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Sex-related Variations in Some Haematologic Values of Certain Freshwater Teleosts

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Abstract Sex-related variations in total erythrocyte count, total leucocyte count, hemoglobin level and packed cell volume were determined in 12 Indian freshwater fish species. Except for total leucocyte counts in two species, all the parameters were usually higher in males than in females. Seasonal variations in these values were presented in *Notopterus notopterus* with peaks at April or June. Possible reasons for the sex differences in the haematologic parameters were discussed.

Hickey (1976), in a brief review, pointed out that various factors affect the haematological values in fishes, as in higher vertebrates (Schalm, 1967). However, sex-related variations in various haematological values of fishes are scant (Haws and Goodnight, 1962; Banarjee, 1966; Poston, 1966; Snieszko et al., 1966; Mulcahy, 1970). But none of these authors gave detailed reports based on annual studies on fishes. This is important since haematological values show conspicuous seasonal fluctuations round the year (Yamashita, 1969; Joshi and Tandon, 1977). This paper presents some normal haematological values in the two sexes of 12 freshwater teleostean species of India.

Material and methods

Live specimens of twelve species were conveniently obtained round the year from the local fishing grounds of Lucknow, Moradabad and Almora districts, India. The 12 species are: *Notopterus notopterus*, *N. chitala* (Notopteridae), *Tor tor* (Cyprinidae), *Xenentodon cancila* (Belonidae), *Anabas testudineus* (Anabantidae), *Nandus nandus* (Nandidae), *Channa punctata*, *C. striata*, *C. marulia* (Channidae), *Macrognathus aculeatus*, *Mastacembelus armatus* (Mastacembelidae), and *Amphipnous cuchia* (Amphipnoidae). The fishes were brought to the laboratory in natural water and transferred to large glass aquaria, given rest from 24～72 hours to 10～15 days, in order to allow recovery from catching and transportation stress, as also discussed in detail by Ikeda et al. (1975). However, it has been noted that it does not take more than 72 hours to recover from these stresses (Joshi, 1973). To make haematological studies, fish were made senseless by using 2～3% paraldehyde solution, immediately wiped dry, measured to the nearest mm and weighed to the nearest mg. This all took about 3～5 minutes. Immediately, blood was drawn from the caudal vein (see Ikeda et al., 1975) for various haematological studies following usual clinical methods (see Wintrobe, 1973). There is hardly any chance that handling stress or asphyxia during these 3～5 minutes would have influenced the haematological parameters. In each month at least 6～8 specimens of both sexes were examined, for each species. Fishes of a certain length group were selected, round the year. Each fish was also carefully autopsied for any visible disease or parasitic infestation, in all its organs.

In general, values for both sexes were pooled monthly. This also provided an opportunity to find out the monthly fluctuations in both sexes round the year. However, except in the case of *Notopterus notopterus*, the monthly values for both sexes were pooled separately for all species for the twelve months. Giving all the monthly fluctuations for the species studied here would have made the presentation inconvenient. The example of *N. notopterus* given in detail is sufficient to reveal the monthly as well as sex-related variations in all the four parameters, viz., total TEC and TLC counts, Hb and PCV.

Results

The pooled values for the twelve species of fishes studied here (Table 1) show that total erythrocyte counts (TEC) were higher in the males, significant variations ($P<0.05$) were noted in some species like *Notopterus chitala*, *Anabas testudineus*, *Channa punctata*, *C. striata*, *C. marulia* and *Tor tor*. The total leucocyte counts (TLC) were also found higher in male fishes of ten species than their females (Table 1) except in the case of *N. chitala* and *Macrognathus aculeatus* where females had significantly ($P<0.01$) higher values of TLC than the males. Except the males of *A. testudineus* and *C. marulia* all other species showed marked and significantly higher values ($P<1.05$) of TLC in males. The TLC value was found nearly the same in both sexes of *T. tor*, *Amphipnous cuchia* and *Nandus nandus* (Table 1).

The hemoglobin level (Hb) of male *C. punctata*, *N. chitala* and *A. testudineus* were significantly ($P<0.01$) higher, whereas, males of *N. notopterus*, *C. striata*, *Xenentodon cancila* and *Mastacembelus armatus* had insignificantly higher values as compared to their respective females. The rest of the species showed only marginal differences in Hb contents of both sexes. The packed cell volume (PCV) values of male *A. testudineus*, *C. punctata*, *N. chitala* and *M. armatus* were significantly higher than their females. Males of *N. notopterus*, *X. cancila*, and *M. aculeatus* has insignificantly higher values, and in the rest of the species the PCV was nearly the same in both sexes (Table 1).

Monthly values given separately for both sexes of *N. notopterus* (Fig. 1) very comprehensively show that there certainly occurs some variations in haematogical values of male and female fish.

Usually almost all the values, barring few exceptions, were found higher in male *N. notopterus* as compared to the female. Though at times the differences in both sexes in

Table 1. Sex-related values (mean±SD) of TEC, TLC, Hb and PCV in 12 freshwater fish species. M, male; F, female.

Species	No. of specimens	Sex	Standard length (cm)	TEC ($\times 10^6$/cmm)	TLC ($\times 10^3$/cmm)	Hb (g %)	PCV (%)
Notopterus notopterus	84	M	19.2±2.1	2.315±0.485	22150.0± 480.0	13.2±3.3	33.1±3.6
	84	F	19.4±1.6	2.047±0.401	20200.0± 124.0	12.1±2.4	31.8±2.9
N. chitala	80	M	18.6±2.2	2.508±0.365	24710.0± 419.0	14.2±2.4	35.4±2.7
	80	F	18.7±1.7	2.082±0.127	28728.0±1107.0	12.0±0.8	32.5±3.8
Tor tor	80	M	20.2±1.7	2.680±0.501	18650.0± 726.0	10.2±0.7	40.2±2.8
	80	F	20.5±2.4	2.568±0.178	18420.0± 298.0	10.0±0.7	40.0±2.7
Xenentodon cancila	96	M	18.2±3.2	1.820±0.098	24816.0±7850.0	9.4±1.8	30.2±3.2
	96	F	18.0±2.7	1.480±0.156	20610.0± 852.0	8.2±0.7	28.6±1.7
Anabas testudineus	80	M	14.6±2.1	3.164±0.375	14680.0± 545.6	15.0±3.1	42.5±1.6
	80	F	14.5±1.6	2.814±0.785	12850.0± 417.0	13.2±1.0	38.4±2.9
Nandus nandus	80	M	13.0±1.2	1.885±0.301	28450.0± 780.0	7.8±0.8	33.4±1.5
	80	F	13.2±1.4	1.820±0.297	27420.0±2451.0	7.2±0.5	33.2±3.4
Channa punctata	80	M	18.6±2.0	2.865±0.281	29672.0±6517.0	14.8±3.4	37.0±2.2
	80	F	18.5±3.1	2.211±0.470	24250.0± 980.0	12.2±1.2	33.2±2.9
C. striata	84	M	19.2±2.8	2.416±0.128	24616.0± 518.0	12.8±1.6	38.0±2.7
	84	F	20.1±2.2	2.260±0.436	20061.0±1256.0	11.4±1.5	37.4±3.6
C. marulia	84	M	15.8±4.2	2.360±0.217	27812.0±7650.0	11.4±0.9	37.2±2.5
	84	F	16.0±2.6	2.295±0.098	25200.0± 526.0	11.0±0.9	36.8±2.0
Mastacembelus armatus	80	M	38.0±1.7	2.185±0.112	22460.0±1150.0	10.8±1.7	34.4±1.9
	80	F	37.2±1.8	2.048±0.050	16590.0± 780.0	9.2±1.2	32.4±3.5
Macrognathus aculeatus	80	M	32.4±2.7	2.316±0.416	22250.0± 367.0	11.0±0.9	32.6±1.7
	80	F	32.6±2.5	2.290±0.281	26450.0± 742.0	10.6±1.4	31.4±3.2
Amphipnous cuchia	80	M	25.2±1.9	2.180±0.145	24650.0± 976.0	12.0±1.5	38.2±3.0
	80	F	25.0±2.2	2.075±0.128	23450.0± 741.0	12.0±1.3	37.4±2.1

these parameters were found very inconspicuous (or even higher in females, as TEC and PCV values in March, and TLC values in March and June) (Fig. 1). But, this could have been due to some specific physiological needs.

Discussion

The foregoing results amply show that excluding the TLC values in *Notopterus chitala* and *Macrognathus aculeatus*, all the haematological values were predominantly higher in the male than in the respective female. That the males usually possess higher values round the year is also amply demonstrated from the monthly values given for *N. notopterus* (Fig. 1). It is postulated that the reason for having higher haemotological values in male fish are primarily due to its being biochemically as well as nutritionally richer than the female (Joshi, 1973) where much of the metabolites and nutrients are continuously being exhausted in the development of the ovary. This is further substantiated by a rapid fall in the female fish during the spawning period (July, August and September), as compared to the male (Fig. 1), in *N. notopterus*. Smirnova (1965) noted that TLC values in fish blood exhibit a direct correlation with the feeding status. This fact also finds support from the present observations, where female feeds voraceously at the onset of spring (March) or after the end of the spawning period (October) when TLC rose sharply (Fig. 1). During the prespawning period males feed almost with the same intensity, whereas feeding depletes in females due to gradually decreasing space in the abdominal cavity following the rapid development of the gonads. Naturally, though the metabolic demands may be higher in females during spawning period, all the factors make the female fish poorer in various haematological parameters at the same time. A temporary microcytic anemia may be present.

A few earlier workers like Slicher (1961) and Summerfelt et al. (1967) in *Carassius*, Radzinskaya (1966) in *Misgurnus*, Snieszko et al. (1966) in *Salmo*, Banarjee (1966) in *Anabas* and Einszporn-Orecka (1970) in *Tinca*, noted higher values of PCV, TEC and Hb contents in the males as compared to the females, respectively. Since none of them

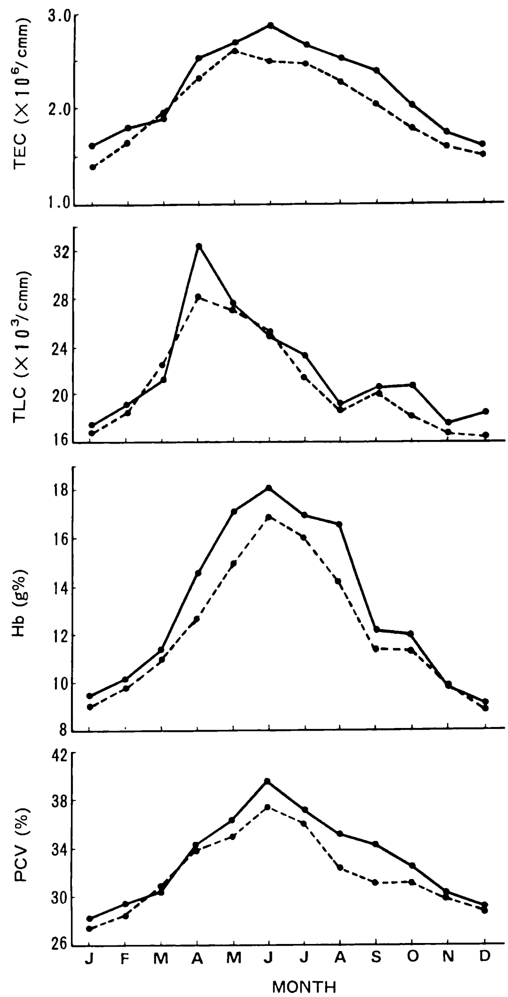

Fig. 1. Monthly variations in total erythrocyte count (TEC), total leucocyte count (TLC), hemoglobin content (Hb) and packed cell volume (PCV) of both sexes of *Notopterus notopterus*. Solid line, male; broken line, female.

have given monthly variations as has been given in the present study for *N. notopterus* (Fig. 1), it is not possible to know the real intensity of cyclic sex-related changes in the parameters evaluated by these authors. But even the pooled values of the same length weight group in a species may vary significantly, as Steucke and Atherton (1965) found in the PCV value of two sexes of the largemouth bass. These authors were able to use the micro-haematocrit technique to identify the sex of the fish. Similarly, Mulcahy (1970) also noted that male *Esox* always had higher values of TEC, PCV and Hb contents. Besides, she also pointed out that females had narrow range variations as compared to the males. This is almost the same as has been observed by the author in the present study.

The author also agrees with Slicher (1961), who suggested that certain hormonal activity is more or less responsible for such intra-species sex-related variations. This is further confirmed by the observations of Haws and Goodnight (1962) and Poston (1966), who noted sharp differences in blood values of certain sexually mature and immature fishes. The same has been observed in the case of *N. notopterus* in the present study, where maturing or mature fishes of both sexes showed highly significant ($P<0.01$) differences in almost all the parameters studied as compared to the spawning, and recuperating and spent fish during August to December. But, McKnight (1966), contrary to all these above findings, never found any sex-related variation of blood values in *Prosopium williamsonii*. Apparently, such contradictory findings are scant in the existing literature. Perhaps this can be treated as exceptional. However, the author suggests that more detailed studies are, indeed, required on a still greater number of specimens and species before making a final decision. Since, if hormones are concerned with such phenomena of physiobiochemical importance, then sex-linked genes or internal physio-biochemical milieus of the respective sex could also be involved.

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淡水魚の血液性状の性別による差異

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インド産の *Notopterus* 2 種，*Channa* 3 種，*Xenentodon*, *Nandus*, *Anabas*, *Tor*, *Mastacembelus*, *Amphipnous*, *Macrognathus* 各 1 種を 1 年間に亘り両性 80 尾以上を採集し，性別，体長，赤血球数，白血球数，ヘモグロビン量，ヘマトクリット値を測定した．*N. notopterus* でのこれらの測定値の年間変動をみると，どの項目も 4 月または 6 月に極大を示し，♂>♀ となった．年間平均値でみると，2 魚種の白血球数を除いて，他はいずれも ♂>♀ となった．これらの性別による差異の原因について論じた．