

HABITAT HEALTH OF ILOILO RIVER – INSIGHTS FROM A STUDY ON BENTHIC COMMUNITY STRUCTURE

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ABSTRACT

In west central Philippines, the monitoring of aquatic systems traditionally focused on dissolved oxygen values and biological oxygen demand, e.g. monitoring by the Environmental Monitoring Bureau around Panay Island. However, single or two factors are considered to be insufficient to assess habitat health precisely. In this paper, we investigated a benthic community and examined their implications to habitat health of the Iloilo River. According to a prior benthic survey, warning signs pertaining to biotic, abiotic and community factors have been detected. The disturbed conditions in Iloilo River can be attributed to 3 factors; 1) its inherent topography, where bends serve as sinks for materials; 2) the lack of vigorous water exchange that promotes deposition and hinders complete flushing; and 3) the manner of utilization of the river by the local people. We thus concluded that: 1) monitoring for water parameters only is not enough to get a clear picture of habitat health; and 2) proposed that biotic components should be included for monitoring aquatic system.

Keywords: Iloilo River, habitat health, environmental monitoring.

INTRODUCTION

The Iloilo River, Panay Island, west central Philippines is a seawater inlet of the Iloilo Strait and about 10 km long from the mouth to its inner reaches in Arevalo, Iloilo City (Fig. 1a). The river supports fisheries for crabs, shrimps and small demersal fishes with yield estimates of 35.1–48.0 metric ton/km² and hosts about 600 ha of fishponds (del Norte-Campos and Campos, 2008). The river also passes through some of the city's most densely populated areas, as well as economic and commercial centres (Environmental Management Bureau, 2006). Major water inputs come from Calajunan and Dungan Creeks along with agricultural run-off and tidal inputs coming from the Iloilo Strait. According to the Environmental Management Bureau (2006), the river is classified

as a Class C body of water; it serves as a transport lane, major water source, drainage of fish ponds and agricultural land use on its banks.

Characterization of macrobenthic community structure traditionally gives baseline information along with valuable insights on interactions between biotic and abiotic components of the community. The benthos can be considered as possible indicators of environmental changes due to effluent discharges (Rees et al., 1991). Information from macrobenthic studies (i.e. shifts in population and community parameters) have been used in monitoring programs (Kemp et al., 2005), assessment of water quality (Che and Morton, 1991; 1995) and pollution effects (Gray et al., 1990; Grizzle and Penniman, 1991; del Norte-Campos and Nacionales, 2008); providing baseline information on the impacts of human-as-

sociated activities such as dredge fishing (Thrush et al., 1998; Thrush and Dayton, 2002;), dumping of sewage sludge (Lopez-Gappa et al., 1990) and recovery after cessation of dumping (Moore and Rodger, 1991).

Spatio-temporal trends in the distribution and composition of macrobenthic organisms in Iloilo River have been studied by Palla (2010). This paper examined the habitat health of Iloilo river based on the results of this previous study. We discuss the habitat health linked to the existing monitoring scheme being done on the river.

MATERIAL AND METHODS

The materials and methods used in Palla (2010) are as follows. The benthic survey was done in March, June, September and November 2007 and covered 15 stations (except stations 4 and 6 in March) from the mouth of the Iloilo River towards its inner reaches (Fig. 1). Core samples (10 cm deep) were collected to examine the macrofauna using a cylindrical PVC corer (inner diameter=7.8 cm; area = 47.78 cm²) from sediment hauled by a grab sampler. These samples

were immediately fixed in 10% buffered formalin with rose bengal dye. Macrobenthic animals were identified, and the community indices, namely, Shannon-Weaver's diversity index (H') and evenness (J') were computed based on the number of individuals. Additional core samples were taken for total organic matter content analysis (in %) and sediment analysis (Buchanan, 1984), specifically sediment grain size as well as sorting class and type of sediment. GPS readings were recorded for all stations along with depth (m), water temperature (°C) in surface water, and salinity (ppt) and dissolved oxygen (DO, mg/L) in surface and bottom waters.

RESULTS

A summary of the results obtained by Palla (2010) is shown in Tables 1–3 and Fig. 2–3. For precise information, see Palla (2010).

The most remarkable characteristic of the sediment from the inlet is its muddiness (Table 1). The sediment was intact and packed when collected by the grab sampler and black, with a very thin brown layer on the surface. Sediment

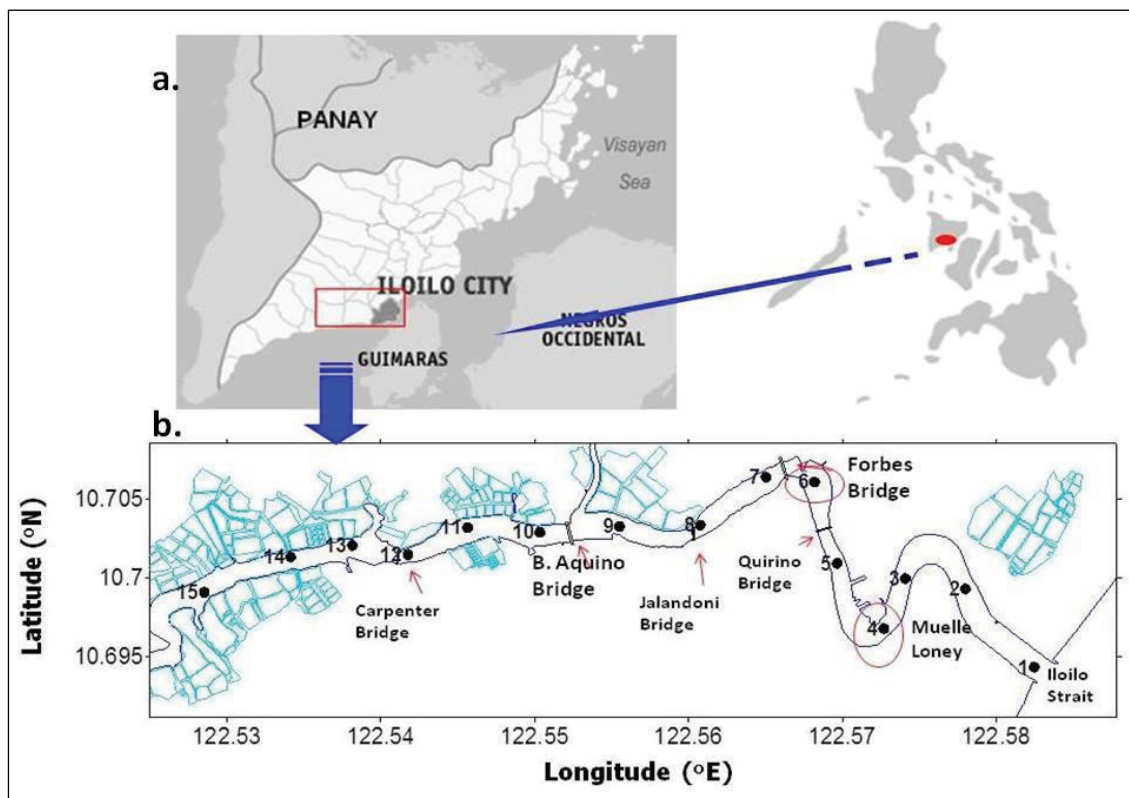


Figure 1. a) Location of the study area, b) location of sampling stations along Iloilo River.

analysis revealed a very poorly sorted bottom (sorting index of 2.1–2.9) composed of sediments classified as medium sand to coarse silt. Total organic matter content of the sediment (Fig. 2, Table 1) ranged from 2% to 52% ($10.3 \pm 7.5\%$; $n=58$). An increase in organic matter content was

observed during the onset of rainy season in the Philippines (June) especially in stations near bends (Stations 3, 4, 5, 6, 7, and 15). An unusually high deposit occurred in station 13 which coincided with a bridge construction in the area. Surface and bottom dissolved oxygen ranged from 2.6–5.4

Table 1. Annual average of sediment and water parameters in Iloilo River. The mean of 4 seasonal samples is shown for each station.

Station	Sorting index	Median phi	% sand	% silt-clay	Total Organic Matter Content	Depth (m)	Surface Salinity (ppt)	Bottom Salinity (ppt)	Surface Water Temp. (°C)	Surface Dissolved Oxygen (mg/L)	Bottom Dissolved Oxygen (mg/L)
1	2.3	3.9	43.6	56.4	9.1	4.0	33.0	34.0	30.6	5.4	4.0
2	2.7	4.7	19.4	80.6	7.2	4.0	31.0	34.0	30.1	5.3	3.5
3	2.9	5.0	8.9	91.1	14.8	4.0	31.5	34.0	30.0	3.9	3.5
4	2.8	4.8	12.4	87.6	13.0	3.8	29.3	34.3	30.4	3.5	4.4
5	2.6	4.3	23.1	76.9	13.6	3.6	31.8	32.8	30.7	2.6	3.3
6	2.8	4.4	20.4	79.6	16.0	3.7	31.0	32.3	30.9	4.8	4.1
7	2.1	3.2	54.0	46.0	10.3	1.9	32.0	31.5	30.4	4.4	3.8
8	2.1	2.7	61.9	38.1	7.0	2.0	28.3	32.3	30.6	3.7	3.6
9	2.1	2.7	59.5	40.5	6.5	1.8	32.5	33.3	30.5	2.9	3.0
10	2.3	3.6	40.0	60.0	9.0	1.8	32.0	30.0	30.2	4.3	4.3
11	2.2	2.4	66.8	33.2	6.8	1.9	29.3	29.0	30.2	4.9	3.9
12	2.3	3.5	44.6	55.4	18.6	1.9	28.0	27.0	29.7	4.1	4.1
13	2.3	2.9	54.5	45.5	9.1	1.7	26.5	26.7	29.5	4.4	4.5
14	2.3	3.3	43.8	56.2	7.0	1.4	25.8	21.5	29.7	3.7	4.3
15	2.4	3.3	46.6	53.4	8.4	1.3	23.3	19.0	29.5	4.1	4.0
Mean	2.4	3.6	40.0	60.0	10.4	2.6	29.7	30.1	30.2	4.1	3.9
Minimum	2.1	2.4	8.9	33.2	6.5	1.3	23.3	19.0	29.5	2.6	3.0
Maximum	2.9	5.0	66.8	91.1	18.6	4.0	33.0	34.3	30.9	5.4	4.5

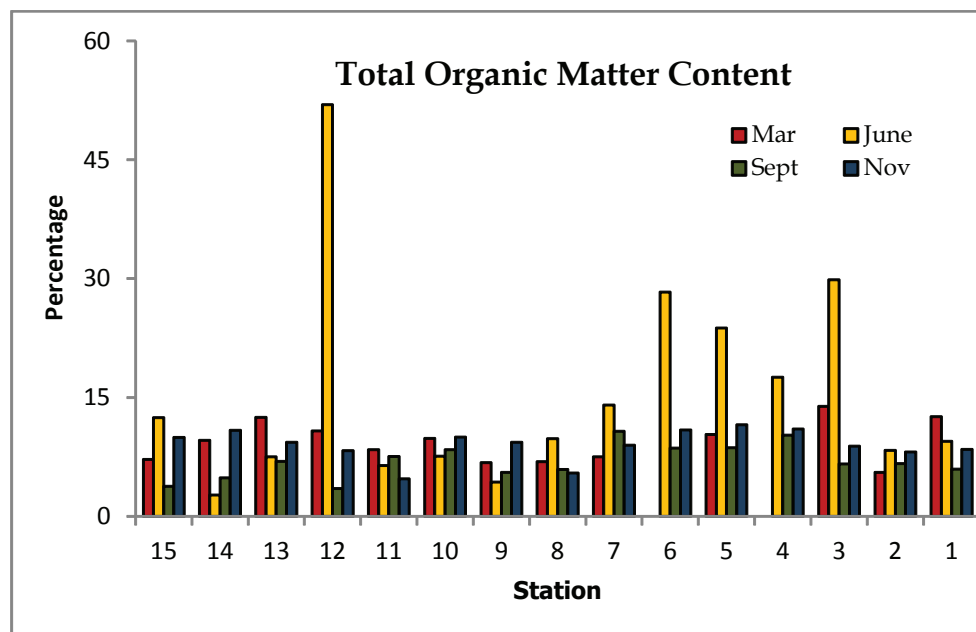


Figure 2. Total organic matter content in each station sampled in Iloilo River for the 4 sampling periods.

mg/L and 3–4.5 mg/L, respectively (Table 1). Only surface values at Stations 1 and 2 had dissolved oxygen levels of ≥ 5 mg/L.

A total of 43 macrobenthic taxa were sampled (Table 2). Polychaeta was the most abundant group, contributing about $\approx 50\%$ of the macrofaunal density in every station. Twelve polychaete families were found (Fig. 3a), primarily of the

families Capitellidae and Spionidae. These two families occurred in almost all stations (Fig. 3b).

Community indices at each station are shown in Table 3. The number of taxa (S) ranged from 6–22. Diversity (H') ranged from 0.50–0.91 while evenness (J') ranged from 0.50–0.93. Number of taxa was high in 5 neighbouring stations (Stations 7–11); however the highest diversity index (H') was found at Station 15 and highest evenness index (J') was at Station 2.

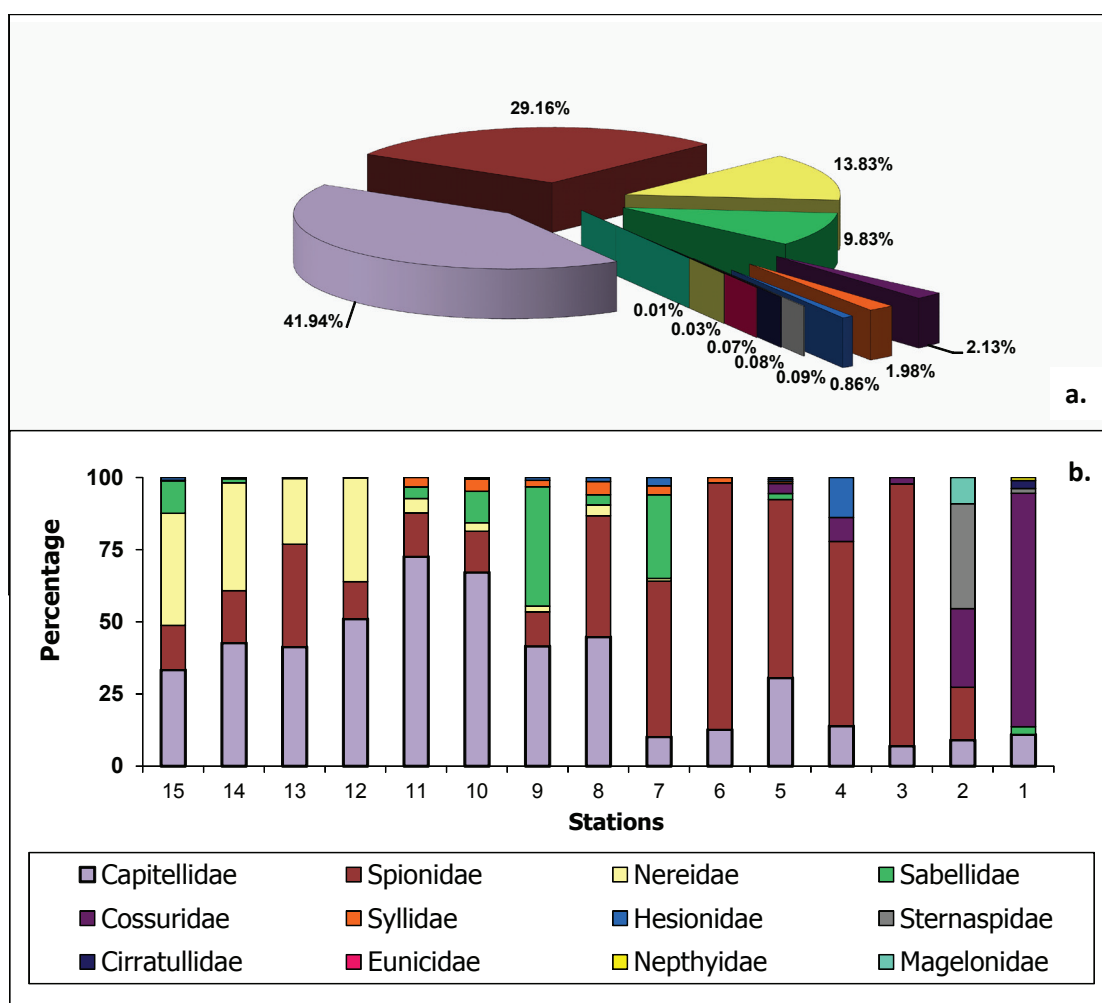


Figure 3. Composition of polychaete families. a) Overall composition of 15 stations. b) Composition at each station.

Table 2. Macrobenthic taxa found in Iloilo River with mean density of all 15 stations.

Taxa		Mean density (ind/m ²)	%
Polychaeta	Capitellidae	10911.3	30.08
	Spionidae	7587.0	20.92
	Nereidae	3597.4	9.92
	Sabellidae	2557.0	7.05
	Cossuridae	554.2	1.53
	Syllidae	514.6	1.42
	Hesionidae	223.3	0.62
	Sternaspidae	23.8	0.07
	Cirratullidae	20.4	0.06
	Eunicidae	17.0	0.05
	Nepthyidae	6.8	0.02
	Magelonidae	3.4	0.01
Nematoda	Nematoda	2793.8	7.70
Amphipoda	Gammaridea	2526.4	6.97
	Caprellidea	20.4	0.06
Tanaidacea	Tanaidacea	2461.8	6.79
Copepoda	Harpacticoida	489.6	1.35
	Misophrioida	275.4	0.76
	Cyclopoida	180.2	0.50
	Calanoida	167.7	0.46
	Nauplius	3.4	0.01
Mollusca	Bivalvia	618.8	1.71
	Gastropoda	193.8	0.53
	Polyplacophora	3.4	0.01
Cnidaria	Anthozoa	115.6	0.32
	Hydrozoa	37.4	0.10
Platyhelminthes	Platyhelminthes	132.6	0.37
Ostracoda	Ostracoda	64.6	0.18
Cumacea	Cumacea	27.2	0.08
Dendrobranchiata	Dendrobranchiata	27.2	0.08
Isopoda	Isopoda	23.8	0.07
Brachyura	Brachyura	13.6	0.04
Cirripedia	Cirripedia	13.6	0.04
Insecta	Insecta	13.6	0.04
UNIDENTIFIED TAXA	unidentifid animal sp. 1	6.8	0.02
	unidentifid animal sp. 2	3.4	0.01

Brachiopoda	Brachiopoda	7.9	0.02
Cephalocarida	Cephalocarida	6.8	0.02
Euphausiacea	Euphausiacea	6.8	0.02
Pycnogonida	Pycnogonida	6.8	0.02
Chaetognatha	Chaetognatha	3.4	0.01
Priapulida	Priapulida	3.4	0.01
Sipuncula	Sipuncula	3.4	0.01
Total		36268.8	100.00

Table 3. Diversity (H'), species richness (S) and evenness (J') at each station in Iloilo River.

Station	H'	S	J'
1	0.60	16	0.50
2	0.84	8	0.93
3	0.50	9	0.53
4	0.61	6	0.79
5	0.72	16	0.60
6	0.53	7	0.63
7	0.74	19	0.58
8	0.81	22	0.60
9	0.83	22	0.62
10	0.78	19	0.61
11	0.72	19	0.56
12	0.71	15	0.61
13	0.63	13	0.56
14	0.87	14	0.76
15	0.91	17	0.74

DISCUSSION

There are strong indications that the river is under stress. These are: 1) high organic matter content of the sediments; 2) low dissolved oxygen values; 3) the dominance of opportunistic taxa; and 4) relatively low diversity and evenness.

Organic matter content of the sediments in Iloilo River is comparable to values in highly enriched areas adjacent to mangrove stands in Southern Guimaras (3.1 ± 3.3 ; $n=35$) surveyed by Nacionales-Narida and Campos (2004). In the case of Iloilo River, the sources of organic matter are anthropogenic (i.e. residential, fishery and industrial inputs), which tends to accumulate in estuaries (McLusky, 1981). Deposition of organic matter is also enhanced by the inherent topography of the river, wherein bends/loops hinders complete

withdrawal of saltwater and encourages deposition, similar to the case observed in the Fatibello Lagoon in Italy (Frasconi et al., 2002).

The Environmental Management Bureau monitors dissolved oxygen, biochemical oxygen demand and total suspended solids at 6 stations along the whole length of the river (EMB, 2006). The EMB cites a dissolved oxygen value of 5 mg/L as their standard for compliance. According to this standard, only 2 stations (surface values at Stations 1 and 2 near the mouth) were able to comply with this standard while the rest of the river can be considered as hypoxic.

In Iloilo River, major sources of organic matter would be anthropogenic in nature such as sewage (from riverbank shanties and hotels), industrial effluent and wastewater from ponds

and factories. Degradation of organic matter could result to the depletion of dissolved oxygen near the bottom (Diaz and Rosenberg, 1995). The high organic load is especially deposited in bend areas (Frasconi et al., 2002). Water exchange is minimal in Iloilo River that leads to hypoxia. While in the area with greater movement such as the mouth, there is no considerable accumulation of organic matter by transporting the excess to outside (McLusky, 1981; Frasconi et al., 2002). But water exchange is minimal in Iloilo River and the water cannot be replaced in a single cycle, thus stagnates, which leads to hypoxia.

Capitellidae and Spionidae were the dominant polychaete families in Iloilo River. The organically-enriched and hypoxic conditions in the inlet are advantageous for non-selective deposit feeders such as capitellid worms (Bilyard, 1987; Leong et al., 1987; Pearson and Rosenberg, 1978; Grassle and Grassle, 1974). Capitellid and spionid worms are usually associated with stressed conditions (Rosenberg, 1975 and Coumo and Zinn, 1997) and occur in high density. They are generally considered to be opportunistic, having the capacity to take advantage of newly-opened resource/niche after a disturbance due to rapid dispersal and high reproductive rates (Thistle, 1981; Rhoads & Germano, 1982).

Because of the prevalence of capitellids and spionids, diversity and evenness were depressed. Reductions in species richness, abundance and biomass can be direct consequences of overabundant organic content (Shine, 2005). Increased organic matter leads to smothering of surface sediment and enhanced oxygen demand along with toxic by-product and chemical stressors (Shine, 2005). Stressed conditions were inferred for the Biscayne Bay, where opportunistic and cosmopolitan species were the dominants along with lowered diversity (2.6–3.2) and evenness (0.56–0.66) (Rosenberg, 1975). In Iloilo River, diversity is lower than Rosenberg's (1975) while evenness is comparable to those of Rosenberg's (1975) values, suggesting a stressed biotic structure.

Among the fishing gears utilized in Iloilo River, the mechanized push net (hudhud) targeting shrimps and crabs poses a considerable bottom disturbance (del Norte-Campos and Campos, 2008). The net is similar to trawls but is equipped

in front of the boat, which is pushed by the boat instead of being dragged behind. Observations by del Norte-Campos and Campos (2008) show 3–5 boats trawl each night and may contribute to the dominance of opportunistic species in Iloilo River. Trawling may cause sediment resuspension, substrate destruction and removal/scattering of non-target benthos (Collie et al., 1997). The physical disturbance of benthic community may contribute to the dominance of opportunistic species in Iloilo River.

Moore and Rodger (1991) tracked the recovery of benthic animal composition in a sewage dumping ground after dumping ceased. The faunal diversity is increasing along with decreasing organic carbon content of the sediment and has completely recovered 11 years later after the sewage dumping stopped. In the case of Iloilo River, the local government has been successful in rehabilitating the river by removing fishing corrals since 2008. The government also has replanted mangroves in the banks of Iloilo River. For successful rehabilitation in Iloilo River, it is important to monitor living resources such as fish, crabs, phytoplankton and benthic communities, in monitoring programs as in the case of Chesapeake Bay (Murphy, 2004).

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