J. Ecophysiol. Occup. Hlth. 15(1 & 2), 2015, 23–30

DOI : 10.15512/joeoh/2015/v15i1&2/91185

Ontogeny in Feeding Behaviour of Chocolate Mahseer, *Neolissocheilus hexagonolepis* in Captive Environment

Debajit Sarma*, Suman Sanwal, Partha Das and M. S. Akhtar

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Nainital (Uttarakhand), India - 263 136

Abstract: *The paper embodies to determine the sequential pattern of feeding behaviour of chocolate mahseer in pond condition. The diet composition of different developmental stages of Neolissochilus hexagonolepis during fry, fingerling and juvenile were determined based on the analysis of 98 specimens (17 fries, 43 fingerlings and 38 juveniles), collected from the pond environment of Mahseer Hatchery Complex of ICAR- DCFR, Bhimtal. Zooplanktons were the most dominant prey category (%F = 129.38, %N = 45.73) in fry, while phytoplankton's were the most dominant prey items in fingerling (%F = 139.59, %N = 63.67) and juvenile (%F = 233.88, %N = 70.84). The results of the study revealed that fry and juvenile seems to have a higher feeding activity in relation to fingerling and the diet of the fish varies with different stages of development. Hence, the fry are carni-omnivore while fingerlings and juveniles are herbi – omnivore.*

Keywords: *Neolissochilus hexagonolepis*, Feeding behavior, Ontogeny, Vacuity coefficient.

Introduction

The study of the natural diets of fish species is a very useful approach for understanding aspects of the species biology and ecology, towards a more sustainable management of their stocks and the development of conservation measures (Pedersen, 1999; Watanabe *et al*., 2006; La Mesa *et al*., 2007; Sara and Sara, 2007).

It is known that the feeding habit of fish changes with different life stages. Unlike terrestrial animals, fishes may not have much choice in feed intake. In certain cases, food items available in the stomach of a prey also form a part of the gut content of the predator. Therefore, rational judgments based on a number of stomachs analyzed, if possible from a variety of environments is the right way to decide the basic feeding habits of a fish species. Examination of the distribution of food elements in the environment and in the gut enables to make a decision on the selectivity or non- selectivity in the feeding habits of the fish.

In recent years *Neolissochilus hexagonolepis* (McClelland), has recorded a sharp decline in the rivers, streams and reservoirs of Meghalaya due to various natural and anthropogenic factors and now considered as an endangered fish (Sarma and Bhuyan, 2007 and Nath and Dey, 2000). The distribution of this fish is available upto a gradient of 1500 m asl specially in coldwater of North East states (Laskar *et al.,* 2009). It is also found in most of the big rivers, lakes and reservoirs of Nepal from 250 m to 1500 m altitudes, having a preference for water temperature 10^{o}C to 30^{o}C (Rai and Swar, 1989).

There are very few studies dealing with the feeding habits and diet of *Neolissochilus hexagonolepis* in the wild (Dasgupta (1988a, 1988b, 1988c, 1989); Sarma *et al*., 2010 and Sanwal *et al*., 2010; Sanwal, 2011). *Neolissochilus hexagonolepis* is listed as the prioritized fresh water fish species for culture (Ayyappan *et al.,* 2001). Despite its importance, the culture of this fish is not widely practiced in different regions particularly in hilly areas. Keeping this in mind a stock was brought to the

*Email: dsarma_sh@yahoo.co.in

hatchery complex of DCFR (ICAR), Bhimtal from the wild aquatic environment of Arunachal Pradesh with an objective to culture the fish under controlled conditions.

Although a series of work was undertaken for the study of growth and biology of this fish species from wild aquatic environment, there is a paucity of information on the food and feeding habit of *Neolissochilus hexagonolepis* in the culture environment. So, the aim of the study was to give inclusive information on the ontogenetic changes in natural diet composition of *Neolissochilus hexagonolepis,* to have further well understanding and information for better growth and conservation of this fish.

Materials and Methods

Site of the experiment

Experiments were carried out in the mahseer hatchery complex of Directorate of Coldwater Fisheries Research, Bhimtal (29 ° 20’40” N; 79 ° 36’16”E.) during January 2009 to May 2010. Under this programme a flow – through mahseer hatchery including all the accessories has set up near the experimental pond.

Sampling procedure

The feeding habits of *Neolissochilus hexagonolepis* were studied in their fry, fingerling and juvenile stages. Live fishes were collected once in every two months from the experimental ponds for dietary analysis. After recording the morphometric data of the whole fish, all the sampled individuals of *Neolissochilus hexagonolepis* fry, fingerling and juvenile were immediately and rapidly sacrificed. The abdomen of each fish specimen was opened with a ventral incision along the keel and gut was removed.

Growth

The total length of the fish was measured from the tip of the anterior part of the mouth to the caudal fin using meter rule calibrated in millimeters. Fish weight was measured after blot drying. Weighing was done with a tabletop weighing balance to the nearest gram. The above length-weight data was further categorized based on various stages (stage 1: Fry up to 40 mm in length: stage 2: fingerling > 40 to 100 mm: stage 3: juvenile > 100 mm) followed by the classification of Jhingran (1975).

Gut content analysis

Gut fullness was estimated on a five point percentage scale: empty (0%), moderately full (25%), half full (50%), full (75%) and very full (100%). A lengthwise incision along the gut was then made and the contents were washed through a 125 μm sieve. All prey items were identified to the lowest possible taxonomic level and counted.

In order to analyze the data that resulted from the gut-content analysis, different methods (Pillay (1952); Hyslop, 1980; Lima-Junior and Goitein, 2001) were used and the following indices were calculated: frequency of occurrence (% F): $\%F = n\ 100N_s^{-1}$ and percentage of prey (% N) = $n'\ 100N_p^{-1}$, where n = the number of guts containing a certain prey, N_s = the total number of guts examined, n’ = the total number of individuals of a certain prey and N_p = the total number of prey items.

Based on the number of empty guts, the vacuity coefficient index (I_v) was calculated from: $I_v = E_v\ 100N_s^{-1}$, where E_v = the number of empty guts (Molinero and Flos, 1992).

Body Indices (GSI and RLG)

Gastro somatic index

The gastro somatic index (GSI) was calculated to find out the feeding intensity using the formula (Desai, 1970)

$$GSI = \frac{GW}{TW} \times 100$$

Relative gut length

A usual index which gives an idea of the nature of food is relative gut length (RLG). The value of RLG was calculated by taking the ratio of gut length, i.e. (Al-Hussaini, 1949).

$$RLG = \frac{\text{Length of the gut}}{\text{Total body length}}$$

Statistical analysis

One-way ANOVA was used to examine the GSI and RLG of different ontogenic stages of *Neolissochilus hexagonolepis*.

Results and Discussion

Data on length and weight of *Neolissochilus hexagonolepis* are presented in the Table 2. There was a significant ($p<0.05$) increase in length and weight of the species during the culture period. The mean values of length in each sampling month were significantly different from each other. The specimens of *Neolissochilus hexagonolepis* fry, length ranged from 28 mm to 38.9 mm (mean ± S.E., L = 33.32 ± 4.66 mm), fingerling from 71.5 mm to 94.2 mm (mean ± S.E., L = 83.35 ± 8.84 mm) and juvenile from 120.5 mm to 211.8 mm (mean ± S.E., L = 156.05 ± 37.86 mm).

Prey categories found in the guts of the specimens examined are given in Table 1. In *Neolissochilus hexagonolepis* fry, total numbers of 12 prey items were identified belonging to 59 prey categories, in fingerlings total number of 29 prey items were identified belonging to 157 prey categories, while in juvenile the corresponding examination yielded 27 prey items belonging to 175 prey categories.

The %F and %N values for the different prey categories found in fry are given in Fig. 2 and Table 1. The most prominent prey categories were of Chlorophyceae (%F = 58.8, %N = 16.9), Cladocera (%F = 52.93, %N = 18.6), Copepoda (%F = 52.93, %N = 16.9), Bacillariophyceae (%F = 35.28, %N = 10.2), Rotifera (%F = 23.52, %N = 10.2), Cyanophyceae (%F = 23.52, %N = 6.77) and unidentified matter (%F = 70.58, %N = 20.3). Zooplanktons were the most dominant prey category (%F = 129.38, %N = 45.73) in comparison to phytoplankton (%F = 117.6, %N = 33.85) in the fry stage. The %F and %N values for the different prey categories found in fingerling are given in Fig. 3 and Table 1. Chlorophyceae (%F = 72.13, %N = 31.83) were the most abundant prey category followed by Bacillariophyceae (%F = 48.85, %N = 24.2) and unidentified material (%F = 67.44, %N = 18.47).

These two categories (Chlorophyceae and Bacillariophyceae) accounted cumulatively for c. 56.03% of the species diet. In terms of higher taxonomic groups phytoplankton (%F = 139.59, %N = 63.67) were the most dominant prey category. The %F and %N values for the different prey categories found in juvenile are given in Fig. 4 and Table 1. Chlorophyceae (%F = 123.65, %N = 35.99) was the most abundant prey category followed by Bacillariophyceae (%F = 91.82, %N = 26.85) and unidentified material (%F = 71.05, %N = 21.14). These two categories (Chlorophyceae and Bacillariophyceae) accounted cumulatively for c. 62.84% of the species diet. In terms of higher taxonomic groups phytoplankton (%F = 233.88, %N = 70.84) were the most abundant and frequent prey category.

The results of the present study revealed that the diet of fry is carni-omnivore type since they feed mainly on the zooplankton, while the advanced fingerlings and juvenile are herbi-omnivore, feeding mainly on phytoplankton. It may be noted in this context that food and feeding habit of *Neolissochilus hexagonolepis* studied in Samsung river of Meghalaya was found to be omnivore and considered as voracious feeder subsisting mainly on algae and vegetable matter (Dasgupta, 1988). In the present study, percentage of vegetable matter was found to increase with increase in length of this species and prefers mainly animal matters in fry and vegetable matter in the fingerling and juvenile stages which were similar to the result of Jhingran, 1975. The presence of sand and mud in the gut of fry, fingerling and juvenile stages showed that the fish is column to bottom dweller and occasionally rise near to

Table 1 Prey categories found in the gut of *Neolissochilus hexagonolepis*, fry, fingerling and Juvenile n’, total number of individuals of certain prey; n, number of gut containing a certain prey; %F, frequency of occurrence index; %N, percentage of prey index

	FRY				FINGERLING				JUVENILE			
	n’	n	%F	%N	n’	n	%F	%N	n’	n	%F	%N
Cholorophyceae												
Actinastrum					5	8	11.63	5.1	1	2	2.63	1.14
Ankistrodesmus	1	1	5.88	1.69	1	4	2.33	2.55	6	6	15.79	3.43
Chlamydomonas									1	4	2.63	2.29
Closteredium					1	3	2.33	1.91	1	3	2.63	1.71
Closterium					1	2	2.33	1.27	2	2	5.26	1.14
Coelestrum					1	3	2.33	1.91	1	2	2.63	1.14
Micractinium					2	2	4.65	1.27	2	2	5.26	1.14
Pediastrum	2	2	11.76	3.39	5	6	11.63	3.82	7	9	18.42	5.14
Scenedesmus	2	2	11.76	3.39	7	7	16.28	4.46	15	16	39.47	9.14
Schroederia					1	2	2.33	1.27	1	2	2.63	1.14
Selenastrum					1	3	2.33	1.91	1	1	2.63	0.57
Spirogyra	1	1	5.88	1.69	2	3	4.65	1.91	3	4	7.89	2.29
Ulothrix	1	1	5.88	1.69	1	2	2.33	1.27	1	2	2.63	1.14
Uronema	1	1	5.88	1.69	1	3	2.33	1.91	3	4	7.89	2.29
Volvox	2	2	11.76	3.39	2	2	4.65	1.27	2	4	5.26	2.29
Bacillariophyceae												
Amphora	1	1	5.88	1.69	2	3	4.65	1.91	2	4	5.26	2.29
Cymbella	1	1	5.88	1.69	2	4	4.65	2.55	2	3	5.26	1.71
Diatoma					1	4	2.33	2.55	2	2	5.26	1.14
Fragilaria					1	3	2.33	1.91	1	4	2.63	2.29
Frustulia					2	4	4.65	2.55	1	2	2.63	1.14
Gyrosigma					2	5	4.65	3.18	1	3	2.63	1.71
Navicula	1	1	5.88	1.69	2	4	4.65	2.55	1	2	2.63	1.14
Surirella					1	2	2.33	1 .27	3	3	7.89	1.71
Synedra	3	3	17.64	5.08	7	9	16.28	5.73	17	19	49.74	10.86
Tabellaria					1	2	2.33	1.27	3	5	7.89	2.86
Cyanophyceae												
Microcystis	1	1	5.88	1.69	2	3	4.65	1.91	2	4	5.26	2.29
Oscillatoria	3	3	17.64	5.08	3	4	6.98	2.55	3	3	7.89	1.71
Dinophyceae												
Ceratium					1	2	2.33	1.27	1	4	2.63	2.29
Peridinium					2	3	4.65	1.91	1	3	2.63	1.71
Rotifera												
Branchionus	2	3	11.76	5.08	2	3	4.65	1.91	1	2	2.63	1.14
Keratella	1	2	5.88	3.39	1	2	2.33	1.27	1	1	2.63	0.57
Mytilina	1	1	5.88	1.69								
Cladocera												
Chydorus	3	3	17.64	5.08	2	4	4.65	2.55	1	2	2.63	1.14
Cypris	2	2	11.76	3.39	1	1	2.33	0.64				
Daphnia	4	5	23.53	10.16	5	6	11.63	3.82	3	4	7.89	2.29
Copepoda												
Cyclops	6	7	35.29	11.86	4	6	9.3	3.82	2	3	5.26	1.71
Diaptomus	2	2	11.76	3.39	1	3	2.33	1.91	1	2	2.63	1.14
Nauplius	1	1	5.88	1.69	1	3	2.33	1.91				
unidentified matter	12	12	70.58	20.33	29	29	67.44	18.47	27	37	71.05	21.14

Table 2 Growth performance, relative gut length and gastro-somatic index of *Neolissochilus hexagonolepis* during experimental period

Months	Fish length (cm)	Fish weight (g)	%L	%W	RLG	GSI
Jan, 09	29.17^{a}±0.60	0.17^{a} ±0.01	28.51±2.50	198.31±10.81	1.05^{a} ±0.01	3.92^{a} ±0.20
Mar, 09	37.47^{b} ±0.73	0.50^{a} ±0.04	97.27±2.43	651.70±18.54	1.08^{a} ±0.01	5.59^{ab} ±0.28
May,09	73.90^{c}±1.48	3.72^{b} ±0.17	15.93±1.25	61.66±6.34	1.79^{c}±0.03	9.66^{b} ±2.14
July, 09	85.63^{d}±0.86	6.0^{bc} ±0.26	9.39±0.69	25.27±4.34	1.66^{b} ±0.07	9.25^{b} ±1.00
Sep, 09	93.67^{e}±0.35	7.50^{c} ±0.23	29.22±0.18	116.07±6.99	1.57^{b} ±0.05	7.54^{ab} ±2.83
Nov, 09	121.03^{f}±0.32	16.17^{d} ±0.046	3.61±0.08	6.34±14.01	1.97^{d} ±0.02	6.72^{ab} ±0.49
Jan, 10	125.40^{g}±0.31	17.19^{d} ±2.26	33.44±0.83	159.05±30.29	1.95^{d} ±0.01	5.59^{ab} ±0.56
Mar, 10	167.33^{h}±1.20	43.27^{e} ±1.41	25.77±0.61	64.46±5.44	1.997^{d} ±0.02	5.91^{ab} ±0.42
May,10	210.43^{i}±0.70	71.01^{f} ±0.59	----------	-----------	2.72^{e} ±0.01	6.33^{ab} ±0.27

Mean values with different super scripts (a, b, c etc.) in the same column differs significantly (p<0.05). Data expressed as Mean ± SE, n = 3 (each replicate was the representative of 10 fishes).

the surface for nibbling the flowing food items (Dasgupta, 1988).

The Iv value for fry, fingerling and juvenile are given in Fig.1 (a), Fig. 2(b) and Fig. 3 (c), while, percentage gut fullness of all the three categories of this species are given in Fig. 4. A total of 5 guts were found empty in fry, 14 guts were empty in fingerling and 11 guts were empty in juvenile giving an Iv of 29.41%, 32.56%, 28.95% respectively (Fig.1 (a), Fig. 2(b) and Fig. 3 (c)).

Relative Gut Length (RLG) and Gastro Somatic Index (GSI)

In the present investigation, the RLG values ranged from 1.048 to 2.72 for the fish having size range of 29.17 mm to 210 mm. In fry the average relative gut length (RLG) value was 1.05 ± 0.01 (Mean ± SE) to 1.08 ± 0.01 (Mean ± SE). In fingerling, it was 1.79 ± 0.03 (Mean ± SE) to 1.66 ± 0.07 (Mean ± SE) and in juvenile, it was recorded 1.97 ± 0.02 (Mean ± SE) to 2.72 ± 0.01 (Mean ± SE). The result shows the similarity as observed by Das and Nath, 1965. As fishes grow in length; a change is observed in their feeding habits from carnivorous to herbivorous through the omnivorous type (Sinha and Moitra, 1976). The ratio of gut length and length of the fish (RLG value) itself also shows some indications about the nature of the fish diet (Alikunhi and Rao, 1951; Al Hussaini, 1949; Das and Moitra, 1956). Similar observations were found in our investigation, indicating changes in feeding habits from carni-omnivorous to herbi-omnivorous. Hence, they can be kept in the category of omnivorous fishes. It has also been observed from the present study that RLG values of *Neolissochilus*

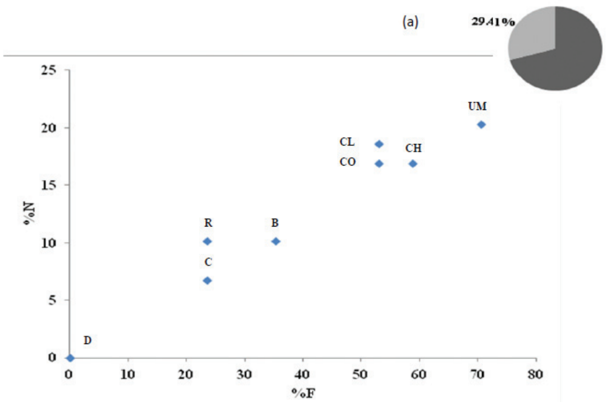

Fig. 1 Percentage frequency of occurrence index (%F) and percentage of prey index (%N) values for the various prey categories found in: chocolate mahseer fry (a) Vacuity coefficient (Iv) values are given for fry.

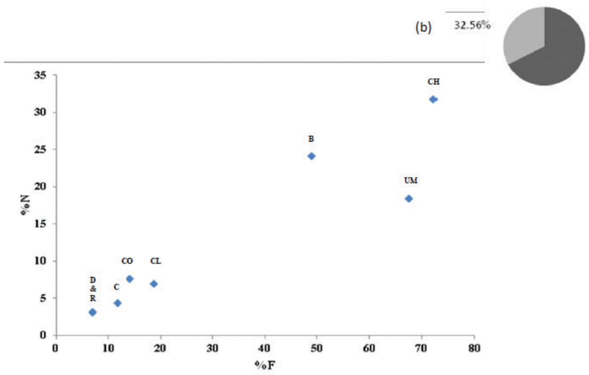

Fig. 2 Percentage frequency of occurrence index (%F) and percentage of prey index (%N) values for the various prey categories found in: chocolate mahseer fingerling (b) Vacuity coefficient (Iv) values are given for fingerling.

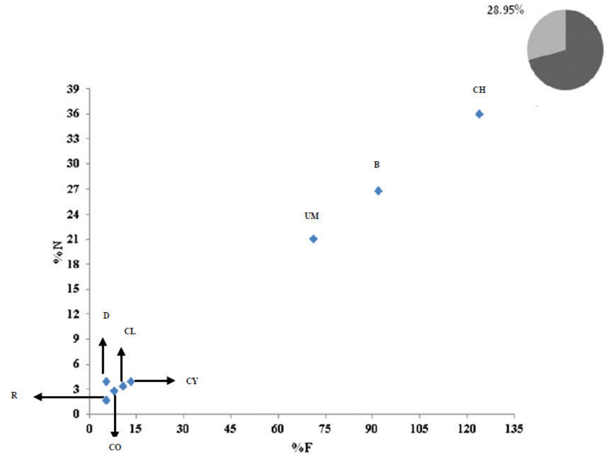

Fig. 3 Percentage frequency of occurrence index (%F) and percentage of prey index (%N) values for the various prey categories found in: *Neolissochilus hexagonolepis* juvenile (b) Vacuity coefficient (Iv) values are given for juvenile.

hexagonolepis increased with increasing length of the fishes as shown in Fig 1 and Table 2. RLG values were lowest in fry, intermediate in advanced fingerling and highest in the juvenile showing omnivorous nature of the fish. Similar result were observed (Girgis, 1952), recording the lowest RLG value in the fry stage and highest in the older fishes.

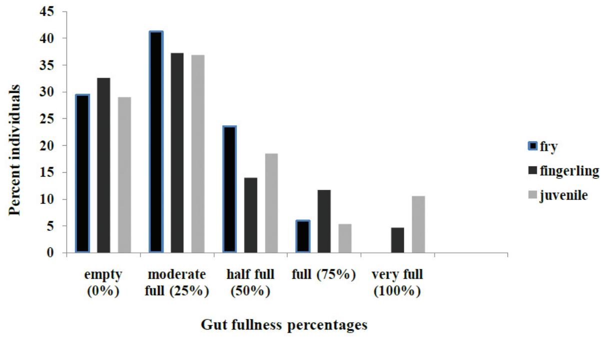

Fig. 4 Gut fullness percentage of fry, fingerling and juvenile of *Neolissochilus hexagonolepis.*

The GSI values ranged from 3.92 to 9.65 for the fishes having weight range of 0.166 gm to 71.01 gm. GSI values ranged from 3.92 ± 0.20 (Mean ± SE) to 5.59 ± 0.28 (Mean ± SE) in fry and 7.54 ± 2.83 (Mean ± SE) to 9.66 ± 2.14 (Mean ± SE) in fingerling. In juvenile the value ranged from 5.59 ± 0.56 (Mean ± SE) to 6.72 ± 0.49 (Mean ± SE) (Table 2). From the results, it was observed that feeding intensity was higher in case of fry and juvenile as compared to the fingerling. Gastro-somatic index (GSI) of fish having size range of 29.17 mm to 210.00 mm (0.166 gm to 71.01 gm) was computed to study variation in feeding intensity with respect to the size. In the present investigation, the maximum 9.65 and minimum 3.92 GSI values was recorded for the fish (Fig 2). It was clearly observed from the study that the feeding intensity was found to increase in lower size groups (3.72 gm to 7.5 gm). Percentage of feeding was higher among young individuals than bigger in case of *Neolissochilus hexagonolepis* studied from Simsang river, Meghalaya and few other parts of the country (Dasgupta, 1988; Hardy, 1924; De Silva, 1973; Kishor *et al*., 1998).

Relationship between gut length and body length

The logarithmic relationship between gut length (Y) and total body length (X) can be expressed by the regression equation between these two parameters which has been derived as:

$$\text{Log } Y = -0.609 + 0.430 \text{ Log } X$$

The value of correlation coefficient 'r' was found to be 0.934.

From the present finding, it can be concluded that ontogenic changes in food and feeding pattern of *Neolissochilus hexagonolepis* changes from carni-omnivorous to herbi-omnivorous. So, this fish can be included under the category of omnivorous fishes. It can also be inferred that this data provide a useful contribution for improved understanding of biology of this endangered fish.

References

Al-Hussaini, A.H. (1949) The anatomy and histology of the alimentary tract of the plankton feeder, Atherina forskali. *Rupp. J. Morp*., **80**, 251–286.

Alikhuni, K.H. and Rao, S.N. (1951) On the bionomics, development and growth of a cauvery carp, Labeo kontius. *Jerdon Rec. Indian Mus*. **49**, 157–174.

Ayyappan, S., Raizada, S. and Reddy, A.K. (2001) Captive breeding and culture of new species of Aquaculture. Captive breeding for aquaculture and fish germ-plasm conservation. *NBFGR – NATP*, **3**, 1–20.

Das, S.M. and Moitra, S.K. (1958) On the feeding types of fishes and the variation in the alimentary canal in relation to food, *J. Icthyol.,* **10,** 29–40.

Das, S.M. and Moitra, S.K. (1956) Studies on the feeding types of fishes and variations in the alimentary canal in relation to food. *J. Ichthyol*., **10**, 29–40.

Das, S.M. and Nath, S. (1965) The comparative anatomy of the alimentary tract and its modification in relation to the food and feeding habits in some fishes of Jammu Province, India. Ibid., **4**, 63–78.

Dasgupta, M. (1988a) A study on the food and feeding habits of the Copper Mahseer *Acrossochilus hexagonolepis* (McClld) *Indian J. Fish*. **35**, 92–98.

Dasgupta, M. (1988) Biometry of the copper mahseer *Acrossochilus hexagonolepis* (McClld) from the North Eastern India. *Nova Serie*. **1**, 361–374.

Dasgupta, M. (1988b) Fecundity of *Acrossochilus hexagonolepis* (McClld) from Garo hills Meghalaya. Uttarpradesh*. J. Zoology*. **8**, 159–167.

Dasgupta, M. (1988c) Length – Weight relationship and condition of the Copper Mahseer *Acrossochilus hexagonolepis* (McClld). *Matsya*, **14**, 79–91.

Dasgupta, M. (1989) Biometry of the copper mahseer *A. hexagonolepis* (McClelland) from the North-Eastern India. *Arq. Mus. Roc*, **1**, 361–374.

De Silva, S.S. (1973) Food and feeding habits of the herring *Clupea harengus* and the Sprat *C. sprattus* in inshore waters of the west coast of Scotland. *Mar. Biol*., **20**, 282–290.

Desai, V.R. (1970) Studies on the fisheries and biology of *Tor tor* (Ham.) from river Narmada. *J. Inland Fish. Soc. India*. **2**, 101–112.

Edmondson, W.T. (1959) Freshwater Biology, 2nd edition. John wiley and Sons. Inc. New York, 1248.

Girgis, S. (1952) On the anatomy and histology of the alimentary tract of herbivorous bottom feeding Cyprinidae fish, Labeo horie (Cuv.). *J. Morph*. **90**, 317–362.

Hardy, A.C. (1924) The herring in relation to its marine environment Part I. The food and feeding habits of the herring with special references to the east coast of England, Fish. Invest., London Ser., **2**, 1–53.

Hyslop, E.J. (1980) Stomach content analysis: a review of methods and their applications. *J. Fish Biol.,* **17**, 411–429.

Jhingran, V.G. (1975) Fish and Fisheries of India Hindustan Publishing Corporation, New Delhi, India. 954.

Kishore, B., Bhatt, J.P., Rawat, V.S. and Nautiyal, P. (1998) Variations in food and feeding habit of the Himalayan mahseer- Tor putitora (Ham.) inhabiting the Ganga river system in Garhwal region. *Indian J. Fish*. **45**, 113–118.

La Mesa, G., La Mesa, M. and Tomassetti, P. (2007) Feeding habits of the Madeira rockfish Scorpaena maderensis from central Mediterranean Sea. *Marine Biol.,* **150**, 1313–1329.

Laskar, B.A., Das, D.N. and Tyagi, B.C. (2009) Growth performance of the *Neolissochilus hexagonolepis* (McClld) in pond system in Arunachal Pradesh. *Indian J. Fish*. **56**, 55–59.

Lima-Junior S.E. and Goitein R. (2001) A new method for the analysis of fish stomach contents. *Acta scientiarum*, **23,** 421–424.

Molinero, A. and Flos, R. (1992) Influence of season on the feeding habits of the common sole Solea solea. *Marine Biol.*, **113**, 499–507.

Nath, P. and Dey, S.C. (2000) Fish and fisheries of North Eastern India (Arunachal Pradesh), Narmdra Publishing House, Delhi. 217.

Pedersen, J. (1999) Diet comparision between pelagic and demersal whiting in the North Sea. *Journal of Fish Biology*, **55**, 1096–1113.

Pillay, T.V.R. (1952) A critique of the methods of study of food of fishes*, J. Zool. Soc. India*. **4**, 185–200.

Rai, A.K. and Swar, B.D. (1989) Katle, *Acrossochilus hexagonolepis* (McClld), A cold water cyprinid of Nepal. FAO Fisheries Rome, **405**, 95–99.

Sanwal, S., Sarma, D. and Singh, N.O. (2010) Effect of stage and seasonal differences on length-weight relationship and condition factor of Chocolate mahseer (*Neolissochilus hexagonolepis). J. Inland Fishery Soc. India*. **42,** 52–56.

Sanwal, S. (2011) Culture and growth studies on Chocolate mahseer *(Neolissochilus hexagonolepi*s) in pond environment of Kumaun Uttarakhand. Ph.D. Thesis, Kumaun University, Nainital.

Sara, G. and Sara, R. (2007) Feeding habits and trophic levels of bluefin tuna Thunnus thynnus of different size classes in the Mediterrenean Sea. *J. Appl. Icthyology*, **23**, 122–127.

Sarma, D., Sanwal, S., Haldar, R. S., Das, P. and Mahanta, P.C. (2010) Development of culture and breeding strategies for mahseer (*Tor putitora* and *Neolissochilus hexagonolepis*), Coldwater Fisheries Management, 61–72.

Sarma, D. and Bhuyan, R.N. (2007) Chocolate mahseer (*Neolissochilus hexagonolepis*): Icon of Meghalaya water. *Fishing chimes*, **26,** 116–11.

Sinha, G.M. and Moitra, S.K. (1976) Studies on the morpho-histology of the alimentary canal of freshwater fishes of India. Part I. The alimentary canal of young *Cirrhinus reba* (Ham.) with a comparison with that of the juvenile in relation to food. Vest. Cs. Spol. Zool., **40**, 221–231.

Watanabe, H., Kubodera, T. and Kawahara, S. (2006) Summer feeding habits of the Pacific pomfret Brama japonica in the transitional and subarctic waters of the central North Pacific. *Journal of Fish Biology*, **68**, 1436–1450. doi: 101111/j. 1095-8649.2006.01027x.