

## HATCHING PERFORMANCES AND YOLK SAC ABSORPTIONS OF CASPIAN BROWN TROUT (*SALMO TRUTTA CASPIUS* T., 1954)

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### ABSTRACT

*Salmo trutta caspius* T., 1954 is a native to Caspian Sea and is an important fish species due to its aquaculture potential, economic value and high marketability. The aims of this study were to determine hatching rate, body and yolk weight at hatching, the growth rate during the yolk absorption and yolk conversion efficiency of *S. t. caspius* larvae. Studies were further extended to determine the relationships between length, total wet weight, dry yolk body weights of alevins and degree-days. Results revealed that the mean wet weight was  $16.78 \pm 2.17$  mg ( $n = 10$ ) at hatching and reached  $52.62 \pm 3.55$  mg just before the swim-up stage. The mean dry weights of the body and yolk sac were  $2.36 \pm 0.28$  mg and  $10.67 \pm 0.67$  mg at hatching and  $7.21 \pm 0.71$  mg and  $2.57 \pm 0.62$  mg at swim-up stages, respectively. The mean body dry matter and water content of the larvae were 33.10% and 66.90% at hatching and 15.46% and 84.54% of the total biomass at swim-up stages, respectively. Our results indicated that dry yolk, total larval weights and dry matter of the larvae decreased, while body weight and water content increased with degree-days. The growth of larva, yolk sac absorption and yolk conversion efficiency were calculated as 0.18 mg/day, 0.23 mg/day and 0.60, respectively. The data collected during these studies contribute to the management practices of the stocks of this species.

**Key words:** *Salmo trutta caspius*; Hatching rate; Yolk sac absorption; Degree days.

### INTRODUCTION

The Caspian brown trout, *Salmo trutta caspius* (Kessler, 1877), is one of the nine subspecies of brown trout *Salmo trutta* (Quillet *et al.* 1992). This subspecies attains the greatest size of all brown trouts (Sedgwick, 1995) and is currently an endangered species mainly found in the southwestern Caspian Sea in Iranian waters. *S. trutta* used to be heavily fished especially during spawning migration to fresh waters (Kiabi *et al.*, 1999) because of its very high market value (Niksirat and Abdoli, 2009).

The yolk sac sustains embryo which provides nutrients to embryo until development of its functional ability to feed upon exogenous feeding (Skjærven *et al.* 2003). The first external feeding activities of the fish larvae start when the larvae swim-up (Başçınar *et al.*, 2010; Başçınar, 2010).

In Salmonids, embryonic and larval development stages such as first eye pigmentation, hatching and swim-up larvae as day-degree reveal differences and in addition to genetic condition, incubation temperature and its variation during these periods are the main factors controlling the duration of the early development stages of fish embryos and larvae. Especially, temperature is an important parameter and it effects to the rate of yolk absorption and the utilization of energy reserves, resulting in the largest first-feeding

larvae. With increasing temperature, yolk conversion efficiency increase some species, in others efficiency decreases at higher temperatures (Cavalli *et al.* 1997). Although several studies have been performed on larval development of salmonid species, namely, sea trout (Hansen, 1985), Black Sea trout (Başçınar, 2005; Başçınar *et al.*, 2008), brown trout (Kocaman, 2009; Demir, 2010), Atlantic salmon (Hansen and Møller 1985; Peterson 1995), rainbow trout (Hodson and Blunt, 1986; Başçınar, 2010), brook trout (Kocaman, 2009; Başçınar, 2003), and Arctic charr and their hybrids (Dumas *et al.*, 1995), black sea trout and brook trout and their hybrids (Başçınar, 2010) but studies on the first relation with yolk sac absorption of *Salmo trutta caspius* is scarce.

The objectives of the present study were (1) to investigate hatching performance, body and yolk weight at hatching and (2) the growth rate during the yolk absorption and yolk conversion efficiency of *S. t. caspius*.

### MATERIALS AND METHODS

Adult (20 female and 20 male) *S. t. caspius* were caught during the spawning run (private permission by Ministry of Agriculture and Rural Affairs General Directorate of Protection and Control). Eggs from 20 females were collected and fertilized with milt from 20 males at the trout hatchery in the Faculty of Marine

Sciences, Karadeniz Technical University, Trabzon, Turkey. The eggs were hatched in a vertical incubator. After hatching, about 3000 larvae were randomly divided into triplicate batches for each treatment. Aerated water in the batches was recirculated and 20% was replaced daily. Temperature was measured with a digital thermometer twice a day (8:00-9:00, 16:00-17:00) and ranged 6.5-13.0°C (mean 9.87±1.30°C). Dead larvae were removed twice a week. Ten larvae were randomly sampled at each sampling period (10 times) at 4 day intervals from the 173th degree-day ( $\Sigma T$ : sum of daily mean temperatures) when 50% of the larvae had hatched i.e. a total of 100 larvae were used during the study (Başçınar *et al.* 2010). Thus, larvae were sampled at the 350, 380, 410, 440, 470, 500, 530, 560 and 590 degree-days. Sampled larvae were anesthetized in a benzocaine solution (30 mg/l) and preserved in 10% formaldehyde. After a minimum interval of three weeks, fixed larvae were dissected to separate the yolk sac from the body. Body and yolk were dried separately at 60°C for 48 h and then weighed individually (Hansen 1985). Yolk sac efficiency was calculated as  $YCE = (L_t - L_0)/(Y_0 - Y_t)$  (Hodson and Blunt (1986), where L is dry larvae weight, Y is yolk sac dry weight, and t is day. The dry yolk sac consumption rate (mg/day) was calculated as  $YCR = (Y_0 - Y_t)/t$ , daily length growth rate (mm/day) as  $LGR =$

$(length_t - length_0)/t$ , daily weight growth rate (mg/day) as  $WGR = (wt_t - wt_0)/t$ ; and development index as  $KD = 10(wet\ wt^{1/3})/length$  (Peterson & Martin-Robichaud 1995).

## RESULTS

Egg size of *S. t. caspius* was 4.23±0.26 mm. Incubation water temperature was 9.6±0.5°C (8.6–10.2°C). The eggs were eyed at 221 day degree (26 days) and hatched after 44 days (589 day degree) (Table 1). Length and total wet weight (Figure 1), dry larva weights and dry yolk weights (Figure 2) of Caspian brown trout exhibited linear relationship with degree-days (ranged 173-590); dry yolk weight decreased, while length, total wet weight and dry body weight increased. The dry body weights of Caspian brown trout larvae at hatching and before swim up were calculated to be 2.36 ± 0.28 mg (33.10% of total wet weight) and 7.21 ± 0.71 mg (15.46% of total wet weight), respectively.

Increasing in length and weight, growth rates, daily yolk sac consumption and yolk sac efficiency values were calculated as 0.18 mm/day, 0.68 mg/day, 0.23 mg/day, and 0.60, respectively.

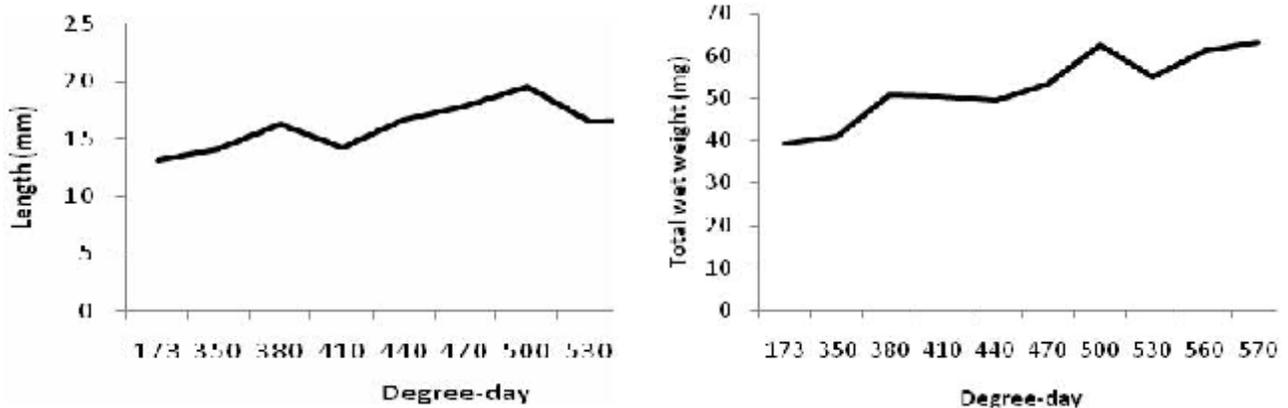


Figure 1: Relationship between degree-day and length and wet weight in Caspian trout larvae

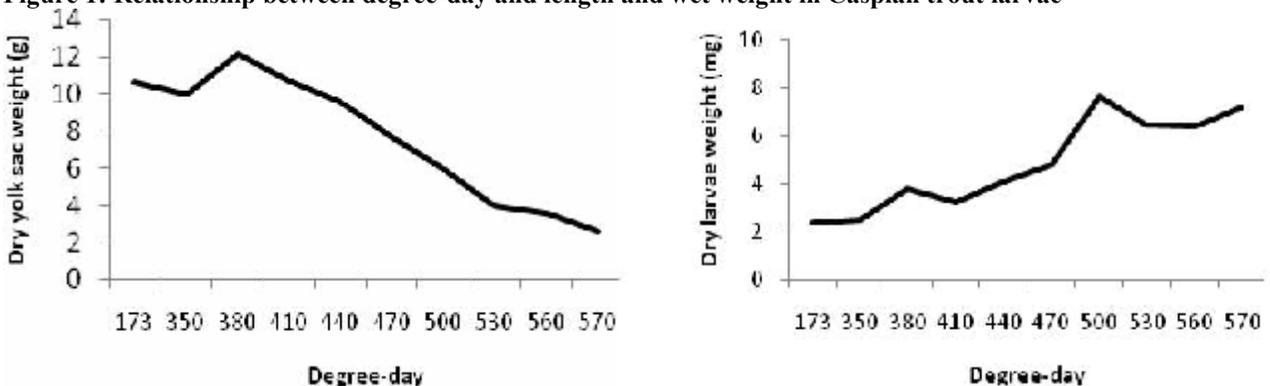


Figure 2: Relationship between degree-day and yolk sac weight and dry larvae weight in Caspian trout alevins

**Table 1. Duration (day) of eyed-egg, hatch and swim-up phases**

Parametre	Eyed-egg stages	Hatching	Swim-up
Day	26	44	79
D-D	221±25	409.2±27	595±43
	185–252	363–462	477–651
°C	9.2±0.9	9.6±0.5	9.6±0.7
	7.7–10.5	8.6–10.5	7.7–10.5

**Table 2 Summary of some characteristics reported from brown trout and comparisons with the present study results.**

Researcher	Eyed-egg stages (days)	Hatching (days)	Dry yolk weight (mg)	YCE	Development index
Başçınar <i>et al.</i> (2008)		43			1.98-1.99
Başçınar <i>et al.</i> (2010)	17-24	35-41		0.41-0.76	
Dumas <i>et al.</i> (1995)			12.26	0.65	
Hodson and Blunt (1986)			31		
Blaxter (1969)				0.4-0.8	
Başçınar <i>et al.</i> (2003)				0.50	
Hansen (1985)				0.46-0.68	
Peterson and Martin-Robichaud, 1995					2
In this study	26	44	10.67 ± 0.67	0.60	2.05

## DISCUSSION

Embryonic and larval development stages such as first eye pigmentation, hatching and swim-up larvae as day-degree reveal differences in *Salmonids* and in addition to genetic condition, incubation temperature and its variation during these periods were the main factors controlling the duration of the early development stages of fish embryos and larvae. Uysal and Alpbaz (2003) found that the diameter of Caspian trout eggs was 5.01±0.16 mm-5.20±0.19 mm, 84.80±1.42 mg and the fertilised eggs of Caspian trout were eyed at 279 day degree (36 days) and hatched after 52 days (439 day-degree) at the temperature of 7-10 °C. In this study, egg size of Caspian trout was 4.91±0.37 mm and the eggs were eyed at 221 day degree (26 days) and hatched after 44 days (409 day degree) at the temperature of 8.6–10.5°C.

The mean wet weight of larvae at hatching was 16.78 ± 2.17 mg and reached 52.62 ± 3.55 mg just before the swim-up stage. It may vary with egg size (large eggs produce large larva) and incubation period (the heavier the larva) (Başçınar *et al.* 2010).

In the present study, the dry yolk weight of *S. t. caspius* larvae at hatching was 10.67 ± 0.67 mg. This value is much smaller than the value of 12.26 mg as reported by Dumas *et al.*, (1995), Hodson and Blunt (1986) for rainbow trout, which was estimated to be 31 mg (Hodson & Blunt 1986; Dumas *et al.*, 1995). These within and between species differences in yolk size might arise from egg and larva size, incubation temperature and period, and the nutrition and husbandry of brood fish.

There are contrasting views on the relation between the size of larva and amount of yolk at hatching. For example, as cited by Dumas *et al.*, (1995), Rana (1990) observed an inverse relationship between the size of larva and the yolk; in contrast, Dumas *et al.*, (1995) found that hybrids of Arctic charr (female) and brook trout (male) had higher net body weight at hatching than pure Arctic charr larva, but they both had the same amount of yolk. The authors concluded that the amount of yolk at hatching is mainly determined by trout species; the larvae of brook trout females had more yolk reserves than the larvae from Arctic charr females.

The results obtained in the present study indicated that dry yolk and total larval weights and dry matter of the larvae decreased, while dry body weight and water content increased with degree-days. This decrease in dry matter was also reported by Hansen and Møller (1988) for Atlantic salmon and Başçınar (2010), Hodson and Blunt (1986) for rainbow trout (Hansen and Møller 1985; Hodson and Blunt 1986; Başçınar 2010). These variations may be due to two reasons that salmonids are particularly rich in nutrients and so the dry matter contents of eggs and newly hatched larvae are relatively high and the water content of the body increases towards the swim-up stage to ease buoyancy during swimming just before filling the gas or swim bladder (Başçınar *et al.* 2010).

According to previous studies, the observed value of YCE on a dry weight basis approached 0.7, although the theoretical value was 0.82. Blaxter (1969) (cited by Hodson and Blunt (1986)) reviewed estimates of YCE for several species and the range was 0.4-0.8

(Hodson and Blunt 1986). The values of YCE for *Salmo* species were from 0.41 to 0.70 at 10 °C. Dumas *et al.*, (1995) and Başçınar *et al.*, (2003) reported that the YCE value was 0.65 for brook trout at 8-13 °C and 0.50 for brook trout at 4.5-13°C. Başçınar *et al.*, (2010) reported the YCE value was 0.76, 0.41 and 0.46 for Black sea trout, brook trout and their hybrids, respectively. Hansen (1985) reported values ranging from 0.46 to 0.68 at 7-8.5 °C for *Salmo trutta*. The YCE in our study was 0.60 on a dry weight basis.

Previous studies indicated that development index values are "2" around when alevins reached a maximum weight (Peterson and Martin-Robichaud, 1995) and development index values increased with increasing water temperature (Rombough, 1985). KD values calculated for this period is important information for the first feeding (Başçınar, 2008). Başçınar *et al.*, (2008) calculated that development index values were as 1.98 and 1.99 when alevins reached a maximum for 5 °C and 9 °C groups in *S. t. labrax*. In this study, development index was calculated as 2.05 and this value was similar to reported by Peterson and Martin-Robichaud (1995). All these values were compared with the present findings Table 2.

In conclusion, information on early development of *S. t. caspius* larvae has provided during yolk absorption in this study. It was also determined YCE values, and dry weight and water contents. The results indicated that dry yolk and total larval weights and dry matter of the larvae decreased. Dry body weight and water content increased with degree-days. These data can be used for further comparative studies and to assist in developing efficient hatchery management programs.

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