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*Full Length Research Paper*

# Hatching performance and yolk sac absorption of Abant trout (*Salmo abanticus*, T., 1954)

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***Salmo abanticus*** **is a native to Lake Abant and it is known to be endemic to Turkey. The purpose of this study was to determine hatching performance, body and yolk weight at hatching, the growth rate during the yolk absorption and yolk conversion efficiency of Abant trout (*S. abanticus*, T., 1954) larvae, and the relationships between length, total wet weight, dry yolk body weights of alevins and degree/days. While the mean wet weight was 18.2±5.58 mg (n = 10) at hatching and reached 88.24±6.22 mg just before the swim-up stage, the mean dry weights of the body and yolk sac were 2.18±0.63 and 18.47±1.14 mg at hatching and 12.58±0.98 and 2.29±0.77 mg at swim-up stages, respectively. The mean body dry matter and water content of the larvae were 61.87 and 38.18% at hatching and 22.49 and 77.51% at swim-up stages, respectively. Our results 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. The growth of larva, yolk sac absorption and yolk conversion efficiency were estimated as 0.29 mm/day, 0.39 mg/day and 0.64, respectively. Information on yolk sac absorption and hatching performance of this species would contribute to knowledge of management of the stocks.**

**Key words:** Abant trout, *Salmo abanticus*, hatching performance, yolk conversion efficiency, growth.

## INTRODUCTION

*Salmo trutta abanticus* is native to Abant and Yedigöller Lake and the nearest rivers and creeks and known to be endemic to Abant Lake (Turan et al., 2009) and is important as a biological gene source for restocking in Turkey (Hatipoğlu and Akçay, 2010).

The yolk sac that sustain the embryo and larva until it has developed the functional ability to feed upon exogenous prey (Skjærven et al. 2003). The first external feeding activities of the fish larvae start when the larvae swim-up (Bascinar et al., 2010; Bascinar, 2010). The growth and development of abant trout, *Salmo abanticus*, from hatch to first feeding depends upon the nutrients stored in the yolk sac.

Several studies have been performed on larval development of salmonid species, for example, sea trout (Hansen, 1985), brown trout (Demir et al., 2010), Atlantic salmon (Hansen and Møller, 1985; Peterson and Martin-Robichaud, 1995), rainbow trout (Hodson and Blunt, 1986; Bascinar, 2010), brook trout (Bascinar et al., 2003; Kocaman et al., 2009), brook trout and Arctic charr and their hybrids (Dumas et al., 1995). Uysal and Alpbaz (2002) studied comparison of the growth performance and mortality in Abant trout. Uysal and Alpbaz (2003) examined fertilisation, eyeing, hatching and survival rate of Abant trout but no other research has conducted on Abant trout and this study is the first relation with yolk sac absorption of Abant trout.

The purposes of the present study were to determine hatching performance, body and yolk weight at hatching,

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**Abbreviation: YCE,** Yolk sac efficiency.

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

| Parametre | Eyed-egg stages | Hatching | Swim-up |
|---|---|---|---|
| Day | 27 | 54 | 81 |
| Day/degree | 330±16 | 589±27 | 965±130 |
| | 299–330 | 569–733 | 624–1110 |
| °C | 12.7±0.6 | 9.6±1 | 10.6±1.6 |
| | 11.5–12.7 | 7.7–11.5 | 7.7–13.7 |

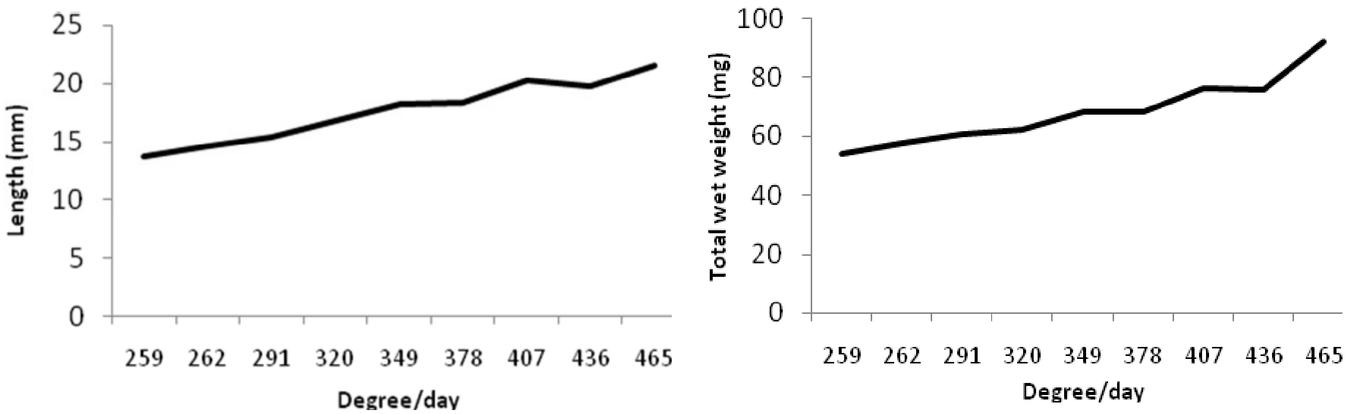


**Figure 1.** Relationship between degree/day and length and wet weight in Abant trout larvae.

the growth rate during the yolk absorption and yolk conversion efficiency of Abant trout (*S. abanticus*).

## MATERIALS AND METHODS

Twenty three females and twenty five males were used as broodstock (47.0±50.50 g, 374.34±360.44 g). They were held at the trout hatchery in the Faculty of Marine Sciences, Karadeniz Technical University, Trabzon. 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 two times a day (8:00 to 9:00, 16:00 to 17:00) and recorded. Observations of the eggs and alevins were made together with the temperature readings. The eyed-egg stage was defined as when the eyes were clearly visible as black spots. The 50% hatching time was defined as when 50% of the embryos were swim-up. The swim-up stage was considered to begin when approximately 50% of the alevins were starting to feed and were actively swimming up in the water for feeding. The dead eggs and larvae were removed and counted periodically. Ten larvae were randomly sampled at each sampling period (9 times) at 3 or 4 day intervals from the 259 th degree/day (ΣT: sum of daily mean temperatures) when 50% of the larvae had hatched, that is, a total of 90 larvae were used during the study (Bascinar et al. 2010). Larvae were sampled at the 262, 291, 320, 349, 378, 407, 436, and 465 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 sac were dried separately at 60°C for 48 h and weighed individually after 48 h (Hansen, 1985). Yolk sac efficiency (YCE) was calculated as YCE=(Lt-L0)/(Y0-Yt) as per 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 = (Y0-Yt)/t, daily length growth rate (mm/day) as LGR = (lengtht-length0)/t, daily weight growth rate (mg/day) as WGR = (wtt-wt0)/t; and development index as KD = 10 (wet $wt^{1/3}$)/length (Peterson and Martin-Robichaud, 1995).

## RESULTS

Abant trout eggs were incubated and hatched at 9.6±1°C (7.7–11.5). Egg size was estimated 4.91±0.37 mm (4.3-4.9) as a diameter. Eggs reached the eyed stage at 330 day/degree (about 27 days) and hatched after 54 days (589 day/degree) (Table 1). Length (Figure 1), total wet weight (Figure 1), dry larva weight (Figure 2), and dry yolk weight (Figure 2) were determined. As a result, dry yolk weight decreased, while length, total wet weight and dry body weight increased.

Length and weight, growth rate, daily yolk sac consumption and yolk sac efficiency value were calculated as 0.29 mm/day, 1.42 mg/day, 0.39 mg/day and 0.64, respectively.

The mean wet weight of larvae at hatching was 18.2±5.58 mg and reached 88.24±6.22 mg just before the

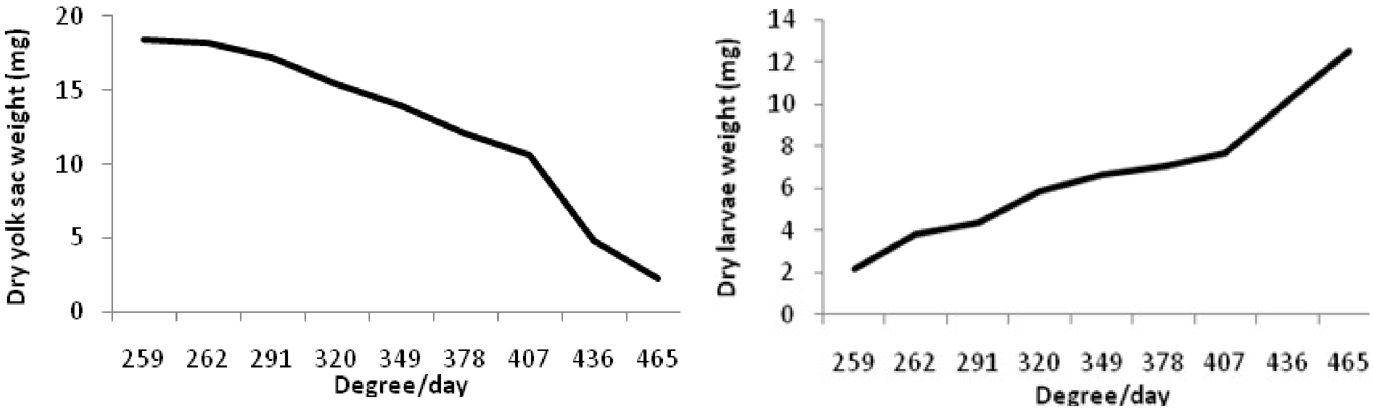


**Figure 2.** Relationship between degree/day and yolk sac weight and dry larvae weight in Abant trout alevins.

swim-up stage. It may vary with egg size (large eggs produce large larva) and incubation period (the shorter the duration, the heavier the larva).

## 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 (Bascinar and Okumus, 2004). Uysal and Alpbaz (2003) found that the diameter of Abant trout eggs was 5.01±0.16 to 5.20±0.19 mm, 84.80±1.42 mg and the fertilised eggs of Abant trout were eyed at 279 day/degree (36 days) and hatched after 52 days (439 day/degree) at the temperature of 7 to 10℃. In this study, egg size of abant trout was 4.91±0.37 mm and the eggs were eyed at 330 day/degree (27 days) and hatched after 54 days (589 day/degree) at the temperature of 7.7 to 11.5℃.

In the present study, the dry yolk weight of Abant trout larvae at hatching was calculated to be 18.47±1.14 mg. The value is much higher than the value of 12.26 mg reported by Dumas et al. (1995), whereas it is much smaller than that presented by Hodson and Blunt (1986) for rainbow trout, which was estimated to be 31 mg. The 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 (Dumas et al., 1995).

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. The dry body weights of Abant trout larvae at hatching and before swim up were calculated to be 2.18±0.63 (61.87% of total wet weight) and 12.58±0.98 (22.49% of total wet weight), respectively. This decrease in dry matter was also reported by Hansen and Møller (1985) for Atlantic salmon, and Bascinar (2010), Hodson and Blunt (1986) for rainbow trout. 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 swim bladder (Bascinar et al., 2003).

According to previous studies, the value of YCE on a dry weight basis approached 0.7, although the theoretical value was 0.82. Blaxter (Hodson and Blunt, 1986) reviewed estimates of YCE for several species and the range was 0.4 to 0.8. The values of YCE for Salmo species were from 0.41 to 0.70 at 10℃. Dumas et al. (1995) and Bascinar et al. (2003) reported that the YCE value was 0.65 for brook trout at 8 to 13℃ and 0.50 for brook trout at 4.5 to 13℃. Bascinar 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 and Møller (1985) reported values ranging from 0.46 to 0.68 at 7 to 8.5℃ for *Salmo trutta*. The YCE was observed 0.64 on a dry weight basis in our study. The result shows similarity with previous studies.

Earlier studies were indicated that development index values were "2" around when alevins reached a maximum weight (Peterson and Martin-Robichaud, 1995) and development index values increased with increasing water temperature (Bascinar et al., 2008). Bascinar et al. (2008) calculated that development index values were as 1.98 and 1.99 when alevins reached a maximum for 5℃ and 9℃ groups in *Salmo labrax*. In this study,

**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 |
|---|---|---|---|---|---|
| Bascinar et al. (2008) | | 43 | | | 1.98-1.99 |
| Bascinar et al. (2010) | 17-24 | 35-41 | | 0.41-0.76 | |
| Dumas et al. (1995) | | | 12.26 | 0.65 | |
| Hodson and Blunt (1986) | | | 31 | | |
| Blaxter (1969) | | | | 0.4-0.8 | |
| Bascinar et al. (2003) | | | | 0.50 | |
| Hansen (1985) | | | | 0.46-0.68 | |
| Peterson and Martin-Robichaud (1995) | | | | | 2 |
| In this study | 27 | 54 | 18.47 ± 1.14 | 0.64 | 2.09 |

development index was calculated as 2.09 and this value was similar to reported by Peterson and Martin-Robichaud (1995). All these values were compared with the present findings Table 2.

## Conclusıon

In conclusion, information on early development of Abant trout larvae has provided during yolk absorption in this study. It was also determined YCE values, and dry weight and water contents. These information could be used for further comparative studies and to assist in developing efficient hatchery management programs.

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