

AN INVESTIGATION ON
SOME ASPECTS OF THE ECOLOGY AND BIOLOGY OF A
HILL-STREAM FISH, *GARRA LISSORHYNCHUS* (McCLELLAND)

ABSTRACT

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A B S T R A C T

The lack of investigations on the biology and ecology of the fishes indigenous to the highlands of the North-Eastern Hill Regions of the country has led to a general paucity of scientific information which is necessary not only for academic purposes but also for the proper aquaculture management. Therefore, due to a virtual absence of such knowledge, a study has been undertaken to elucidate on the ecology and biology of the stone-licking torrential fish, Garra lissorhynchus (McClelland).

The study pertains to the specimens of the species collected from three different lotic systems viz.,

- (i) Umiam river - one of the major drainage systems of Meghalaya flowing by the western border of Shillong (25°5' Lat. and 91°9'E Long.) at 4,862 feet above sea level.
- (ii) Umkhras stream - a torrential hill stream flowing westwards and which for a major portion of its course passes through the town of Shillong, Meghalaya.
- (iii) Umshing stream - a torrential hill stream originating at Mampat village near Shillong and flowing in a somewhat north-westerly direction and approachable by road from near Umiam lake.

The results obtained during the present study have been presented in the present thesis entitled- "An investigation on some aspects of the ecology and biology of a hill-stream fish - Garra lissorhynchus (McClelland)".

The dissertation containing 243 pages inclusive of 34 tables and 41 figures has been divided into four chapters.

The first chapter deals with a general introduction pertaining to ecology of fish. The environment of the fish has been dealt with, in the second chapter which has been further divided into four sections. The first being an introduction of the limnological aspects with reference to work hitherto done on limnology in India, and a brief description of the study area. The second and the third sections share respectively the materials and methods applied for ecosystem analysis and results obtained on the abiotic factors viz., temperature, conductivity, pH, dissolved oxygen, free carbon-dioxide, alkalinity, phosphate, nitrate, silicate, calcium, magnesium, chloride, total hardness, calcium hardness and magnesium hardness and the biotic factors viz., periphytic algae and benthic organisms. Then follows the discussion on the abiotic and biotic factors along with their interrelationship.

The third chapter, which pertains to the study on the biology of Garra lissorhynchus has also been divided into four sections. The first section deals with an introduction to the biological studies on fishes with particular reference to the studies done so far in India on Garra. This is followed by diagnostic characters, taxonomic status and synonyms of the species. In the second section of the chapter, the materials and methods adopted for the biological studies of the fish have been presented. Then follows the third section dealing respectively with the results obtained on morphometric and meristic characters, length/mass relationship, condition factor, maturity and spawning, fecundity

and food and feeding habits of the fish. Then follows the fourth section in which discussion have been made reviewing the results obtained on the biology of the species.

In the fifth and final chapter, the summary and conclusion of the entire study has been presented. This is followed by the list of literature cited in the dissertation.

The following are the important results obtained during the present investigations and embodied in the thesis :-

(1) The water temperature varied from 12.2°C to 24.5°C and 12.5°C to 24.1°C respectively during 1979-80 in the Umiam and Umkhrach systems. In 1980-81, their respective range of fluctuation was from 11.2°C to 24.5°C and 12.8°C to 23.5°C, while the Umshing system registered a range of 10.0°C to 22.8°C. The water temperature of all the systems showed a close affinity with the atmospheric temperature.

(2) The conductivity values ranged from 44.0 to 58.0 μ mhos/cm and 17.2 to 56.52 μ mhos/cm during 1979-80 in the Umiam and Umkhrach systems respectively. During 1980-81, the respective range of values were from 42 to 59.0 μ mhos/cm and from 16.24 to 77.0 μ mhos/cm, while during the same period the range was from 26.0 to 52.0 μ mhos/cm in the Umshing system. The present study indicated that the conductivity values fluctuated widely in all the systems.

(3) The pH values too, have been observed to fluctuate widely ranging from 6.4 to 7.9 and 6.0 to 7.2 respectively in the Umiam

and Umkhrach systems in 1979-80. During 1980-81, the range was from 6.5 to 6.9 (Umiam) and from 5.9 to 7.2 (Umkhrach), while that of the Umshing stream was from 6.1 to 6.72. The pH values in all the three systems usually were found to be in the acidic range.

(4) Dissolved oxygen ranged from 6.4 to 9.28 mg/l and 5.6 to 11.4 mg/l respectively in 1979-80 in Umiam river and Umkhrach stream. In 1980-81, these values were found to range from 6.4 to 10.2 mg/l in Umiam river, 4.2 to 11.6 mg/l in Umkhrach stream, and 7.4 to 8.4 mg/l in Umshing stream. Dissolved oxygen showed an inverse relationship with temperature.

(5) The quantity of free carbon-dioxide varied from 1.3 to 5.0 mg/l and 3.5 to 9.5 mg/l in 1979-80 in the Umiam and Umkhrach systems respectively, whereas in 1980-81 the respective range was found to be 1.4 to 3.8 mg/l and 2.1 to 8.2 mg/l. During this period the fluctuations of free carbon-dioxide in the Umshing stream was from 2.8 to 4.0 mg/l.

(6) During 1979-80 the values of alkalinity in Umiam and Umkhrach systems varied respectively from 12.0 to 38.0 mg/l and 4.1 to 24.0 mg/l. In 1980-81, these values ranged from 16.0 to 26.0 mg/l and 4.1 to 28.0 mg/l respectively in the above systems while in the Umshing stream, the range was between 28.0 to 49.0 mg/l. Alkalinity values show an inverse relationship with free carbon-dioxide concentration.

(7) Phosphate content in Umiam and Umkhrach ranged from 0.32 to 0.9 mg/l and 0.118 to 0.89 mg/l respectively during 1979-80.

During 1980-81, the values fluctuated from 0.22 to 0.79 mg/l and 0.234 to 0.804 mg/l respectively in Umiam and Umkhrah systems, while the range was from 0.26 to 0.87 mg/l in the Umshing stream. The concentration of phosphate in all the three systems were found to be quite poor.

(8) Low concentration of nitrate have been detected in all the three systems. In 1979-80, the values ranged from 0.06 to 0.68 mg/l and 0.02 to 0.5 mg/l in the Umiam and Umkhrah systems respectively. The respective range of fluctuations during 1980-81 was 0.06 to 0.62 and 0.01 to 0.32 mg/l, while it was 0.08 to 0.62 mg/l in the Umshing stream. Nitrate showed an inverse relationship with oxygen content and temperature.

(9) The silicate content in Umiam and Umkhrah during 1979-80 was recorded to range from 0.2 to 2.45 mg/l and 0.35 to 1.88 mg/l respectively. In 1980-81 their respective range of fluctuations varied from 0.15 to 2.125 mg/l and 0.14 to 2.0 mg/l, while it was 4.26 to 6.0 mg/l in the Umshing stream. In all the three systems, silicate was found to vary inversely with alkalinity. An inverse relationship between silicate content and free carbon-dioxide has been observed in the Umiam and Umkhrah systems.

(10) During 1979-80, calcium values were found to vary from 4.775 to 2.70 mg/l and 1.3 to 4.6 mg/l respectively in Umiam and Umkhrah. The respective fluctuations for the above two systems during 1980-81 were from 2.80 to 4.80 mg/l and 2.10 to 4.95 mg/l, while in the Umshing stream, it was from 2.0 to 4.8 mg/l.

- (11) Magnesium values ranged from 1.2 to 2.15 mg/l and 0.7 to 1.6 mg/l respectively in Umiam and Umkhrah during 1979-80. In 1980-81 the respective ranges were 1.24 to 2 mg/l and 0.5 to 1.9 mg/l, while it was 1.42 to 3.3 mg/l in the Umshing stream.
- (12) Chloride values in Umiam and Umkhrah varied from 0.32 to 0.95 mg/l and 0.28 to 0.68 mg/l respectively during 1979-80. In 1980-81 the respective chloride values ranged from 0.21 to 0.92 mg/l and 0.22 to 0.75 mg/l. During this period the range was found to be from 0.37 to 0.90 mg/l in the Umshing stream. Chloride content was found to be low in all the three systems.
- (13) Total hardness levels during 1979-80 in Umiam and Umkhrah have been found to fluctuate from 14.5 to 36.0 mg/l and 8.4 to 22.0 mg/l respectively. Their respective range during 1980-81 was from 14.2 to 38.0 mg/l and 11.55 to 24.4 mg/l, while the Umshing stream waters showed a range of 18.4 to 26.34 mg/l during this period. Total hardness levels were comparatively poor in all the stations.
- (14) During 1979-80, the levels of calcium hardness varied from 10.0 to 22.0 mg/l in Umiam and from 6.2 to 15.4 mg/l in Umkhrah. Their respective fluctuations during 1980-81 were from 10.1 to 21.0 mg/l and from 8.1 to 15.3 mg/l, while in Umshing stream it was from 14.36 to 20.98 mg/l.
- (15) During 1979-80 the levels of magnesium hardness varied from 3.5 to 22.0 mg/l and from 1.67 to 11.0 mg/l in the Umiam and the Umshing systems respectively. The fluctuations of values during

1980-81 ranged from 2.2 to 20.0 mg/l and 1.0 to 10.8 mg/l respectively in the above two systems, while in the Umshing stream the levels of magnesium hardness fluctuations were from 3.59 to 5.81 mg/l. The peak levels of magnesium hardness were generally found to coincide with the peak levels of calcium and total hardness.

(16) In all the three systems true planktonic algae were scarce, but mostly were periphytic and their abundance has been observed to increase during the months of March to May.

(17) The benthic samples of the systems showed the presence of various insect groups.

(18) The factors found to affect the growth of periphytic algae are: temperature, pH, dissolved oxygen, free carbon-dioxide, alkalinity, phosphate, nitrate, silicate, calcium, magnesium and hardness of water.

(19) In the present study, morphological variations have been observed between three populations of G. lissorhynchus. A few of the morphological parameters viz., Fork length, Pre-dorsal length, Head width, Post-orbital distance, Diameter of the disc and Length of the caudal peduncle were found to be higher in the population of Umshing stream, whereas Least height of body, Inter-orbital width and Girth were observed to be higher in specimens from the Umkhrah stream. In the Umiam river population, parameters like Head length, Eye diameter, Body depth, Length of dorsal fin, Length of pelvic fin and Length of anal fin were found to be higher than other populations investigated. The regression

equations of the various parameters on the Standard length were found to differ from population to population.

(20) The length-weight relationship formulae of G. lissorhynchus from the three systems have been derived to be :-

$$\begin{aligned} \text{Log } W &= -4.957933 + 3.055714 \log TL \\ W &= 0.00001102 \quad \sphericalangle 3.0557 \\ r &= 0.994536 \end{aligned} \quad \left. \begin{array}{l} \text{X} \\ \text{X} \\ \text{X} \end{array} \right\} \text{(Umiar population)}$$

$$\begin{aligned} \text{Log } W &= -5.042796 + 3.125132 \log TL \\ W &= 0.000009061 \quad \sphericalangle 3.1251 \\ r &= 0.999446 \end{aligned} \quad \left. \begin{array}{l} \text{X} \\ \text{X} \\ \text{X} \end{array} \right\} \text{(Umkhrah population)}$$

$$\begin{aligned} \text{and, Log } W &= -4.843737 + 2.997391 \log TL \\ W &= 0.00001433 \quad \sphericalangle 2.9974 \\ r &= 0.999128 \end{aligned} \quad \left. \begin{array}{l} \text{X} \\ \text{X} \\ \text{X} \end{array} \right\} \text{(Umshing population)}$$

The regression equations of length-weight relationship for juveniles and adults from the three different populations have been worked out as has also been for length-weight of the populations during different seasons (viz. summer and winter). The regression and parabolic equations for males and females too, has been calculated.

(21) Condition factor varied from 0.9699 to 1.8994 in the Umiar river individuals and from 1.3372 to 1.7456 in the Umkhrah stream specimens. In the Umshing stream population, it varied from 1.2505 to 1.9034. Such variations have been attributed to different factors such as environmental conditions, food availability and gonadal maturity.

(22) Maturity studies indicated that G. lissorhynchus has one spawning season, i.e. from June to September. In all the populations, the ovaries of the species contained only one batch of maturing ova clearly demarcated from the immature stock.

It has been observed that 50% maturity (M_{50}) of specimens from Umiam and Umkhrah systems occur at the 60-64 mm length group, while the individuals of the Umshing stream attained M_{50} at the 55-59 mm length group.

(23) Gonado-somatic index (Gn.S.I.) calculations indicated that in G. lissorhynchus the spawning season lasts from June to September confirming the other results obtained for spawning season of the fish. It has also been observed that there is a tendency for Gn.S.I. to increase with the increase in total length of the fish.

(24) The fecundity of G. lissorhynchus has been found to range from 427 to 1808, 263 to 1410 and 210 to 1003 eggs in specimens from the Umiam, Umkhrah and Umshing systems respectively. The fecundity estimates suggest that the fish is highly fecund compared to other cyprinids of same size. Regression relationships between fecundity and various other parameters have been derived and presented in the text.

(25) Food items found in the digestive tracts of all the specimens examined have been demarcated in four broad groups :-

(a) Periphytic Bacillariophyceae (b) Chlorophyceae (c) Myxophyceae (d) Detritus. The major food of the species has been found to be periphytic algae belonging to the family of Bacillariophyceae.

Feeding intensity or G.S.I. was found to be higher in the individuals of smaller length groups in all the three populations. The relative length of the gut (R.L.G.) was found to range from 2.775 to 8.160, 2.663 to 8.050 and 2.550 to 5.850 in the individuals from Umiam, Umkhrah and Umshing systems respectively.

It may be inferred from the present investigation that unity of any fish and environment represents a system of adaptive relation between the species and the abiotic and biotic nature of their immediate environment. Hence, the successful existence and development of the fish depends on its adaptive interaction with its environment. The character of the interdependence of the fish to its environment, seems to be specific not only for various species, but also for different individuals of the same species. It is also clear that the dominant relations are not fixed, but are dependant on all other correlated factors of the system. They change during ontogenesis and may differ between populations of the same species.

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