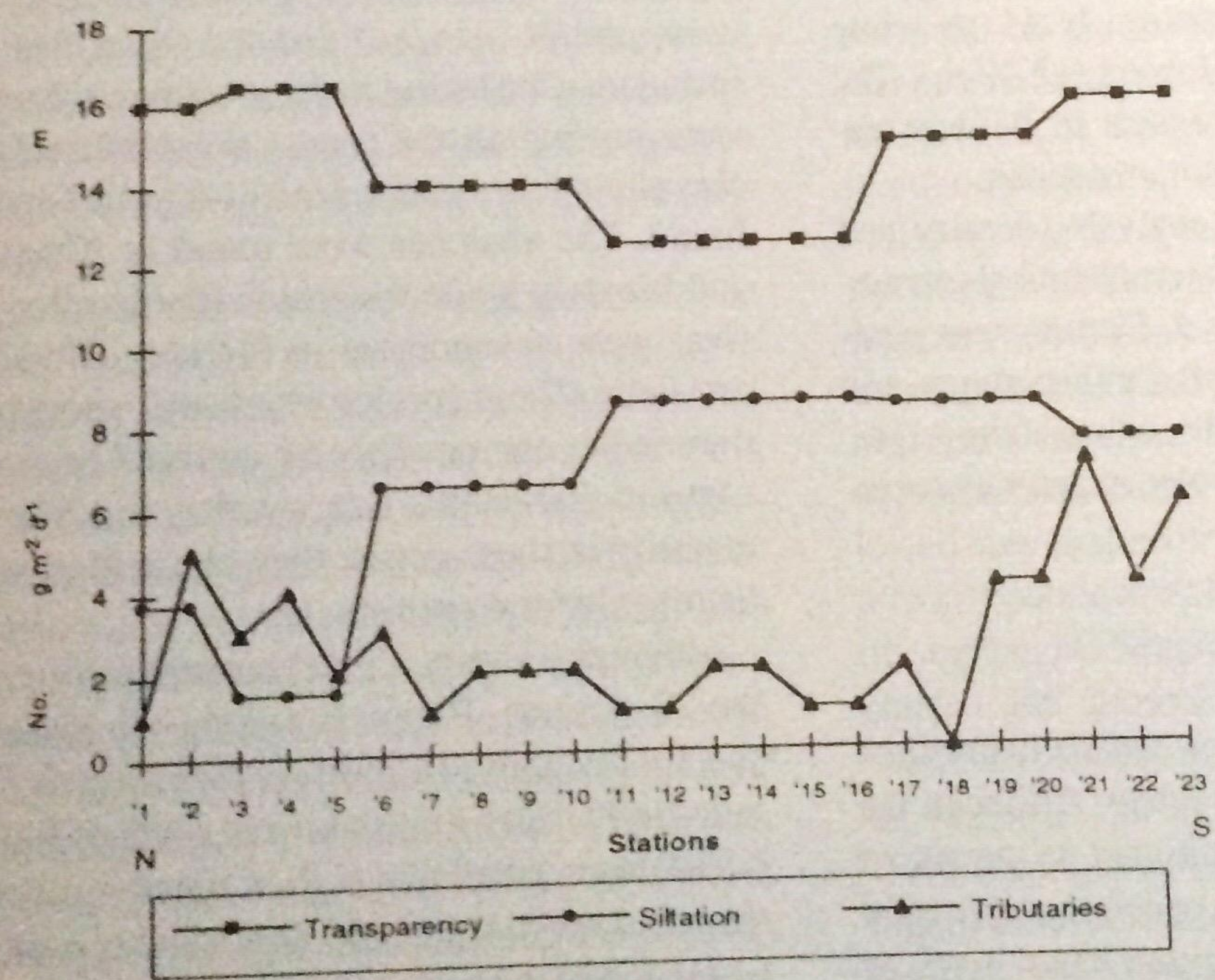

Figure 5. Mean water transparency, sedimentation rate and number of tributaries of different stations in Baybay.

Table 5. Correlation matrix of density and diversity versus physico-chemical data.

	DENSITY	DIVERSITY
Density	1.0000	1.0000
Diversity	-.4275*	-.0364
Temperature	.0259	-.0877
Salinity	.0936	.2821
D.O.	.1995	-.3019
Transparency	.4283*	.4896*
Sedimentation	-.5638*	.0963
Tributaries	.2763	

CRITICAL VALUE (1 - TAIL, .05) = + or - .35214
CRITICAL VALUE (2 - TAIL, .05) = +/- .41228
N = 23
* = significant

Mean temperature and dissolved oxygen content were fairly uniform in the different stations established. Caridad stations had the highest mean salinity while ViSCA stations had the lowest. The Hilapnitan stations had the highest water transparency reaching 16.45 m while Baybay stations had the lowest (12.19 m). The sedimentation rate was highest in Baybay stations and lowest in Hilapnitan stations.

Results of correlation analysis (density and diversity versus the physico-chemical parameters) are shown in Table 5. Density was positively correlated with water transparency and negatively correlated with sedimentation rate. Density and diversity were also negatively correlated.

DISCUSSION

The gastropods are the most widely distributed group of invertebrates in Baybay. Although the barnacle *Balanus* sp. dominated in terms of abundance, the species was encountered in only 5 out of 23 stations. On the other hand, many of the dominant gastropods are among the most ubiquitous species. This is due to the predominantly rocky supralittoral fringe in the area which favors the dominance of certain gastropods (Nybakken 1982). These gastropods are edible and locally consumed albeit they do not fetch a high price in the market. The abalones (*Haliotis varia* and *H. asinina*) and the tridacnids (not included in the listing as the specimens observed were not within the transects established) are also among the economically important species found. The abalones were found in Bitanhuan and Maybog while tridacnids (the smaller species) were encountered in Plaridel, Bitanhuan and Palhi. These species which are expensive in the market can possibly be cultured in marine cages to marketable size. As they reach sexual maturity in these cages, they can also possibly increase natural seed stocks.

Although it had the highest mean density among the 23 stations, Bunga is among the lowest in species diversity. Highest species diversity was noted in Plaridel. Stations to the south of Baybay wharf have generally higher species diversity than stations to the north. This trend is probably a function of the bottom topography and the kind of fishing methods practiced. In stations to the south of Baybay wharf, the bottom is coralline rocky as shown in the hydrographic/topographic study of Baybay, with some stations having mangrove trees. This coralline rocky bottom as well as the presence of mangrove trees makes the destructive fishing method, beach seining, less practicable. In stations to the north of Baybay wharf up to Marcos where the bottom is just sand or silty sand and the subtidal area can be waded during low tide, beach seining is rampant. This fishing method sweeps the bottom and destroys vegetation and other sessile forms in its way. Vegetation significantly contributes to primary production aside from increasing diversity of habitats for other species. Thus in areas where this fishing method is practised, the bottom is devoid of vegetation and species diversity is comparatively lower. To improve species diversity in these stations, beach seining should be regulated.

The lower species diversity observed in Baybay compared to the neighboring Cuatro and Camotes Islands can probably be attributed to two main factors -- greater/overexploitation and pollution from land sources in Baybay. Overexploitation and pollution are both reflective of population pressure. Hence, the need to limit population growth can not be overemphasized.

The significant positive correlation between density and water transparency, and negative correlation between density and sedimentation rate (siltation) suggest that siltation may be a major macroinvertebrate density-controlling factor in the area. Higher siltation rate limits photosynthesis and primary production hence, also secondary production especially that of primary consumers. The highest siltation rate observed in Baybay and Punta may be due to land runoff and/or to resuspension of sediments by wave action. The contribution of land run-off to siltation is increased by *kaingin* cultivation in the uplands and the removal of rocks and boulders from major rivers for construction purposes which is extensively done in Kilim. These two activities need to be minimized to improve aquatic productivity in the area.

The negative correlation between density and diversity can be attributed to only 1 or 2 species dominating the others in stations where density is high. High diversity index means that density is more or less evenly distributed among the different species (Nybakken 1982). The positive correlation between diversity and siltation could then be a result of the negative effect of siltation on density. If siltation can limit the abundance of certain species, especially primary consumers, then the distribution of individuals to the different species becomes more even and diversity increases.

RECOMMENDATION

Since the economically important genera *Haliotis* and *Tridacna* thrive in the southernmost stations, mariculture of these species in said stations should be initiated to determine its feasibility. If found feasible, the activity could be extended to the northern stations to possibly increase natural stocks of these species and perhaps introduce a potential source of alternative livelihood for small-scale fishermen.

To improve the species diversity and productivity of beach-seined stations (from Baybay wharf to Marcos), beach seining should be controlled by the local government and policed by local fishermen's organizations. Since it is difficult if not impossible to stop beach seining altogether, it should be allowed only in specific sites and some sites in each affected station must be reserved for rehabilitation of vegetation. Seagrass and algae can be transplanted and allowed to flourish in reserve sites which could then serve as a source of recruits for the exploited site and other adjacent areas.

The local government should also monitor and regulate the activities of *kaingineros* as well as the removal of rocks and boulders from major rivers for construction or other purposes to minimize siltation.

ACKNOWLEDGMENT

This work was funded by the ViSCA-GTZ Ecology Program. The contributions of Ms. Merilyn Lariba and Mr. Henry Ternura during the fieldwork are gratefully acknowledged. The assistance of the other members of the marine research team - Prof. Alejandro Caliente and Mr. Jun Montes - is also appreciated.

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