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Fecundity and Egg Size of Three Salmonid Species (*Oncorhynchus mykiss*, *Salmo labrax*, *Salvelinus fontinalis*) Cultured at the Same Farm Condition in North-Eastern, Turkey

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Abstract: In this study, fecundity and egg size of rainbow trout (*Oncorhynchus mykiss*), Black Sea trout (*Salmo labrax*) and brook trout (*Salvelinus fontinalis*) were examined. Two and six years old female fish reared in commercial fish farm were used and the female size, total and relative fecundity and egg size (mm) were determined for the broodstock fish of three tested species. The average weights of broodfish of rainbow trout, Black Sea trout and brook trout 1.357.27±406, 532±673.7 and 310.40±85.0 g, respectively. The total fecundity (number of eggs fish^{-1}) was 2.809±791, 1.401±1374 and 723±320, the relative fecundity (number of eggs kg^{-1} fish) was 2.180±676, 3.558±1307 and 2.571±1530 and the egg size (mm); 4.95±0.2, 4.51±0.67 and 4.49±0.21 were determined for rainbow trout, Black Sea trout and brook trout, respectively. A significant linear relationship was found total fecundity and the post-stripped fish weight of Black Sea trout (r = 0.96), but this relationship was low for the rainbow trout (r = 0.28) and brook trout (r = 0.17). A negative relationship was observed between the relative fecundity and brood size in rainbow trout (r = 0.57), Black Sea trout (r = 0.58) and brook trout (r = 0.54). A significant linear relationship was observed in rainbow trout (r = 0.63), Black Sea trout (r = 0.86) and brook trout (r = 0.41) ($p<0.01$).

Key words: *Oncorhynchus mykiss*, *Salmo labrax*, *Salvelinus fontinalis*, fecundity, egg size, Turkey

INTRODUCTION

Rainbow trout farming in Turkey continues to expand and grows rapidly during recent years. Although, the main cultured salmon species is rainbow trout (*Oncorhynchus mykiss*) (Okumus, 2002), Black Sea trout (*Salmo labrax*) and brook trout (*Salvelinus fontinalis*) are also cultured in several fish farms in Turkey. A sea-going form of brown trout, called the Black Sea trout, *Salmo trutta* L., is found in only some Turkish and Georgian rivers of the Black Sea (Okumus *et al*., 2006).

Under normal conditions, Salmonids produce a single batch of eggs each year, which is usually stripped on a single occasion. The principal aim of fish hatcheries is to maximize the number of produced eggs from the available broodstock fish. Egg production capability is directly related to fish size, stocking density, feeding rate, water quality, fish age, environmental stress (Bromage *et al*., 1992). Most Salmonids, including rainbow trout, Black Sea trout and brook trout appear to rely on the seasonally changing cycle of day length for the timing of gonadal recrudescence, maturation and spawning (Bromage and Cumaranatunga, 1988; Duston and Bromage, 1987; Duston and Bromage, 1988).

Although, egg production of rainbow trout has been studied extensively (Scott and Crossman, 1973; Bromage and Cumaranatunga, 1988; Healy and Heard, 1984; Huang and Gall, 1990; Bromage *et al*., 1990; Bromage *et al*., 1992; Estay *et al*., 1994; Springate and Bromage, 1985; Okumus *et al*., 1999; Kurtoglu *et al*., 1998), there is insufficient information on the other two species. Only limited data are available on egg production of brook trout (Akbulut *et al*., 1999; Bascinar and Okumus, 2004) and there are a limited number of publications on cultured Black Sea trout.

Scott and Crossman (1973) reported that the fecundity (number of ripe or mature eggs produced by a female) of Salmonid's is highly variable and is related to brood size. For example fecundity for rainbow trout may ranges from 200-12.700 eggs female^{-1}, but generally it ranges from 900-4.600 (with an average of about 2.000 eggs) per fish with eggs ranging from 3-5 mm in diameter. On the other hand, the average number of eggs for 5 and 6 year old female Black Sea trout was 2.020 eggs fish^{-1} but, fecundity can be as high as 10.000 eggs female^{-1} with eggs ranging from 5-6 mm in diameter. Brook trout eggs number varies from 100-5.000 females^{-1} and diameter of these eggs ranges from 3.5-5.0 mm. Akbulut *et al*. (1999),

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studies of brook trout, reported a relative fecundity ranging from 3.124±716 eggs kg^{-1}, a total fecundity of 2.735±804 eggs $female^{-1}$ and an estimated egg size of 4.9±0.22 mm in diameter.

Egg size is one of the important determinants of egg and larval quality as it is positively correlated with both survival of egg and fry and also of the growth rate of larvae (Gall, 1975). Fecundity is desirable trait for broodfish since farmers want to keep fecund broodfish to get more eggs from available stocks. In that reasons how much eggs can be taken from available brood fishes should be known.

This study performed to compare, the fecundity and the egg size of three salmonid species reared in commercial trout farm, at the same conditions.

MATERIALS AND METHODS

Studies were conducted during the 2005-2006 breeding season at a commercial fish farm located in the North-East Black Sea region of Turkey (40°59'2.0"N; an altitude 150 m). Three years old broodfish were raised different pond but all conditions (for example: stock density, feed and feeding rate, water condition and flow rate) were same but their size were different. During the spawning season, females were checked two weeks intervals for each group. Fish were fed by commercial trout feed once a day 2% of biomass. Water temperature was measured daily.

Fish were checked for ripeness once a week during the expected ovulation period beginning November, 2005. One assessment per week was considered to be within the limits for avoiding deleterious effects on the quality of the eggs caused by over-ripening (Craik and Harvey, 1984; Springate *et al*., 1984). Fish were checked for rapines after draining 50% of the water in the ponds. Ovulation controls were made by applying gentle pressure to the female's abdomen and ovulated females was taken from pond for egg stripping, but non-ovulated fish were returned to the ponds. Selected ovulated females and males were anaesthetized with a 50 mg L^{-1} benzocaine and females were weighed in a scale with 1 g accuracy, before and after stripping, named post stripped weight. Tan mature male broodfish were stripped for pooled sperm stock. The eggs of each female were collected in separate dry bowls. Fertilization was performed after stripping, using 2 mL pooled semen. After fertilization, the eggs were rinsed for 5 min and hydrated for 20 min. The fertilized eggs of each female were incubated in small containers with individual compartments in fiberglass trays. Total eggs were weighed and sub sampled after egg hardening occurred. To estimate eggs number, 50 eggs weighted and measured subsample with a Von Boyer trough to determining egg size according to Piper *et al*. (1982). Using these method, following parameters were determined; spawning time, post spawned brood size, total fecundity (number of eggs stripped from each fish yielding the values of number of eggs/fish), relative fecundity (number of eggs/kg fish), egg size (mm) and the correlations between brood fish weight and total fecundity and egg size. The post-stripped weights of females were used to estimate relative fecundity. Statistical analyses were performed Minitab version 13.0.

RESULTS AND DISCUSSION

The spawning season started in the middle of the November and lasted until the middle of January for Black Sea trout and brook trout, but this season started in the middle of the December and lasted until the middle of February for rainbow trout. During the spawning season temperature ranged from a minimum of 4°C up to and maximum of 10°C (Fig. 1).

The Total Fecundity (TF) showed positive correlation with post stripped rainbow trout, brood size ($r = 0.28$), Black Sea trout brood size ($r = 0.96$) and brook trout brood size ($r = 0.17$) ($p<0.01$). Relative Fecundity (RF) exhibited negative correlation with post-striped rainbow trout brood size ($r = 0.57$), Black Sea trout brood size ($r = 0.58$) and brook trout brood size ($r = 0.53$) ($p<0.01$).

Egg size or Egg Diameter (ED) showed positive correlation with post stripped rainbow trout brood size ($r = 0.63$), Black Sea trout brood size ($r = 0.86$) and brook trout brood size ($r = 0.41$) ($p<0.01$). Correlation between three different trout species fecundity-weight and egg size-fish weight relationships were mentioned Fig. 2-4.

The reproductive parameters of three different salmon species summarized Table 1. Although, rainbow trout egg size (4.9 mm) bigger than Black Sea trout (4.51 mm) and brook trout (4.49 mm) eggs, there is no differences statistically ($p<0.01$).

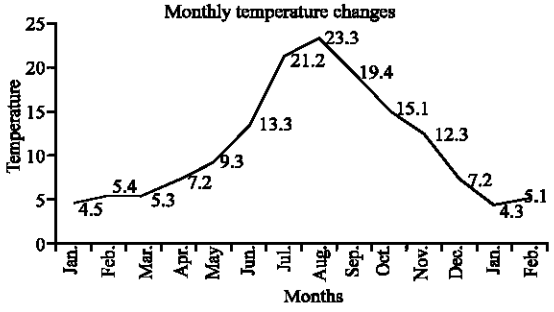

Fig. 1: The monthly water temperature (°C) in the pond

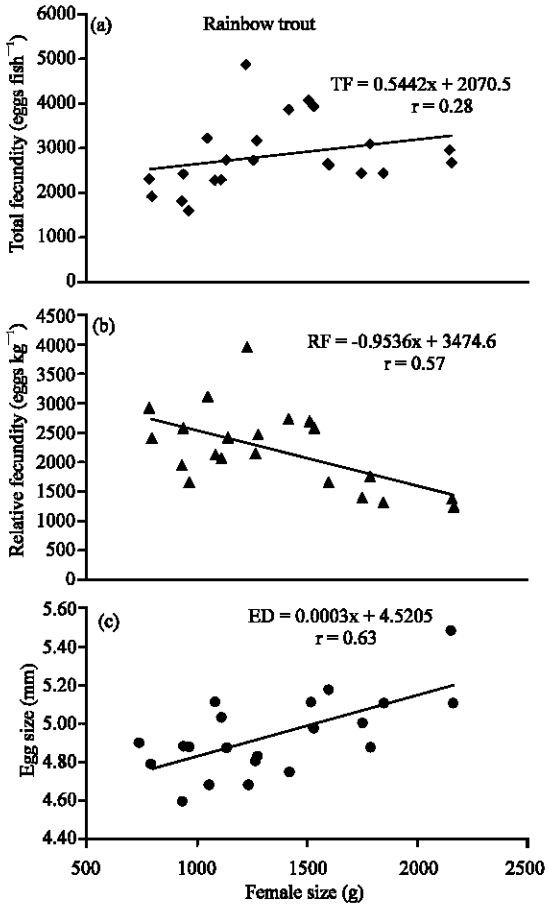

Fig. 2: The relationship between the post-stripped weights of rainbow trout females (g) and the total fecundity (a), relative fecundity (b) and egg size (c)

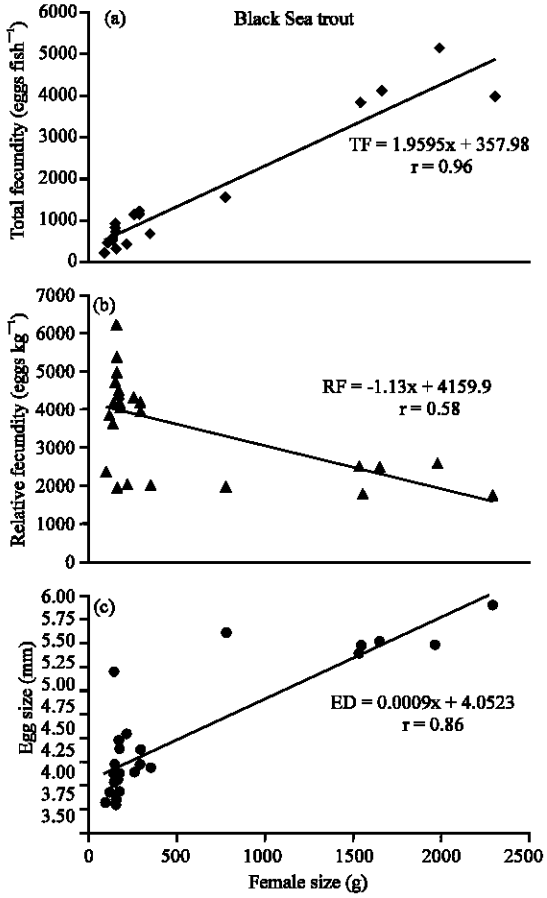

Fig. 3: The relationship between the post-stripped weights of Black Sea trout females (g) and the total fecundity (a), relative fecundity (b) and egg size (c)

Salmonids are the most common cultured species in the world from 1880's. In Turkey, trout culture began with rainbow trout in the 1970's and this fish culture sector expands nowadays with the culture of black sea trout and brook trout. Black Sea trout is a native Salmonid species, in contrast to brook trout and rainbow trout that are not native species in Turkey.

Brook trout was imported from Europe for research studies. Some fish farms culture Black Sea and brook trout in North Eastern of Turkey, but most farmers have problems with slow growth, low fecundity, small egg size and abnormalities.

Spawning time of cultured fish determines the capacity and timing of marketing. Because of all fish raised fish are grown at the same time of the year, increases fish prices. So, harvesting is separated all of the time of year, is necessary. On the other hand, capacity is limited by broodfish performance such as fecundity. Other important correlations are fecundity-post striped broodfish weight and egg size (diameter)-post stripped broodfish weight relationships. Producers have to be known their brood fish performance, because this is necessary to planning how many fish will be produced.

Trouts can reach sexual maturity between the age of 2 and 5 years. However, maturation generally occurs at the age of 2, 3 or 4 (Kause *et al*., 2003). This is consistent with the observations in this study where the majority of the population matured at 3-4 years of age. The spawning season varies between the Salmonid species in the world. Black Sea and brook trout start spawning about one month earlier than rainbow trout and the spawning season lasts only 2 months. Originally, the rainbow trout spawned in the spring or early summer, but hatchery stocks spawn during autumn-winter period. It seems that autumn spawning has been developed by either selective breeding or as a response to seasonal variation in photoperiod and water temperature (Bromage and Cumaranatunga, 1988). However, even within the same

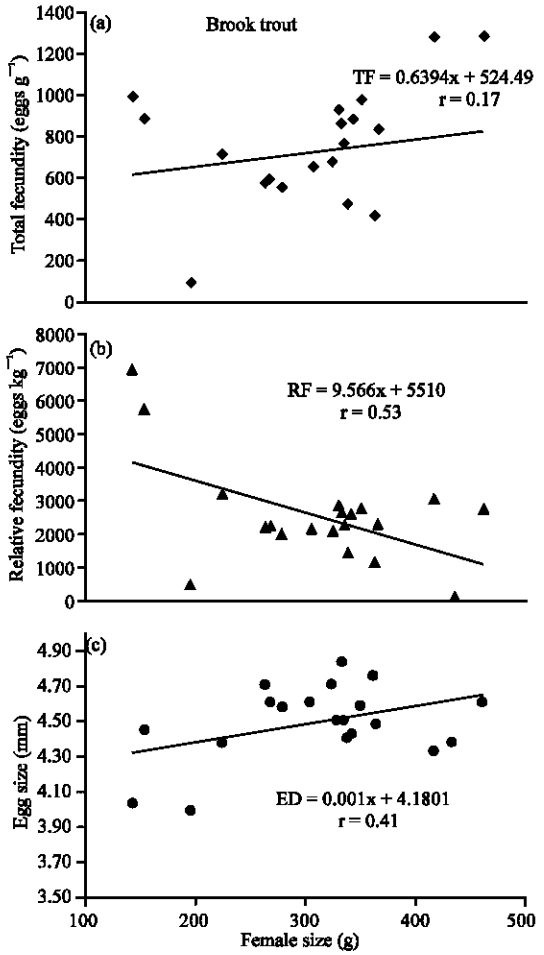

Fig. 4: The relationship between the post-stripped weights of brook trout females (g) and the total fecundity (a), relative fecundity (b) and egg size (c)

Table 1: Reproductive and biometric parameters variables of the rainbow trout, Black Sea trout and brook trout in north-eastern Turkey

Variables	Rainbow trout (n = 22)	Black sea trout (n = 25)	Brook trout (n = 20)
Weight (g)	1357.27±406.01 (787-2156)	532±674 (95-2290)	310.4±85.05 (143-460)
Spawning time	15 Dec-15 Feb	15 Nov-15 Jan	15 Nov-15 Jan
Total fecundity (egg fish^{-1})	2809±791 (1584-4848)	1401±1374 (224-5117)	723±320 (53-1279)
Relative fecundity (egg kg^{-1})	2180±676 (1238-3951)	3558±1307 (1728-6239)	2541±1530 (122-6900)
Egg diameter (mm)	4.9±0.2 (4.6-5.47)	4.51±0.67 (3.8-5.9)	4.49±0.21 (4-4.83)

stocks, there seems to be very large variations between stocks and individuals. In Turkey, in the same geographical region rainbow trout spawning starts in the late November and lasts up to April, but the peak occurs during January-February. There is no off-season egg production with selective breeding or photoperiod manipulation.

As has been well documented in the literature, spawning in brown trout occurs during the autumn-winter period: in the northern hemisphere and this is between the end of October and December (Estay *et al*., 1994), while in the southern hemisphere, it occurs between the end of May and July (Hopkins, 1970; Estay *et al*., 1994). In North-Eastern of Turkey, spawning was observed during November and early January for a population of Black Sea trout and brook trout, but for the rainbow trout the spawning season starts in December and lasts until March (Serezli and Okumus, 2009).

Observation made in this study show that egg size did not different statistically between the three studied species ($p>0.05$). The mean egg size was 4.9 mm for rainbow trout, 4.51 mm for Black Sea trout and 4.49 for brook trout. On the other hand, the relative fecundity in the Black Sea trout (3.558 eggs female^{-1}) was higher than that of the other two species and than those (946 eggs female^{-1}) reported by Hao and Chen (2009), who showed also lower egg diameter (4 mm) in Black Sea trout. The relative fecundity (2.180 eggs kg^{-1}) observed for rainbow trout was higher than the results (1.364 eggs kg^{-1} fish) reported previously by Kurtoglu *et al*. (1998) from the same region. The results for about brook trout egg size (4.49 mm) and fecundity (2.541 eggs kg^{-1} fish) were similar to those of Bascinar and Okumus (2004) (4.58 mm, 2.843 eggs kg^{-1}).

CONCLUSION

This study evaluated the broodstock egg production of three different trout species, cultured at the same conditions. While, brook trout and Black Sea trout were spawned at the same time of the year, the rainbow trout was spawned 1 month later. The fecundity of Black Sea trout was higher than that of rainbow trout or brook trout.

REFERENCES

Akbulut, B., I. Okumus, N. Bascinar and I.Z. Kurtoglu, 1999. Fecundity, egg size and correlation of body weight in an brook trout (*Salvelinus fontinalis*) broodstock in Northeastern Turkey. Proceedings of 1st International Symposium on Fisheries and Ecology, Sept. 2-4, Trabzon, Turkey, pp: 162-166.

Bascinar, N. and I. Okumus, 2004. The early development of Brook Trout *Salvelinus fontinalis* (Mitchill): Survival and growth rates of alevins. Turk. J. Vet. Anim. Sci., 28: 297-301.

Bromage, N., P. Hardiman, J. Jones, J. Springate and V. Bye, 1990. Fecundity, egg size and total egg volume differences in 12 stocks of rainbow trout, *Oncorhynchus mykiss* Richardson. Aquacult. Res., 21: 269-284.

Bromage, N.R. and R. Cumaranatunga, 1988. Egg Production in the Rainbow Trout. In: Recent Advances in Aquaculture, Muir, J.F. and R.J. Roberts (Eds.). Croom Helm, London.

Bromage, N.R., J. Jones, C. Randall, M. Thrush, B. Davies, J. Springate, J. Duston and G. Barker, 1992. Broodstock management, fecundity, egg quality and the timing of egg production in the rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 100: 141-166.

Craik, J.C.A. and S.M. Harvey, 1984. Biochemical changes associated with overripening of the eggs of rainbow trout (*Salmo gairdneri*). Aquaculture, 37: 347-357.

Duston, J. and N. Bromage, 1987. Constant photoperiod regimes and the entrainment of the annual cycle of reproduction in the female rainbow trout (*Salmo gairdneri*). Gen. Comparetive Endocrinol., 65: 373-384.

Duston, J. and N. Bromage, 1988. The entrainment and gating of the endogenous circannual rhythm of reproduction in the female rainbow trout (*Salmo gairdneri*). J. Comparative Physiol. A: Neuroethol. Sensory Neural Behav. Physiol., 164: 259-268.

Estay, F., N.F. Diaz, R. Neira and X. Fernandez, 1994. Analysis of Reproductive performance of rainbow trout in a hatchery in Chile. Progressive Fish Culturist, 56: 244-249.

Gall, G.A.E., 1975. Genetics of reproduction in domesticated rainbow trout. J. Anim. Sci., 40: 19-28.

Hao, F. and Y. Chen, 2009. The reproductive traits of Black Sea trout (*Salmo trutta fario* L.) from the Yadong River, Tibet. Environ. Biol. Fish, 86: 89-96.

Healy, M.C. and W.R. Heard, 1984. Inter and intra population variation in the fecundity of chinook salmon (*Oncorhynchus tschawytscha*) and its relevance to life history theory. Can. J. Fish. Aquat. Sci., 41: 476-483.

Hopkins, C.L., 1970. Some aspects of the bionomic fish in the brown trout nursery stream. Fish Res. Bull. N. Z., 4: 1-38.

Huang, N. and G.A.E. Gall, 1990. Correlation of body weight and reproductive characteristics in rainbow trout. Aquaculture, 86: 191-200.

Kause, A., O. Ritola, T. Paananen, E. Mäntysaari and U. Eskelinen, 2003. Selection against early maturity in large rainbow trout *Oncorhynchus mykiss*: The quantitative genetics of sexual dimorphism and genotype by environment interactions. Aquaculture, 228: 53-68.

Kurtoglu, I.Z., I. Okumus and M.S. Celikkale, 1998. Analysis of reproductive performance of rainbow trout (*Oncorhynchus mykiss*) broodstock in a commercial farm in Eastern Black Sea Region. Turk. J. Vet. Anim. Sci., 22: 489-496.

Okumus, I., Z. Kurtoglu and Ş. Atasaral, 2006. General Overview of Turkish Sea Trout (*Salmo trutta* L.) Populations. In: Sea Trout: Biology, Conservation and Management, Harris, G. and N. Milner (Eds.). Blackweii Publishing Ltd., UK., ISBN-13: 978-1-4051-2991-6, pp: 115-127.

Okumus, I., 2002. Rainbow trout broodstock management and seed production in Turkey: Present practices, constraints and the future. Turk. J. Fish. Aquat. Sci., 2: 41-56.

Okumus, I., M.S. Celikkale, I.Z. Kurtoglu and N. Bascinar, 1999. Growth performance, food consumption and feed conversion rates of rainbow (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) reared as duo- and mono-culture groups. Turk. J. Vet. Anim. Sci., 23: 123-130.

Piper, R.G., I.B. McElvain, E. Orme, J.P. McCraren, L.G. Fowler and J. Leonard, 1982. Fish Hatchery Management. US Fish and Wildlife Service, Washington, DC.

Scott, W.B. and E.J. Crossman, 1973. The freshwater fishes of Canada. Fish. Res. Board Canada Bull., 173: 381-381.

Serezli, R. and I. Okumus, 2009. Spawning time and spawning time repeatability of rainbow trout (*Oncorhynchus mykiss*). J. Fish. Sci., 3: 199-206.

Springate, J.R.C. and N.R. Bromage, 1985. Effect of egg size on early growth and survival in rainbow trout (*Salmo gairdneri* R.). Aquaculture, 47: 163-172.

Springate, J.R.C., N.R. Bromage, J.A.K. Elliott and D.L. Hudson 1984. The timing of ovulation and stripping and their effects on the rates of fertilization and survival to eyeing, hatch and swim-up in the rainbow trout (*Salmo gairdneri*). Aquaculture, 43: 313-322.