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Intrabasin Variation in Growth and Condition of Brown Trout (*Salmo trutta*) Inhabited Coruh Basin, Turkey

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Abstract: Growth and condition were analysed for brown trout from the streams from Coruh Basin, Norteastrean Turkey from summer to Fall in 2008. There were slightly variability both length and weight for brown trout among the streams. The highest instantenous Growth rate for Length (GFL) and total weight (GW) occured between 0 and 1 age for all streams with highest values in Kocun Bogazi stream. The lowest condition coefficient (K) for brown trout was observed in Cenker stream with mean value of 1.16 whereas the highest value was recorded in Yagli stream with mean value of 1.24 and there was statistical differences among the streams with analyses of one-way ANOVA ($p<0.05$). Also, length-weight relationship was calculated for brown trout from streams. It varied 3.008-3.166. Fishes in streams of Cenker and Mulk displayed isometric growth whereas those in other streams had positive allometric growth characteristic. Von Bertalanffy equation also was calculated to analyse growth in length for brown trout. Variability in growth and nutrition for brown trout among the stream might be attributed to physical envirionmental variables.

Key words: Brown trout, Coruh river, conditon, growth, *Salmo trutta*, Von Bertalanffy

INTRODUCTION

Brown trout widely distrubuted in Europe, Nort Africa and Western Asia including Turkish waters and was introduced at least 24 countries within 90 years. So, it is status changed to global fish species also, it has importance in sportive fishing, commercial fishing and aquaculture interest (Bagliniere and Maisse, 1999). The length-weight relationship is a very useful tool in fisheries assessment. It is usually easier to measure length than weight and weight be predicted later on using the length-weight relationship.

Furthermore, biomass can be calculated (Morey *et al*., 2003) and seasonal variability in fish growth can be tracked in this way (Richter *et al*., 2000). The length-weight relationship also can helps to explain the condition, reproductive history and life history of fish species (Nikolsky, 1963; Wootton, 1992; Pauly, 1993) and in morphological comparison of species and populations (King, 1995; Goncalves *et al*., 1997). Life history characteristics of brown trout can be affected by biotic and abiotoc factors.

Most important environmetal factors is water flow, water temperature, density and food availability. Become such factors can vary so much in time and space (McFadden and Cooper, 1962; Elliott, 1975, 1994).

Biological aspect such as age distrubition, growth, reproductive properties, feeding and economic aspect for brown trout has been investiged in literature across the world (Jonnson and Sandlund, 1979; Lobon-Cervia *et al*., 1986; Jonnson, 1989; Haugen and Rygg, 1996; Nicola and Almodovar, 2002; Hesthagen *et al*., 2004; McFadden and Cooper, 1962) and also Turkish freshwater (Alp *et al*., 2003) as well as Coruh basin (Aras, 1974; Arslan *et al*., 2004, 2007; Yildirim and Arslan, 2007; Becer *et al*., 2009).

Aim of this study was to determine affect of different environmental charecteristics on growth and nutrition and to compare brown trout population in different streams Coruh basin. Also, age and growth parameters of brown trout in Yagli, Mulk, Kocun Bogazi stream has been recorded first time with this research.

MATERIALS AND METHODS

This study was carried out in the different streams of Coruh river situated in Northeastern Turkey (Fig. 1). Some physical and chemical charecteristics of streams was shown in Table 1. Brown trout is the only species regularly found in those streams. Fish were collected with electrofishing from August to November 2008 within 100 m. Samples were placed on ice and transferred

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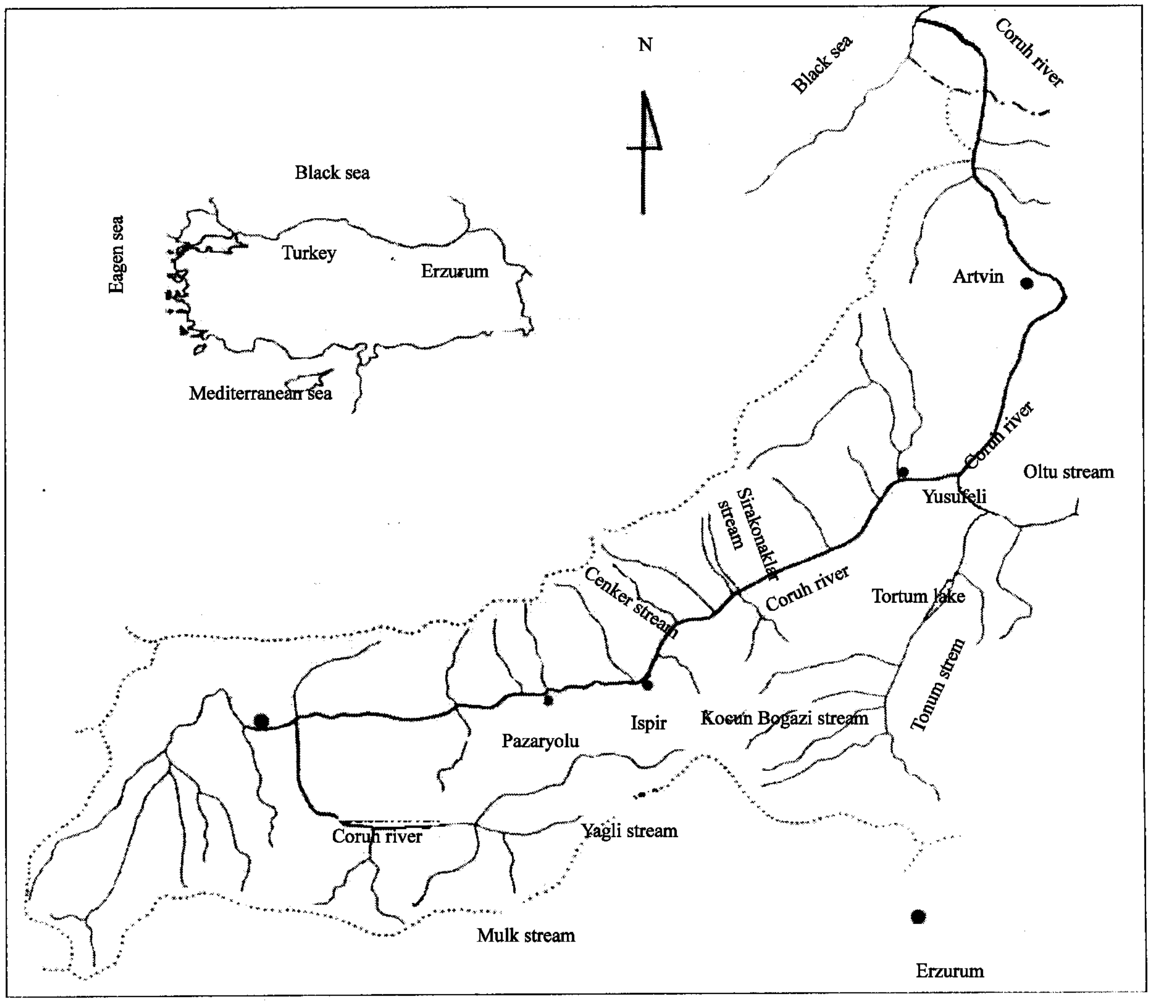

Fig. 1: Sample streams from Coruh basin

Table 1: Some chemical and physical characteristics of streams, Coruh river, Turkey

Parameters	Yagli stream	Mulk stream	Cenker stream	Sirakonaklar stream	Kocun Bogazi stream
Coordinate	40°21' 50" N	41°05' 12" E	40°17' 09" N	40°54' 53" E	40°36' 36" N
	40°55' 29" E	40°46' 04" N	41°11' 25" E	40°28' 09" N	41°05' 58" E
Altitude (m)	2350	2091	2088	1927	1800
Dominant substrat type	Cobble and pebble	Pebble and gravell	Cobble and pebble	Cobble and pebble	Cobble and boulder
Depth (cm)	45.6	13.0	15.08	14.5	27.5
Width (m)	5.10	2.10	2.800	2.80	5.40
Dominant canal type	Pool and riffle	Pool and riffle	Riffle and pool	Riffle and pool	Waterfull and run
Phosphate (mg L^{-1})	5.00	6.69	5.80	4.00	3.72
Nitrit (mg L^{-1})	0.028	0.054	0.056	0.009	0.020
Nitrate (mg L^{-1})	1.30	0.50	1.97	1.06	2.26
pH	7.70	6.60	8.40	7.00	8.10
Temperature (°C)	6.20	9.00	8.40	7.30	8.10

to the laboratory where they were held in a freezer at -10°C forlater analysis. Prior to dissection, all fish were thawed, rinsed and blotted dry, measured to the nearest 1 mm (Fork Length) (FL) and Weighted (W) to the nearest 0.01 g. Somatic Weight (SW) was determined after gonad and gut were removed. Age was determined by using the otoliths on alcohol under a binocular stereomicroscope (Devries and Frie, 1996). The Von Bertalanffy growth curve was fitted to the observed length at age data of resulting age-length key by means of Marquard's algorithm for non-linear least-squares parameter estimation for Cenker, Sirakonaklar, Kocun Bogazi, Sirakonaklar stream. Fishes was in Mulk stream was exludesed because of inefficient age classes. The form of the growth curve is:

$$L_t = L_{inf}(1 - e^{-K(t-t_0)})$$

Where:

L_{inf} = The average asymptotic length
K = The growth coefficient that determines how fast the fish approaches L_{inf}
t_0 = The hypothetical age for $L_t = 0$

Overall growth performance of a species can be interpreted by the growth index $\varphi = \log(K) + 2\log(L_{inf})$ which can also be used for comparing growth rates among species (Phi prime test) (Munro and Pauly, 1983). Instentaneous growth rate was calculated using:

For weight:

$$Gw = \frac{Loge(Wt+1) - loge(Wt)}{\Delta t}$$

For length:

$$GFL = \frac{Loge(FLt+1) - loge(FLt)}{\Delta t}$$

Where Wt + 1 and Flt + 1 were weight and fork length in age of t+1 and Wt and FLt and Δt were weight and fork length in age of t and time, respectively (Weatherley and Rogers, 1978).

Length-total weight relationship was described using the logarithmic form of the formula of $W = axFL^b$ (Ricker, 1975). The Fulton condition factor, K was calculated as:

$$K = \frac{W}{FL^3} \times 100$$

According to Anderson and Neumann (1996). The Somatic Index (SI) was calculated as:

$$SI = \frac{SW}{FL^3} \times 100$$

Substrat was considered as boulder, cobble, pebble, gravel, sand and sild-grey and habitat type was recorded as waterfull, riffle, run and pool (Armour *et al*., 1983; Bain and Stevenson, 1999). pH and temperature were measured directly from the stations using pH meter (Delta HD 2156.2) and its temperature probe. For the other water quality parameters, samples from the each stations were taken to the laboratory, analyzed using spectrophotometer (Nova 60). Some chemical and physical charecteristics of streams were shown in Table 1. Analyses of one-way ANOVA were used to compare mean fork length and total weight among the habitat for same age classes.

To estimate effects of stream and age classes on condition factor and somatic index was used an analyses of two-way ANOVA. To identify allometric or isometric growth, the b value of the length-weight relations was tested for deviation from the value of 3.0 by a t-test. When b is not statistically different from 3.0, growth is isometric. Positive or negative allometric growth is indicated when bstatistically differs from 3.0 (Ricker, 1975). χ^2-tests were performed to test differences in expected and observed value for age-length growth. Statistical significance were based on p = 0.05 for all tests performed.

RESULTS AND DISCUSSION

Growth: The longest and haviest samples for brown trout were 38.7 cm and 638.13 g for Kocun Bogazi stream, 22 cm and 110.4 g for Cenker stream, 17.1 cm and 57.43 g for Mulk stream, 23.3 cm and 153.12 g for Sirakonaklar stream and 20.6 cm and 126.92 g for Yagli stream. Average fork length and total weight in age classes displayed almost similar pattern for all streams. To estimate difference among streams at the same age classes for fork length and total weight were performed with analyses of one-way ANOVA.

There were slightly variability in fork lenght and total weight at the same age classes among the streams. For example, age of 0 and 1 classes were observed the highest value for fork lenght and total weight in Sirakonaklar stream while those were the lowest valeu in Kocun Bogazi stream but there was no statistical difference in age class of 2 among the streams. Age classes of 3-6, fork length and total weight values slightly higher in Kocun Bogazi stream than those in other streams (Table 2 and 3).

Instantaneous growth rate: The highest instantaneous growth rate for both fork length and total weight was observed at age of 0-1 in all streams. While fishes in Kocun Bogazi stream had the highest G_{FL} and G_W for all age classes followed by those in Yagli stream. Fishes in other streams were almost similar fluctation to each other with low value.

Additionally, fishes from Mulk stream had the lowest instantaneous growth rate for both fork length and total weight in all age classes (Table 4).

Condition coefficient and somatic index: There were sligthly variability in condition coefficient (K) and Somatic Index (SI) values and displayed similiar pattern to each

Table 2: Age and mean fork length $\overline{FL} \pm SE$ (cm) of brown trout from different streams in Coruh basin, Turkey

Age classes[1]	Yagli stream	Mulk stream	Cenker stream	Sirakonaklar stream	Kocun Bogazi stream
			$\overline{L} \pm SE$		
0	5.2±0.108^{ab}	5.4±0.370^{ab}	6.1±0.096^{b}	6.4±0.196^{b}	4.3±0.188^{a}
1	9.3±0.450^{ab}	9.5±0.125^{ab}	10.4±0.226^{bc}	11.1±0.290^{c}	8.3±0.264^{a}
2	13.1±0.259	13.1±0.236	12.9±0.585	13.6±0.237	13.5±0.441
3	15.5±0.221^{a}	14.9±0.436^{a}	16.3±0.668^{a}	15.9±0.316^{ab}	17.8±0.39^{b}
4	17.7±0.487^{a}	-	18.0±0.890^{a}	18.8±0.293^{ab}	20.1±0.461^{b}
5	19.7±0.578	-	21.0±1.000	21.6	23.7±1.239
6	-	-	23.5	23.3±0.1	25.3±0.050
7	-	-	-	-	26.9±0.350
8	-	-	-	-	38.5

[1]According to analyses of one-way ANOVA, differences for age classes of 0, 1, 3 and 4 among the streams was statistically important and F and p values were F = 13.75, p=0.00, F = 28.06, p = 0.00, F = 8.716, p = 0.00, F = 4.406, p = 0.009, respectively but not important for age classes of 2 and 5 with F = 1.58, p = 0.57 and F = 2.341, p = 0.129. Within age classes with similar superscripts were not significantly different (p>0.05)

Table 3: Age and total weight SE (g) of brown trout from different streams in Coruh basin, Turkey

Age classes[1]	Yagli stream	Mulk stream	Cenker stream	Sirakonaklar stream	Kocun Bogazi stream
			W±SE		
0	1.54±0.147^{a}	2.49±0.657^{b}	2.64±0.173^{b}	3.19±0.432^{b}	1.08±0.214^{a}
1	10.23±1.777^{ab}	11.46±0.547^{ab}	13.86±1.032^{bc}	18.27±1.587^{c}	7.77±0.791^{a}
2	26.91±1.921	29.64±1.595	26.90±3.334	30.96±2.130	34.03±4.180
3	47.67±2.409^{a}	40.76±2.556^{a}	54.55±7.468^{a}	50.13±3.208^{a}	76.96±5.311^{b}
4	75.06±7.194^{a}	-	68.57±10.820^{a}	80.88±6.688^{ab}	106.92±7.060
5	107.20±8.633	-	113.87±3.130	131.23	168.9±21.763^{b}
6	-	-	-	158.71±5.590	204.47±23.530
7	-	-	-	-	228.64±27.235
8	-	-	-	-	638.13

[1]According to analyses of one-way ANOVA, differences for age classes of 0, 1, 3 and 4 among the stream was statistically important and F and p values were F = 4.23, p = 0.004, F = 12.62, p = 0.00, F = 10.40, p = 0.00, F = 4.44, p = 0.009, respectively but not important for age classes of 2 and 5 with F = 0.93, p = 0.448 and F = 2.23, p = 0.141. Within age classes with similar superscripts were not significantly different (p>0.05)

Table 4: Instanstenous growth ratio of fork length (G_{FL}) and total weight (G_w) of brown trout from different streams in Coruh basin, Turkey

	Yagli stream		Mulk stream		Cenker stream		Sirakonaklar stream		Koc stream	
Age classes	G_{FL}	G_w	G_{FL}	G_w	G_{FL}	G_w	G_{FL}	G_w	G_{FL}	G_w
0	0.59	1.90	0.57	1.53	0.54	1.66	0.53	1.75	0.65	1.97
1	0.34	0.97	0.32	0.95	0.22	0.66	0.21	0.53	0.48	1.48
2	0.17	0.57	0.13	0.32	0.23	0.71	0.16	0.48	0.28	0.82
3	0.13	0.45	-	-	0.09	0.23	0.17	0.48	0.12	0.33
4	0.11	0.36	-	-	0.15	0.51	0.14	0.48	0.17	0.46
5	-	-	-	-	0.11	-	0.08	0.19	0.06	0.19
6	-	-	-	-	-	-	-	-	-	0.06
7	-	-	-	-	-	-	-	-	-	-

Table 5: Analyses of two-way ANOVA of effect of streams and age classes on condition coefficient (K) and Somatik Index (SI) of brown trout from different streams in Coruh basin, Turkey

	Conditon Coefficient (K)				Somatic Index (SI)			
Source of variance	df	MS	F-value	p-value	df	MS	F-value	p-value
Age classes	7	0.074	5.080	0.000	7	0.018	1.453	0.183
Sites	4	0.048	3.260	0.012	4	0.045	3.701	0.006
Age classes×site interection	18	0.030	2.031	0.012	19	0.020	1.639	0.045
Error	475	0.015	-	-	395	0.012	-	-

other. The analyses of two-way ANOVA was performed to determine affect of stream and age classes on K and SI (Table 5). Both stream and age class had an affect on K but only stream had a important affect on SI statistically.

Fishes in Kocun Bogazi stream had the highest K and SI values followed by Yagli and Mulk stream and those in Cenker stream had the lowest K and SI values. Moreover, there were two homogenous group in K values. First one was Kocun Bogazi, Yagli and Mulk stream, second one was Cenker and Sirakonaklar stream. Homegenous groups in SI for streams were different pattern with three homegenous groups, Cenker, Yagli stream, Mulk stream,Sirakonaklar stream and Kocun Bogazi stream, Sirakonaklar stream (Table 5-7).

K values in 0 of age class for brown trout was the lowest for all streams and those in other age classes displayed different fluctation among the streams. For example, K values in Yagli stream get to increase with age while those in Yagli and Mulk stream

Table 6: Condition coefficient (K) values by age classes and streams for brown trout from different streams in Coruh basin, Turkey. Differences among the age classes or streams were not significantly different if the same letter identities those grouping ($p>0.05$)

Age classes	Yagli stream	Mulk stream	Cenker stream	Sirakonaklar stream	Kocun Bogazi stream	Overall
0	1.08±0.052	1.20±0.027	1.14±0.038	1.09±0.044	1.14±0.030	1.15±0.024 [a]
1	1.22±0.050	1.24±0.014	1.17±0.015	1.29±0.020	1.27±0.020	1.23±0.009[ab]
2	1.17±0.016	1.26±0.021	1.15±0.016	1.19±0.039	1.32±0.032	1.22±0.015 [ab]
3	1.26±0.027	1.22±0.050	1.17±0.014	1.21±0.024	1.31±0.024	1.25±0.013 [ab]
4	1.31±0.025	-	1.15±0.069	1.19±0.048	1.28±0.029	1.26±0.020 [ab]
5	1.39±0.041	-	1.25±0.212	1.25	1.24±0.041	1.29±0.03[b]
6	-	-	-	1.21±0.145	1.25±0.137	1.25±0.057 [ab]
7	-	-	-	-	1.16±0.094	1.16±0.094
8	-	-	-	-	1.01	-
Overall	1.24±0.017[b]	1.24±0.011 [b]	1.16±0.012 [a]	1.19±0.014 [a]	1.26±0.012 [b]	1.21±0.007

Table 7: Somatic Index (SI) values by age classes and streams for brown trout from different streams in Coruh basin, Turkey. Differences among the age classes or streams were not significantly different if the same letter identities those grouping

Age classes	Yagli stream	Mulk stream	Cenker stream	Sirakonaklar stream	Kocun Bogazi stream	Overall
1	1.07±0.012	1.12±0.052	1.07±0.023	1.00±0.026	1.13±0.043	1.10±0.013
2	1.10±0.021	1.12±0.012	1.06±0.015	1.08±0.045	1.16±0.036	1.11±0.012
3	1.11±0.032	1.09±0.021	1.06±0.029	1.09±0.029	1.15±0.025	1.09±0.012
4	1.15±0.051	1.07±0.043	0.93±0.103	1.06±0.055	1.15±0.038	1.06±0.020
5	-	-	0.85	1.08±0.052	1.10±0.067	1.13±0.032
6	-	-	-	-	1.10±0.064	1.11±0.058
7	-	-	-	-	1.01	1.01
Overall	1.10±0.011[b]	1.11±0.012[b]	1.03±0.023[a]	1.11±0.025[bc]	1.14±0.014[c]	1.10±0.006

was stable fluctation with age. Also, those for Kocun Bogazi stream displayed stable fluctation from 2-5 of age classes than get to decrease in older fish (Table 6).

Length-weight relationship: Length-weight relationship for all stream were calculated and the slope (b) of length-weight relationship was slightly vairability among the streams. The lowest b value was observed in Cenker stream with value of 3.008 while the highest b value was considered in Yagli stream with value of 3,166. Also, all determination coefficient was recognised over the >0.95 for all population. Also, fishes in Cenker stream and Mulk stream displayed isometric growth while those in other stream had positive allometric growth characteristic (Table 8, Fig. 2).

Von Bertalanffy: Von Betalanffy equations were calculated as $L_t = 31.91x\ (1\text{-exp}\ (-0.161x\ (t + 1.476)))$ for Sirakonaklar stream, $L_t = 28.52x\ (1\text{-exp}\ (-0.195x\ (t + 1.071)))$ for Yagli stream, $L_t = 40.93x\ (1\text{-exp}\ (-0.148x\ (t + 0.693)))$ for Kocun Bogazi stream and $L_t = 35.61x\ (1\text{-exp}\ (-0.134x\ (t + 1.512)))$ for Cenker stream. Fishes in Kocun Bogazi stream grew to a greater a asymptotic length (L_{inf}) than those in other streams. The equations of Von bertalanffy growth curves for all streams Von bertalanffy growth curves were plotted in Fig. 3.

There was no statistical difference between expected that calculated from Von bertalanffy and observed for all streams with χ^2-test (Table 9, Fig. 3). The Φ values for brown trout from Yagli stream, Cenker stream, Sirakonaklar stream, Kocun Bogazi stream were as 2.2003, 2.2302, 2.2146, 2.3943, respectively (Table 9). The lowest mean fork length was reported as 2.8 cm by Crisp and Beamount (1996) and the highest value of mean fork length was 11.6 cm. Even there were slightly variation for mean fork length of 0 age class in different streams at the same basin (Nicola and Almodovar, 2002).

There were statistical variation 3 of age and older of age classes among the streams with analyses of one-way ANOVA. Moreover, fishes in Kocun Bogazi stream had the lowest mean fork length by 2 of age class but those had the highest mean fork length value for older age classes (Table 2). This may be attributed that streams have different environmental condition. It is suggested that Cenker stream characterising low width and dept, riffle habitat and cooble subtrat and low velocity and Mulk stream having low width and dept, pool habitat, low velocity and pebble subtrat were more suitable habitat than other stream for subtrat age 0 and age 1 while Kocun Bogazi stream characterising cobble and boulder substrate (Table 1), more deeper and weder, dominant waterfull habitat, high discharge was more suitable for older brown trout.

On the other hand, the quantity and quality of the food eaten are very important for the growth rate of the fish (Wootton, 1998) and the ability to grow continuously during the all life span depends heavily on whether the fish have opportunities to change to arger sized food items as they grow larger (Gorman and Nielson, 1982). ariation in food consumption and temperature are probably the main reasons for variability of growth rate but also food particle size is important (Wootton, 1998). The relative variation in the size of fish was not a stable parameter of brown trout population and can changed due

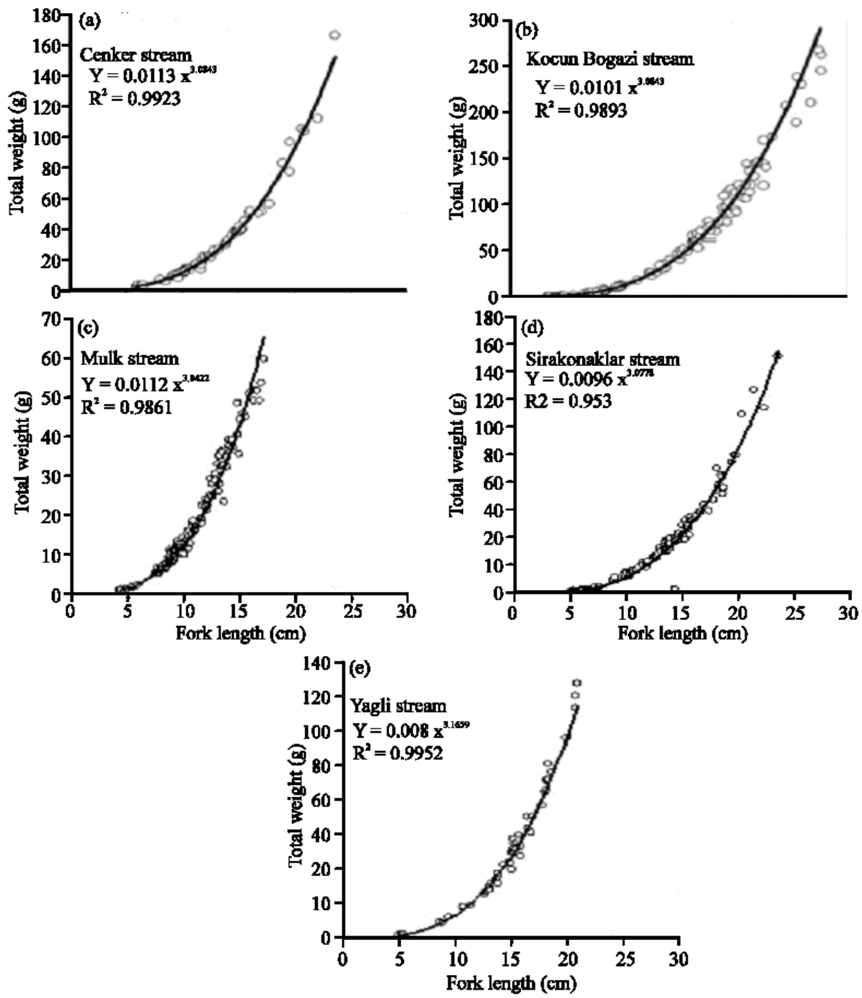

Fig. 2: Length-weight relationship of brown trout populations from differen streams in Coruh basin

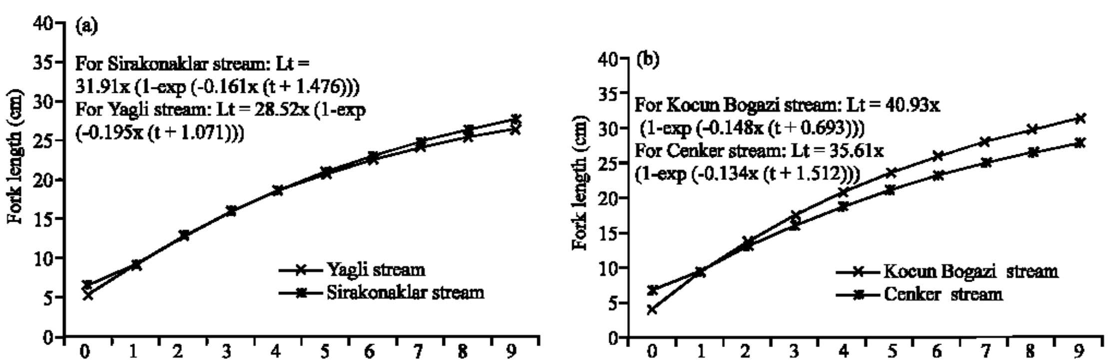

Fig. 3: Von Bertalanffy equations for brown trout from different streams in Coruh basin

to density of fish genotype, food availability and water temperature (Allen, 1985; Zalewski *et al*., 1985). While instentaneous growth rate for fork length was faster in young age classes than older ones and that for total weight was almost stable variation age of 3-5 classes (Table 4). This can be attributed sexual maturity and gonadal maturation that brown trout inhabited some streams in Coruh basin stated to reach 2 of age for male

Table 8: Length-weight relationship for brown trout from different streams in Coruh basin, Turkey

Sites	b±SE	a±SE	R^2	t-value
Kocun Bogazi stream	3.084±0.037	0.0960±0.001	0.9981	4.530[a]
Cenker stream	3.008±0.039	0.0113±0.001	0.9823	0.220[b]
Mulk stream	3.042±0.028	0.0112±0.001	0.9861	1.920[b]
Sirakonaklar stream	3.077±0.065	0.0096±0.002	0.9530	6.300[a]
Yagli stream	3.166±0.003	0.0080±0.001	0.9952	4.660[a]

[a] Display positive allometric growth, [b] display isometric growth

Table 9: Von Bertalanffy parameters for brown trout from different streams from Coruh basin, Turkey

Streams	L_{inf}	K	to	χ^2 value	Φ
Yagli stream	28.52	0.195	-1.071	$\chi^2 = 0.002 < \chi^2_{0.05,5)} = 11.07$	2.2003
Cenker stream	35.61	0.134	-1.512	$\chi^2 = 0.089 < \chi^2_{0.05,6)} = 12.59$	2.2302
Sirakonaklar stream	31.91	0.161	-1.476	$\chi^2 = 0.830 < \chi^2_{0.05,6)} = 12.59$	2.2146
Kocun Bogazi stream	40.93	0.148	-1.512	$\chi^2 = 0.106 < \chi^2_{0.05,7)} = 15.50$	2.3943

Table 10: Mean fork length for brown trout from different area

Researchers	Study areas	0	1	2	3	4	5	6	7	8	b-value
Geldiay	Han creek, Turkey	8.50	12.60	18.90	-	-	-	-	-	-	-
	Celebi stream	7.30	12.10	15.70	19.90	-	33.00	-	-	-	-
	Isikli stream	6.30	14.80	16.00	-	-	-	-	-	-	1.78-2.78
	Ayazma creek	6.90	11.40	18.80	-	-	-	-	-	-	-
	Kirse	-	9.00	16.60	-	-	-	-	-	-	-
	Sutuven	-	13.70	22.60	-	-	-	-	-	-	-
Papageorgiou *et al.* (1983)	Aspropotamos stream, Greece	-	7.60	11.70	14.80	17.00	18.70	20.50	21.20	22.6	2.950
Lobon-Cervia *et al.* (1986)	River Ucero, Spain	-	11.00	20.10	27.80	34.20	39.50	-	-	-	-
	River Avion	-	9.30	18.70	25.30	31.80	-	-	-	-	-
Yanar	Hodacu stream, Turkey	-	-	-	-	-	-	-	-	-	2.996
	Barhal stream, Turkey	-	-	-	-	-	-	-	-	-	3.000
Crisp and Beaumont (1995)	Afon Dyfi, England	-	7.60	11.40	14.40	16.20	-	-	-	-	-
Crisp and Beamount (1996)	Wye, England	2.80	7.90	11.20	14.70	17.00	18.60	-	-	-	-
Arslan *et al.* (2004, 2007)	Cenker, Turkey	-	11.03	14.29	17.48	20.38	23.42	25.36	26.50	27.85	-
Cetinkaya	Catak stream, Turkey	-	9.30	11.90	14.30	16.60	18.80	-	33.50	39.00	3.070
Tabak	East Black sea streams, Turkey	11.60	14.60	20.10	27.70	36.20	-	-	-	-	3.035
Nicola and Almodover (2002)	Hoz Seca, Spain	7.70	13.50	18.80	-	-	-	-	-	-	-
	Cabrillas	8.10	14.30	19.40	-	-	-	-	-	-	-
	Gallo	9.60	15.50	19.90	-	-	-	-	-	-	-
	Dulce	9.40	17.50	22.70	-	-	-	-	-	-	-
	Jarama	7.30	12.90	16.90	-	-	-	-	-	-	-
	Cega	6.60	11.50	15.70	-	-	-	-	-	-	-
	Eresma	6.40	10.80	14.90	-	-	-	-	-	-	-
Arslan	Anuri, Turkey	6.84	10.30	1 3.70	16.10	18.70	23.60	27.10	-	-	3.037
	Cenker	6.20	10.10	13.20	16.00	18.80	22.20	24.90	30.20	-	3.000
Hesthagen *et al.* (2004)	Sulbalpine Norweigan Section-1	3.50	7.60	12.40	15.30	19.50	22.20	22.90	-	-	-
	Section-2	4.30	7.80	11.10	14.30	16.90	-	-	27.80	-	-
Arslan *et al.* (2004)	-	-	-	-	-	-	-	-	-	-	2.970
Yildirim and Arslan (2007)	Kan stream, Turkey	6.80	9.20	12.50	15.80	19.00	19.90	21.60	26.10	-	-

and age of 3 for female (Yildirim and Arslan, 2007). Length-weight relationship helps in estimating the nutrition, condition, reproduction and life history of fishes (Nikolsky, 1963; Wootton, 1992).

In this study, fishes in Cenker and Mulk streams had isometric growth chphysical charecteristic but those in other stream displayed positive allometric growth (Table 8, Fig. 2).

b values of L-W relationship in literature is generally varied as 1.78-3.07 (Table 9). Moreover, b values from studied streams are higher than those reported by Papageorgiou *et al.* (1983) and Arslan *et al.* (2004) and fishes in Cenker stream had similar to those cited by and for Cenker stream. Fishes in Mulk stream with 3.042 of b values also similar to those recorded by Tabak and Arslan for Anuri stream. Fishes in Yagli stream with 3.166 had the highest b value if compared with literature (Table 10).

It can be suggested that studied streams may have favorable environmental condition in comperason with other habitat in the world.

Variation of b values in studied streams can be attributed food availability, water temperature and gonadal maturation (Weatherley and Gill, 1987; Wootton, 1992).

L_{inf} from studied streams from Coruh basin for brown trout varied 28.52-40.93 cm (Fig. 3). Variations among different brown trout populations for asymptotic length and brody (K) may be affected by

Table 11: Von Bertalanffy parameters and Ö` values for brown trout from different locations

Researchers	Study areas	L_∞ (cm)	K ($year^{-1}$)	Φ
Crisp *et al.* (1974)	Cow Green Stream, England	39.00	0.1500	2.3580[1]
Crisp *et al.* (1975)	Trout Beck, England	21.50	0.2000	1.9660[1]
Crisp and Cubby (1978)	Cnook Ore Gill, England	30.80	0.2200	2.3200[1]
Lobon-Cervia *et al.* (1986)	River Ucero, Spain	65.94	0.1831	2.1920[1]
	River Avion-Milanos	64.03	0.1753	2.9010[1]
Crisp and Beaumount (1995)	Afon Dyfi, England	21.60	0.3100	2.1600[1]
Crisp and Beaumount (1996)	Wye, England	21.50	0.3400	2.1960[1]
Haugen and Rygg (1996)	Norwegian reservoir, Norway	37.90	0.3250	2.6690[1]
		42.80	0.2850	-
Hesthagen	Sub-Alpine reservoir, Norway	39.10	0.2100	2.5070[1]
Arslan *et al.* (2000)	Cenker, Turkey	36.88	0.1510	2.3130[1]
Tabak	East Black sea streams, Turkey	40.52	0.2860	2.6720[1]
Arslan	Anuri, Turkey	36.94	0.1260	2.8570
	Cenker	38.41	0.1250	2.2350
Yildirim and Arslan (2007)	Kan Stream, Turkey	33.93	0.1510	2.2402
Streams in current study				
Yagli Stream	$t = -0.054 < t_{0.05,14} = 1.76$	-	-	2.2003
Cenker Stream	$t = -0.046 < t_{0.05,14} = 1.76$	-	-	2.2302
Sirakonaklar Stream	$t = -0.050 < t_{0.05,14} = 1.76$	-	-	2.2146
Kocun Bogazi Stream	$t = -0.002 < t_{0.05,14} = 1.76$	-	-	2.3943[1]

Values of Φ were calculated by Yildirim and Arslan (2007) by using values of L_{inf} and K in the study

biotic and abiotic factors such as water temperature, water chemistry and genetics and fish size (Jonnson, 1989). Some researchers have also reported similar patterns in their studies. The Φ values of different brown trout populations ranged between 1.966 and 2.901. In this study, it was calculated as 2.2003 for Yagli stream, 2.2302 for Cenker stream, 2.2146 for Sirakonaklar and 2.3943 for Kocun Bogazi stream which similar to other population in the different locations from the world (Table 11). It may be suggested that brown trout from different streams from Coruh basin would show similar growth in those locations.

Condition coefficient and Somatic Index were almost similar fluctation in this study (Table 6 and 7). Mean condition coefficient for brown trout from Cenker stream and Sirakonaklar stream having the lowest values in Coruh basin was a good agrement with Cenker stream by Arslan, Catak stream by Cetinkaya, Barhal basin by Yildirim and Upper part of Karasu by Nakipoglu. On the other hand, K value in other studied streams was relatively similar with Anuri but better K value than those in other studies.

Differences among the habitat placed different location in the world may be attributed both maturation, using different length for measuring and ecological differences among the habitats (Nikolsky, 1963; Bruton, 1990). There were also sligthly variability in K value for brown trout in studied streams because of stream characteristics. Moreover, fishes in Mulk and Yagli having dominant pool habitat and low velocity and Kocun Bogazi stream having dominant waterfull habitat had relatively higher K values than those in Cenker and Sirakonaklar stream having dominant riffle habitat and high velocity. Pool habitat type is more suitable and fishes spends less energy daily routine movement (Jutila *et al*., 2001).

CONCLUSION

It might be suggested that generally growth and condition for brown trout in studied streams in Coruh basin is in better condition in comperasion with those in other population in the world.

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