Long Term Ecological Changes in the Gulf of Thailand

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The Gulf of Thailand is a tropical enclosed sea in the southwestern part of the South China Sea. The increasing deteriorating conditions in the coastal environment have raised concern among scientists and public. The frequency of occurrence of plankton bloom has markedly increased in some estuarine and mangrove areas corresponds to the increase in nutrients loading. Patterns of changes in biomass of phytoplankton are discussed in relationship to the increased nutrient discharge in the Inner Gulf. The changes in species composition of demersal fishes and benthic communities, disappeared species and species with strong change in population sizes are also discussed. Bivalves fishery had deteriorated as early as 1970 caused by organic pollutant discharged directly via the river to the sea. In regard to the decline of fishery production in the Gulf of Thailand, the principal cause is overfishing, however, discharges of organic pollutants from cities and industries have caused marine pollution in some estuarine and coastal areas that impacted the coastal aquaculture activities and bivalves fishery.

The Gulf of Thailand covers an area of about 350,000 square kilometers, receives a total flow from the four major rivers between $59X10^6 m^3$/day to $150X10^6 m^3$/day. With its nutrient-rich, confined nature and shallow water, the effects of pollution on the marine ecosystem are reported to have increased significantly over the past several years (Rojanavipart, 1987). Marine environment is closely link with economic and other human activities through exploration and exploitation of living and non-living resources. Conversion of mangrove forests to other use of about 30 percent, sewage from densely populated coastal areas, industrial waste, agricultural runoff as well as fisheries are sources of marine pollution. The first evidence of pollution that cause mass mortality of fishes and bivalves was reported in 1970 resulted from waste water discharged from sugar mills via river into the Gulf. This type of pollution kept increasing over the next few years that caused serious damage to cockle farms at the vicinity of the river mouth, at this area up to now has not yet been recovered.

Long term monitoring

The Marine Fisheries Division of the Thai Department of Fisheries has carried out research surveys in the coastal area of the Gulf of Thailand continuously since 1961. Compiled data from 1961 on trawl surveys by research vessel Pramong 2 have been given by Tiews et al (1967), Ritragsa (1976), Boonyubol and Pramokechutima (1984), and Charnprasertporn and Iamsa-ard (1987). Oceanographic studies of the Gulf have been carried out by Marine Fisheries Laboratory of the Department of Fisheries since 1976, continuously up to the present time. The results of the studies were reported annually in the Annual Reports of the Marine Fisheries Laboratory which were reviewed by Hongskul (1978) and Suvapepun (1984).

Changes in abundance of phytoplankton

The long term study from 1971 to 1987 phytoplankton data were analysed for trends of changes of biomass and blooms. Mean phytoplankton number

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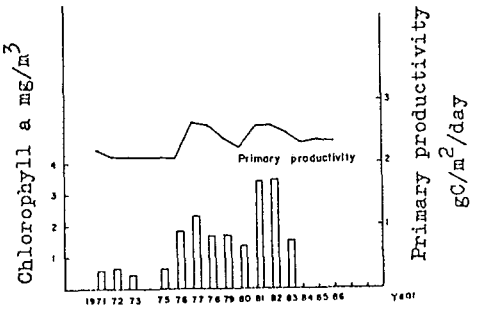

Fig. 1 Primary productivity and chlorophyll a contents

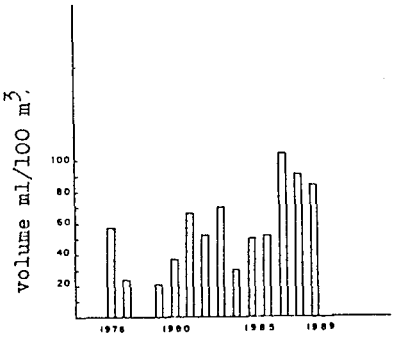

Fig. 3 Mean volume of zooplankton in the Gulf of Thailand

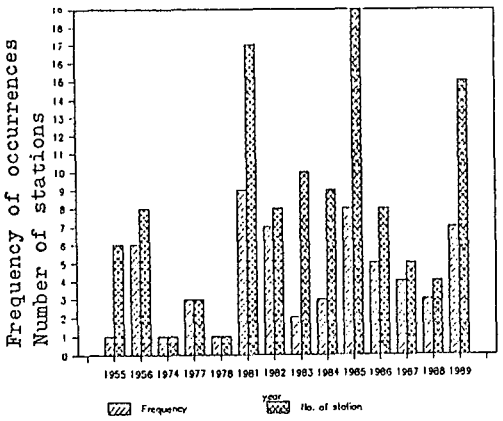

Fig. 2 Occurrences and number of stations affected by red tide during 1955-1989

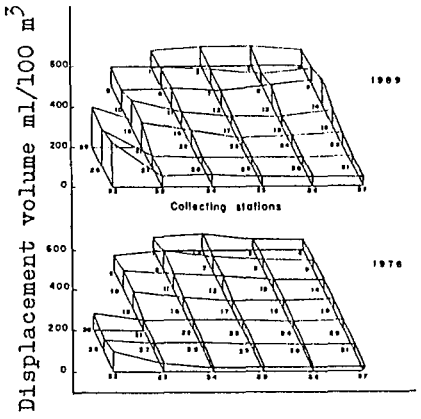

Fig. 4 Spatial variation in abundance of zooplankton

TABLE 1

Concentration of nutrient in the coastal area of the Inner Gulf of Thailand.

	1974	1979	1984	1985	1986	1989
Nitrate (µg-at N/l)	3.024	14.934	9.146	10.886	17.578	24.86
Phosphate (µg-at P/l)	0.936	1.05	1.588	1.046	1.402	1.023

in coastal area in the Gulf of Thailand has increased more than two times between 4,453 cells/l in 1976 and 11,553 cells/l in 1987. The increasing trend is also noticed in chlorophyll a content in sea water and primary productivity (Fig.1). Species composition do not show any detectable trend beyond natural spatial and seasonal variation. Phytoplankton blooms which were noticeable has recently been observed in wider areas and the frequency of occurrences has fluctuated during the last decade with detectable trend of increase in estuarine and mangrove areas (Fig. 2). It should be noted that red tides causative organisms normally were Trichodesmium erythraeum and Noctiluca scintillans, but in 1989 dinoflagellates blooms were detected in a certain mangrove area close to the river outlets causing mass mortallity of mullet (Liza spp.). The major organisms in red ties were Alexandrium sp, Mesodinium rubrum, Peridinium spp., and Gymnodinium sp. This happens in connection with increased nutrient in the coastal water in recent years (table 1).

Changes in zooplankton biomass

The zooplankton biomass in the Gulf of Thailand have increased over the period 1976-1989, it appears to have increased more as it is during the last three years (Fig 3). The mean values of displacement volumes of plankton samples from the Gulf in 1976 ranged from 20.61 to 155.30 ml/100m^3 with a total mean of 55.64 ml/100m^3 compared with the range in 1989 was 44.7 to 184.9 ml/100m^3 with a total mean of 85.97 ml/100 m^3. The spatial variation in abundance in 1989 appeared to be similar to that varialion in 1976 as showed in Fig.4. During the past decade predominant groups of zooplankton did not show any changed in abundance. Copepods dominated the communities in comprising 54% of the average numbers, other dominant groups were Appendicularia, Chaetognatha, Siphonophora, Luciferidae, Ostracoda, Mollusca larvae, Echinodermata larvae, Cladocera, Polychaeta and Decapoda larvae. Radiolaria appeared in high concentration in samples collected near shore.

Fisheries

Owing to the rapid expansion of marine fisheries of Thailand after the introducing of otter-boardtrawl fishing method in 1961, the amount of demersal fishes caught in the Gulf of Thailand increased from 106,550 MT in 1961 to 805,794 MT in 1973. After that year the stock gradually declined to 644,109 MT in 1985. The demersal fish stocks in the Gulf are clearly overfished both in biological and economic terms which indicated by decrease in catch rate from 297.6 kg/hr in 1961 to about 96 kg/hr in 1972 and steady declined to 54 kg/hr in 1983 (Phasuk 1987). This led to a drastic reduction in biomass and individual fish size, change in species composition, disappearance of some species and increase landing of trash fish. However, reduction of fish biomass has resulted also in increase in shrimps and squids abundance and catches. During the past two decades squid catches have increased by three fold from 20,818 MT in 1969 to 68,326 MT in 1987. At present time, the stock of squids in the Gulf are close to full exploitation (Supongpan, 1988). Catches of shrimps have increased considerably, rising from 50,814 MT in 1971 to the highest catch of 155,544 MT in 1982 and gradually declined to 11,898 MT in 1987, and that the shrimps stock are already fully exploited (Vibhasiri 1988). Some fish species have disappeared from the Inner Gulf such as rays, marine catfish (Tachysuridae), false trevally (Lactarius lactarius), grunters (Pomadasys spp.), pomfrets (Pampus argenteus., Parastromateus niger) Indian halibut (Psettodes erumei), and fusilier (Caesio sp.),

Changes in fish populations

Based upon the data on catches of demersal fishes by long term trawling surveys in the Gulf of Thailand from 1963 to 1983 by research vessel "Pramong 2" were annalyzed for the changes in fish communities. The comparison of group compositions of catches by the analysis of Spearman's rank correlation of principle species groups indicated a significant change in species compositions of demersal fishes during 20 year monitorings Fish communities have been modified by 10 years of heavy trawl fishing. The catch composition during 1975-1983 was slightly different from that in 1970-1974 but clearly different from catches in 1963. (Fig.5). Consequent changes were found in species compositions of demersal fishes where large predator and high valued species such as rays, false trevally, pomfrets, were replaced by short lived species such as squids, shrimps and crabs (Table.2). Abundance ranking of 17 principle species groups of 40 categories were changed to be dominated by Loligo spp. which had been ranked 10th in 1963. Many groups ranked lower than 10th were predominat in 1983, they were Priacanthus spp., Sphyraena sppl, Lutjanidae, crabs and shrimps. Species group with strong population decrease were

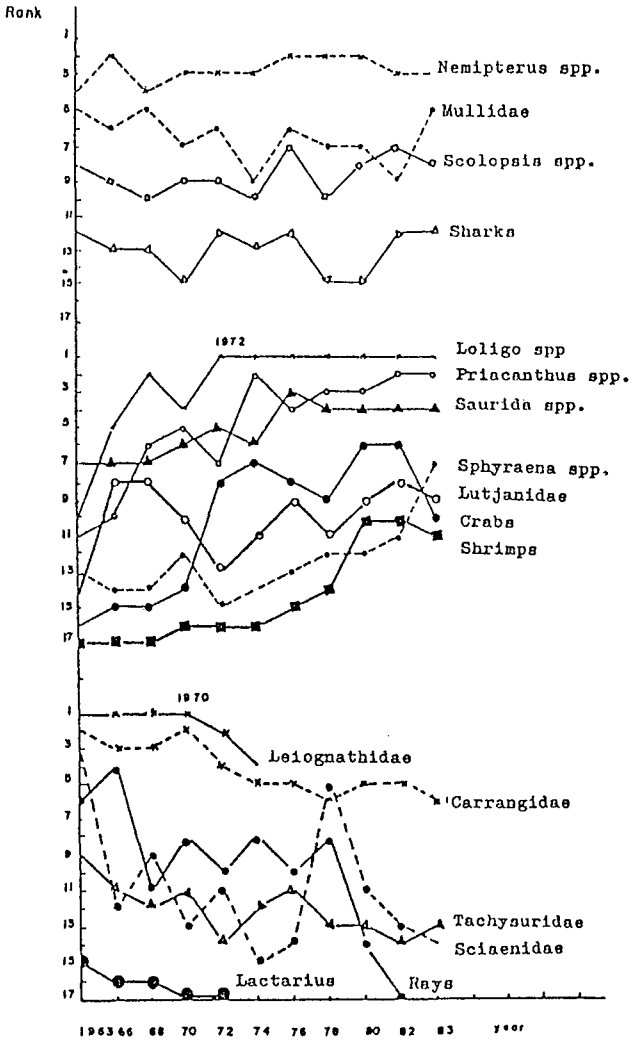

Fig. 6 Change in ranked of catch from the annual trawl survey by the research vessel Pramong 2 in the Gulf of Thailand during 1963-83

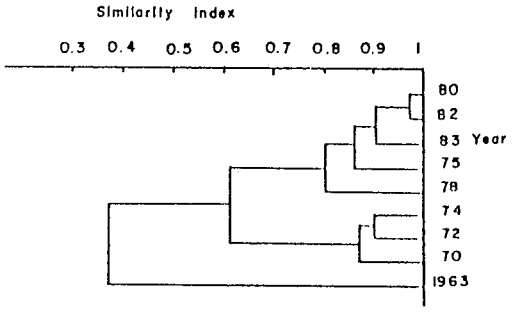

Fig. 5 Complete linkage clustering on the similarity of fish compositions between years of catch

TABLE 2

The anual change of groups association in order of dominancy of demersal fish in the Gulf of Thailand.

Rank	1963	1970	1974	1978	1983
1.	Leiognathidae	Leiognathidae	Lolio spp.	Loligo spp.	Loligo spp
2.	Carrangidae	Carrangidae	Priacanthus spp.	Nemipterus spp.	Priacanthus spp.
3.	Sciaenidae	Nemipterus spp.	Nemipterus spp.	Priacanthus spp.	Nemipterus spp.
4.	Nemipterus spp.	Loligo spp.	Leiognathidae	Saurida spp.	Saurida spp.
5.	Mullidae	Priacanthus spp.	Carrangidae	Sciaenidae	Mullidae
6.	Rays	Saurida spp.	Saurida spp.	Carrangidae	Carrangidae
7.	Saurida spp.	Mullidae	Crabs	Mullidae	Sphyraena spp.
8.	Scolopsis spp.	Rays	Rays	Rays	Scolopsis spp.
9.	Tachysuridae	Scolopsis spp.	Mullidae	Crabs	Lutjanidae
10.	Loligo spp	Lutjanidae	Scolopsis spp.	Scolopsis spp.	Crabs
11.	Priacanthus spp.	Tachysuridae	Lutjanidae	Lutjanidae	Shrimps
12.	Sharks	Sphyraena spp.	Tachysuridae	Sphyraena spp.	Sharks
13.	Sphyraena spp.	Sciaenidae	Sharks	Tachysuridae	Tachysuridae
14.	Lutjanidae	Crabs	Sphyraena spp.	Shrimps	Sciaenidae
15.	Lactarius lactarius	Sharks	Sciaenidae	Sharks	•
16.	Crabs	Shrimps	Shrimps	•	••
17.	Shrimps	Lactarius lactarius	•	••	•••

* Lactarius lactarius disappeared
** Leiognathidae include in trash fish portion
*** Rays disappeared

Liognathidae, rays, Sciaenidae, Tachysuridae, and some fishes species have disappeared, e.g., Lactarius lactarius, rays, Pampus argenteus, Psettodes erumei and Caesio sp. Four groups that kept ranking at their original level of abundant in the communities during two decades were Nemipterus spp., Mullidae, Scolopsis sp. and sharks (Fig.6).

Changes in macrobenthos communities

Data in 1986 were compared with results of studies which have been carried out in 1976. There was a clear decrease of macrobenthos in the Inner Gulf that the average weight have changed from 582 g/100 m^2 to 80 g/100 m^2 in 10 years. Bivalve dominated the benthic community which accounted for over 50 percentage of the benthos. Paphia undulata was the most abundant as it was in 1976. Species with strong population decreased were Chama sp., Plicatula sp., and Vepricardium multispiniosum. Two rare species reported in 1976 were found predominant in 1986. They were Spondylus sp. and Siliqua sp. Disappeared groups were Porifera and Coelenterata.

Discussion

The principle cause of long-term ecological change in marine communities in the Gulf of Thailand is attributable to heavy fishing pressure, resulting in biomass decline and change in species compositions of demersal fishes and macrobenthos as well as disappearance of some species. While the increase in bivalves population seem to be due to the increase of phytoplankton density which is related to the increase in nutrients. Increasing nutrients in some coastal areas has encouraged excessive growth of phytoplankton that cause red tide in wider area, will certainly affect the coastal aquaculture activities and bivalve fishery at the vicinity of river outlet

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