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Monitoring Population Parameters for Fisheries Management: I. Species Composition, Abundance and Distribution Patterns of Fishes in Paya Bungor

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ABSTRAK

Satu kajian pengawasan selama 1 tahun ke atas populasi ikan telah dijalankan di Paya Bungor. Tasik tersebut mengandungi 12 famili dan 43 spesies ikan air tawar. Ikan cyprinid yang menyumbangkan sebanyak 54 peratus adalah dominan bagi komuniti ikan diikuti oleh ikan jenis 'catfish' (16 peratus). Lebih banyak spesies telah direkodkan di bahagian utara tasik. Lebih 80 peratus daripada komposisi spesies di Paya Bungor terdiri daripada ikan sungai. Peratus yang tinggi bagi spesies pemangsa (49 peratus) juga diperhatikan. Amblyrhynchichthys truncatus *adalah spesies yang terbanyak (33 peratus) diikuti oleh* Thynnichthys thynnoides *(20 peratus) dan* Puntius schwanenfeldii *(18 peratus). Bersama dengan 12 cyprinid yang lain, jumlah mereka mengandungi lebih 90 peratus daripada jumlah tangkapan. Ikan jenis 'catfish' terdiri daripada 7 spesies yang menyumbangkan hanya 1.4 peratus. Bentuk am kelimpahan bermusim menunjukkan banyak ikan didapati di bulan Januari, Mac, Jun dan September manakala kekurangan ikan berlaku di bulan Februari, Mei, Ogos dan September. Corak ini berkaitan dengan perubahan paras air WL, suhu air, T dan konduktiviti, K sebagaimana ditunjukkan oleh persamaan: Populasi, P = −886 + 135 WL + 23.77 T − 0.1515 C. Populasi ikan yang berbentuk heterogen di Paya Bungor menunjukkan corak taburan ruang dan temporal. Spesies-spesies di Paya Bungor mempunyai taburan log-normal dengan lengkungan taburan seperti berikut:*

$$S(R) = 5.366 \exp^{-(0.365R)^2}$$

ABSTRACT

A one year direct monitoring study of fish populations was conducted in Paya Bungor. The lake comprised 12 families and 43 species of freshwater fishes. The cyprinids dominated the fish community, contributing to about 54% followed by the catfishes (16%). More species were recorded in the northern part of the lake. Riverine species accounted for more than 80% of the species composition in Paya Bungor. A high percentage of predatory species (49%) was also observed. Amblyrhynchichthys truncatus *was the most abundant species (33%) followed by* Thynnichthys thynnoides *(20%) and* Puntius schwanenfeldii *(18%). Together with 12 other cyprinids, they made up more than 90% of the total catch. Catfishes, comprising 7 species constituted only 1.4%. The general pattern of seasonal abundance indicate that more fishes are found in the months of January, March, June and September while less fish occur in the months of February, May, August and September. This pattern is related to fluctuations in water levels, WL, water temperature, T, and conductivity, C, as exemplified by the equation: Population abundance, p = −886 + 135 WL + 23.77 T − 0.151 C. The heterogenous fish population in Paya Bungor exhibit spatial and temporal patterns of distribution. The species in Paya Bungor are log-normally distributed with the distribution curve as follows:*

$$S(R) = 5.366 \exp^{-(0.365)^2}$$

INTRODUCTION

Inland fishery management has to account for changes in terrestrial environment especially within the catchment area. Alterations in the surrounding area can cause changes in the physico-chemical properties of the aquatic environment which in turn can lead to changes in the biotic system as well.

To this end, water quality monitoring has been practised and used for fish protection especially for the European countries (EIFAC Working Party on Water Quality Criteria for European Freshwater Fish, 1964; 1968; 1970; 1972; 1973; 1977). However, chemical analysis most often need sophisticated equipment especially with increasing industrial discharge of organic compounds.

For this reason, biological monitoring has been used as an indicator of pollutant loading (Hawkes, 1977; Bryce *et al.*, 1978). A more recent development is the direct monitoring of fish population. Accurate estimates of population structure of fish communities in a pollution-free area and monitoring changes in the parameters at population level are very important. So far, this method is very little used either in Europe or elsewhere (EIFAC, 1978). The parameters which are potentially useful for detecting changes in the fish population include analysis of community composition, relative species abundance, changes in species composition and diversity indices. A pollution-free environment is needed so that these inventories can be regarded as the normal population and used as reference.

As mentioned in earlier papers (Ambak *et al.*, 1983; Ambak 1984), the development of the freshwater lake, Paya Bungor is underway. Landbased activities will definitely be on the increase and will affect the water quality and eventually the fish populations. This paper therefore will provide the necessary baseline information for future fish monitoring works.

METHODS AND MATERIALS

Based on the results of earlier investigations conducted from July – December 1981, 3 sampling stations were defined, i.e., stations A, B and C. Briefly, Station A located in the north end of Paya Bungor had typical whitish water, while Station B, located at the northern portion of the lake, had a tea brown water colour. Station C, located in the middle part of the lake, in between stations A and B, served as a gateway to Sungai Lepas, a tributary of Sungai Pahang (Fatimah *et al.*, 1984).

Sampling for fish population analysis was carried out once every two weeks from January 1982 to December 1982.

Species Composition and Seasonal Abundance

For the purpose of studying the species composition, two methods were employed. The first method involved using trammel nets, gill nets of mesh sizes 3.8 cm, 7.0 cm and 10.0 cm, cast nets and scoops nets for fish collection. The trammel nets and gill nets, often interconnected, were set perpendicular to the shore out to the open water, sometimes reaching the opposite shore. Where there were dense patches of aquatic plants or emergent weeds, these nets were set around (enclosing) the vegetation. This method is especially useful in catching nocturnal species. Scoop nets were also used at various localities in areas of dense vegetation. Cast netting was done both during the night and daytime at various localities in the 3 stations where good catches were expected.

The second method involved visual observation and on-the-spot identification. These involved mainly mobile small fishes (mostly Rasborinae) which could not be caught by any of the gears used in the first method. This method has been used in Malaysian waters by other workers since most of the small fishes can be quite easily recognised at a glance (Johnson, 1967; Furtado & Mori 1983).

In studying relative and seasonal abundance, the data collected from the 9 gill nets and 6 trammel nets set every two weeks in Stations A, B and C were used. Relative abundance is defined as the total number of individuals of a particular species compared to the total number of fish individuals caught during the study period.

Patterns of Distribution

Spatial and temporal distribution patterns of fishes were determined using trammel and gill nets placed in the three stations already mentioned, at various distances from the shore and times of the day and year.

The species abundance distribution patterns were also tested to find out if it fitted Preston's (1948, 1962) log-normal distribution or canonical log-normal distribution. The log-normal curve was drawn by first constructing a frequency diagram with the numbers of species on the ordinate and abundance (in orders of magnitude in terms of natural logarithms) on the abscissa. The conventional method was also followed whereby the abundance was scaled at intervals or 'octaves', R of logarithms to the base 2. When a species has abundance that falls on the boundary of an octave (2, 4, 8, etc.), it was counted ½ on the left octave and ½ on the right octave.

The estimation of the parameters (mean, std. dev.) of the log-normal distribution was performed using linear regression.

RESULTS AND DISCUSSIONS

Species Composition

Using various types of gears, a total of 43 species were collected in Paya Bungor (Table 1).

The Cyprinidae dominate the fish community, contributing 53.5% of the total species present in Paya Bungor. The next dominant group are the catfish (Siluriformes) comprising 7 species of 16.3%. The rest of the taxa, consisting of 13 species make up 30% of the entire ichthyofauna. A total of 27 fish genera were recorded among which 9 have more than 1 species; these 9 genera are: *Notopterus, Masta cembelus, Chela, Rasbora, Puntius, Cyclocheilichthys, Labiobarbus, Mystus* and *Channa*.

These results are comparable to other works done in Malaysia and Thailand (Smith, 1945; Johnson, 1967; Lowe-Mc Connell, 1969; Furtado, 1974; Furtado and Mori, 1983; Yap, 1982). In Bukit Merah reservoir, Yap (1982) recorded 14 families and 38 species while in Tasik Bera, 16 families and 75 species were recorded in 1974 (including 15 *Rasbora* spp.) increasing later to 95 species in 1982 as a result of compilation from various studies (Furtado, 1974; Furtado and Mori, 1983). Johnson (1967) reported the freshwater ichthyofaunal composition in Malaysia to be 46% cyprinid, 10% catfish species and the rest of the taxa comprising the remaining 44%. Similarly in Tasik Bera, the cyprinid comprised 42%, catfishes 20% and the rest of tha taxa 38%. Yap (1982), likewise reported the composition of the fish species in Bukit Merah to be 37%, 16% and 47% for cyprinids, catfishes and the rest of the taxa respectively. In Thailand, cyprinids also predominate the freshwater ichthyofaunal composition (Lowe-Mc Connel, 1969) with similar ratios to that of Tasik Bera (Smith, 1945).

In terms of area, Station A had the most number of species (35 species) followed by Station B (30 species) and Station C (29 species). All the three stations exhibited similar trends in cyprinid dominance, each station having 19 species of cyprinids.

In percentages, the cyprinids, catfishes and the rest of the taxa in Station A comprised 54%, 20% and 26% respectively; in Station B, 63%, 7% and 30%; and in Station C, 65%, 14% and 21% respectively. Thus, Station B had a smaller proportion of catfish to the total fish fauna than Stations A and C. This may be due to the nature of the habitat — Station B had less aquatic/emergent vegetation and clearer water as compared to Stations A and C.

Five exclusively riverine species were recorded in Paya Bungor namely *Macrochirichthys macrochirus, Barilius guttatus, Puntius daruphani, Probarbus jullieni* and *Barbichthys laevis*. The rest of the species were riverine or semi-lacustrine with the possible exception of 6 species (*Puntius tetrazona, P. pentazona, Thynnichthys*

TABLE 1
List of fish species in Paya Bungor

Scientific name	Local name
OSTEOGLOSSIFORMES	
Osteoglossidae	
Seleropages formosus (Miiler & Schlegel)	Kelesa
Notopteridae	
Notopterus notopterus (Pallas)	Selat
N. chitala (Hamilton)	Belida
MASTACEMBELIFORMES	
Mastacembelidae	
Mastacembelus maculatus C. & V.	Tilan
M. armatus (Gunther)	Tilan
CYPRINIFORMES	
Cyprinidae	
Abraminae	
Chela oxygastroides (Bleeker)	Lalang
C. anomalura van Hasselt	Lalang
C. laubuca Gunther	Lalang
Macrochirichthys macrochirus	Parang Sungai
Rasborinae	
Rasbora sumatrana (Bleeker)	Seluang
R. heteromorpha Duncker	Seluang
R. dorsiocellata Dunker	Seluang
Barilius guttatus Day	Sikang
Cyprininae	
Puntius bulu (= *Puntioplites* sp.)	Tengalan
Puntius schwanenfeldii Bleeker	Lampam Sungai
P. daruphani Smith	Krai
P. tetrazona (Blkr.)	Tiger Barb
P. pentazona (Blkr.)	Tiger Barb
Thynnichthys thynnoides (Blkr.)	Lomah
Hampala macrolepidota van Hasselt	Sebarau
Osteochilus hasseltii Cuvier & Valenciennes	Terbol
Cyclocheilichthys apogon Valenciennes	Chemperas
C. heteronema (Blkr.)	Chemperas
Probarbus jullieni Sauvage	Temoleh
Amblyrhynchichthys truncatus (Blkr.)	Paruh Puling
Labiobarbus leptocheilus (van Hasselt)	Kawan

L. festiva Heckel	Kawan
Barbichthys laevis (C. & V.)	Bentulu
SILURIFORMES	
Bagridae	
Mystus nemurus (Valenciennes)	Baung
M. nigriceps (Valenciennes)	Baung
M. baramensis (Regan)	Baung
Ompok bimaculatus Bloch)	Lais
Siluridae	
Silurichthys hasselti (Blkr.)	Tapah Bembam
Clariidae	
Clarias batrachus (Limnaeus)	Keli
Prophagorus nieuhofi (Cuvier and Valenciennes)	Keli Limbat
CHANNIFORMES	
Channidae	
Channa striatus (Bloch.)	Haruan
C. micropeltis (Bleeker)	Toman
ANABANTIFORMES	
Anabantidae	
Trichogaster trichopterus (Pallas)	Sept
Osphronemus goramy Lacepede	Kalui
Sphaerichthys osphronemoides (Canestrini)	Biji Durian
PERCIFORMES	
Nandidae	
Pristolepis fasciatus (Bleeker)	Kepor
Centropomidae	
Chanda siamensis Fowler	Seriding
Eleotridae	
Oxyleotris maromoratus (Blkr.)	Ketutu/Bodoh

thynnoides, Trichogaster pectoralis, Osphronemus goramy and *Sphaerichthys osphronemoides).* Paya Bungor therefore is dominated by riverine or semilacustrine species accounting for more than 80% of the total. There was also a high percentage of predatory species in Paya Bungor. Piscivorous species included *Notopterus chitala, Barilius guttatus, Macrochirichthys macrochirus, Hampala macrolepidota, Silurichthys hasseltii, Ompok bimaculatus, Channa striatus, C. micropeltis* and *Oxyleotris marmoratus,* while another 12 predatory species i.e. *Scleropages formosus, Notopterus notopterus,* 2 *Mastacembelus* spp., *Chela oxygastroides, Probarbus jullieni,* 3 *Mystus* spp., *Clarias batrachus, Prophagorus nieuhoffi* and *Pristolepis fasciatus* were fish fry/small fish and macroinvertebrate feeders. Together they made up almost 49% of the species composition in Paya Bungor.

Relative and Seasonal Abundance

The abundance of fishes in Paya Bungor is presented in Table 2. *Amblyrhyncichthys truncatus* was the most abundant species acounting for 32.9%, followed by *Thynnichthys thynnoides* (20%) and *Puntius schwanenfeldii* (17.5%). Together with other cyprinids, they comprised

TABLE 2
List of fish species abundance in Paya Bungor January 1982 to December 1982
(in increasing order of abundance)

Code/	Fish species	Number of individuals Station A	Station B	Station C	Total
1.	*Prophagorus neiuhofi*	1	—	—	1
2.	*Cyclocheilichthys heteronema*	—	1	—	1
3.	*Scleropoges formosus*	—	2	—	2
4.	*Silurichthys hasselti*	1	—	1	2
5.	*Trichogaster trichopterus*	—	2	—	2
6.	*Channa striatus*	2	—	—	2
7.	*Osphronemus goramy*	*1*	*2*	—	*3*
8.	*Barbichthys laevis*	2	—	2	4
9.	*Ompok* sp.	2	—	2	4
10.	*Probarbus jullieni*	1	—	4	5
11.	*Chanda siamensis*	—	2	3	5
12.	*Hampala macrolepidota*	1	1	3	5
13.	*Clarias batrachus*	3	1	2	6
14.	*Channa micropeltis*	2	—	4	6
15.	*Mastacembelus* spp.	4	—	3	7
16.	*Mystus* spp.	3	2	3	8
17.	*Oxyleotris marmoratus*	4	1	5	10
18.	*Macrochirichthys macrochirus*	2	4	5	11
19.	*Puntius (= Puntioplites) bulu*	4	3	6	13
20.	*Notopterus chitala*	5	2	9	16
21.	*Chela* spp.	6	13	3	22
22.	*Pristolepis fasciatus*	9	6	7	22
23.	*Barilius guttatus*	4	2	26	32
24.	*Notopterus notopterus*	12	19	3	34
25.	*Puntius daruphani*	13	2	27	42
26.	*Osteochilus hasseltii*	12	30	5	47
27.	*Labiobarbus festiva*	25	8	20	53
28.	*Cyclocheilichthus apogon*	34	11	24	69
29.	*Puntius schwanenfeldii*	78	85	92	255
30.	*Thynnichthys thynnoides*	131	83	74	288
31.	*Amblyrhynchichthys truncatus*	112	146	221	479

more than 90% of the total catch, compared to the catfishes (7 species) which constituted only 1.4%. The anabantid and ophicephalid population was also very low (0.3% and 0.5% respectively). The situation was similar in various parts of the lake (illustrated in *Figure 1*). The observations differ from other swampy lakes like Tasek Bera where air breathers are more common probably due to low dissolved oxygen concentration (Furtado and Mori, 1983).

The piscivorous population in Paya Bungor was quite low, accounting for only 6% of the total catch in numbers Station C had the highest

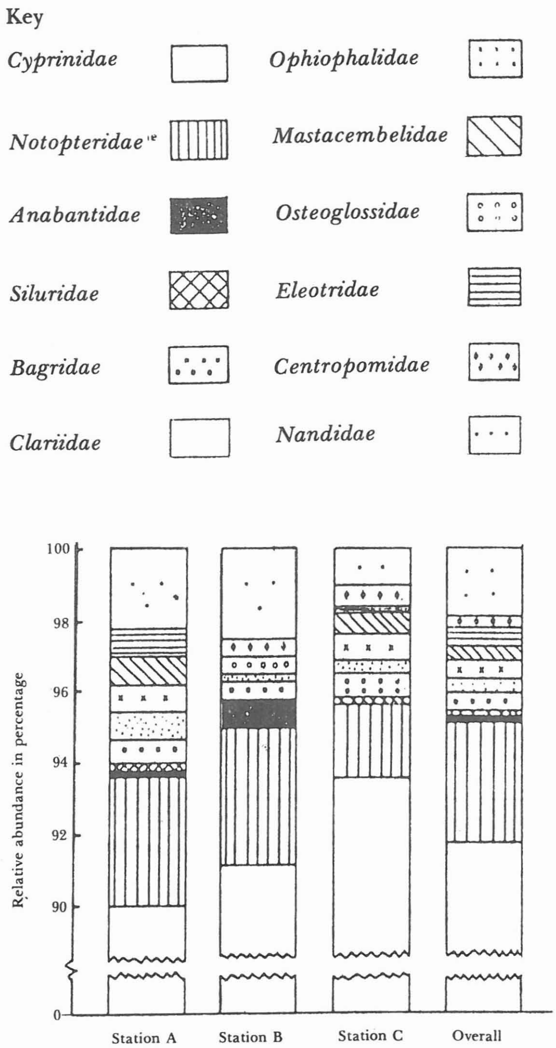

Fig. 1: Relative abundance of Fish Family in Paya Bungor

percentage of the piscivorous fishes making up almost 10% of the total fish landed in the station while Station B had the lowest piscivorous population of only 2%. This phenomenon is probably due to the fact that Station C is the gateway to Paya Bungor, where the predatory fishes (mostly riverine species) entered the study area from Sungai Lepar.

The seasonal abundance of fishes in Paya Bungor is illustrated in *Figure 2*. Peak abundance occured in January and a second peak was observed in June. The lowest catch was recorded in August. The seasonal abundance at various regions of the lake, however, showed some differences. The general pattern of the seasonal abundance in numbers indicate that more fishes were recorded in the months of January, March, June and September while in the month of February, May, August and October, the fish were less abundant. This pattern may be related to fluctuation in water levels and other physicochemical parameters.

When multiple linear regression was carried out, treating the abundance and water levels, temperature and conductivity as the independent variables, the following relationship was obtained.

$$P = -886 + 135\,WL + 23.77T - 0.151C$$

$$R^2 = 34.4\%$$

where

P = population abundance, in numbers

WL = water level in meter

T = water temperature in degrees centigrade

C = conductivity in umhos/cm

R^2 = coefficient of multiple determination.

Fish abundance in Paya Bungor is therefore positively correlated to water levels and temperature and negatively correlated to the conductivity. However, the coefficient of determination ($R^2 = 34.4\%$) is rather low which could be due to results from Station C which were different from those of Stations A and B. For both

TABLE 3
Working sheet for the construction and estimation of parameters of the log normal distribution curve for Paya Bungor's ichthyofauna

Class interval (Log_2)	Octave	R	R^2	S (R)	In S (R)
0 – 1	1	4.5	20.25	1	0.00000
1 – 2	2	3.5	12.25	3	1.09861
2 – 4	3	2.5	6.25	4	1.38629
4 – 8	4	1.5	2.25	7	1.94591
8 – 16	5	0.5	0.25	3.5	1.25274
16 – 32	6	0.5	0.25	3	1.09861
32 – 64	7	1.5	2.25	4.5	1.50408
64 – 128	8	2.5	6.25	1	0.00000
128 – 256	9	3.5	12.25	0.5	– 0.69315
256 – 512	10	4.5	20.25	2.5	0.91629

$\ln S(R) = 1.31 - 0.0562\, R^2$
$r^2 = 27.6$ per cent

Class interval (Log_e)	Octave	R	R^2	S (R)	In S (R)
0 – 1	1	3.5	12.25	1	0.00000
1 – 2.72	2	2.5	6.25	4	1.38629
1.72 – 7.39	3	1.5	2.25	9	2.19722
7.39 – 20.08	4	0.5	0.25	5	1.60944
20.08 – 54.60	5	0.5	0.25	7	1.94591
54.60 – 148.41	6	1.5	2.25	1	0.00000
148.41 – 403.43	7	2.5	6.25	2	0.69315
403.43 – 1096.6	8	3.5	12.25	1	0.00000

$\ln S(R) = 1.68 - 0.133\, R^2$
$r^2 = 49.8$ per cent

Stations A and B, the peak population abundance occurred in January while least catches were recorded in November for Station A and in December for Station B. In contrast, Station C had maximum populations in June and minimum in August. In December, more fishes were recorded in Station C and less in Stations A and B. The month of December is the beginning of the monsoon season as indicated by heavy rainfall, rise in water level and the lowering of the temperature. It is probable that fishes from Sungai Lepar start to enter the lake during this time of the year hence the observed abundance in Station C. In January, the water was at its peak level *(Figure 3)* and the fish had already dispersed themselves throughout the lake thus explaining the occurrence of peak abundance in Stations A and B during this time.

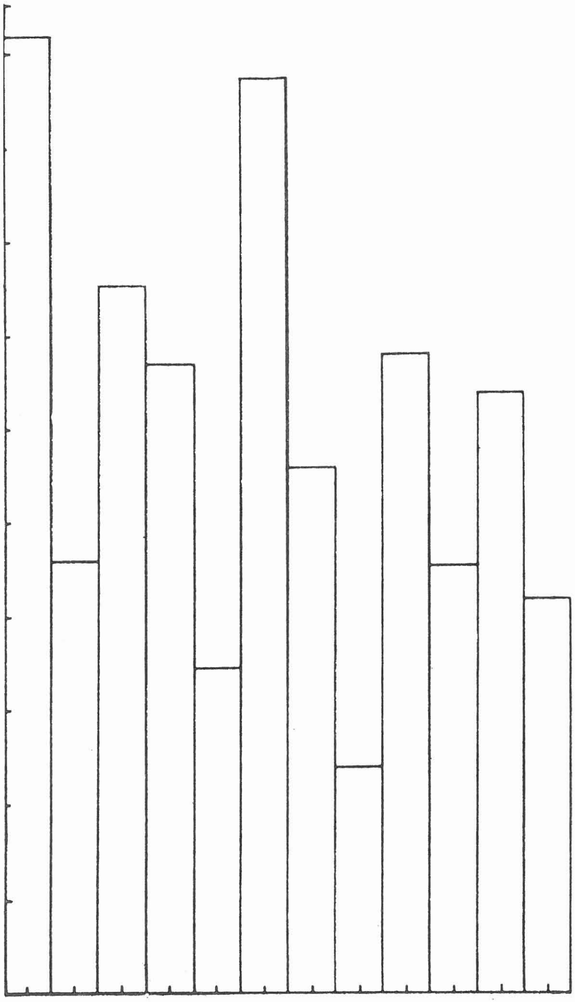

Fig. 2: Seasonal abundance of fishes in Paya Bungor

In view of this, results from Stations A and B can be considered as more reflective of Paya Bungor Lake (furthermore Station C is proportionately smaller in area); thus a further analysis was carried out to relate abundance with the three physico-chemical parameters i.e. water level, temperature and conductivity. For Station A, the relationship is as follows:

$$P_A = -498 + 38.7\ WL_A + 15.0\ T_A - 0.022\ C_A$$
$$R^2 = 0.648$$

where

P_A = population/abundance in Station A

WL_A = water levels in Station A in metres

T_A = water temperature in Station A in degrees centigrade

For Station B, the relationship is as follows:

$$P_B = -421 + 45.5\ WL_B + 11.9T_B - 0.111C_B$$
$$R^2 = 0.49$$

where

P_B = abundance/population in Station B

WL_B = water levels in Station B in metres

T_B = water temperature in Station B in °C

and C_B = conductivity of Station B in umhos/cm

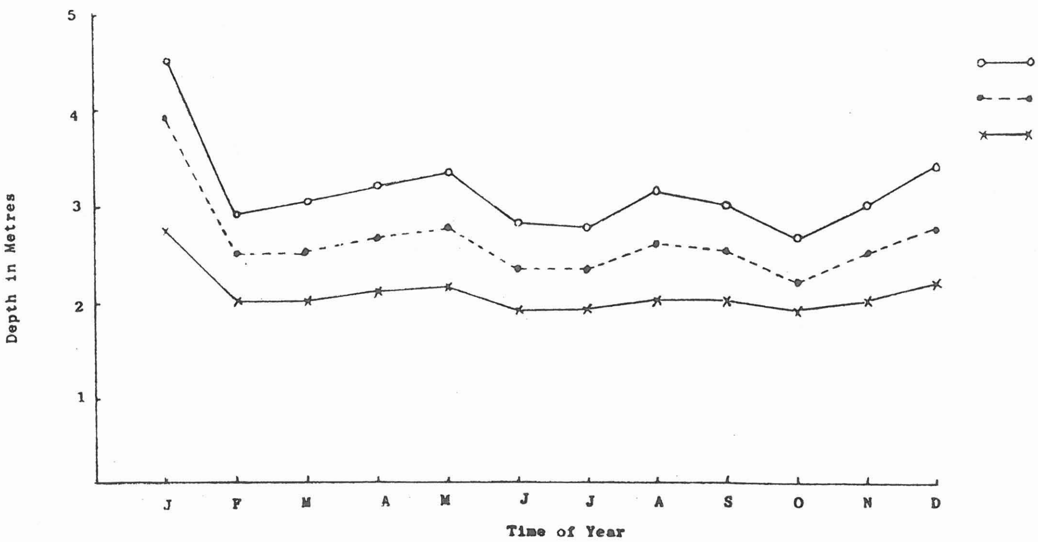

Fig. 3: Fluctuations in water levels in Paya Bungor

The results accordingly show high correlations between fish abundance and the three environmental variables. The usefulness of these simple environmental variables in predicting abundance of fishes (hence yield) in Paya Bungor is stressed. Of these variables, water level is the most important especially in low lying areas like Station B where larger areas are inundated. The equations of their relationships are given below:

$$P_B = -49.5 + 32.5\,WL_B$$
$$R^2 = 0.31$$

These findings complement the results by other workers especially for floodplain fisheries (Rawson, 1955; Hayes, 1957; Welcomme, 1983). In the tropical river basins, Welcomme (1983) recommended the use of index of flood density for catch predictions. He found good correlations of yearly catches with the index of flood density for catch predictions since he found good correlations of yearly catches with the index of flood density for that year and the year before that. The use of an index similar to Ryder's (1965) morphoedaphic index (MEI) with conductivity as a correlate for total dissolved solids (TDS) was attempted but the result showed poor correlation.

Patterns of Distribution

Spatial and Temporal Distribution Patterns
The heterogenous fish populations in Paya Bungor exhibited complex patterns of distribution. More species were found at the littoral areas as compared to the open waters. Among those commonly found near the shores were: *Scleropages formosus, Notopterus notopterus, Chela* spp. *Rasbora* spp., *Puntius* spp., *Barbichthys laevis, Ompok* spp., *Silurichthys hasselti, Clarias batrachus, Trichogaster trichopterus Osphronemus goramy, Sphaerichthys osphronemoides, Chanda siamensis, Oxyleotris marmoratus* and *Mastacembelus* spp. Those that frequented the open water were: *Notopterus chitala, Macrochirichthys macrochirus, Barilius guttatus, Thynnichthys thynnoides, Hampala macrolepidota, Osteochilus hasselti, Cyclocheilichthys apogon, Probarbus jullieni, Amblyrhynchichthys truncatus, Cyclochelichthys heteronema, Labiobarbus* spp., *Mystus* spp., *Channa micropeltis* and *Pristolepis fasciatus.*

Depth distribution was also noticed, with some species exhibiting distinct vertical distributions. During the daytime, groups of *Rasbora* spp., *Puntius schwanenfeldii, Puntius tetrazona* and small *Oshphronemus goramy* were observed at or near the surface. Night time trammel and gill net catches revealed more fish occuring at or near the surface. These comprises the following species: *Scleropages formosus, Chela* spp., *Macrochirichthys macrochirus, Barilius guttatus, Hampala macrolepidota, Barbichthys laevis, Ompok* sp. and *Channa micropeltis.* At the bottom layer, the presence of *Notopterus* spp., *Probarbus jullieni, Amblyrhynchichthys truneatus, Labiobarbus* spp., *Mystus* spp., *Clarias* sp. and *Mastacembelus* spp., were documented. Other species were found in the middle strata of the lake with the exception of *Thynnichthys thynnoides* which exhibited a rather random distribution.

The result of the diurnal study showed a distinct pattern of fish movement in Paya Bungor at different times of the day (Ambak *et al.*, 1983). In general most fishes were more active during the early night time and before dawn, as manifested by the number of species caught as well as the diversity indices. Highest species diversity and richness occurred at 2000 hrs (H = 1.6888; D = 2.14560) followed by 2100 hrs (H = 1.4882; D = 1.8234) and at 0500 hrs (H = 1.4228; D = 1.4427). These findings are in accordance with work done by others (Shiraishi and Nishiyama, 1972; Yap and Furtado, 1980; Bhukaswan, 1980; Helfman, 1981; Furtado and Mori, 1983).

The pattern of population distributions varied with the types of fish species which can be explained by the nature of the feeding habits and food availability.

The physico-chemical conditions of the water has an indirect influence on the distribution pattern for the same reason. Summerfelt (1971) for example found pissivorous fish to be directly correlated with density of its forage. In Tasek Bera, Furtado and Mori (1983) observed large shoals of *Labiobarbus festiva* grazing upon benthic algae at night with the piscivorous *Notopterus chitala* closely following them.

This pattern however, is altered during the breeding season. Bhukaswan (1980) remarked that seasonal movement for breeding occurs in tropical fishes, while Helfman (1981), in studying the twilight activities of freshwater fish community in Cazenovia Lake, New York, noted that the characteristic diel and twilight activities of fishes broke down during the breeding season. This situation is also applicable in Malaysian fishes as exemplified by *Thynnichthys thynnoides* (Ambak *et al.*, 1983). They were captured in large numbers at 0100 hrs and 0300 hrs with all the female specimens in gravid condition with running eggs.

Specific Distribution Pattern The trammel and gill net catch data revealed the presence of 31 species (congenerics of *Mystus, Chela, Labiobarbus* and *Mastacembelus* are treated as one) in Paya Bungor. The distribution pattern of species abundance can be represented by the following number of individuals in each of the 31 species: 1, 1, 2, 2, 2, 2, 3, 4, 4, 5, 5, 5, 6, 6, 7, 8, 10, 11, 13, 16, 22, 22, 32, 42, 47, 53, 69, 256, 288 and 478 (i.e. 2 species having one individual, 4 species with two individuals, 1 species with three individuals, 2 species with four individuals and so on).

The log normal curve plotted is shown in *Figure 4*, using logarithm to the base 2 following Preston (1948). The equation for the lognormal distribution curve is:

$$S(R) = 3.706\exp^{-(0.237R)^2}$$
$$\sigma = 2.992$$

σ = standard deviation of the distribution

The curve did not seem to fit well, thus, a new curve was plotted using octaves of natural logarithm. Table 3 presents the working data and the new equation for log-normal distribution curve as:

$$S(R) = 5.366\exp^{-(0.36R)^2}$$
$$\sigma = 1.943$$

In Station A, 27 species were recorded and the specific distribution equation for this station is:

$$S(R) = 5.155\exp^{-(0.359R)^2}$$
$$\sigma = 1.976$$

From Stations B and C, the number of species caught by trammel and gill nets were 23 and 25 species respectively. The specific distribution curve equation for Station B is as follows:

$$S(R) = 3.387\exp^{-(0.335R)^2}$$
$$\sigma = 3.018$$

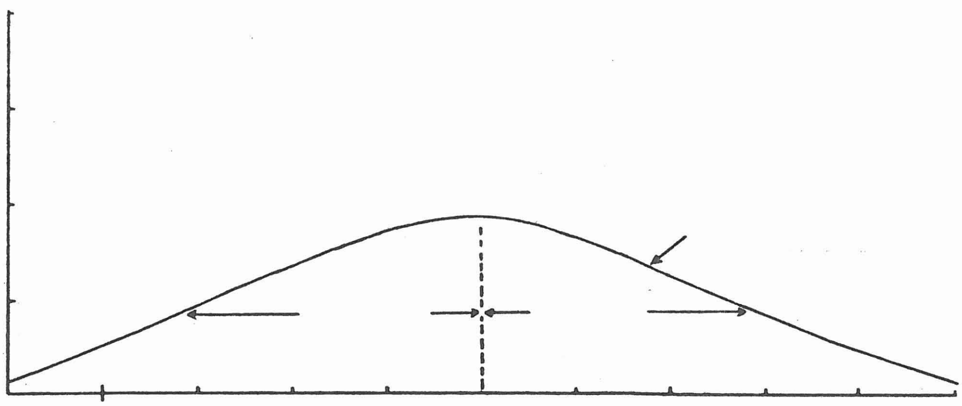

Fig. 4: Log-normal distribution of fishes in Paya Bungor (with abcissae in logarithm to the base 2)

For Station C the equation for the distribution curve is:

$$S(R) = 4.953^{-(0.453R)^2}$$
$$\sigma = 1.566$$

The log-normal distribution therefore seems to fit the patterns of species abundance distribution rather well especially in Stations A and C.

The canonical log-normal distribution was also examined for Paya Bungor as well as for the 3 stations. Two methods were tried, that of Preston's (1962) using logarithm to the base of 2 and another method where natural logarithm was used as the scale for abundance. Both methods showed similar results i.e. the modal octave of the species curve occurred at or near the last octave for all stations and for Paya Bungor as a whole. Therefore the distribution of the fish communities in Paya Bungor can be considered as canonical log-normal distribution (i.e. RN = 1, where RN is the octave in which total numbers peak and Rmax is the octave containing the most abundant species).

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