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ASSESSMENT OF BREEDING CAPACITY AND SEX-RATIO OF *Barilius barna* (HAMILTON) IN SPRING-FED TAMSA STREAM,GARHWAL REGION, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study deals with the assessment of breeding capacity of *Barilius barna* in the spring-fed Tamsa stream of Garhwal region (Lat.30°21'25.84"N and Lon.78°01'00.45"E), India. It was found that the absolute fecundity of this species were varied depending on the sizes, the lowest was 401 and highest 1395 recorded in 51 mm to 82 mm fish sizes respectively. The breeding capacity was mostly dependent on the ovary length than any other body parameters. The maximum sex composition was noticed 1.00 male: 1.50 female in the month of April whereas the lowest was observed as 1.25 male: 1.00 female in the month of December and the overall, sex-ratio was recorded 1.00 male: 1.08 female.

Keywords: *Barilius barna;* breeding capacity; Sex-ratio; Garhwal Region; India.

1. INTRODUCTION

The minor carp, *B.barna* locally know as "Chilkari" is an ornamental fish. It was found to inhabit the sandy and pebbly bottom of the hill-stream of Tamsa River. The species belonging to the order Cypriniformes and family Cyprinidae is a preferable cultivable fish species. Body compressed, ventral portion is more convex than the dorsal side. Its mouth is moderate and barbells are absent. Fish body with 7-11 lateral dark bluish bands. The present fish specimens bear 7 to 10 dark bluish bands.

Information about breeding capacity or fecundity of a fish is necessary for evaluating the commercial potentialities of its stock, life history, practical culture

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and actual management of the fishery [1,2]. Fecundity may vary as a result of various adaptations to environment habitat even within a given species [3]. Studies on the fecundity of fishes were very helpful in understanding their breeding capacity [4]. Several workers have done very good work on the breeding biology of fish viz. breeding capacity or fecundity, sex ratio [5-34], sexual dimorphism [35-37] and maturation biology [38-45]. Some preliminary work were reported on this species, pre and post changes of ovary, extrusion of nuclei and fate of yolk nucleus [46-47]. The present study helps to standarzied the absolute fecundity of this commercially important both food fish as well as an ornamental fish in Garhwal region.

2. MATERIALS AND METHODS

2.1 Study Area

Sampling was done in Tamsa stream, located in the North-Eastern part of the Doon Valley between 30°21'25.84"N Latitude and 78°01'00.45"E Longitude.

2.2 Sampling Methods

Ninety-Nine specimens of *B.barna* were collected from April 2020 to March 2021. Local fishermen used conventional fishing methods; like cast net, gill net and dragnet [48-53]. Recorded all datas like total fish length (mm), weight (mg), ovaries length (mm) and weight (mg) from freshly collected specimens. The fish ovaries were dissected out and fixed it in 5% formalin solution. After proper hardening, kept it on filter paper for 30-45 minutes to absorbed excess water. The weight and volume of the preserved ovaries were carefully noticed. The sub-samples from the anterior, middle and posterior regions of both the ovaries were mixed and subjected to gravimetric [54]. The relationship between breeding capacity and other body parameters were obtained by the least square test, using the formula as: Y = a + bx, Where Y = (breeding capacity, dependent variable), x = Body parameters (independent variables); a = Slope and b = Intercept.

The numbers of fish samples were segregated based on their gender (male and female) to find out the percentage composition of each sex. This helped to understand the distribution of gender in different month-wise sex population structures. Sex ratio was determined for the entire period of study and its significance was tested by Chi-Square test (χ^2) using this equation:

$$\chi^2 = \Sigma (O-E)^2/E,$$

Where;
O = observed value
E = expected value.

Significance was determined by using table value at $F_{0.05}$ variable.

3. RESULTS

Total 99 individuals were collected and out of which 50 were females and the rest 49 were males.

The information regarding breeding capacity is presented in Table 1.

(1). Breeding capacity (BC) and Fish Length (FL): The minimum breeding capacity was 401 for a fish measuring 51mm and the largest specimen of 82 mm had the maximum breeding capacity of 1396. The relationship is shown in Fig. 1. The relationship between breeding capacity and total length of fish can be expressed as

BC = -1008.2+27.431 FL, r = 0.9556

Where F = fecundity and FL = Fish length in mm.

(2). Breeding capacity (BC) and Fish Weight (FW): The data relating to fish weight and breeding capacity were plotted in Fig. 2. The relation between fish weight–breeding capacity was found to be BC= 72.596+ 0.1325 FW, r = 0.9707

(3). **Breeding capacity (BC) and Ovary Length (OL)**: Breeding capacity increase with an increase in the length of ovaries (Fig. 3). This relation can be expressed as:

BC = -909.63 + 82.242 OL, r = 0.9960

(4). **Breeding capacity (BC) and Ovary weight (OW):** In order to study this relationship the breeding capacity values were plotted against the ovaries weight (Fig.4).Where fecundity were 401 and 1395 in 195 mg and 526 mg weight of ovaries respectively. The relationship between breeding capacity and ovary weight can be expressed as:

BC = 4382 + 36.016 OW, r = 0.9752.

Month wise sex ratio of *B.barna* was showen (Table 2) from April, 2020 to March, 2021. The maximum sex composition was noticed 1.00 male: 1.50 female in the month of April whereas the lowest was observed, 1.25 male: 1.00 female in the month of December. Overall, in the present study, sex-ratio was recorded 1.00 male: 1.08 female in river Tamsa.

Table 1. Breeding capacity of *B. barna* in spring fed Tamsa stream during April, 2020 to March, 2021

S.No.	Total Fish Length (mm)	Fish Weight (mg.)	Ovary Length (mm)	Ovary Weight (mg.)	Breeding Capacity
1	51	2549.78	16	195	401
2	52	2689.12	16	197	413
3	52	2799.37	17	218	456
4	53	2895.44	17	256	481
5	54	2954.87	17	279	492
6	54	2999.21	17	298	511
7	55	3289.58	18	296	578
8	56	3451.13	18	312	587
9	58	3749.38	18	310	580
10	60	3997.47	18	329	591
11	62	4557.56	19	341	654
12	65	4964.25	19	368	686
13	69	5769.68	20	389	693
14	71	6535.39	21	397	786
15	73	7024.51	23	423	943
16	77	7893.27	25	499	1124
17	79	8567.59	26	544	1287
18	82	8986.67	28	586	1395

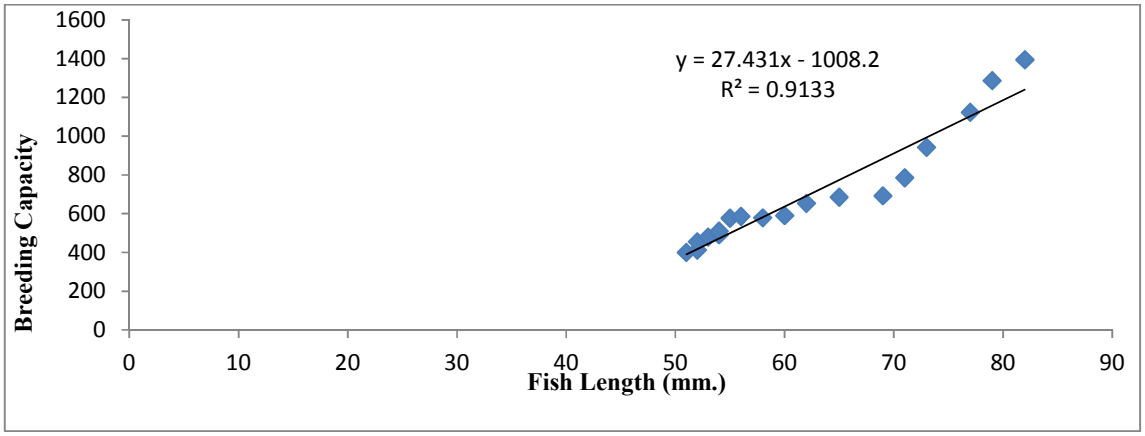

Fig. 1. Relationship of Breeding Capacity with fish length of *Barilius barna*

Table 2. Month wise Sex ratio of *B.barna* during April, 2020 to March, 2021 from spring fed river Tamsa

Month	Total no. of fishes	Male	Female	% Male	% Female	Ratio Male	Ratio Female	Chi square	Remarks
Apr., 2020	10	04	06	40.00	60.00	1.00	1.50	0.200	NS
May, 2020	11	05	06	45.45	54.55	1.00	1.20	0.045	NS
Jun., 2020	12	06	06	50.00	50.00	1.00	1.00	0.000	NS
Jul., 2020	10	05	05	50.00	50.00	1.00	1.00	0.000	NS
Aug.,2020	04	02	02	50.00	50.00	1.00	1.00	0.000	NS
Sept.,2020	05	03	02	60.00	40.00	1.50	1.00	0.100	NS
Oct., 2020	06	03	03	50.00	50.00	1.00	1.00	0.000	NS
Nov.,2020	07	04	03	57.14	42.86	1.33	1.00	0.071	NS
Dec.,2020	09	05	04	55.56	44.44	1.25	1.00	0.055	NS
Jan., 2021	08	04	04	50.00	50.00	1.00	1.00	0.000	NS
Feb.,2021	07	03	04	42.86	57.14	1.00	1.33	0.071	NS
Mar.,2021	10	05	05	50.00	50.00	1.00	1.00	0.000	NS
Total	**99**	**49**	**50**	**49.49**	**50.51**	**1.00**	**1.08**	**0.005**	NS

**NS= Non-significant*

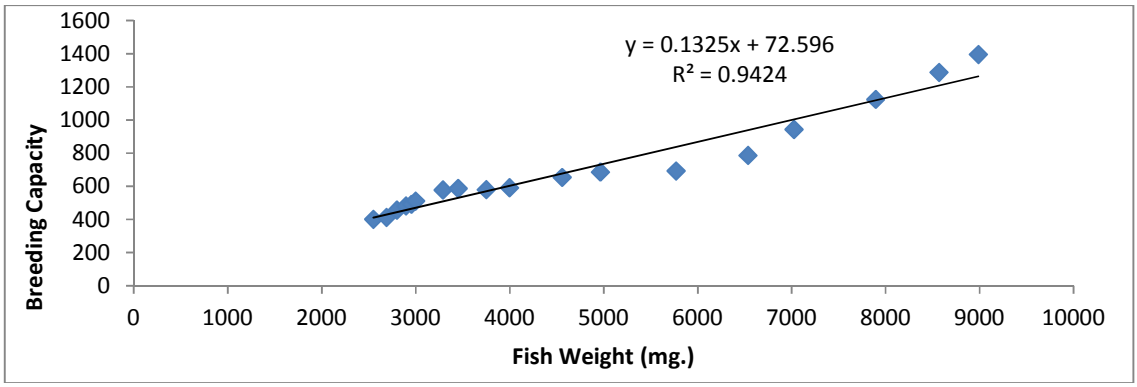

Fig. 2. Relationship of Breeding Capacity with fish weight of *Barilius barna*

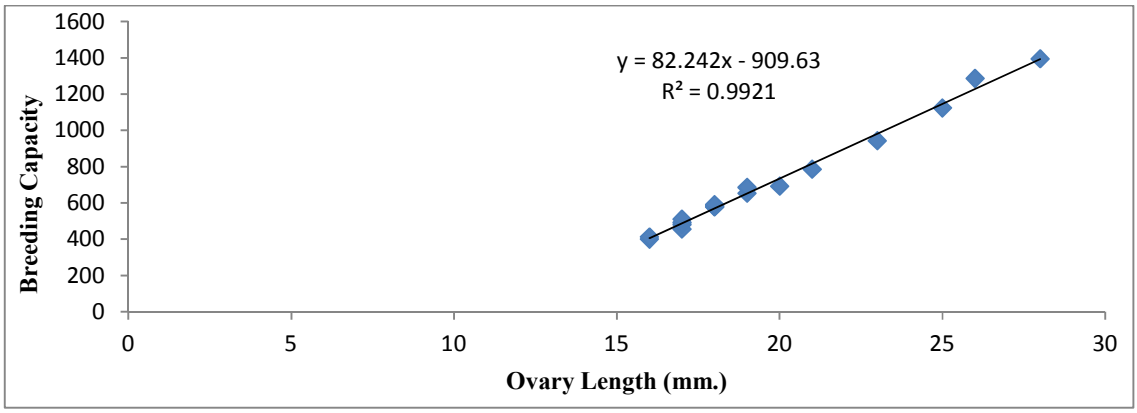

Fig. 3. Relationship of Breeding Capacity with ovary length of Barilius barna

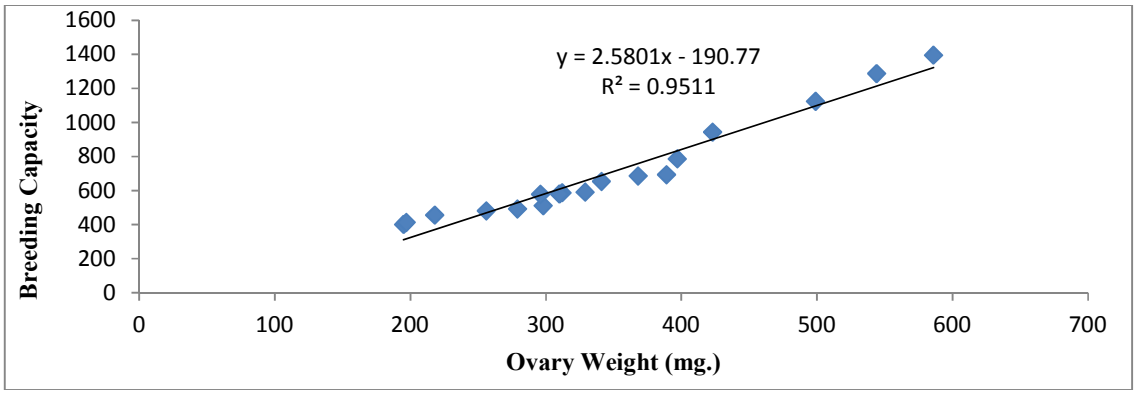

Fig. 4. Relationship of Breeding Capacity with Ovary weight of Barilius Barna

4. DISCUSSION

The knowledge of breeding capacity, its mathematical relationship, with the body parameters and sex-ratio is considered very useful in fishery sciences, as it provides prior information regarding number of eggs that are likely to be received for hatching process and further management of nursery, etc.[44]. Fecundity may vary over time within species, albeit the variation seems to be relatively modest [55,56]. More fecundity also increase with size within species but it will only worsen the problem by affecting mainly the large one [57]. Nonetheless, fish living under different conditions may differ in fecundity. The present

work indicated that breeding capacity was more closely related to ovary length and ovary weight than fish body weight and fish length. Therefore ovary weight is more predictor of breeding capacity than fish body weight. Several previous studies indicate ovary length to be a better indicator of breeding capacity than other body parameters [20,58].

The fecundity of fish by an individual female is dependent upon various factors like age, size, food availability, space, climate condition, season, environmental factors, habitat, nutritional status and genetic potential [59]. Dobriyal and Singh [13] calculated higher fecundity (900–5048eggs) in *B.bendelisis* from Garhwal Himalayan. Rautela [60], while working on *Glyptothorax telchitta* observed the fecundity of catfish as 1208 to 7472 in the body length of 71 to 133cm. The reproductive capacity of *B. vagra* was calculated by Bahuguna et al. [17] from Garhwal region ranging from 510 to 7214 eggs in the fish measuring 55 mm to 89 mm in total length and 407 mg to 4260 mg ovarian weight. Bahuguna et.al, [16] reported a high fecundity of 360 to 1727 for hill stream minor carp *Puntius conchonius.*

Bahuguna et al. [16] worked on the fecundity of *Puntius conchonius* and correlated it with various body parameters and reported that the fecundity had a general linear relationship with all the body parameters. It is evident that the ecological conditions of rivers play a vital role in the development, maturation and fecundity of fish. The reproductive potential of spring-fed river fish is generally good due to the moderate temperature range and good availability of food in nature.

The sex ratio comprises essential data in surveying reproductive potential in fish population [61]. Holcik et al. [62] expressed hypothetically, the normal composition of male to female is 1:1. In the present study about *B.barna*, it is observed that the sex organization is not equivalent consistently throughout the year but overall observations were showed that this species population quite natural one in Tamsa river. In the present work, it was found that the sex composition is somewhat predominant towards female (1.00 male : 1.08 female). Dominance in population preferring any of two sexes relies on the climate and versatile abilities of the type itself. Nasar and Biwas [63] showed a 1:1 sex composition in *Puntius stigma* and *Puntius clavatus* respectively. Rautela [60] established that the sex composition in *Glyptothorax telchitta* and *Garra lamta* was 1:1.052 and 1:1.18 (Male:Female) respectively. As per Bahuguna and Dobriyal [4] the sex arrangement was very normal in *Puntius conhonius* (1:1.17/M:F) from Mandal river. The sex composition of *Barilius varga* was noticed to be 1.29:1 (M:F) from Mandal river around Garhwal region [17]. Nikolsky [64] reported that the optimum sex organization may change radically by numerous elements. He additionally proposed that various population possessing diverse locality shows distinctive sex proportion [65].

5. CONCLUSION

Good breeding capacity was noticed in *B. barna* and it was estimated from 401 to 1395 in this study. On the basis of the present observations, we can conclude that a 1.00 male: 1.08 female sex ratio population is quite natural one in *B.barna* from River Tamsa.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lagler KF. Enumerations of fish eggs. In freshwater fishery biology. 2nd Edn. W. M. Brown company publishers. Dubuque. 1956; 106-110.
2. Doha S, Hye MA. Fecundity of Pandma river Hilsa (*Hilsa ilisha*). Pakistan J. Sci. 1970;22: 176-184.
3. Witthames PR, Green Walker M, Dinis MT, Whiting CL. The geographical variation in potential annual fecundity of dover sole, *Solea solea*, from European shelf water during 1991. Netherlands Journal of Sea Research; 1995.
4. Bahuguna P, Dobriyal AK. Biology of the ornamental fish *Puntius conchonius* (Ham.-Buch.). Narendra Publishing House, Delhi (India). 2019;1-228.
5. Sarojini KK. Biology and fisheries of the grey mullets of Bengal. I. Biology of Mugil parsia (H a m.) with notes on its Fishing in Bengal , India J. Fish. 1957;4:160-207.
6. Swarup K. The fecundity of Indian Shard, Hilsa ilisha, J. Zool. Soc. 1962;13:108-112.
7. Das SM. A Study on the fecundity of some freshwater fishes of India with a note on the new concept of comparative fecundity Icthyologica. 1964;3:33-36.
8. Chonder SL. Fecundity and its role in racial studies of *Gudusia chapra* (Pisces: Clupidae). The Proceedings of the Indian Academy of Sciences. 1977;86:245-254.
9. Joshi SN, Khanna SS. Relative fecundity of *Labeo geonius* (Ham.) from Nanaksagar reservoir, Proc. Ind. Acad. Sci. (Animal Sci.), 1980;89:493-503.

10. Thorpe JE, Miles MS, Keau DS. Development rate, fecundity and egg size in Atlantic Salmo salar. L. Aquaculture. 1984;43:299-305.
11. Singh HR, Nauriyal BP, Dobriyal AK. Fecundity of a hill stream minor carp *Puntius chilinoides* (McClelland) from Garhwal Himalaya; Proc. Indian Acad. Sci., 1982;91(5): 487-491.
12. Hoda MS, Akhtar Y. Maturation and fecundity of mudskipper *Baleopthalmius dentatus* in the Northern Arabian sea. Indian J. Fish. 1985;32(1): 64-73.
13. Dobriyal, AK, Singh HR. The reproductive biology of a hillstream minor carp *Barilius bendelisis* (Ham.) from Garhwal Himalaya, India. Vestnik Ceskoslovenske Spolecnosti Zoologicke. 1987;51:1-10.
14. Bhutiyan AS, Islam MN. Fecundity of *Xenentodon cancila* (Hamilton) (Belonidae: Beloniformes). Environment and Ecology India. 1990;8(5):1004-1007.
15. Kumar K, Bish, KL, Dobriyal AK, Joshi HK, Bahuguna Pankaj, Goswami S, Badoli VP, Thapliyal A. Fecundity and sex ratio in a rare hill stream fish *Botia dayi* Hora from Garhwal Himalaya, Uttaranchal. Uttar Pradesh J. Zool. 2006;26(23):271-276.
16. Bahuguna P, Joshi HK, Dobriyal AK. Fecundity and sex ratio in *Puntius conchonius* (Pisces; Cyprinidae) from Garhwal Himalaya. Environmental conservation Journal. 2007;8(1-2):37-43.
17. Bahuguna P, Kumar R, Shah KK. Breeding power and sex-ratio in *Barilius vagra* (Ham.) from spring fed river Mandal, Garhwal Himalaya, India. Aquacult. 2009;10(2):279-283.
18. Bahuguna P, Kumar R, Shah KK. Studies on the reproductive capacity and sex ratio in a hill – stream local fish *Noemacheilus denisoni* Day from river Mandal of Garhwal Himalaya, Uttarakhand. Uttar Pradesh J. Zool. 2010;30(1): 71-76.
19. Dobriyal AK, Thapliyal A, Joshi HK, Bahuguna P, Balodi VP. Biology and Growth dynamics of hill stream catfish *Pseudecheneis sulcatus* (McClelland) from Uttarakhand, India. Essence J. 2010;1:34-42.
20. Joshi HK, Bahuguna P, Kotnala CB, Kumar S. Reproductive power of a hill stream loach sune machi, *Lepedocephalythys guntea* (Hamliton) from mountain region Garhwal, Central Himalaya, India. Aquacult. 2010;11(1):115-118.
21. Bahuguna P, Kumar R. Fecundity of fresh water Prawn *Macrobrachium assamense peninsularie* from Khoh River, India. Essence J. 2011;2(1): 1-7.
22. Bahuguna P, Kumar R. Sex composition analysis of a Himalayan cold water cat fish *Pseudechenies sulcatus* (McClelland) in the eastern ram Ganga River, Uttarakhand, India. J. Natcon. 2011;23 (1):105-110.
23. Krishan R, Dobriyal AK, Bisht KL, Kumar R, Bahuguna P. Population ecology of the Indian torrent catfish, *Amblyceps mangois* (Ham.-Buch.) from Garhwal Uttarakhand, India. Int. J. Environ. Rehabi. and Conserv. 2011;2(2):23-28.
24. Bahuguna P, Joshi HK, Kumar R. Sex population status of *Lepedocephalythys guntea* (Hamilton) in the lotic water body of Pauri Garhwal. Uttar Pradesh J. Zool. 2011;31(1): 349-355.
25. Bahuguna P, Kumar R. Breeding capacity observation of Snow fed water catfish *Pseudechenies sulcatus* (McClelland) of the Eastern Ram Ganga river from Kumaun region, Uttarakhand. Aquacult. 2011;12(1):93-98.
26. Krishna K, Dobriyal AK, Bahuguna P, Fecundity of *A mblyceps mangois* (Hamilton-Buchanan) from Garhwal Himalaya. J. Mountain. Res. 2011;6:121-128.
27. Bahauguna, P. Observation on the reproductive capacity of wild major carp *Labeo dyocheilus* from Kumaun Himalaya, India. Essence J. 2012; 3(1):1-7.
28. Dobriyal AK. Conservation biology of cobitid fish *Lepidocephalus guntea* (Hamliton-Buchanan): Reproductive potential J. Sustn. Env. Res. 2012;1(2):101-105.
29. Bahuguna, P. Sex population structure of *Macrobrachium assamense peninsularie* (Tiwari) (Crustacea, Decapoda, Palaemonidae) in Khoh River, Uttarakhand, India. Int. J. Curr. Microbiol. App. Sci. 2013;2(10):382-390.
30. Joshi A, Kumar P, Kujwal SS, Bahuguna P. Sex ratio of *Noemacheilus montanus* (*Mcclelland*) from Pithoragarh district, Uttarakhand, India. Int. J. Curr. Microbiol. App. Sci. 2014; 3(12):761-767.
31. Bahuguna P, Sharma V, Rayal R, Negi S. Reproductive potential of *Puntius ticto* in foot hill river Aasan from Doon valley, India. J. Env. Bio.-Sci. 2021;35(1):
32. Rayal R, Goel S, Sharma N, Joshi HK, Bahuguna P. Fecundity of the snow fed minor carp *Barilius bendelisis* (Ham.) (Pisces: Cyprinidae) from River Yamuna, India. Uttar Pradesh Journal of Zoology. 2021;42(8):70-76.
33. Rayal R, Sharma V, Bahuguna P, Mamgain D. Sex- ratio structure of P*untius ticto* in spring fed River Aasan from District-Dehradun, Uttarakhand, India. Uttar Pradesh Journal of Zoology. 2021;42(12):49-53.

34. Rayal R, Goel S, Joshi HK. Observation of sex ratio *Barilius bendelisis* (Ham.) in Snow fed river Yamuna from Doon Valley, Uttarakhand, India. J. Env. Bio.-Sci. 2021;35(1).
35. Dobriyal AK, Bahuguna PK, Uniyal SP, Joshi HK. Sexual dimorphism in the Cyprinidae fish *Puntius conchonius* (Ham.-Buch.). J. Bom. Nat. Hist. Soc. 2007;104(2):227-228.
36. Bahuguna P, Kumar S, Kumar R, Joshi HK, Verma R. Studies on sexual dimorphism in the cyprinidae fish *Puntius ticto* (Hamilton-Buchanan) from Kumaun Himalaya, India. Essence. J. 2010;1(2):88-93.
37. Bahuguna P, Kumar R. Studies on sexual dimorphism in fresh water prawn, *Macrobrachium assamense peninsularie* from Garhwal Himalaya, India. Int. J. Environ. Rehabi. and Conserv. 2013;4(2):11-14.
38. Bisht KL, Dobriyal AK, Joshi HK, Bahuguna, Pankaj, Singh, HR. Maturation biology and spawning ecology of *Schizothorox plagiostomus* (Pisces: Cyprinidae) from a lotic ecosystem of Uttaranchal, India. Ecologia. 2005;3(2):89-97.
39. Joshi HK, Bahuguna Pramila, Bahuguna Pankaj, Bahuguna SN, Dobriyal AK. Cyto-morphological changes in the ovarian cycle of golden mahseer *Tor putitora* (Ham.) from Doon valley. Aquacult. 2008;9(2):197-203.
40. Joshi HK, Bahuguna Pramila, Bahuguna Pankaj, Dobriyal AK, Bahuguna SN. Morpho-histological study on the testicular cycle of Himalayan golden mahseer, *Tor putitora* (Ham.). J.Nature Conservation. 2009;21(1):77-81.
41. Kumar K, Bisht KL, Dobriyal AK, Joshi HK, Bahuguna PK. Maturation biology of a hill stream fish *Botia dayi* Hora from Garhwal Himalaya, Uttaranchal. Environment Conservation Journal. 2006;7:41-48.
42. Bahuguna P, Kumar R. Comparative studies on the Gonado-somatic index (GSI) and Dobriyal index (DI) to detect the sexual maturity of an ornamental punti, *Puntius conchonius* from India. J. Inland Fish. Sci. 2011;43(1):33-37.
43. Bahuguna P, Dobriyal AK. Comparative analysis of Gonado-somatic index (GSI) and Dobriyal index (DI) used for determination of sexual maturity in *Noemacheilus denisonii* Day. J. Inland Fish.Sci. 2013;45(1):50-52.
44. Bahuguna, P. Appling new modified Maturity Index to detect the spawning season of fish. Int. J. Environ. Rehabi. and Conserv. 2012;3(1):50-55.
45. Bahuguna Pankaj. Fish biology of *Puntius conchonius* (Ham Buch) from Garhwal, Central Himalaya, Uttaranchal. D. Phil Thesis, HNB Garhwal University, Srinagar Garhwal, UK, India; 2007.
46. Joshi, HK, Bahuguna AK, Bahuguna Pankaj, Bahuguna SN, Dobriyal AK. Histological study on the pre and post spawning changes in the ovary of *Barilius barna* (Ham.). J. Mountain Res. 2007;2:83-91.
47. Bahuguna AK, Joshi HK, Balodi VP, Thapliyal A, Bahuguna Pankaj, Kotnala CB, Dobriyal AK. Extrusion of Nuclei and Fate of yolk nucleus in a minor carp *Barilius barna* (Ham.) from Garhwal Himalaya. J. Mountain. Res. 2010;5: 125-128.
48. Bahuguna P, Joshi HK, Dobriyal AK. Conventional and Non- conventional fishing techniques used by rural folk in Mandal Valley, Uttarakhand. Uttar Pradesh J. Zool. 2010;30(2): 221-223.
49. Bahuguna, P, Joshi, HK. A study on fish and fisheries of river kalapani from Kumaun Himalaya, India. J. Mountain. Res. 2012;7:65-71
50. Bahuguna, P. Distribution pattern of Ichthyofauna diversity in different habitats in the first-, second- and third order streams of Randi Gad from Garhwal Himalaya, India. Natl. Acad. Sci. Lett.; 2021.
DOI: https://doi.org/10.1007/s40009-020-01032-9
51. Bahuguna, P. Fish diversity in different habitats in the 1st, 2nd and 3rd order streams of Kyunja Gad from Garhwal Himalaya, India. Uttar Pradesh Journal of Zoology. 2020;41(3):24-29.
52. Rayal R, Bhatt A, Bahuguna P, Joshi HK. Fish diversity of Mal Gad stream Near Purola town from district-Uttarkashi, Uttarakhand, India. Uttar Pradesh Journal of Zoology. 2021; 42(14): 54-59.
53. Rayal R, Bhatt A, Bahuguna P. Fish fauna of river yamuna from Doon Valley, Uttarakhand, India. Journal of Experimental Zoology India. 2021;24(2):973-977.
54. Simpson AC. Methods used for separating and counting the egg in fecundity studies on the plaice (Pleuronectes platessa) and herring (*Clupea herengus*) Occ. Pap. Fao. Indo Pacific fish coun. No. 59/12; 1959.
55. Oskarson GJ, Kjesbu OS, Slotte A. Prediction of realised fecundity and spawing time in Norwegian spring spawing herring (*Clupea harengus*). Journal of Sea Research. 2002;48: 59-57.
56. Thorsen A, Marshall CT, Kjesbu OS. Comparison of various potential fecundity models for north-east Arctic cod Gadus morhua, L. using oocyte diameter as a

standardizing factor. Journal of Fish Biology 2006;69:1709-1730.
57. Kamler E. Parent-egg-progeny relationship in teleost fishes: An energies perspective. Reviews in Fish Biology and Fisheries. 2005; 15:399-421.
58. Rayal R, Kapruwan D, Rana KK, Kashyap K. Breeding Capacity of freshwater prawn *Macrobrachium assamensis* in River Song from Doon Valley, Uttarakhand, India. Uttar Pradesh Journal of Zoology. 2021;42(10):38-44.
59. Doha, S. and Hye, MA. Fecundity of Pandma River Hilsa (*Hilsa ilisha*). Pakistan J. Sci. 1970; 22:176-184.
60. Rautela KK. Ecology studies on the spawning biology on some cold-water fishes from the Khoh stream. D.Phil. Thesis H.N.B. Garhwal University, Srinagar Garhwal; 1999.
61. Vicentini RN, Araujo FG. Sex ratio and size structure of *Micropogoni asfurnieri* (Desmarest, 1823) (Perciformes, Sciaenidae) in Sepetiba Bay, Rio de Janeiro. Brazilian Journal of Biology. 2003;63(4):13.
62. Holick J, Hensel K, Nielslanik J, Skace IJ. The *Eurrasiaan hucken* and Hucho huco largest salmon of world. Published by Dr.W.junk Dordecht J. Boston: Lancaster. 1988;239.
63. Nasar SAK, Biswas B. Studies on the length weight relationships of *Puntius clavatus* (McClelland) from Simshang River, Meghalaya, India. Matsya. 1987;8:59-62.
64. Nikolshky GV. Theory of fish population dynamics. Bishen Sigh Mahendra Pal Singh, India and Ottokoeltz Science Publishers (W. Germany). 1980;317.
65. Nikolsky GV. Ecology of fishes. Academic Press, London. 1956;1-352.