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A CRITICAL ANALYSIS OF CORRELATION COEFFICIENT BETWEEN VARIOUS BODY MEASUREMENTS AND TOTAL LENGTH OF FISH [BOTIA ALMORHAE (GRAY)]

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ABSTRACT

Fish Botia almorhae is migratory fish that dwell and grow to maturity in major rivers before migrating upstream to spawn. The preceding studies focused on migration timing (rain), direction (upstream), and purpose (spawning). Fish Botia almorhae rise to great heights (2500 ft) during floods and travel great distances for the purpose of spawning. The fish ascend during the South-West monsoon floods because they can support Fish Botia almorhae during this time. The streams provide fresh feeding grounds and a suitable spot for laying their spawn, securing fry when they hatch in water that has shrunk to dimensions more suited to their little power than the deeper current of the lower river. The spawning journey takes place in August and September, with the spent fish returning in October and November. Upriver migration is stimulated by rising turbidity and current velocity. During the monsoon, the influx of ions likely triggers spawning activity. The subtropical to temperate Uttaranchal Himalaya contains a number of freshwater bodies. Among these bodies of water, creeks and rivers are home to a variety of flora and fauna with distinctive characteristics. These water bodies sustain a diverse array of native fish species. In terms of the academic and economic importance of the evolution of higher vertebrates, the fish's transitional stage plays a crucial role in the evolution of higher vertebrates. As they are abundant in nature, fish are not only useful for investigating the fundamentals of vertebrates, but also of great significance for experimental and all physiological studies. Thus, fishes constitute the most important group of vertebrates, exerting various influences on human existence. From an Thus, fishes constitute the most important group of vertebrates, exerting various influences on human existence. economic standpoint, fish is the most significant source of protein for the world's growing population, particularly in protein-deficient developing nations like India. With its products, the fishing industry also contributes significantly to employment and the socioeconomic well-being of society.

KEY WORDS: *Fish, Botia Almorhae, Migration, Ecosystems, Hemalayan Region.*

INTRODUCTION

The common name for members of the families Cobitidae and Balitoridae is "loach." Balitorinae fishes are referred to as "hill stream loaches," whereas Cobitidae fishes are commonly referred to as "loaches." These loaches are primarily found in both lentic and lotic bodies of water. Botia species (subfamily Botinae) are uncommon, Endangered, and Vulnerable, whereas other subfamilies of loaches (Nemacheilinae, Cobitinae, and Balitorinae) are numerous and of Least Concern. The Botia loaches are high-demanding species with both ornamental and economically significant food value, and they account for a significant portion of the global market for native fish with attractive colors. Loaches are listed as Endangered species. The Endangered status of the loaches is primarily due to the deterioration of the environment, specifically the water quality, which may be the result of agricultural runoff or the pesticide effect of tea gardens in the Terai and Dooars regions, and the fragmentation of large water bodies into smaller ones, which dries up the water. Botia species are regarded as superior ornamental fish, and are favored by villagers for ornamental fish cultivation. Botia almorhae, Botia lohachata, and Botia rostrata are extremely rare or infrequent in the Terai region throughout the year. Fish habitats are swiftly diminishing due to human activity and drought. Immediate rehabilitation of Botia species is necessary to prevent their extinction in the wild. In order to prevent the extinction of Botia species in this region, it is imperative that they be raised, bred in captivity, and developed embryonically as soon as possible. Reintroduction of captive-bred species into their native habitat is facilitated by captive reproduction. This technology is extremely beneficial for endangered species' survival in the wild.

For evaluating the commercial potentials of a fish's stock, life history, cultural practice, and actual management of small indigenous fishes, it is essential to examine its spawning behavior, embryonic development, and reproductive biology. The reproductive potential of a population is one of the fundamental requirements for classifying its members in terms of their reproductive health. Knowledge of the gonadal development and reproductive season of a species permits studies on the spawning frequency of its population, which is crucial for its management. For successful artificial propagation of a species, histological studies aid in identifying the reproductive season and identifying the phenotypic characteristics of mature brooders. Therefore, it is crucial to evaluate the annual reproductive cycle of loaches to ensure the success of their cultivation. The development of captive reproduction and seed production techniques for native fish species is another conservation strategy. This can be accomplished by restocking their natural habitat with hatchery-reared individuals; a viable alternative to capture fisheries for supplying fishing communities and local populations with a sustainable protein source.

The communities of aquatic vegetation and animals are known as aquatic ecosystems. Aquatic or aquatic environments are separated into fresh water and salt water branches of science that study the biological productivity of inland waters and the causal factors that determine it. Wetze defined it as the study of the structural and functional interrelationships of inland water organisms in response to their dynamic physical, chemical, and biotic environments.

Flowing fresh water ecosystems are termed lotic ecosystems due to the gravity-driven unidirectional water movement along a slope. Lotic environments are essential components of regional and global biogeochemical cycles, functioning as both transport pathways and sites of elemental transformations and storage, and as sources of potable water, fisheries resources, irrigation supplies, and waste removal systems. They are characterized by interactions between physical, chemical, and biological processes that increase in complexity as they progress.

RESEARCH METHODOLOGY

The valley of Kumaun is situated between 280-44'N and 300-49'N latitude and 780-45'E and 810 -5'E longitude with total area of 21,035 sq. Km. The freshwater fish known as Chital (Quarab) or Pattherchatti (Chaukhutiya) is scientifically known as Botia almorhae; Day collected specimens ranging in length from 8.0cm to 16.5cm and weight from 16.96 to 58.21gm monthly for two years from the Suyal and Ramganga river systems using a cast net. Botia almorhae fishes were primarily collected at Quarab (Suyal) and Chaukhutiya (Ramganga) of district Almora, Kumaun Himalaya (29036'N and 79040'N). The collection sites for these freshwater fishes were transported each month to the laboratories of the Zoology Department on the Soban Singh Jeena Campus of Kumaun University in Almora. The total length of Botia almorhae was measured to the nearest millimeter from the tip of the snout to the tip of the greatest caudal ray, and the fish was weighed to the nearest milligram before morphometric measurements were taken. In addition to sexual dimorphism, autopsy was used to corroborate the identification of a fish's gender.

MORPHOMETRIC EXAMINATION:

To determine the morphometric characteristics of the fish, eleven morphometric measurements were collected in relation to the fish's total length and standard length. On the premise of the description provided, the following parameters were determined:

Total length (TL): The greatest distance between the anteriormost protruding portion of the cranium and the posteriormost tip of the caudal fin, including any filamentous prolongations. The measurement is measured along

a straight line and not along the body's curves. Where one lobe of the caudal fin is longer than the other, the maximal length is measured. In cases where the jaws are unequal, the mouth is closed and measured from the longer jaw's point.

Standard length (SL): The straight distance from the anteriormost portion of the head to the end of the vertebral column; in actuality, the flexure line of the body over the caudal peduncle is considered the posteriormost point.

Body depth (BD): The vertical measurement from a point on the fish's back where its height is greatest to the ventral surface or profile. The fleshy or scale-like structures of fine bases are excluded. It does not have to be in the center of the animal.

Head length (HL): A direct measurement of the distance between the tip of the snout and the most distant point on the opercular membrane on the upper angle of the gill orifice. Any fleshy membrane of the gill cover is also included.

Head height or depth (HD): The distance measured perpendicularly from the midline at the occiput vertically downward to the ventral contour of the head or breast. In actual practice, one arm of the divider is positioned at the occipital crest and the other arm is positioned below the head, vertically perpendicular to the upper arm, to form a vertical line. This measurement, unlike body depth, does not extend to the ventral profile line.

Length of the caudal penduncle: An oblique measurement from the posteriormost contact point of the anal fin to the end of the vertebral column or the flexure line of the body over the caudal peduncle.

Length of the head including snout /Post orbital distance (PsOD : The longest distance between the posterior margin of the orbit and the posterior point of the fleshy operculum.

Head width (HW): is the straight distance across the head in a ventral position; if the opercula are dilated, they are forced into a relatively normal position.

Interorbital width (IOW): The minimum distance between the interior margins of the eyes and the bony rims of the orbits.

Diameter of the eye (ED): The distance between the cartilaginous eye ball's outer and inner margins across the cornea.

Predorsal length (PrDL): A straight measurement from the midpoint or apex of the snout, upper lip, or anterior head region to the structural base of the anteriormost dorsal fin ray. In vertebrates with a dorsal spine, the dorsal fin's basal bone serves as the structural foundation.

The external characteristics include fins, scales, barbells, profiles, and lateral line scales.

1. **Length of the anal fin (LAF):** The greatest distance in a straight line between the most anterior and most posterior regions of the body's junction.

2. Length of the pectoral fin (LPF): The largest ray of the fish.

3. Length of the Caudal fin (LCF): The length of its greatest fin ray.

4. Length of the rostral barbel (LRB): The rostral barbel's length is measured from its base to its apex.

5. Length of the maxillary barbell (LMB): The length of the maxillary barbell is measured from its base to its apex.

Jayaram examined the data. Various biostatistics were utilized (correlation coefficient, regression coefficient, and analysis of variance (ANOVA) to determine differences between means (for homogeneity of variance), and correlation and regression analysis was performed on the measurements. The significance of the correlation coefficient (r) and regression coefficient (b) was examined. Then, the data were used to compute the regression equation for each development variable (y1-y31) in order to suit the straight-line equation.

RESULTS AND DISCUSSION

1. **Female Botia almorhae:** • Taking TL as independent variable, the 'r' value ranged from 0.022631 to 0.944129, when correlated with other characters for female Botia almorhae showed a significant correlation with SL (0.944129) ,PrDL (0.935296), LPvF (0.865506), LDF (0.820375), HPvF(0.792086),HDF (0.754296), HL (0.743976), LAF (0.720115), LPF (0.698326), HAF (0.666137), HPF(0.636934), PsDL (0.565919) and DisPP(0.549347), (Table-1) and Fig. 1).

• Using SL as the independent variable, the 'r' value ranged from 0.1978 to 0.965638, indicating a significant correlation with PrDl (0.965638), TL (0.944128), LAF (0.857755), LPvF (0.80501), HPvF (0.804304),HAF (0.765998), LPF (0.741004), DisPP (0.69893), HPF(0.647116), LDF(0.599932),

2. **Male Botia almorhae:** • Taking TL as independent variable, the 'r' value ranged from - 0.232677 to 0.997281, when correlated with other characters for male Botia almorhae showed a significant correlation with PrDL (0.997282), SL (0.985523), LDF (0.984195), HDF (0.889004), HL (0.862551), LPF (0.85491), MBD (0.792583), LCF(0.792583), HCF(0.751285), LAF (0.724559), HPvF(0.627523), PsDL (0.590757), HAF and HAF (0.506492) (Table and Fig.).

• Taking SL as independent variable, the 'r' value ranged from 0.173055 to 0.995264, when correlated with other characters for male Botia almorhae showed a significant correlation with LDF (0.995264), TL (0.985523), PrDL (0.972035), HL (0.895941), MBD (0.859613), LCF (0.859613), HCF (0.811701), HDF (0.80227), LPF (0.75759), LAF (0.73086), PsDL (0.716655) and HPvF(0.581748).

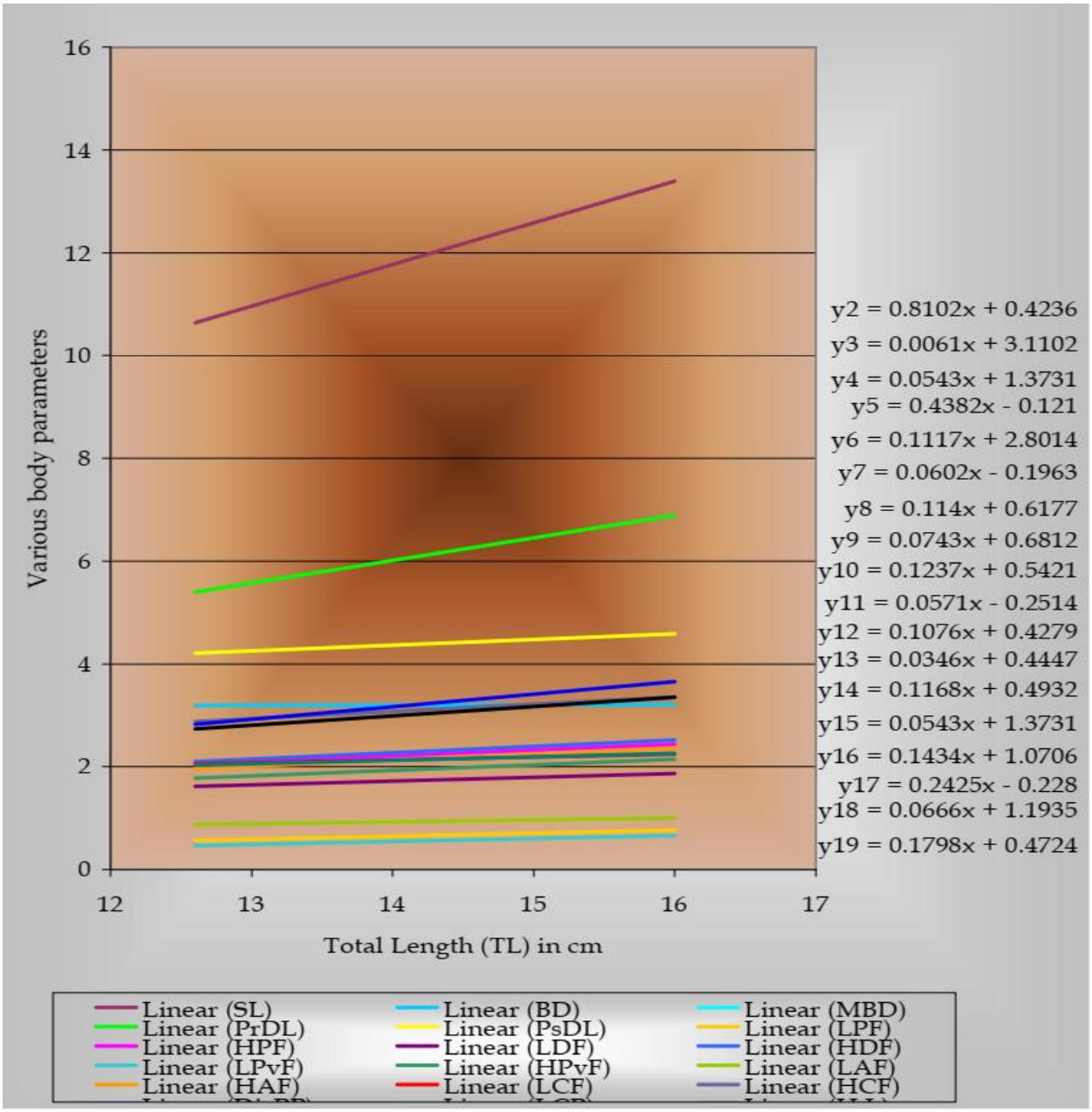
• Taking HL as independent variable, the 'r' value ranged from - 0.2637 to 0.9979, when correlated with other characters for male Botia almorhae showed a significant correlation with LSbOs2 (0.99794), PsOD (0.948847), PrOD (0.948847), LuRB (0.946729), LlMB (0.870368), LuMB (0.851852), ED (0.851852), IOD (0.838052), LlRB (0.831704) and LSbOs1 (0.70565).

Table 1: demonstrates the correlation coefficient between various body measurements and total length for Botia almorhae (Gray).

Serial Number	Character Variables (Dependent variables 'Y-axis').	r-value (correlation coefficient) in relation to total length(Independent variable 'X-axis').		
		Female	Male	General
1.	SL -y2	0.944129	0.985523	0.94112
2.	BD -y3	0.022631	0.350088	0.19552
3.	MBD -y4	0.453348	0.792583	0.56238
4.	PrDL -y5	0.935296	0.997281	0.95509
5.	PsDL -y6	0.565919	0.590757	0.50577

6.	LPF -y7	0.698326	0.854910	0.00520
7.	HPF -y8	0.636934	0.430100	0.53471
8.	LDF -y9	0.820375	0.984195	0.88423
9.	HDF -y10	0.754296	0.889004	0.83482
10	LPvF -y11	0.865506	0.401900	0.31385
11.	HPvF -y12	0.792086	0.627523	0.70163
12.	LAF -y13	0.720115	0.724559	0.59168
13.	HAF -y14	0.666137	0.506492	0.54882
14.	LCF -y15	0.453348	0.792583	0.56238
15.	HCF -y16	0.353130	0.751285	0.31469
16.	DisPP -y17	0.549347	0.276163	0.32807
17.	LCP -y18	0.324893	0.232677	0.22454
18.	HL -y19	0.743976	0.862551	0.81854

• Taking TL as independent variable, the 'r' value ranged from - 0.0052 to 0.95509, when correlated with other characters for Botia almorhae showed a significant correlation with PrDL (0.95509), SL (0.94112), LDF (0.88423), HDF (0.83482), HL (0.81854), HPvF (0.70163), LAF (0.59168), MBD, LCF (0.56238), HAF (0.54882), HPF (0.53471) and PsDL (0.50577)((Table -1 and Fig.1.



Figg. 1. Correlation of different body parameters on the total length offemale *Botia almorhae.*

Table – 2: Morphometric analysis of ***Botia almorhae*(*Gray*):** correlation coefficient ofvarious body measurements with standard length.

Serial Number	Character Variables (Dependent variables	r-value (correlation coefficient) in relation to standard length(Independent variable 'X-axis').

	'Y-axis').	Female	Male	General
1.	TL -y1	0.944129	0.985523	0.941121
2.	BD -y3	0.019780	0.471922	0.316227
3.	MBD -y4	0.244195	0.859613	0.626882
4.	PrDL -y5	0.965638	0.972035	0.968694
5.	PsDL -y6	0.523311	0.716655	0.651764
6.	LPF -y7	0.741004	0.757590	0.003190
7.	HPF -y8	0.647116	0.331375	0.423933
8.	LDF -y9	0.599932	0.995264	0.776882
9.	HDF -y10	0.513169	0.802708	0.690692
10	LPvF -y11	0.805010	0.243010	0.326023
11.	HPvF -y12	0.804304	0.581748	0.653879
12.	LAF -y13	0.857755	0.730860	0.715073
13.	HAF -y14	0.765998	0.436177	0.575449
14.	LCF -y15	0.244195	0.859613	0.626882
15.	HCF -y16	0.027922	0.811701	0.108735
16.	DisPP -y17	0.698930	0.173055	0.444239
17.	LCP -y18	0.046594	0.331375	0.171758
18.	HL -y19	0.570532	0.895941	0.762749

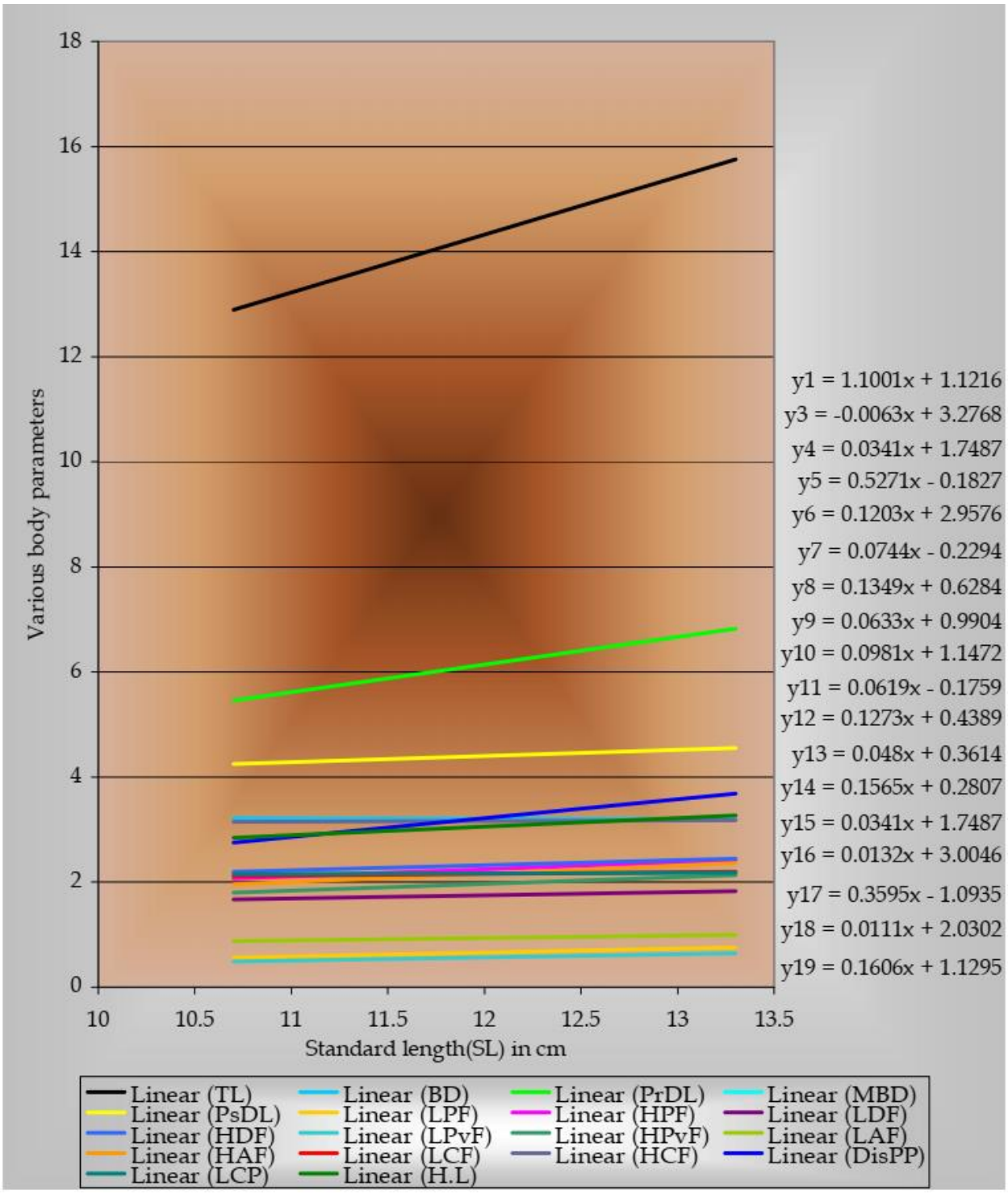


Fig. 2. Correlation of different body parameters on the standardlength of female *Botia almorhae*

Table 3: Morphometric analysis of ***Botia almorhae*(*Gray*):** correlation coefficient of various body measurements with head length.

Serial Number	Character Variables (Dependent variables 'Y-axis').	r-value (correlation coefficient) in relation to head length(Independent variable 'X-axis').		
		Female	Male	General
1.	HH -y20	0.585366	0.263728	0.336369
2.	HW -y21	0.024050	0.425933	0.179557
3.	PrOD -y22	0.359425	0.948847	0.767415
4.	PsOD -y23	0.135790	0.948847	0.553192
5.	ED -y24	0.533114	0.851852	0.696792
6.	IOD -y25	0.442727	0.838052	0.683522
7.	LlRB -y26	0.533114	0.831704	0.665235
8.	LuRB -y27	0.385496	0.946729	0.768690
9.	LSbOs1 -y28	0.132450	0.705650	0.441920
10	LSbOs2 -y29	0.573539	0.997940	0.822541
11.	LlMB -y30	0.811107	0.870388	0.82909
12.	LuMB -y31	0.561951	0.851852	0.533238

Botia almorhae, in general (combined)

• Taking SL as independent variable, the 'r' value ranged from - 0.00319 to 0.968694, when correlated with other characters for Botia almorhae showed a significant correlation with PrDL (0.968684), TL (0.941121), HDF (0.776682), HL (0.762741), LAF (0.715073), LDF (0.690692), HPvF (0.653874), PsDL (0.651764), MBD , LCF (0.626882) and HAF (0.575449).

• Using HL as the independent variable, the r-value for Botia almorhae ranged from -0.1796 to 0.82991, indicating a significant correlation with LlMB (0.8291), LSbOs2 (0.8225), LuRB (0.7687), PrOD (0.7674), ED (0.6968), IOD (0.6835),LlRB (0.6652), PsOD (0.5532), and LuMB (0.5332).

CONLUSION

A typical fishery in tropical waters may lead to harvest of rich diversity of ichthyospecies. Each species often consists of several local groups with a distinct genetic make-up. It could be a little difficult for detailed study of each group. There could be uncertainties with all scientific endeavours to monitor abundance and productivity of stocks and the underlying causes. Further, there are uncertainties with regard to climate, aquatic ecosystem productivity, predation and fishing pressure. Managing for ichthyodiversity provides a useful clue against these uncertainties because it represents the epitome of water stewardship, quite distinct from simply maintaining reliable stocks of individual species. Fishermen and ichthyologists have a critical role to play in understanding and protecting diverse fish resources. Concomitant to the above, the ongoing process of ecosystem change, as is evident in lake Sone today, directly or indirectly affects the abundance and composition of the fish species; and, is, to a large and increasing degree, due to human activities which are sometimes unconnected to fisheries. Such increasing impacts of other human activities on the Sone Beel ecosystem highlights the need for a regional aquatic ecosystem approach to fisheries management including water-use patterns. The state of the fish community may be seen as a valid integrative indicator of aquatic ecosystem quality and health; and, little more distantly, may be viewed as a regional quality of life for the human beings.

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