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Ecology of Fish in Wangat Nalla (Tributary of Sind Stream) with a Note on the Impact of Wangat Barrage on the Spatial Distribution of Fish

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ABSTRACT

The present paper reports on the ecology of fish in Wangat Nalla, a tributary of Sind Stream. The study was carried out from November 2002 to September 2003. Water was soft in the upstream of the Wangat barrage, while below it the water in the Wangat Nalla as well as the Sind stream was hard. Seventeen taxa of zoo benthos and nine fish species were recorded in the study area. Species diversity index and evenness of benthic fauna decreased downstream, while the diversity index of fish increased. Above the barrage the benthic fauna was contributed only by insects with Diptera as the most dominant group quantitatively, while molluscs and leeches were present in good numbers below it. The fishes recorded included nine native species *Schizothorax plagiostomus* Heckel, *S. esocinus* Heckel, *S. labiatus* McClelland & Griffith, *Triplophysa kashmirensis* Hora, *T. marmorata* Hora, *Diptychus maculatus* Steind., *Glyptosternon reticulatum* McClelland & Griffith and *Glyptothorax kashmirensis* Hora and one exotic species *Salmo trutta fario* Linneaus. While *D. maculatus* was restricted only to the upstream of the barrage and contributed 70% of the total catch, *G. kashmirensis* occurred only in the Sind stream.

Key words: Wanghat stream, barrage, limnology, benthos, fish diversity

INTRODUCTION

The riverine ecosystems form a valuable fishery resource, particularly in land locked areas like Kashmir. The Jhelum, along with its tributaries, most of which are famous for their torrential nature, is the nature's most valuable gift to the people of the valley. Heckel (1838) was the first person to report on the fishes of the valley. He described 16 species of fishes from the region from the specimens sent to him by Mr. Von Hugel, who traveled through the valley during 1830s. Since then a number of workers (Lawrence, 1895; Day, 1876, 77; Hora, 1936; Mukherji, 1936; Silas, 1961; Das & Subla, 1963, 64; Yousuf, 1996; Kullander et al. 1999) have reported on the fish fauna of the region. Soon after the introduction of trout and common carp into the aquatic habitats of the Valley, the occurrence and abundance pattern of fish started showing changes (Das & Subla, 1964). During the past century the human interference, varied fishing practices and natural calamities further impacted the water quality vis a vis the fish distribution and abundance. Besides, a number of barrages constructed on the Jhelum and some of its main tributaries have also altered the water flow regime, thereby influencing the ichthyofauna of the river system. However, not much attention has been paid to study the changes in ecological set up of these water bodies brought due to the construction of barrages vis-à-vis fish distribution except for some stray reports (Enderlein and Yousuf, 1999). It was therefore decided to study the impact of the Wangat Barrage on the distribution and dominance of fishes in the Wangat Nalla, a tributary of the Sind Stream an important right bank tributary of the Jhelum River in Kashmir.

MATERIAL AND METHODS

Wangat Nalla is an important right bank tributary of the Sind stream and joins the latter at Kichpora, Kangan (Fig. 1). A barrage has been constructed on the Nalla near Wangat village for the generation of 105 MW of electricity. Construction of the barrage has affected the flow of water in the Nalla to a significant level and at times the downstream of the barrage gets dried up (Fig. 2). In order to have an insight into the impact of the barrage on the limnology and fish distribution in the Nalla three sampling sites were selected (Fig. 1). Site 1 was located at Narayan Nag, about 4 km above the barrage, while Site 2 was located at Kichpora, about 10 km below the Barrage and 1km upstream of its confluence with the Sind. Site 3 was located about 4 km below the Site 2 in the Sind Stream itself. The methodology followed was the same as has been given in Yousuf *et al.* (2003), Bhat and Yousuf (2004) and Mahdi *et al.* (2005).

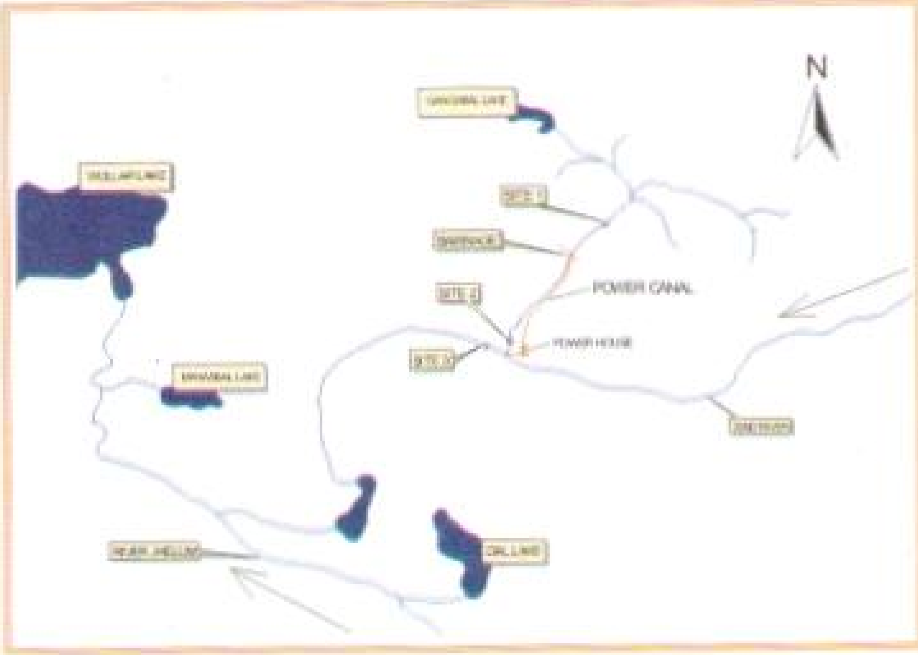


Fig.1. Location map showing different study sites of Wangat stream.

RESULTS AND DISCUSSION

Physico-chemical Features of Water

The physico-chemical characteristics of the Wangat Nalla as well as Sind stream are given in Table 1. The limnological features at the three sampling sites depicted typical hill stream conditions. Water temperature ranged from 3° C in December at Site 1 to 16°C during July- August at Site 2 and 3, while the air temperature ranged from 3°C in December at Site 1 to 30°C in July at Site 3. The marked difference in air and water temperature is a characteristic feature of the lotic systems (Qadri *et al*, 1981; Bhat and Yousuf, 2004). The depth of water ranged from 16cm in January at Site 2 to 60 cm in June- Aug at Site 1 and in May at Site 3. On the whole, the Site 2 was the shallowest (mean depth 17.18 cm) and the Site 1 the deepest (25.91 cm). As the source of water in the stream is mainly the snow melt, the water was very clean and the transparency (14cm in July-September at S 2 to 38cm in December at S 1) varied mainly with depth. The average velocity was the highest at Site 1 (41.09 cm/s) and the lowest at Site 3 (26.55 cm/s). Lower values at Site 2 are due to diversion of water for power generation (Fig.2). The relatively lesser transparency values during summer months are related with the high silt load brought in by increased runoff from the catchment. The highest value of dissolved oxygen (12mg/l) was recorded in November - February at Site 1 and the lowest (6 mg/l) was recorded in June and August at site 3. On the whole the oxygen content was high throughout the year, showing a gradual decrease downstream.

Fig.2. A view of the Wangat Nalla showing dry river bed downstream of the Wangat Barrage

pH of the water was always alkaline and ranged from 7.99 in April at Site 2 to 8.7 in August at Site 3. The pattern of fluctuations was irregular with slightly higher values in the upstream. The lowest value of CO_2 (3 mg/l) was recorded in March at Site 1 and the highest (11mg/l) in April at Site 2. The higher quantities in downstream may be attributed to higher bicarbonate alkalinity and higher organic content. This is further reflected by the concentration of nitrogen and phosphorus content in the stream. The NO_3 N, NH_4 N and TPP recorded an average range of 125µg/l (Site 1) - 173µg/l (Site 3) - 11µg/l (Site 1) 29µg/l (Site 3) - 48µg/l (Site 1) - 53µg/l (Site 3) respectively. The alkalinity of water increased downstream and was mainly due to bicarbonates of calcium and magnesium (Fig 4).

Table 1. Range of mean values in physico-chemical characteristics of Wangat stream

Parameter		Site 1	Site 2	Site 3
Air Temp. °C	A	14.2	16.6	17.4
	R	3 – 25	4 – 28	5 – 30
Water Temp. °C	A	7.7	9.5	10.4
	R	3 – 10	3 – 16	4 – 16
Depth (cm)	A	46.4	25.7	32.6
	R	30– 60	16 – 48	18 – 60
Transparency (cm)	A	25.9	17.2	22.3
	R	20 – 38	14 – 20	14 – 28
Velocity (cm/sec.)	A	41.1	30.4	26.5
	R	30 – 75	21 – 52	20 – 46
Conductivity (μs)	A	63.7	68	74.3
	R	52 – 82	54 – 84	56 – 110
pH	A	8.46	8.18	8.37
	R	8.3 – 9.0	7.99 – 8.32	8.1 – 8.76
CO_2 (mg/l)	A	5.1	8.4	7.2
	R	3 – 7	7 – 11	5 – 9
Dissolved Oxygen (mg/l)	A	10.6	9.4	8
	R	8.9 – 12.2	7 – 12	6 – 11
Alkalinity (mg/l)	A	40.4	84.9	92.5
	R	32 – 47	52 – 142	63 – 156
Chloride (mg/l)	A	8.7	10.1	13.4
	R	6 – 11	8 – 12	10 – 18
Calcium (mg/l)	A	20.9	31	37.3
	R	14 – 28	22 – 40	26 – 52
Magnesium (mg/l)	A	6.1	8.4	9.5
	R	5 – 7	7 – 10	7 – 12
Nitrate (μg/l)	A	125	160	173
	R	100 – 138	130 – 210	140 – 220
Ammonia (μg/l)	A	11	26	29
	R	6 – 20	18 – 32	18 – 36
Total Phosphorus (μg/l)	A	48	50	53
	R	35 – 60	36 – 72	38 – 77

A = Average R = Range

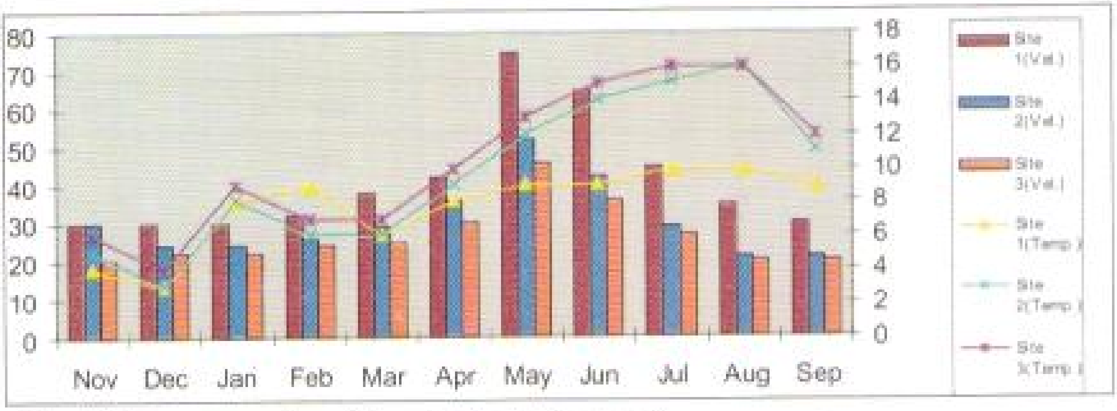


Fig. 3.Water temperature °C and velocity (cm/sec.).

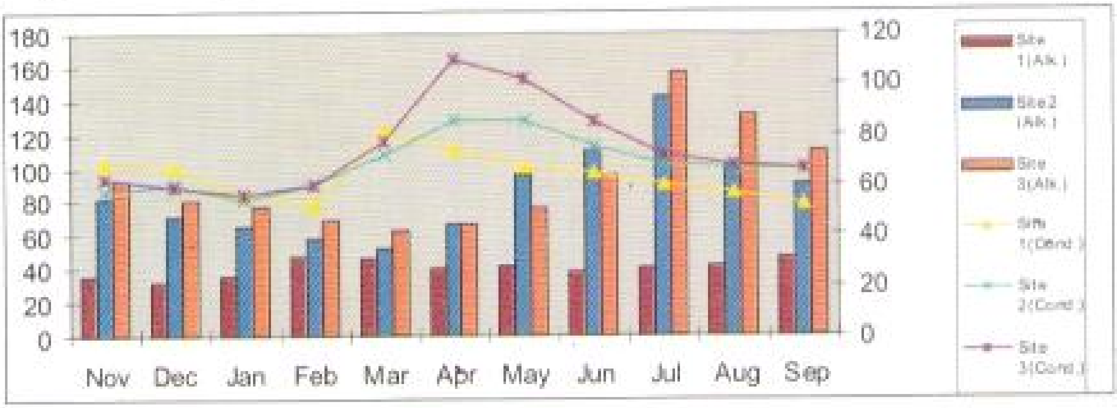


Fig. 4.Alkalinty (mg/l) and conductivity (μs).

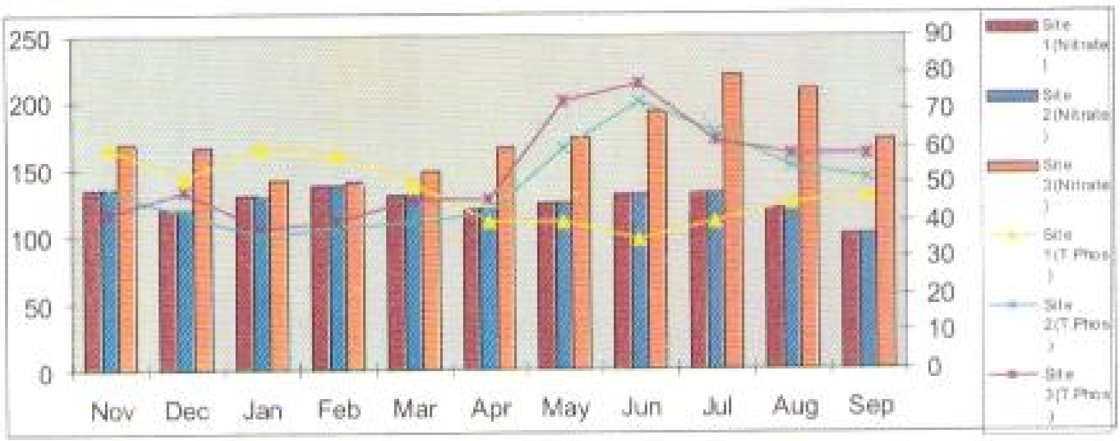


Fig. 5.Nitrate-N(μg/l) and Total phosphorus (μg/l).

Chloride content in water is regarded as an indication of organic load of animal origin from the catchment (Reddy and Rao, 2000, and Kumar *et al.* 2004). It ranged from 8.7mg/l at Site 1 to 13.4mg/l at Site 3, thus increasing downstream, likewise the calcium and magnesium content also increased downstream, ranging between 20.9mg/l (Site 1) 37.3mg/l (Site 3) and 6.1mg/l (Site 1) - 9.5mg/l (Site 3) respectively.

Macrozoobenthos

The benthic fauna in the stream was represented by 17 taxa, out of which 14 belonged to class Insecta and one each to Crustacea, Annelida and Mollusca. At Site 1 Insecta formed 100% of the benthic fauna, with Trichoptera (42.84%) and Ephemeroptera (28.57%) as dominant groups qualitatively (Table 2). However, quantitatively the highest contribution was made by Diptera, which contributed about 49% of the total population at this site, ranging between 45.21% (July) and 54.4% (January). The contribution of Ephemeroptera to the total population ranged from 10.5 % (February) to 21.10 % (March), while the contribution of Trichoptera varied from 25.91% in December to 34.20% in July. The dominant genera among the insects were *Stenopsychae* spp.> *Nectopsychae* spp.> *Rhyacophyllidae* spp.> *Hydrophilus* spp.> *Ephemerella* spp.> *Epeorus* spp.> *Atherix* spp.> *Diamisinae* spp.> *Elmidae* spp. The Shannon Diversity Index at this site fluctuated from 2.99 (November) to 3.67 (March) with the mean value of 3.28.

At Site 2 nine taxa of insects were recorded. Amphipoda, represented by *Gammarus pulex*, and Mollusca, by *Lymnaea* spp., were also present at this site. While May flies (Ephemeroptera) were recorded from November to February, the stone flies (Trichoptera) were recorded only in February. *G. pulex* was recorded from April to September and *Lymnaea* spp. was found during May - August. Trichoptera dominated the population with a mean contribution 49.4%, followed by Diptera (22.01%), Ephemeroptera (12.3%), Amphipoda (11.7%), Gastropoda (2.6 %) and Plecoptera (1.9%). The diversity index at this site fluctuated from 0.811 (November) to 2.422 (June) with an average value of 1.924. The presence of *G. pulex* and *Lymnaea* sp. seems to be related with less water depth and velocity and higher temperature and organic load.

At Site 3 in addition to seven insect taxa, one amphipod (*G. pulex*) and one annelid (*Erpobdella* spp.) were recorded. The highest contribution to the total population was due to Trichoptera (50.8%), followed by Diptera (20.8%), Ephemeroptera (11.4 %), Hirudinea (8.8%), Amphipoda (6.3%) and Gastropoda (2%). At this Site the diversity index ranged from 1.083 (August) to 2.7083 (July), with an average value of 2.185 (Fig. 6).

The species diversity of the benthic fauna in the Wangat Nalla points towards the good water quality in its upper reaches. The occurrence of annelids and molluscs in the lower reaches, however, does indicate the entry of allochthonous organic material from the neighbouring human settlements. Hawkes (1979) has reported that Ephemeroptera and Trichoptera do not tolerate organic enrichment. This is confirmed by the gradual decrease of these groups downstream in the present stream as is also clear from the Shannon diversity index values. However, the presence of Trichoptera throughout the studied stretch of the river clearly indicates that although there has been human interference in the catchment, still the level of pollution is within the tolerance of the Trichoptera. This is also elucidated by Gaufin (1957) and Reddy and Roy (2001), who inferred that an association of may fly, stone fly and caddis fly in a stream is indicative of clean water conditions and their absence often denotes the loading of organic wastes and low oxygen supply.

Ichthyofauna

During the present study nine species of fishes, belonging to families Cyprinidae, Salmonidae, Sisoridae and Balitoridae, were collected from the stream. These included *Schizothorax plagiostomus* Heckel, *S. esocinus* Heckel, *S. labiatus* McClelland & Griffith, *Triplophysa kashmirensis* Hora, *T. marmorata* Hora, *Diptychus maculatus* Śteind, *Glyptosternon reticulatum* McClelland & Griffith, *Glyptothorax kashmirensis* Hora and *Salmo trutta fario* Linneaus. The distribution and dominance of the various species varied from place to place in the stream (Table 3). The fish diversity index at Site 1 fluctuated from 0.769 during winter to 1.337 in summer. At Site 2 the index was 0 (zero) during winter, while the highest value (1.976) was recorded in spring. At Site 3 the diversity index fluctuated from 1.8401 in winter to 2.5871 in spring. On the whole, the index increased downstream, with mean value being 1.0037 at Site 1, 1.8765 at Site 2 and 2.2757 at Site 3 (Fig. 7).

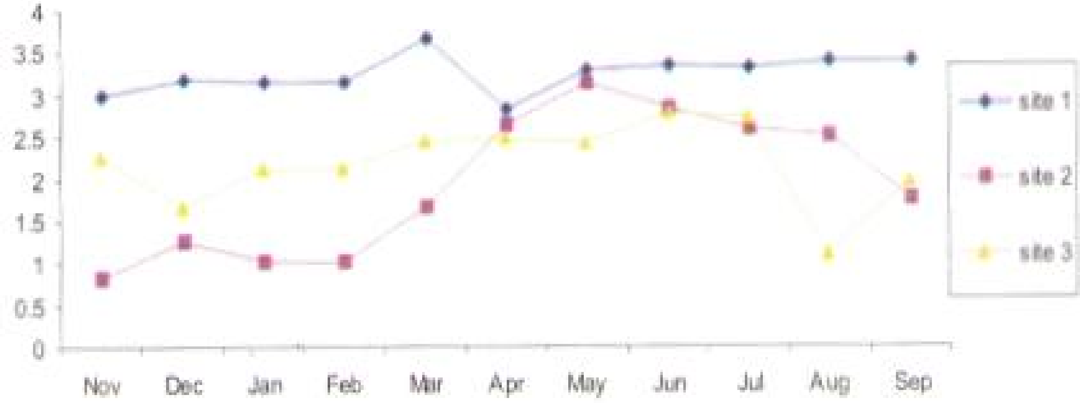
At Site 1 four species of fishes were recorded, out of which three, viz., *D. maculatus*, *S. t. fario* and *G. reticulatum*, were recorded throughout the year, while *S. plagiostomus* was recorded only during spring and early summer season. Das and Subla (1963) reported that *D. maculatus* inhabits the high land reservoirs, rivers and their tributaries but they did not indicate the exact location of its occurrence in Kashmir but Raina (1989) reported the fish from Gadsar and Zumsar lakes and their associated streams. In the Wangat Nalla the fish occurred only at Site 1. *S. t. fario* was recorded at Site 1 and 3. The changed ecological conditions seem to have led to its absence at Site 2. At Site 3 (main Sind River) the trout has flourished well. Similarly the better ecological conditions at Site 1 and 3 are suitable for *G. reticulatum*, having Trichoptera and Ephemeroptera as preferred food (Yousuf *et al*, 2003).

G. kashmirensis was recorded only at Site 3, while *Triplophysa* sp. was recorded at Site 2 and 3, both the sites being slow flowing zones. *G. reticulatum* was recorded in both slow (Site 3) and fast flowing (Site 1) areas. All the three species are adapted to a benthic life and take shelter under small stones and boulders found in plenty in the area. While *Triplophysa* spp. are cylindrical in shape and move quickly in between the stones and boulders, *G. kashmirensis* and *G. reticulatum* are slightly dorso-ventrally compressed and are also provided with a ventral thoracic sucker, which helps them in attaching themselves with the bottom objects so as to avoid being carried away by the water. *S. esocinus* and *S. labiatus* were present only at Site 2 and 3 and their absence at Site 1 indicates that these fishes are not able to withstand the very fast current. Bhat (2003) has also reported the presence of these fishes only in the lower reaches of the Lidder River, a torrential stream of Kashmir, having similar ecological conditions. Both the species were recorded at Site 2 only during warmer months, thereby indicating these species go for upstream migration during this period and towards autumn move downstream.

S. plagiostomus is well adapted to life in hill streams and migrates during summer months to the upper reaches of most rivers and streams for breeding purposes (Yousuf, 2004). In Wangat Nalla the fish seems to reach above the barrage during spring when there is significant increase in water in the Nalla due to melting of snow in the catchment. *S. esocinus* and *S. labiatus* were restricted to the lower reaches of the Wangat Nalla only. Both these species are distributed to the flatland lakes of the valley as well as in the River Jhelum and the lower reaches of its tributaries in the valley and do not seem to go up in to the torrential waters (Kullander et al, 1999 and Enderlein & Yousuf, 1999). The construction of the barrage at Wangat seems to have affected the distribution and abundance of the fishes both up- and downstream by restricting their movement. The barrage seems to have restricted *D. maculatus* and *S. t. fario* to the up-stream of the stream.

Table 2. Percentage composition of different classes of macrozoobenthos (Numbers within parenthesis are % age of total number)

Macrozoobenthos	Site 1	Site 2	Site 3
Crustacea (Amphipoda)	0 (0.00)	1(9.09)	0 (0.00)
Insecta	14 (100.00)	9 (81.81)	7 (87.5)
Ephemeroptera	4 (28.57)	3 (27.27)	1 (12.5)
Plecoptera	1(7.14)0	(0.00)	0 (0.00)
Trichoptera	6 (42.85)	3 (27.27)	3 (37.5)
Diptera	3 (21.42)	3 (27.27)	3 (37.5)
Annelida (Hirudinea)	0 (0.00)	0 (0.00)	1 (12.50)
Mollusca (Gastropoda)	0 (0.00)	1 (19.19)	0 (0.00)



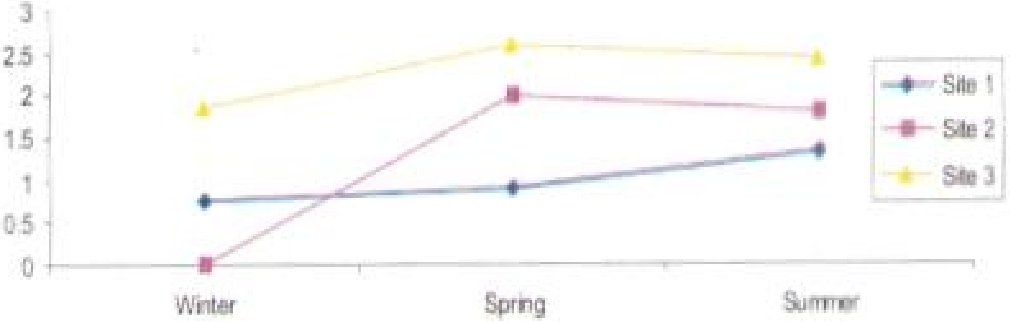


Fig. 7. Diversity Index of Fishes.

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