Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
Accessible at: www.pvj.com.pk

# Some Reproductive Features of Brown Trout (*Salmo trutta macrostigma* Dumeril, 1858) and its Larval Development under Culture Conditions

O. Demir, İ. Gülle[1], E. Gümüş[2]*, F. Küçük, A. Günlü and K. Kepenek[3]

Fisheries Faculty, Süleyman Demirel University, Eğirdir-Isparta, Turkey; [1]Science and Arts Faculty, Mehmet Akif Ersoy University, Burdur, Turkey; [2]Fisheries Faculty, Akdeniz University, 07058, Antalya, Turkey; [3]Agriculture Faculty, Süleyman Demirel University, Isparta, Turkey
*Corresponding Author: egumus@akdeniz.edu.tr

ARTICLE HISTORY

Received: January 27, 2010
Revised: April 05, 2010
Accepted: April 15, 2010

**Key words:**
Brown trout
Fish culture
Larval development
Reproductive features
*Salmo trutta macrostigma*

**ABSTRACT**

In this study, some reproductive features of wild brown trout (*Salmo trutta macrostigma* Dumeril, 1858) populations in Aksu, Eşen, Alara and Alakır streams in Turkey were examined and larval development was also investigated in two different culture conditions established on Eşen Stream (Trial 1) and at the Research Unit of Eğirdir Faculty of Fisheries at Süleyman Demirel University (Trial 2). The spawning time of brown trout in Aksu Stream in the second half of December was different from other localities, at the end of the January and in the first week of February. The gonadosomatic index values ranged between 17.5 and 19.8%, the mean egg diameters of females in all localities were between 3.51 and 3.78 mm ($P<0.05$). The incubation lasted for 370 and 390 day-degree (10.5-10.9 ºC), and the yolk-sac of the larvae was absorbed in 28 and 32 days in trials 1 and 2, respectively. The mean live weight (LW), total length (TL) and mouth widths (MW) in start-fed larvae and those with absorbed yolk-sac in both trials showed non significant differences before the 25th day of the trial. On the 25th, 50th, 75th and 100th day, the mean LW, TL and MW values of the larvae in the trial 1, however, ranged from 108.30 to 547.30 mg, 23.05 to 42.74 mm and 2441 to 3993 µm; whereas these values in trial 2 were 91.30 to 366.60 mg; 20.04 to 35.18 mm and 2123 to 3386 µm, respectively. The differences among the mean values were significant ($P<0.05$).



**To cite this article:** Demir O, İ Gülle, E Gümüş, F Küçük, A Günlü and K Kepenek, 2010. Some reproductive features of brown trout (*Salmo trutta macrostigma* Dumeril, 1858) and its larval development under culture conditions. Pak Vet J, 30(4): 223-226.

## INTRODUCTION

The morphological traits of brown trout, *Salmo trutta macrostigma* Dumeril, 1858, called Mediterranean trout or Anatolian trout and having a wide geographical distribution area in Turkey, as well as the biological traits of some of its populations have been studied earlier (Kocaman *et al.,* 2004). It has also been reported that the species of brook trout (*Salvelinus fontinalis*), brown trout (*S. trutta)* and arctic char (*Salvelinus alpinus*) have been widely reared in North America and Europe with purposes of sportive and fish stocking. In addition, rainbow and brook trout were reported to be better growing in cultural conditions and natural environment than brown trout (Okumuş *et al.,* 1999).

Hesthagen and Johnsen (1989) observed that effects of stocking time of larvae in habitats on growth rates were non significant. In addition, they also studied the importance of some conditions such as stocking season, fish size, altitude and water productivity in fish stocking in natural environment.

The use of fish other than domestic species in fish stocking studies may lead to a change in the gene pools of natural populations and it is, therefore, required to not use the eggs, fry, young and adults of any species other than domestic species. In this way, the risks of parasites and diseases carried by foreign species will decrease (Fernandez-Rueda *et al.,* 1998).

The main aim of the present study was to investigate hatching and larval growth of wild brown trout in two different trial conditions. Moreover, some reproductive features of this species distributed in the southwestern Mediterranean region of Turkey were also studied.

## MATERIALS AND METHODS

Candidate broodstocks were caught alive from four localities, viz. Aksu (Isparta), Eşen (Muğla), Alara and

Alakır (Antalya) streams, with gill and cast nets during July and September, 2005. The live weights (LW) of 10 brown trouts were measured between 104 and 240 g (161.5±14.96g) and total length (TL) between 21.7 and 25.5 cm (23.1±0.41 cm). Moreover, 20 fish, previously caught and stocked at a private trout facility on Alara Stream, the LW of which ranged from 280 to 2305g (952 ± 118g) and the TL ranged from 29.1 to 47 cm (37.31± 1.12cm), were carried to a private trout facility (Erol's Farm) operating on Aksu Stream and stocked in the adaptation pool. The adaptation pool measured 20x3x1m in dimension, had large pebble-stones on its floor, with walls made of soil and water flow of 3.5 L/sec to stock 0.5 $Kg/m^3$ fish (Kelly-Quinn and Bracken, 1988). Furthermore, the values of LW and TL of 10 brown trouts caught from four localities were measured during their natural reproduction season (from end of the 2006 to beginning of the 2007). The fertilization was performed by the dry spawning method. Gonadosomatic index (GSI) of female broodstocks was calculated according to Bagenal and Braum (1978).

Incubation of eggs and maintenance of larvae were carried out at a private (H.A.T. Farm) trout facility established on Eşen Stream (Trial 1) and at the facilities in the Research Unit of Eğirdir Faculty of Fisheries at Süleyman Demirel University (RUEFF-SDU, Trial 2) as triplicate for 100 days. Hatching larvae were stocked into plastic container (100 larvae/12 L). The LW (mg), TL (mm) and mouth width (MW, µm) values of 10 larvae were recorded for each 25-day period for calculation. Egg diameter (ED) and TL were measured with a digital calliper (0.05 mm), LW was weighted with an electronic scale sensitive to 1 mg and MW was measured with a stereo microscope. Water quality parameters such as temperature, dissolved oxygen, pH and electrical conductivity were recorded by a portable WTW Multi 340i model apparatus and turbidity was noted by a WTW Turb 355-IR model portable device. The other parameters such as iron, sulphite, nitrate, total alkalinity and total hardness were determined using Merck Spektroquant® ready test kits and by direct-reading of concentration on Merck Nova 60 Model water analysis photometer.

The larvae of brown trout were fed *ad libitum* with rainbow trout larvae feed, commercial starter extruded diet composed of 58% crude protein, 12% crude fat, 0.5% crude fiber and 9.8% crude ash. The broodstocks were fed twice daily at a rate of 1% body weight with rainbow trout broodstock feed composed of 46% crude protein, 16% crude fat, 1.1% crude fiber and 9.5% crude ash.

SPSS 10.0 (SPSS INC. Chicago, IL, USA) was used to perform statistical calculations. All data were subjected to one-way analysis of variance (ANOVA), followed by the Duncan's multiple range test at 5% probability level (Steel *et al.,* 1996).

## RESULTS

Some physical and chemical parameters of the water in the streams, Aksu, Eşen (Trial 1), Alara or Alakır, and in the RUEFF-SDU (Trial 2) are given in Table 1. These values are within acceptable limits for salmonids (Piper *et al.,* 1982).

The LW, TL, GSI and ED values of broodstocks brown trout caught from four localities are given in Table 2. The mean LW and TL ranged from 116±8.6 to 187.2 23.5g, and 23.5±0.7 to 27.7±0.6cm, respectively. The GSI values were between 17.5 and 19.7%. The ED values ranged from 3.51 to 3.78 mm. The minimum and maximum values were recorded for Aksu and Alara stream, respectively (P<0.05).

**Table 1: Some physical and chemical parameters of water in four localities**

| Parameters | Aksu | Alakır | Alara | Eşen (Trial 1) | RUEFF-SDU (Trial 2) |
|---|---|---|---|---|---|
| Temperature (ºC) | 8.9 | 9.8 | 10.1 | 10.8 | 10.5 |
| Dissolved oxygen (mg/L) | 10.5 | 11.05 | 10.7 | 11.0 | 6.4 |
| Oxygen sat. (%) | 100 | 103 | 110 | 115 | 65 |
| pH | 8.2 | 8.07 | 8.3 | 8.10 | 7.85 |
| Conductivity (µS/cm) | 255 | 275 | 330 | 295 | 533 |
| Turbidity (NTU) | 0.90 | 0.80 | 2.46 | 0.9 | 0.30 |
| Fe (mg/L) | <0.05 | <0.05 | 0.05 | <0.05 | <0.05 |
| $SO_3$ (mg/L) | <0.2 | <0.2 | 0.4 | <0.2 | 0.6 |
| $NO_3$ –N (mg/L) | 0.02 | <0.02 | 0.03 | <0.02 | 0.05 |
| COD (mg/L)[1] | 9 | 7 | 10 | 10 | 12 |
| Total alkalinity (mg $CaCO_3$/L) | 140 | 128 | 148 | 130 | 255 |
| Total hardness (mg $CaCO_3$/L) | 165 | 125 | 180 | 145 | 265 |

[1]Chemical Oxygen Demand

**Table 2: Live weight (LW), total length (TL), egg diameter (ED) and gonadosomatic index (GSI) of broodstock brown trout caught from four localities**

| Streams | LW (g) | | | TL (mm) | | | ED (mm) | % GSI (♀)[1] |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Mean | Male | Female | Mean | | |
| Aksu | 140.0 ± 10.7 | 92.0 ± 8.4 | 116.0 ± 8.6[a] | 25.7 ± 0.5 | 21.3 ± 1.0 | 23.5 ± 0.7[a] | 3.51 ± 0.06[a] | 17.5 |
| Eşen | 214.1 ± 37.9 | 160.3 ± 27.1 | 187.2 ± 23.5[c] | 28.7 ± 0.9 | 26.8 ± 1.0 | 27.7 ± 0.6[b] | 3.74 ± 0.05[bc] | 19.7 |
| Alara | 191.5 ± 16.5 | 116.9 ± 10.3 | 154.2 ± 12.7[bc] | 28.4 ± 0.4 | 24.9 ± 0.9 | 26.6 ± 0.6[b] | 3.78 ± 0.07[c] | 18.0 |
| Alakır | 162.2 ± 18.9 | 125.5 ± 13.1 | 143.8 ± 11.9[bc] | 26.6 ± 1.1 | 25.0 ± 1.0 | 25.8 ± 0.7[b] | 3.64 ± 0.09[ab] | 18.5 |

[a-c]Values (Mean ± SD) in the same column with different letters are significantly different from each other(P<0.05); [1]Gonadosomatic index (GSI) = Gonad weight (g)/Body weight (g) x 100.

When broodstock brown trout were stocked in the adaptation pool, it was observed that the brown trout in the adaptation pool had very little interest in feed because of being under stress during natural reproduction period. Sperms were obtained from stocked males, while no eggs could be obtained with spawning method from female gonads which were puffy and plumpy. When ovaries were dissected, it was noted that some of the eggs reached diameters ranging from 3 to 4.2 mm, were irregular in shape and fused with each other. The egg colour varied between off-white and light orange, appearing pale and dull. Therefore, the eggs and sperms for experiment were obtained through spawning the brown trout caught during reproduction season from other localities, Aksu Stream in the second half of December, Eşen, Alakır and Alara streams at the end of January and in the first week of February. The egg productivity ranged from 1840 to 3200/Kg of fish during spawning season. It was found that the incubation time varied between 370 and 380 day-degree (water temperature 10.5-10.9°C) and the rate of hatching was determined between 32 to 57%. The yolk-sac of larvae was absorbed in 28 to 32 days.

The larvae of brown trout were fed with rainbow commercial larva feed with dimensions 0.3-0.5 mm. It took 5 to 7 days for the larvae to get used to extruder feed. During the experiment, it was observed that the larvae were very willing to form schools, they continuously tended to hide in the medium, became stressful upon any factors such as contact, noise or light and react intensively, swam very quickly and in a bewildered way and then they hid by concealing their heads behind any objects in the medium. On the other hand, under normal conditions, it was observed that the larvae stood next to each other and on one another against the current and did not swim in such a way that their bodies were parallel to the floor but relatively in a position where head section of their body was more upwards and their tail section was more downwards.

Some statistical analysis values of the data obtained from various phases (yolk-sac, first-fed, 25$^{th}$, 50$^{th}$, 75$^{th}$ and 100$^{th}$ days) of the larvae of brown trout in the trial 1 and 2 are given in Figs. 1-3. There was non significant difference (P>0.05) between the LW, TL and MW values of the brown trout larvae, kept in trial 2 and at the facility established on trial 1, whose yolk-sacs were about to be absorbed and which began to be start-fed. However, the data on the 25$^{th}$, 50$^{th}$, 75$^{th}$ and 100$^{th}$ days of the experiment showed that the growth of brown trout larvae kept at the facility condition on trial 1 was significantly better (P<0.05) than that of the trial 2 in terms of LW and TL and MW (Figs. 1-3). The mean LW, TL and MW of the larvae at the facility on trial 1 were 108.30, 207.60, 465.30 and 547.30 mg; 23.05, 26.66, 40.11 and 42.74 mm; 2441, 2925, 3813 and 3993 µm, respectively. For the trial 2, these values were 91.30, 169.10, 288.50 and 366.60 mg; 20.04, 23.37, 29.95 and 35.18 mm; 2123, 2578, 3250 and 3386 µm, respectively. In the periodic measurements on the 25$^{th}$, 50$^{th}$, 75$^{th}$ and 100$^{th}$ days of the larvae at each trial group, the percentage ratios of MW to TL were calculated to be 9.30, 10.50, 10.00 and 9.00%, respectively.

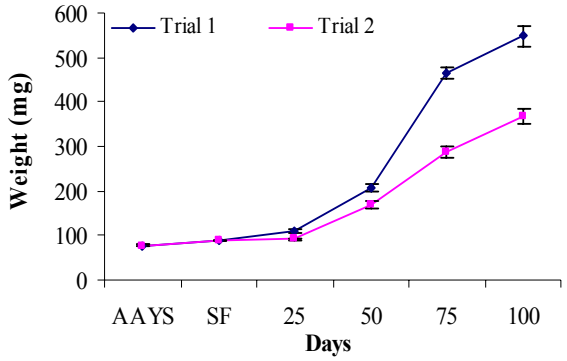


**Fig. 1: Values of live weight of larvae according to trial periods (AAYS: after absorbed yolksac, SF: start-fed).**

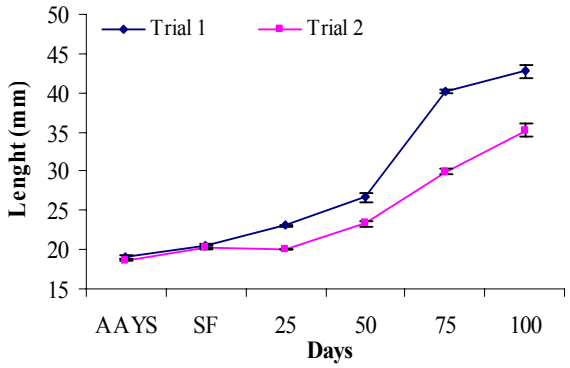


**Fig. 2: Values of total length of larvae according to trial periods (AAYS: after absorbed yolksac, SF: start-fed).**

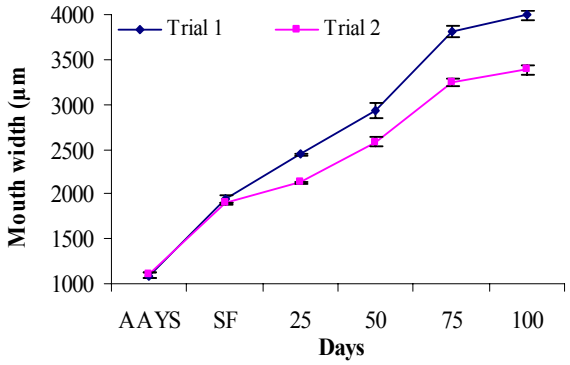


**Fig. 3: Values of mouth width of larvae according to trial periods (AAYS: after absorbed yolksac, SF: start-fed).**

## DISCUSSION

In the present study, differences in mean values of LW and TL of broodstock brown trout caught from four localities were found to be significant (P<0.05). The differences in the ED of population were also significant (P<0.05). These differences may be due to feeding, age

and spawning time of broodstocks as well as water quality and bottom structure in the streams. Moreover, there may be differences in various structures such as tree roots and trunks as well as partially-large stony and rocky structures where the fish could hide on the coasts. It was also observed that the larvae of brown trout were very sensitive in terms of adaptation to the trial conditions other than their natural habitats and their dietary abilities. In addition, the bottom of the reproduction areas of fish was free of mud and plants and covered with fine sand in such a way that it would not made the water muddy. The present findings are supposed by previous researchers (Beard and Carline, 1991; O'Connor and Andrew, 1998).

Differences between the mean values of LW, TL and MW of the larvae, the yolk-sac of which were about to be absorbed and which were completely start-fed, were found to be non significant for the larvae that were kept in two different trial groups. We think that the development of larvae both in yolk-sac phase and on the early days following the absorption of yolk-sac may be due to the effect of yolk-sac and due to the fact that they were scarcely active. It was observed that start-fed larvae were interested more in live pelagic and stream-dwelling feed sources on water surface. These findings have also been supported by various studies (Kelly-Quinn and Bracken, 1988; 1989; 1990; Kara and Alp, 2005).

On $25^{th}$, $50^{th}$, $75^{th}$ and $100^{th}$ days of the experiment, there were significant ($P<0.05$) differences between the mean values of LW, TL and MW of the larvae in the trial groups. The trial 2 was used in underground water which was of less quality than that of trial 1. Hence, these differences are thought to be due to differences in the dissolved oxygen contents and saturation as well as total hardness and total alkalinity of the water of two trials (Table 1). Likewise, it is stated that water and feed quality as well as other trial conditions affect the growth and breeding of Abant trout. Moreover, in a study on the comparison of the productions of Abant trout and rainbow trout of the same family, it has been reported that different species grew differently in the same culture conditions (Uysal and Alpbaz, 2002 a and b). Okumuş *et al.* (1999) observed that rainbow and brook trout grew better than brown trout in cultural and natural conditions. The present study showed that the growth of the same species changed according to habitat, water quality and foods. Similarly, other researcher expressed that larval growth is affected by species, water quality, habitat, stocking time of larvae in habitats, stocking season, fish size, altitude and foods (Hesthagen and Johnsen, 1989; Okumuş *et al.*, 1999; Uysal and Alpbaz, 2002 a and b).

In the light of the biological data obtained from this study, it seems that production success of brown trout in culture conditions changes according to habitat and water quality. More detailed investigations in suitable habitats for obtaining broodstock, larval breeding and growing for conservation of natural stocks are needed.

**Acknowledgements**

This study was financially supported by the Research Fund of the Süleyman Demirel University, Turkey (grant SDUBAP 05.M.1072).

## REFERENCES

Beard TD and RF Carline, 1991. Influence of spawning and other stream habitat features on spatial variability of wild brown trout. Trans Am Fish Soc, 120: 711-722.

Bagenal TB and E Braum, 1978. Eggs and early life history. In: Bagenal, T (ed), Methods for Assessment of Fish Production in Fresh Waters. IBP Handbook No: 3, Blackwell, Oxford, UK, pp: 165-210.

Fernandez-Rueda P, I Garcia-Florez and I Marquez, 1998. An experimental culture of wild Atlantic salmon, *Salmo salar L.*, with the purpose of restocking in auturias (northern Spain). Fish Manag Ecol, 5: 511-514.

Hesthagen T and BO Johnsen, 1989. Survival and growth of summer- and autumn-stocked brown trout, *Salmo trutta L*, in a mountain lake, Aquac Fish Manag, 20: 329-333.

Kara C and A Alp, 2005. Feeding habits and diet composition of brown trout (*Salmo trutta*) in the upper streams of river Ceyhan and river Euphrates in Turkey. Turk J Vet Anim Sci, 29: 417-428.

Kelly-Quinn M and JJ Bracken, 1988. Brown trout, *Salmo trutta L*., production in an Irish coastal stream. Aquac Fish Manag, 19: 69-95.

Kelly-Quinn M and JJ Bracken, 1989. A comparison of the diet of wild and stocked hatchery reared brown trout, *Salmo trutta L*, fry. Aquac Fish Manag, 20: 325-328.

Kelly-Quinn M and JJ Bracken, 1990. A seasonal analysis of the diet and feeding dynamics of brown trout, *Salmo trutta L*, in a small nursery stream. Aquat Fish Manage, 21: 107-124.

Kocaman EM, AY Yüksel and M Atamanalp, 2004. Some growth features of brown trout (*Salmo trutta macrostigma* Dumeril, 1858) Teke brook (Erzurum). Turk J Vet Anim Sci, 28: 981-989.

O'Connor WCK and TE Andrew, 1998. The effects of siltation on Atlantic salmon, *Salmo salar L.,* embryos in the river Bush. Fish Manag Ecol, 5: 393-401.

Okumuş İ, MS Çelikkale, İZ Kurtoğlu and N Başçınar, 1999. Growth performance, feed intake and feed efficiency of brook trout *(Salvelnius fontinlais)* and rainbow trout *(Oncorhynchus mykiss)* grown as steril or mixed. Turk J Vet Anim Sci, 23: 123-130.

Piper RG, IB McElwain, LE Orme, JP McCraren, LG Fowler and JR Leonard, 1982. Fish Hatchery Management. $3^{rd}$ Ed, US Department of the Interior Fish and Wildlife Service, Washington, USA.

Steel RGD, JH Torrie and DA Dickey, 1996. Principles and Procedures of Statistics. A biometrical approach. $3^{rd}$ Ed, McGraw Hill Book Company Inc, New York, USA.

Uysal I and A Alpbaz, 2002a. Comparsion of the growth performance and mortality in Abant trout (*St abanticus* T, 1954) and rainbow trout (*O mykiss* W, 1792) under farming conditions. Turk Zool Derg, 26: 399-403.

Uysal I and A Alpbaz, 2002b. Food intake and feed conversion ratios in Abant trout (S *t abanticus* T, 1954) and rainbow trout (*O mykiss* W, 1792) in pond culture. Turk J Biol, 26: 83-88.