Pakistan J. Zool., vol. 44(1), pp. 181-187, 2012.

Diversity and Community Composition of Fishes in Tropical Estuary Pahang Malaysia

K.C.A. Jalal,* M. Ahmad Azfar, B. Akbar John, Y.B. Kamaruzzaman and S. Shahbudin
Department of Biotechnology, Kulliyyah of Science and INOCEM International Islamic University Malaysia, Jalan Istana, Bandar Indera Mahkota, 25200 Kuantan, Pahang, Malaysia

Abstract.- A study was conducted to determine the diversity and composition of fish communities in Pahang estuary during monsoon and non-monsoon seasons from April to December, 2008. A total of 145 individuals of fish representing 24 species belonging to 14 families were caught during the study period. The fish fauna in the Pahang estuary was dominated by species belonging to the family Ariidae (69.32%) followed by Sciaenidae (8.82%). Pristigasteridae and Latidae constituted 4.2% each of the estuarial fish diversity. Most dominant species were *Arius tenuispinis* (47.06%) followed by *Arius sumatranus* (10.5%) and *Arius thalassinus* (8.82%). These species were abundant during June and April. *Setipinna taty* (Family: Engraulidae), *Pennahia microdon* (Family: Sciaenidae), *Eleutheronema tetradactylum* (Family: Polynemidae) were the least dominant species in the Pahang estuary with 0.42% of total abundance individually. Physico-chemical parameters, such as temperature (26.76 - 30.61°C), salinity (0.02 - 27.01 ppt), pH (4.69 - 8.31), dissolved oxygen (2.9609 - 7.44mg/L), nitrate (0.09 - 1.00mg/L) and phosphate (0.015 - 0.103mg/L) level in the water column were also monitored. Based on the findings of this study, it was concluded that fish diversity of Pahang estuary was high in non-monsoon compared to monsoon seasons.

Key words: Pahang estuary, physico-chemical parameters, fish diversity, fish community.

INTRODUCTION

Fishes are one of the prime important elements in the aquatic habitat and play a key role in economy of many nations as they have been a stable item in the diet of many people (Essetchi *et al*., 2003). Fishes being rich source of proteins and have high nutritive value, need extensive development to feed ever growing population. Hence it is needed to survey diversity of fishes in different types of aquatic habitats all over the country. Environmental changes due to human activities and natural climatic variations have immense effect on biodiversity. The changes in biodiversity should be regularly monitored as they might govern the trend of development over the next decades (Raymond, 1995).

The decline of fisheries and fishing communities were contribute by factors including overexploitation of species, the introduction of exotic species, pollution from urban, industrial, and agricultural areas , as well as habitat loss and alteration through damming and water diversion which all contribute to the declining levels of aquatic biodiversity in both freshwater and marine environments. Many species are encountering increased threat in Pahang estuary because of declining conditions in natural aquatic ecosystems. The greatest threats to these fish fauna arise from environmental perturbations resulting from a rapidly growing human population along the Pahang river basin (Petr, 1994). Pahang estuaries are receiving increasing pressure as people continue to utilize the coastal zone for housing, recreation, and industrial purposes (Curtis *et al*., 2005).

Studies of spatial and temporal patterns of diversity, distribution and species composition of fishes are useful to examine factors influencing the structure of the fish community (Belliard and B¨Oet, 1997; Galactos *et al*., 2004). The distribution and composition of the fish species in each habitat were closely associated with various factors such as the availability of food, breeding sites, water current, depth, topography and physicochemical properties of water (Harris, 1995). Fish populations and characteristics of fisheries are dependent upon water regimes, size of the river system, and proximity to estuarine and marine waters, physical and chemical characteristics of the water and geographic location of the river basin. A considerable amount of the

* Corresponding author: dhaka89@hotmail.com, jkchowdhury@iium.edu.my
0030-9923/2012/0001-0181 $ 8.00/0

information on fresh water fishes and water quality studies were from small rivers, lakes, reservoirs and coastal waters in Malaysia (Jalal *et al*., 2007; Mohsin and Ambak, 1996; Ambak and Jalal, 1998, 2006; Bishop, 1973). But the study on fish diversity in Pahang estuary is still scanty.

Based on the above context, present investigation was undertaken to study the fish biodiversity in Pahang estuary, Malaysia. The objective of study was to give recent data regarding fish diversity in the selected area, aiming to contribute a better knowledge of the fish diversity of Pahang estuary and a tool for conservation planning of aquatic environments in this region since this estuary inhabit various indigenous, commercially important and economically valuable fishes.

MATERIALS AND METHODS

Sampling area

Sampling was carried out in Pahang Estuary (Fig. 1) from April to December 2008. Sampling was done by separating the study area into three zones with the distance of approximately 3 km for each zone to encompass three different habitats of the sampling station. Zone 1 was located at the downstream river mouth of Pahang Estuary. The water body of this area was characterized by high saline water especially during non-monsoon season when the freshwater flow from Pahang River was low and the sea water intrusion was high. Zone 2 was characterized by low salinity area and Zone 3 was located at freshwater area of the Pahang estuary since it is located further away from the open ocean. The sampling stations were lies in-between longitude 103˚25'56.48" E and 103˚29'10.55" E and latitude 03˚33'01.78" N and 03˚30'50.38" N. Fish samples were collected using Random Stratified sampling Method from the three zones of the sampling stations.

Sampling and data analysis

Sampling was done from different locations to investigate the fish diversity in different zones. The sampling was conducted from 1st April 2009 to 31st December 2009 both during monsoon and non monsoon seasons. The non-monsoon season sampling was scheduled in April, June and August, while monsoon season sampling was done during October-December, 2008. The fishing gears used for collecting fish samples included gill nets (1, 2 and 3 inch mesh size, 100 m long), drift nets and fish trap to catch fishes belonging to various sizes. The gill nets were set perpendicular to the shore and vertically from the surface to the deeper part of the river so that the spatial and temporal distribution of the fishes could be easily analyzed. The fishes were fixed in 10% formalin solution and preserved in 70% alcohol at the laboratory. All fishes were identified using available taxonomic keys **(**Ambak, 2010; Mohsin and Ambak, 1983). The species diversity of fishes in Pahang Estuary was calculated by using Shanon-Weiner index (Shannon and Weaver, 1963).

Physico-chemical parameters such as temperature, salinity, pH and dissolved oxygen of the river water were measured by using 'Hydro lab Datasonde 4a, USA'. All the data were recorded in-situ and then analyzed in the laboratory. Standard Method APHA 4500-NO_3-B, 1995 was used to evaluate Nitrogen-Nitrate (NO^{3-}N) at wavelength (λ) of 507nm. HACH program 2515 (detection range: 0-0.50 mg/L) was used to measure nitrate in the sample. Standard Method APHA 4500-P-D, 1995 was used to evaluate phosphorus value at wavelength (λ) of 420nm. HACH program 541 (detection range: 0.00-33.00 mg/L) was used to measure phosphate level in the water column. Differences in physicochemical parameters among the different stations were calculated using student *t*- test analysis. $P < 0.05$ was considered to be statistically significant.

RESULTS

No significant difference in temperature was observed in different stations ($P>0.05$) and the highest temperature (30.61°C) was recorded in April and the lowest in December (26.76°C) in all the 3 zones. All the other water quality parameters showed significant difference between stations ($P<0.05$). Salinity (27.01-0.02ppt), pH (8.31-4.69), dissolved oxygen (7.44-2.96), nitrate (1.00-0.09mg/L) and phosphate (0.103-0.015mg/L) level in the water column was determined since they influence the diversity of any aquatic biota (Table I).

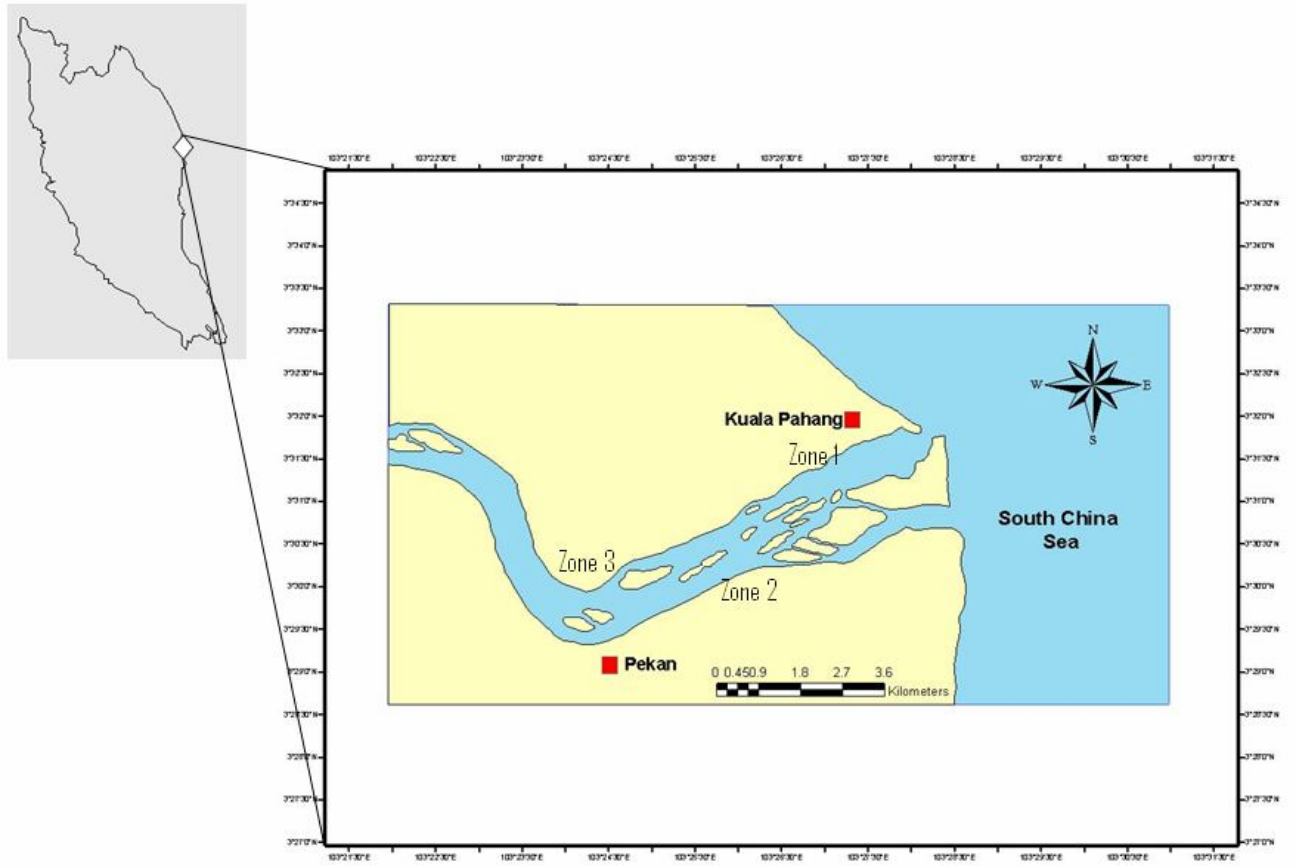

Fig. 1. Map showing location of study area along Pahang river-estuary, Malaysia.

A total of 24 species of fishes belonging to 14 families, 4 orders were recorded from Pahang Estuary, Pahang, during the study period (Table II). The most dominant families were Ariidae (69.32%) followed by Sciaenidae (8.82%). Pristigasteridae and Latidae were constituted 4.2% of the total fish catch individually. The constitution by other families was comparatively less (<3%) with Engraulidae (2.92%), Cyprinidae (2.10%), Mugilidae (2.10%), Clupeidae (1.68%), Eleotridae (1.26%). The least dominant families were Scatophagidae (0.84%), Pangasiidae (0.84%), Plotosidae (0.84%) and Osphronemidae (0.42%).

Family Ariidae was represented by four species (*Arius maculatus, A. sumatranus, A. tenuispinis* and *A. thalassinus*) with high diversity index value (H'= 0.91). These species were found in all the three zones as these species are highly tolerant to salinity and environmental stresses. Out of four species from family Ariidae, *Arius tenuispinis* was the most dominant one with 47% of total catch from the sampling area during August. *Arius sumatranus* was the second dominant species followed by *Arius thalassinus* and *Arius maculates* and high abundance of these species was recorded during June and April.

Family Sciaenidae was the second dominant family caught during the study period which contributed ~9% of all fishes caught with the total diversity value (H'=0.35). The representative species of family Scienidae were *Pennahia mcrophthalmus, Pennahia microdon, Chrysochir aureus, Larimichthys polyactis, Johnieops vogteri* and *Otolithoides biauritus*. These species were caught from zone 1 and 2 only, as they were known to live in high saline water and not tolerant to fresh water or low saline water. All other families showed less diversity (H'=~0.1- 0.2).

Table I.- Physico-chemical parameters of Pahang estuary in three different zones.

Parameters		Zone 1	Zone 2	Zone 3	Significance
Temperature (°C)	Maximum	30.61	30.58	30.56	NS
	Minimum	26.76	27.05	26.86	
	Average	29.21	29.27	29.27	
Salinity (ppt)	Maximum	27.01	20.64	15.41	*
	Minimum	0.02	0.03	0.02	
	Average	11.65	11.89	11.23	
pH	Maximum	7.81	8.31	7.95	*
	Minimum	6.35	5.36	4.69	
	Average	7.15	6.84	6.75	
Dissolved oxygen (mg/L)	Maximum	7.22	7.43	7.44	*
	Minimum	3.27	3.57	2.96	
	Average	5.38	5.22	5.48	
Nitrate NO_3 (mg/L)	Maximum	0.56	0.72	1.00	*
	Minimum	0.09	0.14	0.18	
	Average	0.33	0.18	0.45	
Phosphate PO_4 (mg/L)	Maximum	0.056	0.071	0.103	*
	Minimum	0.025	0.015	0.023	
	Average	0.032	0.039	0.045	

Note: (*) Significant different (P < 0.05), (NS) No significant different, (P > 0.05)

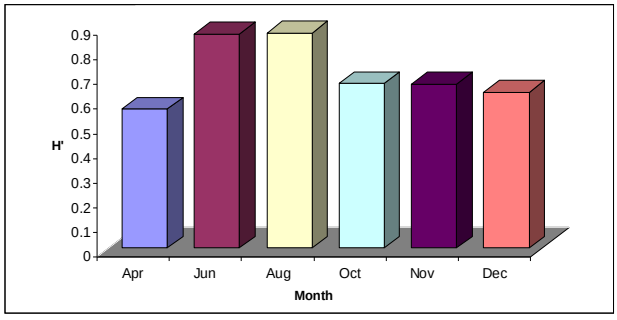

Fig. 2: Monthly fish species diversity in Pahang estuary.

Fishes were caught during the sampling was showing high abundance in the month of August with the diversity value (H'= 0.87) and lowest was recorded on April with the value (H'= 0.63). Over all Shannon diversity value (H'= 2.09) indicates that Pahang estuary is quiet diverse with fish species. The findings from this study also indicate that fish diversity of Pahang estuary was high in non-monsoon season compared to monsoon season (Fig.2). The nutrient levels in Pahang estuary are quiet comparable. As such it was observed that the amount of Phosphate level (0.039 mg/L) is higher than that of nitrate (0.32mg/L) concentration (Table III) in Pahang estuary.

DISCUSSION

A total of 24 commercial and non-commercial fish taxa were obtained out of which 4 were freshwater, 11 estuarine and 9 marine species. Most of the species collected in Pahang estuary were commonly found in rivers, estuaries and coastal waters of Peninsular Malaysia (Ambak *et al*., 2010; Ali *et al*., 1996). Since the Pahang estuary is relatively short and small, the estuarine species composition was not as extensive as other estuarine systems (Lee, 1989). Among the fishes caught, few were marine, estuarine and fresh water species of commercial importance. Most of the species found tend to be hardy with most being air breathers. The most dominant fishes were *Arius tenuispinis* followed by *Arius thalassinus, Arius sumatranus, Arius maculates, Anodontostoma chacunda* and *Arius sagor*. Only one clean water riverine species, *Glossogobius giurus* was found. These species were found near the riverine area (Zone 3), away from the mouth of the sea.

All species caught were euryhaline with ability to tolerate wide range of salinities. Species such as *Arius* sp., *Glossogobius giurus, Ilisha elongata, Ilisha melastoma* and *Plotosius canius* can survive equally well in both fresh and seawater. Larger numbers of marine taxa were obtained and most of these were transient species. Species belong to the family Engraulidae, Sciaenidae and Mugilidae were common along the coast. Species with semi-permanent and permanent home ranges such as those from the family Bothidae and Cyanoglossidae were also sampled. The most important commercial species obtained was *Lates calcarifer*. However, these species are typically transients that move inshore following tidal cycles to feed or to spawn.

Overall, species caught, *Arius* spp. (marine catfish) was abundant. They moved in large schools during high tide and this behavior tends to make the species easy cacheable near the mangrove ecosystem perhaps due to the availability of nutrients around the area. The higher diversity and

Table II.- List of fish species identified in Pahang estuary during the sampling time.

Class	Order	Family	Species	% of Abundance	H'
Osteichthyes/ Actinopterygii	Clupeiformes	Clupeidae	*Anodontosoma chacunda*	1.68	0.07
		Pristigasteridae	*Ilisha elongata*	2.94	0.10
			Ilisha melastoma	1.26	0.06
		Engraulidae	*Setipinna taty*	0.42	0.02
			Thryssa mystax	2.52	0.09
	Cypriniformes	Cyprinidae	*Probarbus jullieni*	2.10	0.08
	Perciformes	Sciaenidae	*Pennahia macrophthalmus*	0.84	0.04
			Pennahia microdon	0.42	0.02
			Chrysochir aureus	0.84	0.04
			Larimichthys polyactis	0.84	0.04
			Johnieops vogteri	2.52	0.09
			Otolithoides biauritus	3.36	0.11
		Mugilidae	*Liza vaigiensis*	2.10	0.08
		Polynemidae	*Eleutheronema tetradactylum*	0.42	0.02
		Latidae	*Lates calcarifer*	4.20	0.13
		Osphronemidae	*Osphronemus goramy*	0.42	0.02
		Eleotridae	*Oxyeleotris marmorata*	1.26	0.06
		Scatophagidae	*Scatophagus argus*	0.84	0.04
	Siluriformes	Ariidae	*Arius maculates*	2.94	0.10
			Arius sumatranus	10.50	0.24
			Arius tenuispinis	47.06	0.35
			Arius thalassinus	8.82	0.21
		Plotosidae	*Plotosus canius*	0.84	0.04
		Pangasiidae	*Pangasius pangasius*	0.84	0.04

abundance of Ariidae fishes could also be due to the muddy bottom of the estuary which might be habitat of hardy Ariidae fishes. Other major species caught in the estuary zone are *Ilisha elongata* and *Johnieops vogleri*. These species were not numerous (3.64% and 3.13%, respectively) and not contributing more to the total catch. Generally the number and abundance of marine and fresh water species is relatively low in the Pahang estuary (only 20 species) which is in contrast to other estuaries. This might be due to their sensitivity to such factors as low nutrients and high turbidity and preference for clean and fast flowing water (Mohsin and Ambak, 1996). It was also evident that fishes belong to family Ariidae, Pristigasteridae and Sciaenidae seemed to be more tolerant of adverse water quality conditions.

However, most of the species are not abundant and this could be due to the industrial and domestic effluents received by the estuary. Furthermore, the high sediment load associated with freshwater outflow in Pahang estuary could affected the fish population. Similar studies were done in other tropical river has shown negative correlation between turbidity and abundance of fish populations (Blaber *et al*., 1989).

Seasonal fluctuations of water quality have influenced the fish composition in Pahang estuary. The greater number of individual fish caught and species composition were observed during the low tide time might be associated with variations in the migratory movements of the fish species (Renato *et al*., 2000). Based on Interim National Water Quality Standard for Malaysia (INWQS) the concentration of DO in this study classify the water body as Class IIA/IIB which represents that the water is of

excellent quality (Paul *et al*., 1999). The pH of water affects the normal physiological functions of aquatic organisms, including the exchange of ions with the water and respiration. Such important physiological processes operate normally in most aquatic biota under a relatively wide pH range (McKee and Wolf, 1963). Comparing mean concentration of observed water nutrients level of Pahang estuary with unpolluted river of the world and Setiu River (Wafar *et al*., 1989; Suhaimi *et al*., 2004). It was reported that a huge amount of river flux could provide higher phosphorus supply to the estuary (Zhao *et al*., 1992). This indicates that the water quality in the study area is still conducive for the fish community.

In Malaysia, the area along the estuaries has been heavily impacted by discharges from municipal and industrial outflows. This was due to the rapid development of the area via expansion of the industrialization area as well as the increase in population and this may indirectly affected the aquatic organisms. Although the maintenance of fish populations in natural environment is possible by variety of techniques (*e.g.* fish stocking, regulation of harvest), ultimately an abundant, diverse, and stable fish community depends on the availability of suitable habitat for the desired species (Angus and Alan, 2000; Ali *et al*., 1996).

Pahang estuary is receiving increasing pressure as people continue to utilize the coastal zone for housing, recreation, and industrial purposes. In 2008, after massive flooded in Pekan areas the concern higher authorities of the Federal government have decided that sand dredgers will be placed at Pahang river-mouth to deepen the estuaries and avoid floods in future. Besides, few bombs which were blasted around the mouth of the Pahang estuary during the flooding time might destroy the habitat of the fish communities along the Pahang estuary. This is evident from the disappearance of most of expensive marine commercial species grouper in estuarine ecosystem indicates that the habitat destruction has changed enough to result in the disappearance of these more environmentally sensitive species. Thus it is better in the long term to improve the aquatic environment so that the existing species can reproduce and grow in abundant and contribute to the local fisheries. Monitoring programmes for fisheries should involve periodic sampling using techniques such as experimental fishing and creel surveying of fishermen in order to determine species diversity and socio-economics of fish community. The information obtained could then be used to determine the healthiness of the estuarine and river system as well to initiate the suitable management and conservation programmes.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to Institute of Oceanography of Maritime Studies Laboratory teams, Faculty of Science for their invaluable assistance throughout the sampling period.

REFERENCES

ALI, A.B., ZULFIGAR, Y., LEONG, Y.K., LIM, P.E. AND TAN, E.S.P., 1996. A comparative study of estuarine ichtyofauna of Sungai Tanjung Piandang, Perak and Sungai Marang, Terengganu. *J. biol. Sci.*, **7**: 12-28.

AMBAK, M.A. AND JALAL, K.C.A., 1998. Habitat utilization by the tropical fish community in the man-made lake Kenyir. *Fish. Managem. Ecol*., **5:** 173-176.

AMBAK, M.A. AND JALAL, K.C.A., 2006. Sustainability issues of reservoir fisheries in Malaysia. Aquatic ecosystem health and management. *Int. J. aquat. Ecosys. Hlth. Managem*., **9:** 165–173.

AMBAK, M.A. MANSOR, M.I., ZAIDI, Z. AND MAZLAN, A.G., 2010. *Fishes of Malaysia*. 2nd edi. pp. 334.

ANGUS, W.P. AND ALAN, K.W., 2000. The Ichthyofauna associated with an intertidal creek and adjacent eelgrass beds in the Kariega Estuary. *S. Afr. environ. Biol. Fishes*. **58**: 145-156.

BELLIARD, J. AND B¨OET, P., 1997. Tales E. Regional and longitudinal patterns of fish community structure in the Seine River basin, France. *Environ. Biol. Fishes*, **50**: 133–147.

BISHOP, J.E., 1973. Limnology of a small Malayan river. 'Sungai Gombak'. *Monogr. Biol*., **22**: 1-485.

BLABER, S.J.M., BREWER, D.T. AND SALINL, J.P., 1989. Species composition and biomass of fishes in different habitats of a tropical northern Australian estuary: their occurrence in the adjoining sea and estuarine dependence. *Estuar. Coast. Shelf Sci*., **29:** 509-531.

CURTIS, J.R., REISS, P., NAJAH, A.H., AZZAM, J.A., DOUGLAS, J.P. 2005. The restoration potential of the Mesopotamian marsh. *Iraq. Sci*., **307**:1307-1311.

ESSETCHI, P.K., GUY, G.T., VALENTIN, N.D., GOULI,

G.B.I. AND TIDIANI, K., 2003. Fish diversity and its relationships with environmental variables in a West African basin. *Hydrobiology*, **505**: 139-146.

GALACTOS, K., BARRIGA, S.R. AND STEWART, D.J., 2004. Seasonal and habitat influences on fish communities within the lower Yasuni River basin of the Ecuadorian Amazon. *Environ. Biol. Fishes*, **71**: 33–51.

HARRIS, J.H., 1995. The use of fish in ecological assessments. *Aust. J. Ecol*., **20:** 65-80.

JALAL, K.C.A., NOOR, F.H.N., KAMARUZZAMAN, B.Y., SHAHBUDIN, S., ALAM, M.Z. AND JASWIR, I., 2007. Studies on physico-chemical characteristics and sediment environment along the coastal waters in Pulau Tuba, Langkawi, Malaysia. *Aquat. Ecosys. Hlth. Managem.*, **12:** 350-357.

LEE, R.E., 1989. *Phycology*. 2nd Edi. Cambridge University Press, New York.

MCKEE, J.E. AND WOLF, H.W., 1963. *Water quality criteria.* 2nd Edi. State Water Quality Control Board, Sacramento, CA. Pub.

MOHSIN, A.K.M. AND AMBAK, M.A., 1996. *Marine fishes and fisheries of Malaysia and neighbouring countries*. Universiti Putra Malaysia Press. Malaysia.

MOHSIN, A.K.M. AND AMBAK, M.A., 1983. Fresh water fishes of Peninsular Malaysia. Penerbit Universiti Pertaninan Malaysia. pp. 284.

PAUL, J.F., GENTILE, J.H., SCOTT, K.J., SCHIMMEL, S.C., CAMPBELL, D.E. AND LATIMER, R.W., 1999. EMAP-Virginian Province Four-Year Assessment Report (1990-93). EPA 620/R-99/004. U.S. Environmental Protection Agency, Atlantic Ecology Division, Narragansett, Rhode Island.

PETR, T., 1994. Intensification of reservoir fisheries in tropical and subtropical countries. *Int. Rev. ges. Hydrobiol*., **79**: 131-138.

RAYMOND, L., 1995. Climate and anthropogenic effects of fish diversity and fish yields in the central delta of the Nigar River. *Aquat. Liv. Resour*., **8**: 43-58.

RENATO, A.M., BENEDITO, S., AMARALC, D. AND OYAKAWAD, O.T., 2000. Spatial and temporal patterns of diversity and distribution of the Upper Juru´a River fish community (Brazilian Amazon). *Environ. Biol. Fishes*, **57**: 25–35.

SHANNON, C.E. AND WEAVER, W., 1963. *The mathematical theory of communication*. University of Illinois Press. Urbana.

SUHAIMI, S., TAHIR, N.M. AND SURIYATI, S., 2004. Dissolved Nutrients and Chlorophyll a Status of the Setiu River, Terengganu, Malaysia, *Bull. environ. contam. Toxicol*., **73**:1094–1100.

WAFAR, M.V.M., LE CORRE, P. AND BIRRIEN, J.L., 1989. Transport of carbon, nitrogen and phosphorus in a Brittany river, France. *Estuar, Coastal Shelf Sci*., **29**: 489–500.

ZHAO, B.R., LE, K.T. AND ZHU, L.B., 1992. The upwelling phenomenon and elementary characteristics of temperature and salinity in the Changjiang estuary. *Stud. Marina Sin*., **33**: 15-26.

(Received 13 November 2010, revised 31 May 2011))