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The Fishes and their Ecology*

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Abstract

An annotated list of 188 species of fishes recorded from San Miguel Bay, Philippines is presented. Of these, 48% are euryhaline marine species. The most abundant fishes belong to marine species whose representatives are known to seek brackish waters, especially when young. Such fish fauna characterizes San Miguel Bay as an estuary. A brief discussion follows of the distribution with regard to salinity of the Philippine fish fauna as a whole.

The fish species of San Miguel Bay can be arranged into the following trophic groups: piscivores (23%), zooplankton feeders (18%), meiobenthos feeders (22%) and macrobenthos feeders (37%). The same ichthyofauna can also be split into the following groups: coastal pelagics (22%), oceanic pelagics (3%), soft-bottom demersals (55%) and reef/hard-bottom demersals (20%). The role of the Bay as a nursery ground for fishes is discussed.

Annotated List of Fishes Recorded in San Miguel Bay, 1868-1981

The first record of a fish from the San Miguel Bay area in the scientific literature is that of the white goby *Glossogobius giurius* from the Libmanan River (Fig. 1) by Peters (1868). However, as is the case for Philippine fish taxonomy in general, most fish records from San Miguel Bay stem from the work of Albert W. Herre and his Philippine associates (notably Agustin F. Umali). Their work can be easily accessed (through Herre 1953) and most of it has also been reprinted in four handy volumes.** From this literature stems 86 (46%) of the first records of San Miguel Bay fishes.

Another source of records is the National Museum of the Philippines in Manila, whose fish collections comprise a number of specimens from San Miguel Bay, identified by several specialists. These fishes were all collected between 1947 and 1953, and provided 35 (19%) new records. Records of fishes were also obtained from earlier papers on the fish resources of the Bay, notably those written in the frame of investigations conducted by K. Tiews and collaborators in the late 1950s,

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** "The Philippine Bureau of Science Monographic Publication on Fishes," 1910. Dept. of the Interior, Bureau of Science, Manila, including 3 monographs (1 volume, reprinted 1965 by TFH Publications for the Smithsonian Institution, Washington, D.C.) and "Selected Ichthyological Papers from the Philippine Journal of Sciences" (3 volumes, also reprinted by TFH Publications for the Smithsonian Institution).

and by Legasto et al. (1975b) in November 1974. These papers provided 11 (6%) new records. Ms. P.V. Conlu, Professor at the College of Fisheries, University of the Philippines, kindly put at my disposal the six volumes of her manuscript checklist of Philippine fishes (Conlu 1977, 1978, 1979a, 1979b, 1980a, 1980b). This source provided 28 (15%) additional records of San Miguel Bay fishes.

During the course of the IFDR/ICLARM project, a further 28 new records of fishes from San Miguel Bay were generated, or 15% of the species now known to occur in San Miguel Bay. Some may be doubtful, having been collected just outside the Bay.

Common names in Bikol, i.e., in the language spoken in the San Miguel Bay area, were obtained from Herre and Umali (1948). It will be noted that in several cases, the Bikol names given to the fishes of a given species depend on the size of the fish in question (e.g., *piyak* for sardine fry, *tamban* for juveniles and adults sardines, or *gisao* for mullet fry, *banak* for market-sized mullets and *aguas* for large spawners). This phenomenon, which is reported from many languages through-

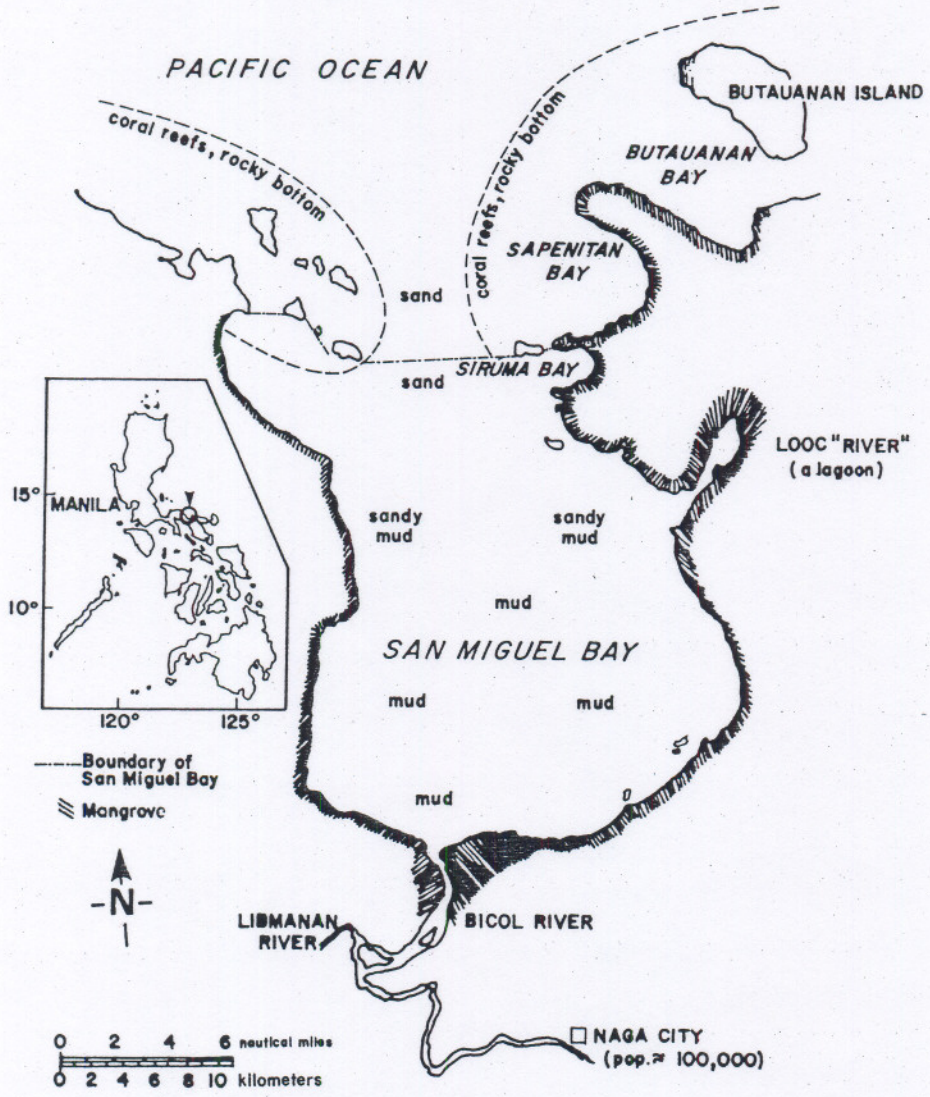

Fig. 1. Major features in and around San Miguel Bay affecting the ecology of the Bay.

out the world is discussed in Pollnac (1981). English common names were obtained from various sources, notably Fischer and Whitehead (1974), Munro (1967) and Herre (1953).

The list of fish obtained was arranged by families according to Herre (1953) for the elasmobranchs, and according to Greenwood et al. (1966) for the teleosts.

Finally, for each species included, a check was made as to its salinity tolerance. All records of freshwater or brackishwater occurrence found (mainly in Herre 1953, 1958; Munro 1967 and Whitfield et al. 1981) are cited (see Appendix I).

Euryhaline Fishes of San Miguel Bay

Mines et al. (this report) present data which suggest that San Miguel Bay is in fact an estuary, i.e., the "Bicol River Estuary." According to Pritchard (1967) an estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage.

Thus, to define the environmental conditions of a certain semi-enclosed coastal habitat as "estuarine", it is generally sufficient to demonstrate that mixing of sea and freshwater takes place (see Mines et al., this report).

Another approach to define the prevailing environmental conditions of a given habitat is to identify the various members of its fauna and to infer from what is known (elsewhere!) of their requirements and/or habits on the character of their habitat. In this context it should be noted that the list of fishes presented here shows a large amount of overlap with the lists of fishes reported from Indian brackishwaters by Pillay (1967) and by Whitfield et al. (1981) from South African estuaries. The estuarine character of the San Miguel Bay fish fauna can be demonstrated directly, however. The list of fish compiled here has been complemented with notes on the salinity tolerated by the various species. As might be seen from the list, 91 (48%) of the species recorded from San Miguel Bay are euryhaline marine species, i.e., species, which tolerate fresh- and/or brackishwater.

The asymmetry between the numbers of marine and freshwater species in San Miguel Bay can be easily explained in terms of what is generally known of the tolerance of freshwater and marine animals to increased and decreased salinities, respectively. Fig. 2A, redrawn from Remane (1971) is a graph of species diversity against salinity, based on a large number of studies conducted in and around large temperate brackishwater bodies (e.g., Zuidersee, Baltic and Black Seas). As the graph shows, true freshwater species tolerate only small increases of salinity, whereas marine species can generally tolerate great reductions of salinity. This explains the preponderance of marine species in estuaries.

However, due to the relative isolation of the Philippine Islands, there are only a few true freshwater species (predominantly Cyprinidae) (Herre 1928a). This has allowed a number of marine fishes to become secondarily adapted to freshwater (e.g., *Arius dispar* and *A. manilensis*, several gobiid species); these fishes are still capable, however, of tolerating salt- or brackishwaters better than true freshwater fishes. Also, it seems that it is altogether easier for tropical than for temperate marine fishes to adjust to freshwater, with the result that there are many more holoeuryhaline (marine fishes capable of living in freshwater) fishes in the Philippines than is suggested by Fig. 2A. For these reasons, I have attempted, based mainly on Herre (1928a, 1953 and 1958), to adapt Remane's graph to the peculiarities of the Philippine fish fauna; the result is given in Fig. 2B. The large number of holoeuryhaline marine fishes, will be noted together with the very small number of true freshwater species (see also Fig. 3A). Also worth noting is the category "secondary freshwater fishes", which replaces the brackishwater species in Remane's graph; this category may include a few truly brackishwater fishes, i.e., fishes which spawn in brackishwater (e.g., the white goby, *Glossogobius giurus).*

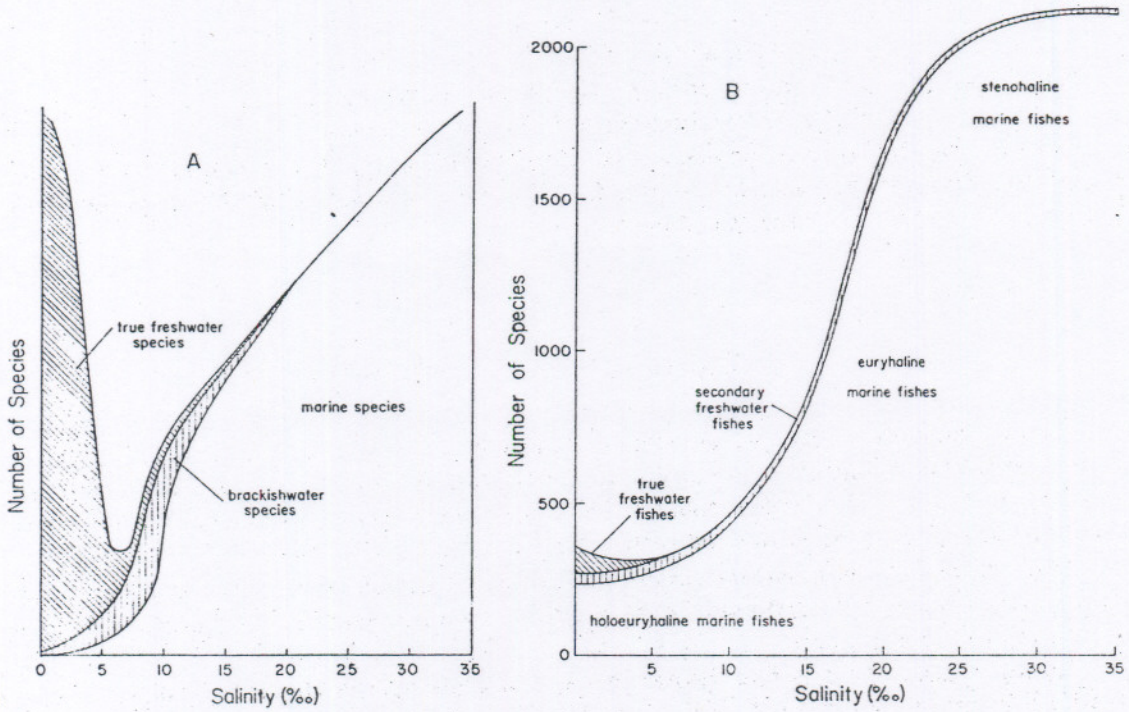

Fig. 2. A. General relationship between salinity and number of species, as suggested by Remane (1971) (based mainly on temperate forms). B. Relationship between salinity and number of fish species in the Philippines (see text).

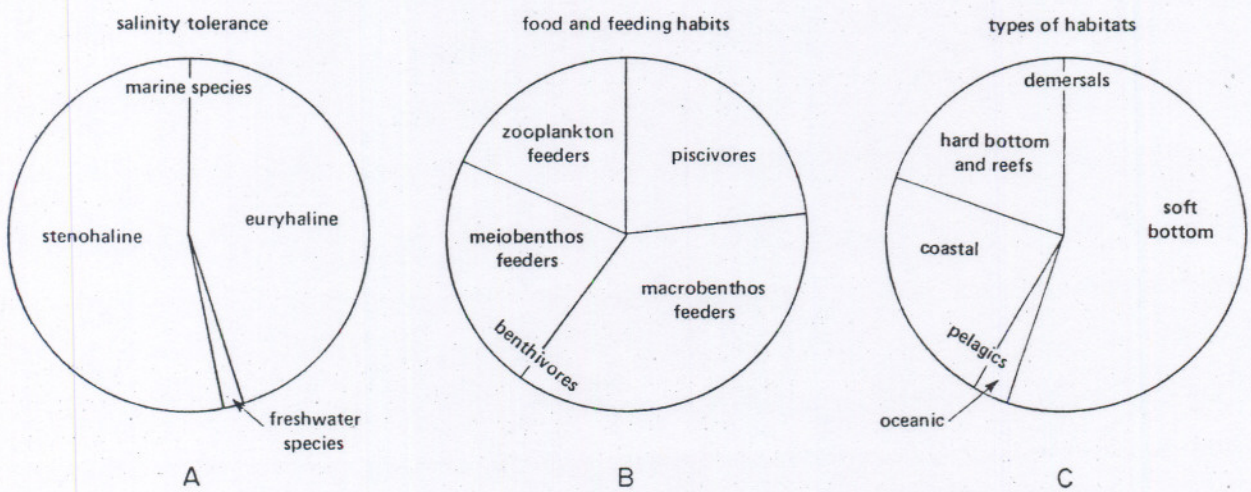

Fig. 3. Occurrence of San Miguel Bay fish species in terms of A) salinity tolerance, B) food and feeding habits, and C) type of habitats. See text.

Food and Feeding Habits of San Miguel Bay Fishes

The species of fishes reported from San Miguel Bay have been grouped, on the basis of a thorough scanning of the literature on the feeding habits of tropical fishes, into the following four broad categories:

a) piscivores
b) zooplankton feeders
c) meiobenthos (small invertebrates, ⩾1 mm, and algae) feeders
d) macrobenthos (large invertebrates) feeders

The results are given in Fig. 3B. As might be seen, most fish species in San Miguel Bay are macrobenthos feeders (37%), followed by piscivores (23%), meiobenthos feeders (22%) and zooplankton feeders (18%).

It must be realized, however, that these figures relate to species numbers, not to the relative biomasses (and catches) of these species. Thus, for example, meiobenthos feeders, which contribute relatively little in terms of species numbers, include leiognathid species which in the unexploited stock contributed more than 60% of the (trawlable) biomass (see Pauly, this report). On the other hand, many of the piscivorous species (e.g., the tuna and other oceanic fishes) are only occasional visitors to the Bay. Their biomass at any given time should generally be low.

Types of Habitats Offered by San Miguel Bay

On the basis of published information on their biology, the fishes have been grouped in Appendix I into four habitat types:

— coastal pelagics (e.g., anchovies)
— oceanic pelagics (e.g., tuna)
— soft-bottom demersals (e.g., most slipmouths)
— hard-bottom/reef demersals (e.g., groupers)

As is the case for the grouping into "food and feeding habits" groups (see above), these are broad categories, with a large overlap and involving essentially subjective decisions.

Nevertheless, an interpretable pattern emerged (Fig. 3C); predominant (55%) in the Bay are (not surprisingly in view of its shallowness and mud-covered bottom) soft-bottom demersal fish. The next group (22%) is the (small) "coastal pelagics", which, along with most soft-bottom demersals, are the fishes which use the Bay as a nursery area. The next category (20%) includes hard-bottom/reef fishes; the specimens belonging to these species were most probably recruited from the rocky outcrops and reefs at the mouth of the Bay (Fig. 1). The least important group is the (large) "oceanic pelagics", which enter the Bay as occasional visitors, and whose young do not use it as a nursery area.

San Miguel Bay as a Nursery Area

Several surveys were conducted in the 1970s which aimed at assessing the role of Philippine bays and estuaries as nursery grounds for marine fishes (Castillo and Barenguel 1975; Del Mundo et al. 1980; Legasto et al. 1975a; Legasto et al. 1975b; Ordoñez et al. 1974; Ordoñez et al. 1975). Although these surveys were generally of very short duration (Legasto et al. 1975b, for example, covered San Miguel Bay in a few days, in November 1974), data were gathered which, when put into an appropriate conceptual framework, clearly indicate a "nursery" role for most of these bays. This is demonstrated here for San Miguel Bay with data collected by Legasto et al. (1975b):

— all fish sampled within the Bay (8 species) were immature

Table 1. Largest observed sizes of fishes caught by trawlers inside and outside of San Miguel Bay.[a]

Species	Largest size observed (in cm) Inside	Outside[b]	# of samples Inside	Outside
Dussumieria acuta	15.5	19.5	1	4
Sardinella gibbosa	15.25	18.25	3	3
Stolephorus commersonii	8.75	11.25	3	4
Atule mate	23.5	25.5	3	4
Alepes djeddaba	17.75	(13.25)	5	1
Leiognathus bindus	7.75	11.25	1	10
Leiognathus splendens	10.8	12.6	7	7
Secutor insidiator	11.1	12.4	6	7
Secutor ruconius	6.75	9.25	2	4
Otolithes ruber	28.5	(24.5)	8	8
Johniops aneus	14.75	21.25	8	8
Johnius belangerii	17.5	22.5	4	6

[a]Based on length-frequency samples collected by J.M. Vakily (pers. comm.) on board large trawlers, except for the data for *Leiognathus splendens* and *Secutor insidiator* which stem from Tiews and Caces-Borja (1965).

[b]Note that maximum observed size is larger outside than inside in 10 out of 12 cases, and that one of the two (bracketed) cases in which this is reversed is a case where sampling outside was much less than inside.

– only 6 fish larvae and 2 (!) fish eggs were sampled from 30 plankton hauls, although sampling occurred during the northeast monsoon, i.e., during the period of the year when most Philippine marine fishes may be expected to spawn (see Weber 1976).

Another important bit of evidence for a nursery role for San Miguel Bay is that, within a given marine species, the largest fish occur at the mouth of, or outside the Bay, rather than inside the Bay (Table 1). These various items, combined with what is known elsewhere of the reproductive migrations of tropical neritic species suggest a reproductive cycle as put forward in Fig. 4. From this figure emerges a clear distinction between *spawning* and *nursery* grounds; the figure also explains

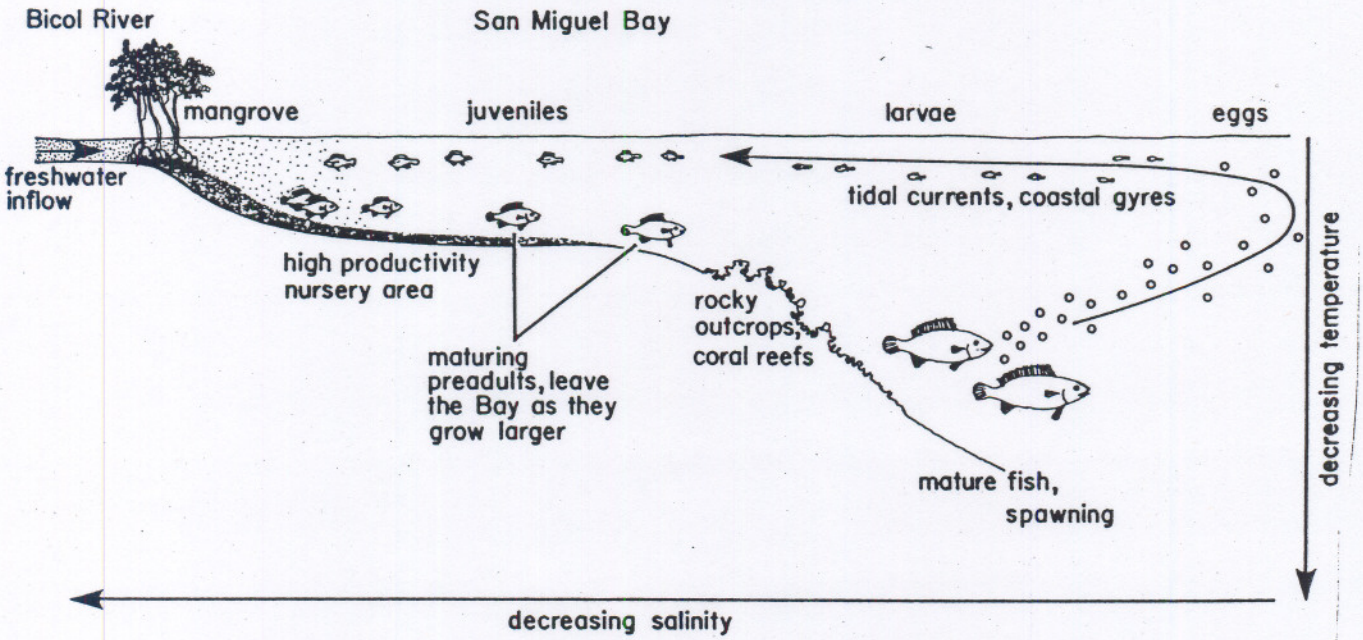

Fig. 4. Schematic representation of the role of San Miguel Bay as a nursery ground for marine fishes hatched further offshore. Generalized from Gunter (1967), Pauly (1976), Johannes (1978) and Buri (1980).

the low numbers of eggs and larvae found by Legasto et al. (1975b), as well as the absence of mature fish from their samples.

A similar graph could be constructed to illustrate the role of this Bay as a nursery ground for catadromous freshwater fishes, e.g., those freshwater gobies which return to the sea to spawn. This is not attempted here, as these migrations have been described by Herre (1927, 1958), whose papers should be consulted for further details on the migrations and relationship with salinity of Philippine fishes.

Allen (1978) wrote with regard to San Miguel Bay:

> one thing presently occurring that will surely diminish the productivity of the Bay, and adjacent coastal waters unless it is stopped, is the loss of mangrove and other types of wetland bordering the Bay. I believe that there is a good chance that the Bay productivity lost from a hectare of mangroves displaced by a fishpond may be as great or greater than the harvest from the pond.

While the mangrove and related ecological literature abounds with categorical statements of this kind (see Nixon 1980), hard data usable for the quantification of the role of mangroves in fisheries-related food chains are extremely scarce, particularly in the Indo-Pacific (Walsh et al. 1975; PCARR 1978).

The basic problem with all attempts to assess the impact of mangrove clearing in the Philippines and elsewhere is that the result, at best, is a time series of e.g., catch of fishes or shrimps which use mangrove/estuaries as nursery areas. Such time series are extremely difficult to interpret since fishing effort—which it should be remembered is a major cause of death among fishes—generally will have increased during the investigation period. Also, while it could be that there is, for example, in the San Miguel Bay area a direct, causal link between mangrove litterfall and fish yield, it could also be that the loss of nutrients to the Bay due to mangrove cutting is compensated or even over-compensated for by increased silt and organic wastes deposited into the Bay by the Bicol River (see Mines et al., this report). Clearly, empirical studies are needed on this topic. Gomez (1980) gives a recent review of the Philippine literature on mangroves.

Another related aspect is the maintenance—in spite of the diversion of water from the Bicol river for irrigation purposes—of an adequate supply of freshwater to the Bay.

Allen (1978) observed:

> a further safeguard for keeping the Bay healthy is insuring the availability of sufficient fresh water inflow from the streams entering the Bay. The exact amount of freshwater needed is not known, but I suggest the present dry season volume be maintained.

While more water than before is being used for irrigation purposes, and thus lost through evaporation, rampant upland deforestation will—other things being equal—actually *increase* overall freshwater inflow into the Bay.

At present, it seems extremely difficult to assess, even qualitatively, the impact, present and future, of these factors on the San Miguel Bay fishes.

Discussion

In spite of the scanty material available, it has been possible to derive here a generalization concerning the relationship of species diversity of Philippine fishes in relationship to salinity (Fig. 2B), as well as to consolidate evidence on the role of Philippine bays and estuaries into a single pattern (Fig. 4) suggested here to apply throughout the country.

Other generalizations pertaining to Philippine estuaries are:

- annual fish and invertebrate yields (excluding sergestid shrimps) can be very high, reaching up to 17 t/km^2 (see Pauly, this report);
- such production is maintained largely by a limited number of meiobenthos-feeding species of fish and shrimps;

- contrary to events in reef ecosystems, the production of such estuarine systems may not be affected negatively by siltation due to erosion; indeed, terrigenous material is a major contribution to estuarine productivity; and
- *non-toxic* organic wastes (from urban areas, from farms and certain factories) may increase the productivity of estuarine systems, given that their application does not fluctuate too rapidly (Soule and Soule 1981)

These generalizations might provide (testable) hypotheses around which to formulate future studies of Philippine estuaries.

Acknowledgements

The list of fishes which form the core of this paper was significantly lengthened by Mr. E. Cinco's list of San Miguel Bay fishes, as well as by the trust of Ms. P. Conlu of the U.P. College of Fisheries in lending her unique set of manuscripts. My gratitude also goes to J. Ingles (UP, IFDR) for compiling the list of San Miguel Bay records from the Catalogue of Fishes of the National Museum of the Philippines.

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Appendix 1. List of fishes recorded from San Miguel Bay, 1868-1981.

Scientific names	English/Bicol names	First record	Remarks
	SCYLLIORHINIDAE (catsharks/—)		
Chiloscyllium punctatum	—/—	Herre (1925)	———
	CARCHARIIDAE (gray shark/pating; young sharks also called "iho")		
Carcharias melanopterus	black-tipped shark/lodlod, tutongan	Umali (1937)	———
Carcharias menisorrah	—/—	IFDR/ICLARM Project	———
Scoliodon palasorrah	sharp-nosed shark/bungalonon, balanohan, balatihan, balanakon	Umali (1937)	———
	SPHYRNIDAE (hammer-head shark/awal)		
Sphyrna zygaena	smooth hammerhead shark/awal, krusan, tampugan, ros	Umali (1937)	———
	PRISTIDAE (sawfish/sorodan)		
Pristis microdon	sawfish/surodan, barasan, pakangan	Herre (1953)	Herre's record is from the Bicol River. One specimen caught in July 1947 in San Miguel Bay weighed 480 lb (Warfel and Manacop 1950); reported from the mouth of the Ganges river (see Herre 1953)
Pristis cuspidatus	sawfish/surodan	NMP collection	entering freshwaters (Herre 1958)
	RHINOBATIDAE (rays/pagi)		
Rhinchobatus djiddensis	spotted guitar-fish/arado, rubarob, sudsud, sudsodan	Umali (1937)	one specimen caught in July 1947 in San Miguel Bay weighed 180 lb (Warfel and Manacop 1950)
	TORPEDINIDAE (electric rays, torpedoes/—)		
Narcine timlei	—/—	IFDR/ICLARM Project	———
	DASYATIDAE (stingrays/pagi)		
Dasyatis kuhlii	blue spotted stingray/daragon, dahunan, kuyampao	Umali (1937)	"bay and inlets, sandy or muddy coasts, enter river mouths" (Herre 1953)
Dasyatis uarnak	marbled stingray, whip ray/ bitoonan, kilkigan, pangladan, pilisan, paging dahunan	IFDR/ICLARM Project	"sometimes entering fresh water [. . ;] reach a meter and half broad and very bulky" (Herre 1953); reported from at least one river (see Herre 1953)
Dasyatis bleekeri	—/—	NMP collection	———
	MYLIOBATIDAE (eagle rays/pagi manok)		
Aetobatus narinari	spotted eagle ray/banugon, kaligmanok, bagtaw, bagtan	Umali (1937)	———
	RHINOPTERIDAE (cow-nosed rays/ogaog)		
Rhinoptera javanica	cow-nosed ray/ogaog, paging bungi, pasa-pasa	Umali (1937)	———
	MOBULIDAE (devil rays, mantas/salanga)		
Mobula diabolus	devil ray, manta/sarangan, pasa-pasa, saiag, salanga	Herre (1953)	reported as *M. ereregoodoo-tenke*, a synonym

Appendix 1 (continued)

	CLUPEIDAE (sardines, herring/tamban; clupeid fry are referred to as "piyak", or "tabyos")		
Anadontostoma chacunda	gizzard shad/kabasi	Roxas (1934)	"marine, frequenting estuaries and tidal streams" (Herre 1953)
Nematalosa nasus	Bloch's gizzard shad/suwagan, kabasi	Umali (1937)	euryhaline, listed in Herre (1958)
Pellona ditchela	big-eyed herring/bas-an, muang, matang-baka	NMP collection	record refers to *Ilisha hoeveni;* a synonym
Dussumieria acuta	rainbow sardine/kabasi, kanasi	Roxas (1934)	some early records are to *D. hasselti,* a synonym
Herklotsichthys punctatus	spotted herring/kabasi	Legasto et al. (1975b)	size sampled 75 to 95 mm; 75% were "immature"
Clupeiodes lile	transparent herring/bolinao	Umali (1937)	———
Sardinella fimbriata	fringescale sardinella/laolao, turay, lawlaw	Umali (1937)	"marine and entering river mouths" (Herre 1953)
Sardinella gibbosa	goldstripe sardinella/—	IFDR/ICLARM Project	reported from inside the Bay by J.M. Vakily (pers. comm.)
Sardinella albella	white sardinella/tamban kabasi-on, alubaybay	Roxas (1934)	early records are to *S. perforata,* a synonym
Sardinella longiceps	Indian sardine/tulay, turay, tamban	IFDR/ICLARM Project	"marine and entering river mouths" (Herre 1953)
	ENGRAULIDAE (anchovies/dilis, bulinao)		
Stolephorus commersonii	Commerson's anchovy/dilis, bulinao	Umali (1937)	most abundant engraulid in San Miguel Bay "marine and entering rivers" (Herre 1953)
Stolephorus zollingeri	—/dilis, bulinao	NMP collection	———
Stolephorus indicus	Indian anchovy/matalos	ICLARM/IFDR Project	euryhaline, listed in Herre (1958)
Stolephorus buccaneeri	buccaneer anchovy/dilis, bulinao	Tiews et al. (1972)	reported from stomachs of *Saurida tumbil*
Stolephorus heterolobus	shorthead anchovy/dilis	Tiews et al. (1972)	reported from stomachs of *S. tumbil*
Thryssa hamiltonii	Hamilton's thryssa/tigi	Legasto et al. (1975b)	"in the sea and estuaries" (Herre 1953). Specimens examined (in Nov. 1974) were "all mature" and ranged from 78 to 89 mm
Thryssa mystax	moustached thryssa/dilis, bulinao	Roxas (1934)	"marine and entering river mouths" (Herre 1953)
Thryssa setirostris	longjaw thryssa/dilis, bulinao	NMP collection	"marine entering estuaries" (Herre 1953)
	MEGALOPIDAE (tarpons/bulan-bulan)		
Megalops cyprinoides	ox-eyed tarpon/bulan-bulan, buan-buan, buwan, mulan-bulan	Umali (1937)	"marine, but occurs in lake and rivers" (Roxas 1934)
	CHIROCENTRIDAE (wolf herrings/balila)		
Chirocentrus dorab	wolf herring/balila, barira	Roxas (1934)	"marine, entering brackish waters" (Herre 1953, with ref. to the genus *Chirocentrus)*
	ANGUILLIDAE (eels/kasili)		
Anguilla marmorata	eel/kasili, barirauin	Herre (1953)	reported from Bicol river
Anguilla pacifica	eel/kasili, birirauin	Conlu (1978)	reported from Lake Bato, and thus had to swim through San Miguel Bay
	MURAENESOCIDAE (pike-eels/obud)		
Muraenesox cinereus	pike-eel/obud, obod, oldok, panapa, pindanga	Umali (1937)	euryhaline, listed in Herre (1958)
	MURAENIDAE (morays/buriwaran)		
Gymnothorax sp.	moray/buriwaran, indong, labung, payangitan, barason	IFDR/ICLARM Project	———

Appendix 1 (continued)

	CONGRIDAE (—/—)		
Conger sp.	—/—	IFDR/ICLARM Project	———
	SYNODONTIDAE (lizardfish/—)		
Saurida tumbil	greater lizardfish/—	Tiews et al. (1972)	Tiews et al. (1972) give an account of the biology of this fish, based on San Miguel Bay samples
Saurida undosquamis	—/—	IFDR/ICLARM Project	———
Trachinocephalus myops	—/—	IFDR/ICLARM Project	———
	ARIIDAE (sea catfish/punicon, dupit, tabangko, also called "laudon" when large)		
Arius leiotocephalus	smooth-headed catfish/pohicon, bunguan, tabanko, tabangongo	Herre (1953)	"marine and estuarine" (Herre 1953)
Arius thalassinus	giant sea catfish/ponicon, bunguan, tabanko, tabangongo	NMP collection	"the commonest Philippine ariid catfish" (Herre 1953). Euryhaline, listed in Herre (1958)
	PLOTOSIDAE (stinging catfish/i-ito)		
Plotosus anguillaris	striped catfish/i-ito, nito	Herre (1926)	"marine but entering rivers" (Herre 1953)
	EXOCOETIDAE (flying fishes and halfbeaks/ilin & kutnog)		
Cypserulus sp.	flying fish/iliu, siliu, siliw	Umali (1937)	———
Hemirhamphus far	spotted halfbeak/kutnog, buroy, sigwil	Umali (1937)	———
Hemirhamphus sp.	halfbeak/bugin, sigwit, bagin, balamban, bangdaw	Umali (1937)	species not identified, but different from *H. far*
	BELONIDAE (garfish/balo, patlay, dual, do-al)		
Tysolurus strongylurus	light colored garfish/hamalit	Herre (1928b)	———
	FISTULARIIDAE (cornetfishes/—)		
Fistularia villosa	cornet fish/—	NMP collection	"juveniles in shallow bays and estuaries, adults moving to deeper water" (Munro 1967)
Fistularia serrata	flutefish/—	Conlu (1978)	———
	CENTRISCIDAE (shrimpfishes, razorfishes/—)		
Centriscus scutatus	razorfish/—	Conlu (1977)	"shallow coastal waters and estuaries" (Munro 1967)
	SCORPAENIDAE (lionfishes/—)		
Pterois russelli	Russel's lionfish/—	NMP collection	———
	PLATYCEPHALIDAE (flatheads/sunog)		
Platycephalus isacanthus	flathead/sunog, itong, itang, lubalob	NMP collection	———
	PEGASIDAE (sea months, sea dragons/—)		
Pegasus volitans	sea dragon/—	Conlu (1979b)	———
	CENTROPOMIDAE (sea bass/bolgan)		
Lates calcarifer	giant sea bass/bulgan, apahap, mangagat	Umali (1937)	"shallow coasts and river mouths" (Herre 1953)
Ambassis gymnocephalus	—/—	De Beaufort (1932)	also reported from Lake Bombon

Appendix 1 (continued)

	SERRANIDAE (groupers/lapo-lapo, lapu-lapu, kugtong, pugapo, baraka, sigapo, kitking, inid)		
Epinephelus sp.	honey-comb grouper/lapo-lapo	IFDR/ICLARM Project	———
	THERAPONIDAE (grunts/bagaong, milipili, abo)		
Therapon quadrilineatus	four-lined grunt/gung-gong, kanigit, kuron, malipili, pagotpot, abo	IFDR/ICLARM Project	"marine, and in brackish and fresh waters" (Herre 1953)
Therapon puta	—/—	IFDR/ICLARM Project	———
Therapon jarbua	—/bugaong	IFDR/ICLARM Project	"marine and entering rivers" (Herre 1953)
Therapon theraps	—/—	NMP collection	———
	PRIACANTHIDAE (bigeyes/—)		
Priacanthus tayenus	purple-spotted bigeye/—	NMP collection	———
Priacanthus macracanthus	red bigeye/—	NMP collection	———
	APOGONIDAE (cardinal fishes/bagsang)		
Apogon quadrifasciatus	cardinal fish/bagaang	NMP collection	an "*Apogon* sp." was also reported from the stomach of *Saurida tumbil* by Tiews et al. (1972)
	SILLAGINIDAE (sandborers, whitings/osoos, tayotos)		
Sillago maculata	spotted whiting/osoos	IFDR/ICLARM Project	"shallow coastal waters and estuaries" (Munro 1967)
Sillago sihama	whiting/asohos, asuos, tayotos	Martin and Montalban (1934)	"marine and in estuaries and river mouths" (Herre 1953)
	LACTARIIDAE (false trevally/algodon, damos)		
Lactarius lactarius	false trevally/algodon, bas-an, damos	Umali (1937)	———
	RACHYCENTRIDAE (cobias, sergeantfishes/balisukan)		
Rachycentron canadus	sergeantfish/salakan-itang, balisukan, pandauan	Umali (1937)	———
	CARANGIDAE (jacks, horse mackerels/talakitok, malapondo, dalupani, marapini, mamsa)		
Alectis ciliaris	cobblerfish/—	NMP collection	———
Alectis indicus	Indian threadfish/bankungan, buhukan, lawihan	IFDR/ICLARM Project	"marine, but sometimes entering fresh waters (Herre 1953)
Alepes melanoptera	—/—	IFDR/ICLARM Project	———
Alepes djeddaba	Djeddaba crevalle/salay-salay	IFDR/ICLARM Project	"harbours and river mouths" (Munro 1967)
Alepes kalla	—/salay-salay	Umali (1937)	"coastal waters around river mouths" (Munro 1967)
Atule malam	—/—	NMP collection	———
Atule mate	—/—	NMP collection	"protected bays, harbours and river mouths" (Munro 1967)
Caranx sexfasciatus	dusky jack/lison	Roxas and Agco (1941)	"marine, and entering rivers and lakes" (Herre 1953)
Caranx malabaricus	Malabar jack/salay-salay	NMP collection	———
Caranx ignobilis	—/—	IFDR/ICLARM Project	euryhaline (Whitfield et al. 1981)
Caranx armatus	longfinned cavalla/lawayan, samin-samin palatikat, mamsa, mansa	NMP collection	"marine, entering rivers and lakes" (Herre 1953)
Carangoides ciliarius	longfinned cavalla/talakitok	Conlu (1978)	———
Gnathodon speciosus	golden toothless trevally/ badlon, malapandong, dilau	NMP collection	———

Appendix 1 (continued)

Scomberoides lysan	yellow leatherjacket/lapis, talang-talang	Umali (1937)	euryhaline (Whitfield et al. 1981)
Scomberoides tala	—/lapis	Umali (1937)	———
Scomberoides tol	—/lapis	Umali (1937)	"marine, and entering river mouths" (Herre 1953)
Megalaspis cordyla	hardtail scad/pakan	Roxas and Agco (1941)	"marine, sometimes in rivers and lakes" (Herre 1953)
Selar boops	eye of the sea/—	Conlu (1977)	———
Selar crumenophthalmus	big-eyed scad/atulay, matang baka, tingin	Umali (1937)	———
Decapterus macrosoma	roundscad/sibubog, tilus	IFDR/ICLARM Project	*D. layang* occurs near the mouth of the Bay (Vakily, pers. comm.)
Selaroides leptolepis	yellowstripe crevalle/ tabaroyan, salay-salay	Conlu (1978)	———
Seriola nigrofasciata	black-barred amberjack/lapis	Roxas and Agco (1941)	reported from Bicol River
	FORMIONIDAE (butterfishes, pomfrets/pampano)		
Formio niger	black butterfish, black pomfret/pampano	Umali (1937)	———
	MENIDAE (moonfishes/bilong-bilong)		
Mene maculata	spotted moonfish/bilong-bilong, tabas	IFDR/ICLARM Project	"rarely entering estuaries" (Munro 1967)
	LEIOGNATHIDAE (slipmouth, ponyfish, silverbellies/sapsap, dalupani, tambong)		
Gazza minuta	toothed ponyfish/—	Herre (1953)	reported from brackishwaters (refs. in Pauly and Wade-Pauly 1981)
Gazza achlamys	toothed ponyfish/sapsap	Tiews and Caces-Borja (1965)	reported from brackishwaters (refs. in Pauly and Wade-Pauly 1981)
Leiognathus bindus	orangefin ponyfish/dalupani	Tiews and Caces-Borja (1965)	———
Leiognathus daura	black-finned slipmouth, gold stripe pony fish/daguldulan, dalupani, tambung	Conlu (1980a)	reported from brackishwaters (refs. in Pauly and Wade-Pauly 1981)
Leiognathus elongatus	elongated slipmouth/dalupani	Conlu (1978)	———
Leiognathus blochi	—/—	Tiews and Caces-Borja (1965)	reported from brackishwaters (refs. in Pauly and Wade-Pauly 1981)
Leiognathus dussumieri	—/—	Tiews and Caces-Borja (1965)	"marine, and entering rivers and lakes" (Herre 1953)
Leiognathus equulus	common ponyfish/barorog, barusog	Umali (1937)	"in the sea, brackishwaters and entering rivers" (Herre 1953)
Leiognathus fasciatus	banded slipmouth/mutamot, striped ponyfish, tabiros	Umali (1937)	reported from brackishwaters by Pillay (1967)
Leiognathus smithursti	Smithurst's ponyfish/dalupani	Umali (1937)	reaches 20 cm
Leiognathus leuciscus	whipfin ponyfish/—	Tiews and Caces-Borja (1965)	———
Leiognathus splendens	splendid ponyfish/mutamot	Umali (1937)	reported from brackishwaters (Herre 1953)
Leiognathus elongatus	elongated ponyfish/—	IFDR/ICLARM Project	———
Secutor insidiator	wily slipmouth, pugnose ponyfish/bilong-bilong, damul-damul, sakmo	Umali (1937)	"marine, and entering rivers" (Herre 1953)
Secutor ruconius	spotted slipmouth, deep pugnose ponyfish/pirak-pirak, tabiros	Umali (1937)	"marine and entering rivers" (Herre 1953)
	LUTIANIDAE (snappers/—)		
Lutjanus argentimaculatus	mangrove red snapper/aliso, batangal, kisang, managagat, pargo	Umali (1937)	"marine, entering rivers and lakes" (Herre 1950)
Lutjanus malabaricus	Malabar red snapper/langit, pulahan, talutoon, dapak	Umali (1937)	euryhaline, included in Herre (1958)
Lutjanus fulvus	flame colored snapper/ tingarog	Umali (1937)	———

Appendix 1 (continued)

		EPHIPPIDAE (—/riring)	
Drepane punctata	spotted sicklefish/riring,	Herre and Montalban (1927)	reported from the Bicol River "reaches half a meter in length" (Herre 1953)
Drepane longimana	—/—	NMP collection	———
Platax orbicularis	leaf fish/bayang, dalapugan, kulyong, paras	Herre and Montalban (1927)	"marine but entering river mouths" (Herre 1953)
		SCATOPHAGIDAE (—/—)	
Scatophagus argus	—/bayang, kikiro, kitang	Herre and Montalban (1927)	"in the sea and in rivers and lakes" (Herre 1953)
		CHAETODONTIDAE (butterflyfishes/—)	
Chaetodon adiergastos	—/—	Herre and Montalban (1927)	———
Chaetodon octofasciatus	eight banded butterflyfish/—	Conlu (1980a)	———
		POMACENTRIDAE	
Abudefduf bengalensis	—/—	Montalban (1928)	"marine and entering river mouths" (Herre 1953)
Abudefduf coelestinus	—/—	Montalban (1928)	"in the sea and brackish waters" (Herre 1953)
		MUGILIDAE (mullets/araran, tabudyos, banak, balanak; large mullets (spawners) are called "aguas saranao, or agwas"; mullet fry is referred to as "gisao", or "ararang")	
Liza subviridis	greenback grey mullet/—	Conlu (1977)	*Mugil dussumieri* is a synonym; euryhaline, included in Herre (1958)
		SPHYRAENIDAE (barracudas/teako, rompe (when large), batig titso, or buleos (when small), dugso batog)	
Sphyraena jello	banded barracuda/batog, dugso, rompe kandado, manabang (large)	IFDR/ICLARM Project	euryhaline (Whitfield et al. (1981)
Sphyraena obtusata	obtuse barracuda/batog, dugso, rompe	IFDR/ICLARM Project	euryhaline (Whitfield et al. (1981)
		POLYNEMIDAE (threadfins/baka-dulce)	
Eleutheronema tetradactylum	fourfinger threadfin/hugao	Herre (1953)	"entering estuaries and rivers" (Herre 1953)
Polynemus microstomus	black spot threadfin/akin-akin, kuwa-kuwa	Umali (1937)	"entering estuaries and rivers" (Herre 1953)
		ELEOTRIDAE (sleepers/—)	
Ophiocara porocephala	—/palu	Herre (1927)	"in fresh and salt water" (Herre 1953)
		GOBIIDAE (gobies/—)	
Ctenogobius caninus	—/—	Herre (1927)	"in bays and estuaries and entering freshwater rivers" (Herre 1953)
Glossogobius giurus	white goby/bakla, batug, mulog, oro-on, sugunayon	Herre (1927)	reported from Lake Buhi, Bicol River and San Miguel Bay by Herre (1953)
Glossogobius giurus var *obscuripinnis*	golden goby/—	Peters (1868)	reported from Bicol River and Lake Bato
Gobius sp.	—/—	Tiews et al. (1972)	reported from the stomachs of *Saurida tumbil*
Oxyurichthys ophthalmonema	—/—	NMP collection	"in the sea and brackish and freshwater" (Herre 1953)

Appendix 1 (continued)

	NEMIPTERIDAE (threadfin breams/bisugo)		
Nemipterus japonicus	Japanese threadfin bream/ kanasi	Conlu (1977)	———
Nemipterus nematophorus	—/kanasi	IFDR/ICLARM Project	———
Scolopsis taeniopterus	monocle bream/buroha	Conlu (1978)	———
Scolopsis vosmeri	whitecheek monocle bream/	Conlu (1978)	———
	GERRIDAE (mojarras/—)		
Gerres filamentosus	whipfin, or spotted mojarra/ latab, malagapas, sakalan	Montilla (1935)	"in the sea and rivers and lakes" (Herre 1953)
Pentaprion longimanus	longfinned mojarra/—	Conlu (1978)	"marine and in brackishwaters" (Herre 1953)
	POMADASYDAE (grunts/—)		
Pomadasys hasta	silver grunt/aguot; balay, ulibalay, kiskisan	Umali (1937)	euryhaline, included in Herre (1958)
Pomadasys argyreus	—/—	NMP collection	"entering bays and rivers" (Munro 1967)
Pomadasys maculatus	blotched grunt/tabal-tabal	IFDR/ICLARM Project	———
Pristipomoides microdon	—/taloto-on	Herre (1953)	Umali's "deep-bodied pristipomid"
	LETHRINIDAE (emperors/—)		
Lethrinus nebulosus	pearl spotted porgy/bakawel	IFDR/ICLARM Project	euryhaline, included in Herre (1958)
	PENTAPODIDAE (—/—)		
Pentapodus setosus	paradisefish/—	Conlu (1978)	———
	SPARIDAE (porgies, pargos/abo)		
Mylio berda	picnic seabream/bakoko	Umali (1937)	"marine and entering rivers" (Herre 1953)
	SCIAENIDAE (croakers/arakaak)		
Otolithes ruber	tigertooth croaker/abo	Umali (1937)	*O. argenteus* is a synonym. "Marine and entering river mouths" (Herre 1953)
Otolithoides biauritus	—/—	NMP collection	———
Johnieops aneus	—/arakaak	Umali (1937)	"marine and entering rivers" (Herre 1953)
Dendrophysa russelli	goatee croaker/pagotpot	NMP collection	"in the sea and entering rivers" (Herre 1953)
Johnius belengerii	Belanger's croaker/—	NMP collection	"marine, and entering rivers" (Herre 1953)
Johnius dussumieri	bearded croaker/—	NMP collection	———
Pennahia macrophthalmus	bigeye croaker/—	Conlu (1978)	———
	MULLIDAE (goatfishes/agingoy, amarilis, saramulyete; large specimen also called "timbungan.")		
Parupeneus bifasciatus	doublebar goatfish/—	Herre and Montalban (1928b)	reported from near a river mouth by Herre (1953)
Upeneus sulphureus	yellow goatfish/saminayon	Herre and Montalban (1928b)	reported from a river by Herre (1953)
Upeneus sundaicus	ochreband goatfish/—	NMP collection	"marine and in river mouths" (Herre 1953)
Upeneus moluccensis	goldband goatfish/agingoy	Conlu (1978)	———
	PEMPHERIDAE (sweepers/—)		
Pempheris moluca	Moluccan sweeper/—	Conlu (1978)	———

Appendix 1 (continued)

TRYPAUCHENIDAE (–/–)			
Trypauchenichthys typus	–/–	Conlu (1980a)	a rare marine fish
ACANTHURIDAE (doctorfishes, surgeonfishes/kalditan, salinkupao, uwakon, yaput, indangan)			
Acanthurus matoides	–/–	Herre (1927)	———
SIGANIDAE (rabbitfishes/baliwis, mublad, bataway, turos, toros, dangit, kuyog, batawayi; siganid fry is referred to as "kuing" or "kuyog")			
Siganus fuscescens	–/–	Herre and Montalban (1928a)	"marine, but entering rivers and lakes" (Herre 1953)
Siganus hexagonata	–/–	Herre and Montalban (1928a)	———
Siganus javus	streaked spinefoot/–	Herre and Montalban (1928a)	"marine and entering rivers and lakes" (Herre 1953)
Siganus oramin	–/–	Herre and Montalban (1928a)	"marine, but entering rivers" (Herre 1953)
Siganus virgatus	blue-line spinefoot/batawayi, mublad, bataway, toros	Herre and Montalban (1928a)	euryhaline, included in Herre (1958)
Siganus canaliculatus	pearly spinefoot/toros, turos, dangit	Conlu (1978)	———
TRICHIURIDAE (cutlassfishes, hairtails/langkay, liwit, sikwan, lankoy)			
Trichiurus lepturus	cutlassfish/lankoy, langkoy	Umali (1937)	*T. haumela* is a synonym
SCOMBRIDAE (mackerels, tunas/turingan (subfamily Thunninae)			
Rastrelliger brachysoma	short-bodied mackerel/ aguma-a, kabalyas, abobongon, amang	Umali (1937)	———
Rastrelliger kanagurta	striped mackerel/bulau, barao	Umali (1937)	reported as *R. chrysozonus*, a synonym
Scomberomorus commerson	spanish mackerel/tangigi, malaudiyong	Conlu (1978)	———
Auxis sp.	frigate, or bullet mackerel/ rayado	Umali (1937)	— —
at least one species of tuna	tuna/turingan	Umali (1937)	Umali's "Thunnidae"
PSETTODIDAE (–/–)			
Psettodes erumei	–/–	IFDR/ICLARM Project	———
BOTHIDAE (flounders, brills/palad)			
Pseudorhombus arsius	largetooth flounder/palad	NMP collection	"in seas, bays and estuaries" (Herre 1953)
Psettina profunda	–/palad	NMP collection	———
Arnoglossus aspilos	–/palad	NMP collection	———
SOLEIDAE (soles/palad)			
Microbuglossus ovatus	–/–	NMP collection	———
Pardachirus pavoninus	peacock sole/palad-palad	NMP collection	———
Solea ovata	–/palad-palad	NMP collection	recorded as *S. humilis*, a synonym
Synaptura cornuta	horned sole/palad-palad	Conlu (1979a)	———
Synaptura mulleri	–/palad-palad	Conlu (1979a)	in "sea and rivers" (Conlu 1979a)
CYNOGLOSSIDAE (tonguesoles/palad)			
Cynoglossus bilineatus	four lined tonguesole/palad	NMP collection	"coastal and brackish waters" (Munro 1967)

Appendix 1 (continued)

Cynoglossus puncticeps	speckled tonguesole/palad	NMP collection	"in salt, brackish and fresh waters" (Herre 1953)
		TRIACANTHIDAE (hornfishes/—)	
Triacanthus blochi	—/—	Herre (1924)	———
Triacanthus biaculeatus	blackfinned triplespine/—	Conlu (1978)	"sandy bays and estuaries"
		BALISTIDAE (triggerfishes/—)	
Abalistes stellaris	starry filefish/—	Conlu (1979a)	———
Balistapus verrucosus	—/—	Herre (1924)	———
Osbeckia scripta	—/—	Herre (1924)	———
Psilocephalus barbatus	barbeled leatherjacket/—	Conlu (1979a)	———
		TETRAODONTIDAE (pufferfishes/—)	
Chelanodon patoca	pufferfish/—	Herre (1924)	"a species of salt and brackish, rarely of fresh water" (Herre 1953)
Sphoerodon lunaris	pufferfish/botin, tikong, tamburauan	Herre (1924)	———