



## Status of brown trout (*Salmo trutta fario* L.) in Garhwal Himalaya with a note on its morphometric characteristics

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### Abstract

The history of introduction of brown trout in Garhwal Himalaya is 100 years. However, the scientific information on brown trout is grossly lacking. The present study is a part of investigation on various aspects of brown trout inhabiting the River Asiganga in Uttarkashi district of Uttarakhand. The status of brown trout was ascertained in River Asiganga and other reports from elsewhere in the region. The morphometric study was based on 253 fish specimens collected from River Asiganga. In addition to the 12 body measurements of the fish, red/orange and brown spots on body were also studied.

**Keywords:** River Asiganga, brown trout, body spots, teeth

### Introduction

Brown trout (*Salmo trutta fario* L.) belonging to family salmonidae are indigenous to Europe, North America, Africa, Australia, New Zealand, Papua New Guinea (Moyle 2002), while, native western Asian countries are Armenia, Afghanistan and Turkey. In Asia, the fish has been introduced in India, Sri Lanka and Nepal. With large variability the existing populations of brown trout significantly differ among them either by geographic isolation of specific conditions from each specific spreading area (Bud *et al.* 2009). It was introduced in India in the early 19<sup>th</sup> century for food and sports, and in spite of being ecologically, economically and scientifically a valuable species, brown trout is too less studied in India. The details of introduction of trout in India has been well described by Molesworth and Bryant (1912), Howell (1916), Mitchell (1918), Mackey (1945) and Jones and Sarojini (1952). Also, the length weight relationship and food and feeding habit of brown trout in Himachal Pradesh and Jammu and Kashmir has also been studied (Khan and Tandon, 1941; Shah, 1975; Kumar *et al.*, 1979; Sehgal *et al.*, 1984

and Sehgal, 1992). As such, various aspects of brown trout have been extensively dealt with in different parts of the world by Frost (1939), Ball (1961), Michael (1970), Elliott (1972,1976), Edwards *et al.* (1979), Lobon-Cervia *et al.* (1986), Belaoud (2002), Alp *et al.* (2003, 2005), Arslan *et al.* (2004), Maric *et al.* (2004), Oscoz *et al.* (2005), Montori *et al.* (2006), Power *et al.* (2007), Fochetti *et al.* (2008), Hao and Chen (2009), Demir (2010), Kara *et al.* (2011), Sanchez-Hernandez (2011).

The history of the introduction of brown trout in the Garhwal Himalaya region of the state Uttarakhand (the hill districts of erstwhile Uttar Pradesh) dates back to 1910 when, the then Tehri State Ruler stocked the eyed ova of brown trout, carried from Kashmir, into Kaldyani (Uttarkashi) and Talwari (Chamoli) hatcheries (Singh *et al.*, 1983). From these hatcheries the seeds were introduced into different rivers and lakes in the region. Surprisingly, in spite of hundred years of introduction in Garhwal region, scientific study on brown trout is grossly lacking.

As of now, this exotic fish has established itself successfully in some of the Garhwal Himalayan water bodies viz., Lake Dodi Tal, River Asiganga, Balkhila Gad, Rupin-Supin, Madhu Ganga etc. The present study is the first attempt to collect information on the biology and ecology of brown

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trout inhabiting the river Asiganga-a tributary of River Bhagirathi in the Garhwal Himalaya region (Fig. 1). The paper gives an account of the status of brown trout in aquatic environment of Garhwal Himalaya along with its morphometric characteristics.

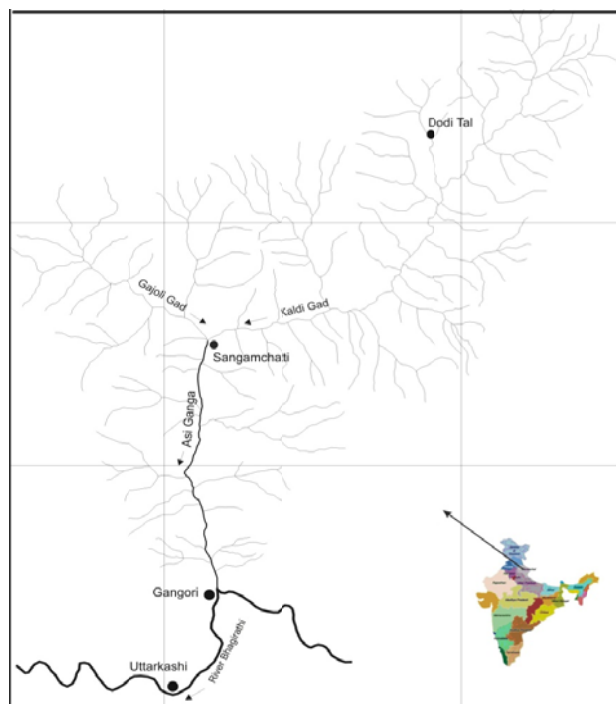


Fig 1. Location map of river Asiganga

### Materials and Method

Kaldi Gad and Gajoli Gad originated from 4521 m asl and 3836 m asl respectively and joins at Sangamchati (1505 m asl) to form River Asiganga. River Asiganga (Latitude 30°48'N and Longitude 78°27'E) traverses a distance of 15 km before meeting River Bhagirathi at 1160 m asl at Gangori 5 km upstream to Uttarkashi township. Specimens of brown trout were collected during August 2007 to July 2009 from local fishermen at the river. In all, 253 specimens were examined fresh in the laboratory. The brown trout specimen ranged from 12.8 to 48.0 cm in length, while the weight was measured in between 20.61 to 1280 gm. The morphometric measurements were taken on the left side of body as described by Lowe-McConnel (1971). The morphological features measured were: total length (TL), standard length (SL), fork length (FL), head length (HL), snout length (SL), eye diameter (ED), caudal length (CL), anal length (AL), pelvic length (PL), pre pectoral length (PPL),

dorsal length (DL), post orbital length (POL), maximum body depth (MBD). The measurements were further subjected to range difference and correlation analysis. All the statistical analysis were made using MS Excel. Also, the number of red/orange and brown spots on the body and fins were counted.

### Morphometric characteristics of brown trout

The body of brown trout is cylindrical with shining silvery grey colour and a squarish tail having red/orange and brownish spots on its body (Fig. 2). The colouration of body changes somewhat according to age; brown trout with the age group of 5<sup>+</sup> years is less shining, dark brown in colour from dorsal side and slightly from lateral side above the lateral line. The brownish colour originating from head region decreases towards dorsal fin and finally finishes at adipose fin. The ventral side of the fish is creamish-white in colour. According to Kottelat and Whitten (1996) and Crivelli *et al.* (2000) the physical-chemical features of aquatic basins are significant conditions of the brown trout body colour. The body of brown trout has red/orange to dark brown colour spots. The reddish/orange spots mostly observed near and below the lateral line, are less as compared to the dark brownish spots. With the increase in age the reddish/orange spots get converted into dark brownish spots. These spots were also present on dorsal and adipose fin, which ranges from 2-98 in number while in pelvic, pectoral, anal and caudal fins no such spots were observed. The approximate number of spots on whole body ranged between 86-312 (Table 1).

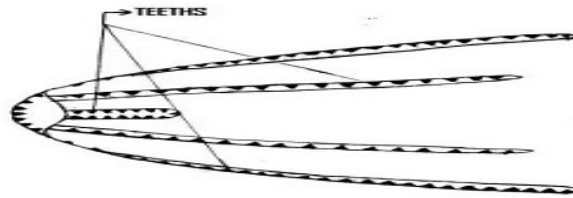
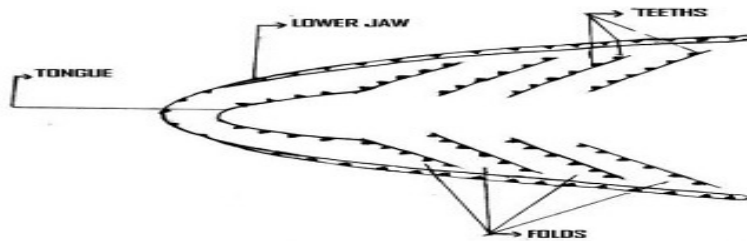
The jaws of the brown trout are dome shaped, equal in size and contained sharp teeth. In the upper jaw the number of teeth ranged from 36 to 38, while the lower jaw contained 22-24 teeth. The ventral side of upper jaw was folded and also contained teeth. The tongue has 4 folds and each fold contained teeth (Fig. 3a & b).



Fig. 2. *Salmo trutta fario* L. from River Asiganga, Uttarkashi

**Table 1. Variability of spots on the various regions of body of brown trout.**

Specification	Head	Lateral Line	Above L. L	Below L.L.	Dorsal Fin	Adipose Fin	Total
Range	2-14	12-46	10-180	8-100	26-98	0-6	86-312
Average	7.57	24.94	62.03	29.03	53.33	4.00	186.67
SD	2.88	8.76	43.31	20.14	28.47	1.73	75.64

**Fig 3a. vertical portion of upper jaw containing teeths****Fig 3b. Structure of lower jaw and tongue showing folds and teeths**

The pectoral, pelvic and anal fins are paired while dorsal and caudal fin are unpaired. In addition to these fins an adipose fin is also present in between caudal and dorsal fin. The various body parameters

of brown trout (*Salmo trutta fario* L.) showed highly positive correlation in relation to total length and head length and presented in Table 2.

**Table 2. Mean standard deviation, (SD), range difference, correlation coefficient (*r*), of different morphometric characters of brown trout in relation to total length (TL) and head length (HL) in River Asiganga.**

S. N.	Parameters in relation to total length (cm)	Mean	SD	Range of %	Range Difference	R
1	Standard length	24.9146	6.9465	20.4841-19.3612	27.8	0.9977
2	Caudal length	4.2906	1.2820	3.3519-3.5928	5.4	0.9329
3	Pre Pectoral Length	5.4866	1.6946	3.9106-4.9401	7.8	0.9462
4	Pelvic Length	13.5333	3.8522	11.1731-0.4935	16.1	0.9860
5	Anal Length	19.2720	5.4787	15.4562-0.4962	22.7	0.9961
6	Fork Length	28.9040	8.2501	22.7188-0.4850	33.7	0.9987
7	Head Length	6.6973	2.0545	4.8417-0.4850	9.3	0.9721
8	Dorsal Length	11.9973	3.4507	9.3109-0.4903	14.7	0.9826
9	Max body depth	8.4440	2.6088	6.1452-0.4787	10.6	0.9594
10	In relation to Head length (cm) Snout length	2.0880	0.7839	26.9230-8.18	3.8	0.9816
11	Eye diameter	0.9720	0.2010	19.2307-7.5466	0.8	0.9056
12	Postorbital Length	8.6373	1.1095	53.8491-8.0833	5.2	0.9940

### Habitat characteristics

The brown trout inhabiting rivers and lakes requires cold water, high dissolved oxygen and fast water current in the river to maintain dissolved oxygen level. Trout streams in the mountains are typically fast flowing soft-water streams with rocky and stony riverbeds, clear water and usually with no macrophytes growing in the streams. Brown trout reportedly prefer water temperature ranging from 12–19°C / 20°C (Bud *et al.*, 2009; Raleigh *et al.*, 1986). Similarly, in the present study the brown trout was recorded inhabiting the high-oxygenated (7.3 to 14.3 mg l<sup>-1</sup>) and cold water (5.0–21.0°C) of River Asiganga. The catchment area of Asiganga is predominantly mixed forest of Oak, Pine, Deodar, Rhododendron, Walnut *etc.* The river substratum is constituted of rocks, boulders of various size, pebbles, cobbles along with gravel and sand in the lower section. The gradient is very high in the upper reaches which decreased below 1450m asl. The water velocity varied between 0.8 to 1.96 m s<sup>-1</sup>. Brown trout inhabiting Asiganga is extremely carnivorous and feed on aquatic insects of order ephemeroptera, plecoptera, diptera, coleoptera, trichoptera *etc.* Terrestrial insects like ants, grasshoppers and spiders were other common food present in the gut. Food items, like small fishes, and earth worms were also consumed by brown trout.

### Status in Garhwal Himalaya

Keeping in view the prospect of brown trout propagation in Garhwal, the then Tehri Garhwal Ruler, in the year 1910 developed two hatcheries at Kaldyani (Uttarkashi) and Talwari (Chamoli). Later, during 1992–94 Fishery Department, Govt. of Uttar Pradesh (U.P.) constructed one more hatchery at Barangana (Chamoli). However, Talwari hatchery is not functional since long.

Kaldyani hatchery is located about 15 km. from Uttarkashi along River Asiganga at an altitude of 1404 m asl. Setup in year 1910, fish seeds collected from Kashmir was introduced in 4 tanks. In 1947–48 this hatchery was handed over to Fishery department, U.P., Lucknow. At present, with a total area of about 1.10 ha, the hatchery has 21 ponds which include nursery, rearing and stocking ponds. The hatchery was functional up to 2001; however, the inlet channel and some ponds of the hatchery were destroyed in the flood of 2002. Later in 2009

the renovation work was completed and now the hatchery is in the functional state.

Barangana hatchery constructed by Fishery department, Govt. of U.P. spread over an area of 2.4 ha, on the bank of snow-fed Balkhila Gad (a tributary of Alaknanda River), is situated about 14 km from Gopeshwar (Chamoli). This hatchery is producing seed of Rainbow trout (*Oncorhynchus mykiss*), Brown trout (*Salmo trutta fario*) and Common carp (*Cyprinus carpio*).

Fisheries department, Govt. of U.P. had also introduced brown trout seeds in different fluvial systems of Garhwal like Balkhila Gad, Birahi Gad, Nandakini and Pinder in Chamoli district, Madhuganga in Rudraprayag, Kaldi Gad, Asiganga and Rupin-Supin in Uttarkashi (Fisheries in Uttaranchal, 2005) (Fig. 4).

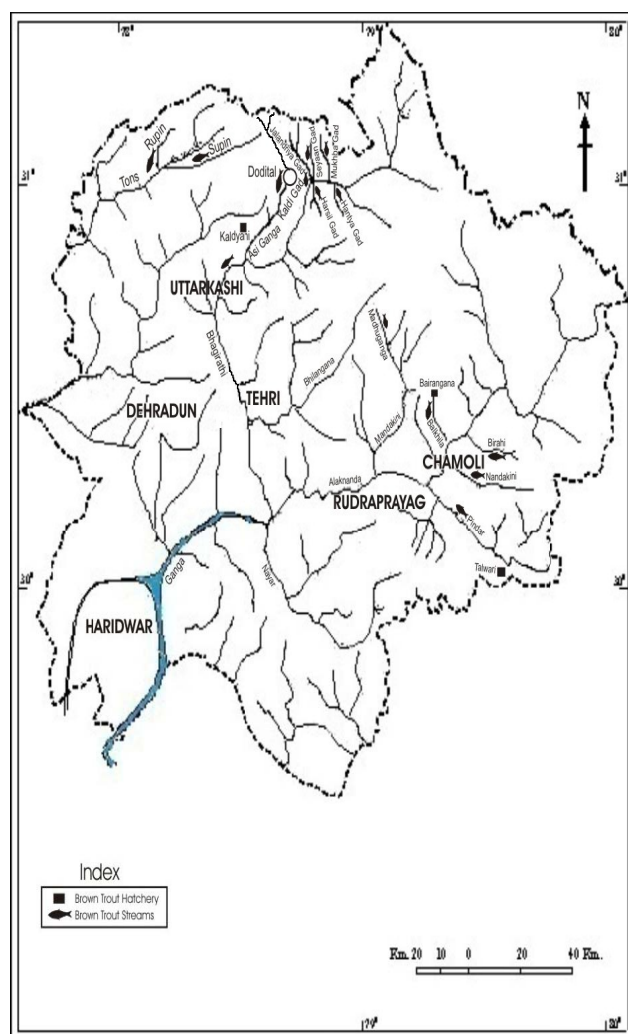


Fig 4. Brown trout in water bodies of Garhwal Himalaya

It is also observed that the fish have reached the tributaries of these rivers. During the present survey, brown trout was also reported from the upper reaches of tributaries of River Bhagirathi (between 2550 and 2685 m asl). These tributaries are Jalandriya Gad, Seyaan Gad, Harsil Gad, Mukhba Gad and Hantya Gad. These are perennial, snow-fed, clear and fast flowing water bodies with highly oxygenated water. Notably, brown trout has established it self in the Bhalkhila Gad and River Asiganga along with other indigenous fish species like *Schizothorax*, *Barilus*, *Noemachelus* etc., in the Bhalkhila Gad mainly due to the fact that seeds are introduced every year from the nearby Barangana hatchery. Also River Asiganga is stocked with seeds from Kaldyani hatchery and Lake Dodi Tal is yet another permanent source of brown trout as during monsoon the fry and fingerlings reach it through Kaldi Gad.

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