

Full Length Research Paper

Seasonal variation in food preference of the brown trout *Salmo trutta macrostigma* (T., 1954) from Uzungöl Stream, Turkey

M. Kocabas^{1*}, M. Kayim², Ö. Aksu², E. Can², V. Kizak², F. Kutluyer², O. Serdar² and N. Demirtaş²

¹Department of Wildlife Ecology and Management, Faculty of Forestry, Karadeniz Technical University, 61080, Trabzon, Turkey.

²Faculty of Fisheries, Tunceli University, 62000 Tunceli, Turkey.

Accepted 12 March, 2012

The present study is aimed to provide information on the abundance of natural foods of *Salmo trutta macrostigma* (T., 1954). Fish were captured from Uzungöl Stream in Trabzon, Turkey between March 2009 and May 2010. It was investigated whether the dietary preferences of trout (*S. t. macrostigma*) change on account of seasons. Captured fish were measured 17.11 ± 4.65 cm (S.D.) (range 5 to 30 cm), 60.38 ± 48.52 g (S.D.) (range 2.34 to 250.84) (n = 163), respectively. The condition factor of trout calculated 1.00 ± 0.5 (S.D.) (range 0.57 to 1.58) (n = 163). The age range was between 0 and 8 years old. Stomach contents were analyzed using two methods, the frequency of occurrence and numerical method. A total of 11 prey groups were identified in the diets of brown trout living in Uzungöl Stream. Prey groups were consisted of Trichoptera, Clitellata, unidentified Insecta, Coleoptera, Ephemeroptera, Haplotoxidae, Diptera, Verenoide, Plecoptera, Hymenoptera and Arachnidae. Analyses of stomach contents showed that the trout feed basically on Arthropoda and Annelidae. Seasonal variation of different food items showed that a high percentage of occurrence of Clitellata were recorded during both winter and autumn, while the highest percent of Coleoptera occurred during summer.

Key words: Uzungöl stream, *Salmo trutta macrostigma*, stomach contents, frequency of occurrence, numerical method, seasonal variations.

INTRODUCTION

Salmo trutta macrostigma is distributed in North Africa, South Europe, west Asia and Anatolia (Tortonese, 1954; Geldiay and Balik, 1988; Çiftçi, 2006). This subspecies occurs in the upper streams of rivers (Tortonese, 1954; Elliott, 1997; Çiftçi, 2006). Studies on diet composition are important in community ecology because the use of resources by organisms has a major influence on population interactions within a community (Mequilla and Compos, 2007). The study of its feeding habits is one of

the basic ways of understanding its biology. Biological characteristics such as growth, reproduction and feeding of *S. t. macrostigma* were thoroughly investigated (Karataş, 1990; Yildirim, 1991; Nakipoğlu, 1992; Küçük et al., 1995; Yüksel and Kocaman, 1998; Çetinkaya, 1999; Karataş, 1999; Tabak et al., 2002; Alp, 2005; Arslan and Aras, 2007). Previous literature on the biology of the trout *S. t. macrostigma* and the different methods of food analysis are reviewed. Scarce information is available on feeding activity of *S. t. macrostigma* populations in Turkey. Alp et al. (2003) studied age, growth and diet composition of the trout *S. t. macrostigma* in the River Ceyhan in Turkey. Against this back-ground, new results obtained on food and feeding habit are presented.

*Corresponding author. E-mail: mkocabas@hotmail.com. Tel: +90 5325584953. Fax: +90 428 213 18 61.



Figure 1. The map of the study area.

This study aimed to provide information about stomach contents and feeding habits of *S. t. macrostigma* and it was determined the type of food, diet seasonal variations in Uzungöl Stream.

MATERIALS AND METHODS

The present study was carried out in Uzungöl Stream located at the latitude of 40° 34' N, longitude of 40° 27' E and latitude of 40° 37' N, longitude of 40° 16' E (Figure 1). A total of 163 individuals of *S. t. macrostigma* were caught monthly on sampling sites in the Uzungöl Stream between March 2009 and May 2010 using electro-fishing. All fish caught were immediately preserved in a plastic barrel containing 4% formalin solution for later analysis in the laboratory. For each fish total weight (g), fork length (cm) and sex were recorded and operculum from each fish was taken for age determinations. Following the removal of digestive tracts, stomachs were opened; stomach contents were flushed into a Petri dish. Stomach contents flooded with distilled water were examined under a stereoscopic microscope. Contents were sorted and prey items were identified to the lowest feasible taxonomic units using the identification keys given by Edmondson (1959), Demirsoy (1990) Geldiay and Balik (1988). Stomachs having no food items were recorded as empty stomachs. Individual stomach fullness index was estimated according to the subjective scale of Lebedev (1946) which goes from 0 (empty stomach) to 5 (0 = empty, 1 = 0 to 25%, 2 = 25 to 50%, 3 = 50 to 75%, 4 = 75 to 100%, 5 > 100%, that is, stomach extended). Subsequently, stomach contents were examined under a binocular microscope. Prey organisms were identified to the lowest possible order. Stomach contents were analyzed under the microscope and quantified in accordance with occurrence method (Hyslop, 1980; Gunn and Milward, 1985).

Frequency of occurrence (f_o) and percentage numerical composition (Cn) were examined for different length classes. The length-weight relationship (LWR) was estimated by using the equation:

$$W = aFL^b$$

Where W = weight (g), FL = fork length (cm), a = constant, b = growth exponent.

The values of the compiled growth exponent were used for the calculation of condition factor:

$$K = W \cdot 100 / FL^b$$

Where K = condition factor, W = total body weight (g), FL = fork length (cm), b = growth exponent.

RESULTS

In this study, a total of 163 specimens of *S. t. macrostigma* in Uzungöl Stream were examined. Captured fish were measured as 17.11 ± 4.65 cm (S.D.) (range 5 to 30 cm), 60.38 ± 48.52 g (S.D.) (range 2.34 to 250.84 g) (n = 163), respectively. Nine age groups (0 to 8) were identified in both sexes. Males of age groups ranged from 2 to 8, while the ages of female fish ranged from 2 to 6 years. The group was 37.80% female (N = 80) and 40.85% male (N = 83). The length-weight relationships were estimated as $W = 0.0112 \times FL^{2.95}$ ($r^2 = 0.9738$, n = 163) (Figure 2). The high r^2 -values indicated

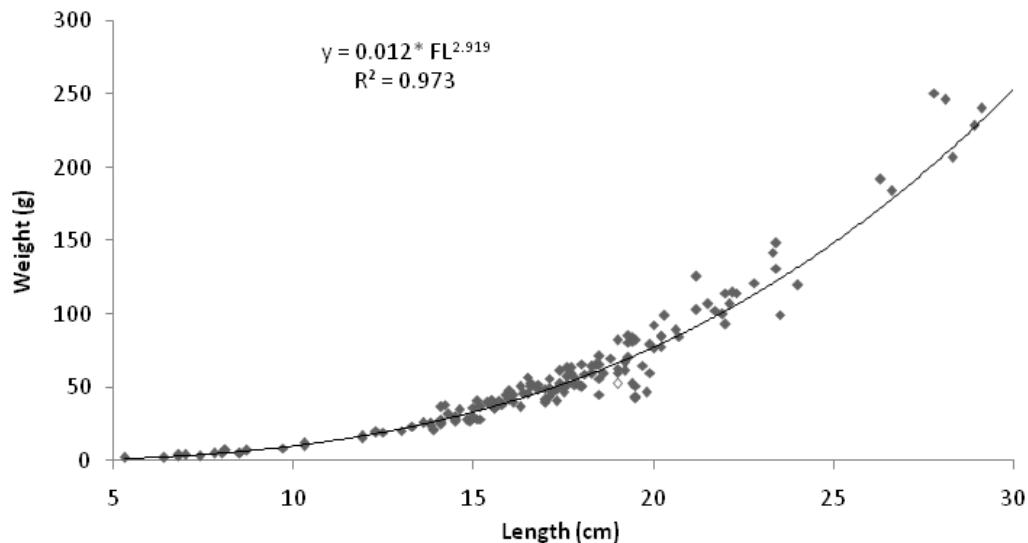


Figure 2. Length-weight relationship.

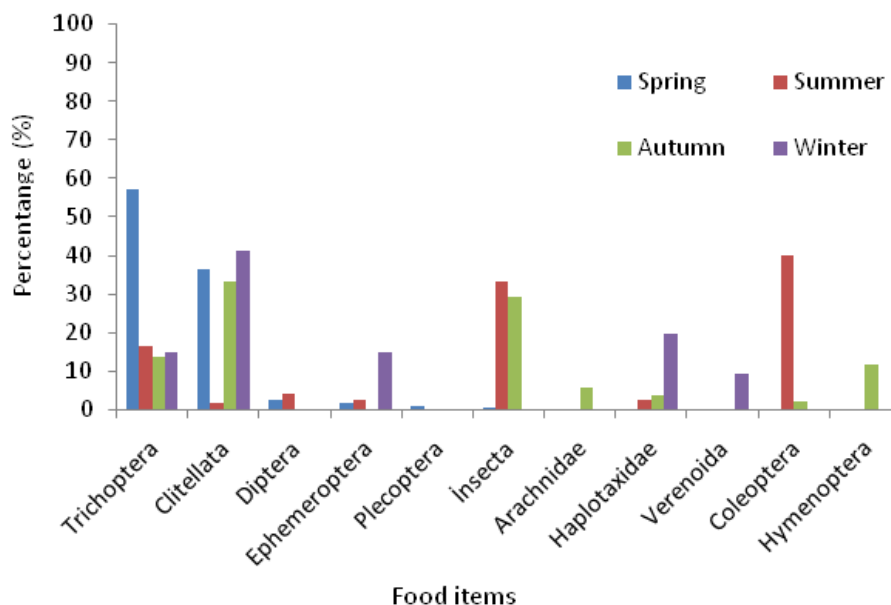


Figure 3. Seasonal occurrence of food items of *S. t. macrostigma* in Uzungöl Stream.

a strong relationship between the two dimensions. The regression coefficient $b \approx 3$ implied that growth was isometric. Stomach contents were analyzed using frequency of occurrence and numerical methods. A total of 11 prey groups were identified in the diets of brown trout and most abundant were Trichoptera, Clitellata, unidentified Insecta, Coleoptera, Ephemeroptera, Haplontaxidae, Diptera, Verenoidea, Plecoptera, Hymenoptera and Arachnidae. Analyses of stomach contents showed that the trout feed basically on Arthropoda and Annelidae. In general, trout fed almost

exclusively on arthropod invertebrates of aquatic and terrestrial origin, but other prey (annelids, micro crustacean and small amounts of plant particles) were also found in the diet composition. Examination of the diet of *S. t. macrostigma* showed that there was high percentage of Trichoptera and Clitellata occurred in its stomach which compressed about 46.01 and 33.56% respectively.

Regarding seasonal occurrence of different food items in the stomachs of *S. t. macrostigma*; Figure 3 shows that a high percentage of occurrence of Insecta were

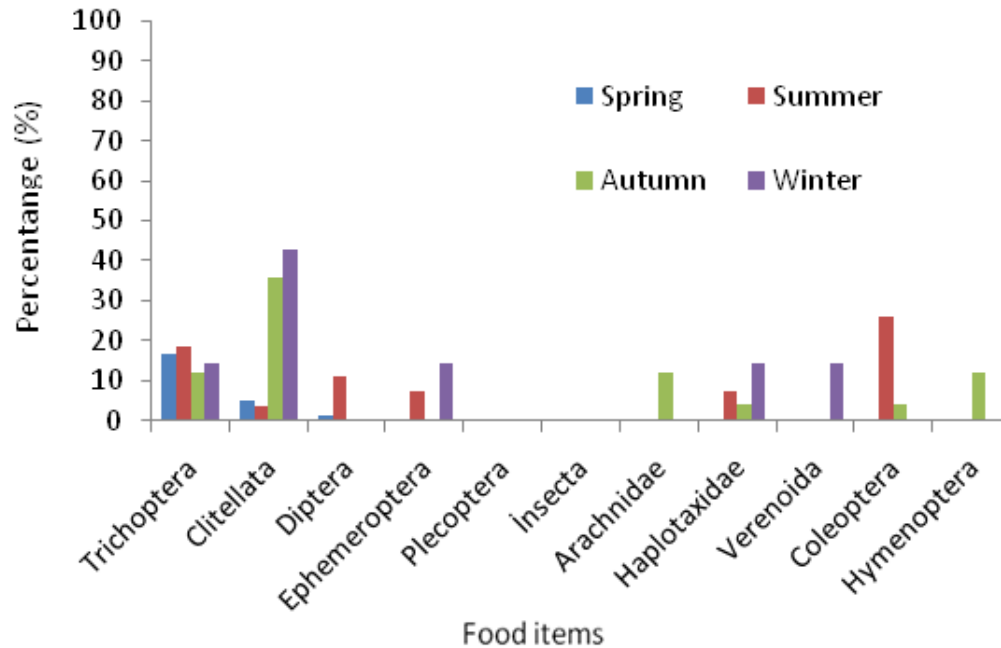


Figure 4. Seasonal percentage of food items of *S. t. macrostigma* in Uzungöl Stream by numerical method.

Table 1. Analysis of empty stomach in *S. t. macrostigma*.

Seasons	No. of stomach examined	No. of empty examined	% of empty examined
Spring	79	1	1.27
Summer	32	6	18.75
Autumn	38	1	2.63
Winter	26	5	19.23

recorded during both summer and autumn (25.93 and 36.00%, respectively), while the highest percent of Trichoptera occurred during winter (42.86%). Clitellata constituted the highest percentage in spring comprised about 45.95% of the total examined stomachs. In the numerical methods, Trichoptera and Clitellata formed the most important diet (46.01 and 33.56%, respectively). Seasonal variation of different food items showed that a high percentage of occurrence of Clitellata were recorded during both winter and autumn (41.21 and 33.33%, respectively), while the highest percent of Coleoptera occurred during summer (42.86%). Trichoptera constituted the highest percentage in spring comprised about 57.35% of the total examined stomachs. Trichoptera nearly attained the same percent during winter, summer and autumn (Figure 4). Regarding the seasonal variation in the feeding intensity as an index of the stomach fullness, it could be stated that, the maximum number of empty stomach was recorded during summer and winter seasons (15.79 and 16.13%, respectively) (Table 1).

DISCUSSION

This study reveals seasonal changes in the feeding habits of the brown trout in the Uzungöl Stream. The preys in the stomachs of *S. t. macrostigma* in Uzungöl Stream were terrestrial and aquatic origin. Fochetti et al. (2003) stressed that trout show a positive selection towards trichopteran prey in the River Nera. The choice of feeding mainly on trichopteran prey was explained by Fochetti et al. (2003). Lehane et al. (2001) reported that most important food items of brown trout in a stream in Ireland were *Ecdyonurus* sp., *Hydropsychid* sp., *Baetis* sp., *Protonemura* sp. and *Gammarus* sp. The most frequent prey items of brown trout in Çatak Stream in Turkey were reported to be Trichoptera (in 17 stomachs, 70.83%), Ephemeroptera (in 14 stomachs, 58.33%) and *Gammarus* sp. (in 11 stomachs, 45.83%) (Çetinkaya, 1996; Alp et al., 2003). *Gammarus* sp. and Plecoptera consist of more than 70% of the total food. In this study, Trichoptera (46.01 %), Clitellata (33.5%) were the most frequent prey. Our detailed analysis of stomach contents

in each age class, Trichopteran preys are dominant species. Joadder (2007) mentioned that the period of poor feeding activity is coincided with the peak of spawning season because the abdominal cavity is fully occupied by the voluminous ripe gonads and so the stomachs were always empty and small in size. These results coincide with that of variation in stomach fullness in this study. Alp (2005) found that in the summer months most of the stomachs of resident brown trout (*S. trutta*) were full, while 24.24% of the stomachs were empty in December during the spawning season. In this study, the maximum number of empty stomach was recorded during winter season (16.13%), this period of poor feeding activity coincided with the spawning season of *S. t. macrostigma* in Uzungöl.

Aras et al. (1986), Yildirim (1991), Nakipoğlu (1992), Çetinkaya (1996), Tabak et al. (2002) and Alp et al. (2003) reported condition factor ranges of 1.087, 1.132, 1.087, 1.173, 1.174, 0.890 to 0.960 and 1.052 to 1.174 in their *S. trutta* populations, respectively. In the present study, the mean condition factor was determinate as 1.00 ± 0.5 (range 0.57 to 1.58) and it was obtained as similar result with the other brown trout populations. Geldiay (1968), Yildirim (1991), Karataş (1997) and Arslan and Aras (2007) reported that age varied in age between 0 and 7 in brown trout populations. Çetinkaya (1999) and Alp et al. (2003) recorded higher than 7 years in Turkish inland waters. One 38-year-old brown trout was recorded by Svalastog (1991) in Norway. Consistent with results of previous studies, age distribution of *S. t. macrostigma* in the Uzungöl Stream was 0 to 8 years. It was concluded that the major food of *S. t. macrostigma* in the Uzungöl Stream were Annelids and Arthropods. Changes occurred in food habits and stomach fullness of this species with season. Seasonal variation had influence abundance and diversity in the diet of *S. t. macrostigma* in the Uzungöl Stream.

ACKNOWLEDGEMENTS

The authors would like to express their special thanks to Turkish Ministry of Environment and Forestry – Environmental Protection Agency for Special Areas (EPASA) for financial support. We would also like to thank Murat Erdem Güzel, Zeynep Çolak, Osman Sinan and Murat Fidan for kindly help.

REFERENCES

- Alp A, Kara C, Buyukçapar M (2003). Reproductive biology of brown trout, *Salmo trutta macrostigma* Dumeril 1, in a tributary of the Ceyhan River which flows into the eastern Mediterranean Sea. J. Appl. Ichthyol., 19: 346-351.
- Alp A (2005). Age, Growth and Diet Composition of the Resident Brown Trout, *Salmo trutta macrostigma* Dumeril 1858, in Firnız Stream of the River Ceyhan, Turkey. Turk. J. Vet. Anim. Sci., 29: 285-295.
- Aras S, Karaca O, Yanar M (1986). Aras Nehri'nin kaynak kollarından Madrek Deresi'nde yaşayan alabalıkların (*Salmo trutta* L.) biyoekojileri üzerine arařtırmalar. Atatürk Üniv. Ziraat Fak. Derg, 1: 69-77.
- Arslan M, Aras NM (2007). Structure and Reproductive Characteristics of Two Brown Trout (*Salmo trutta*) Populations in the Çoruh River Basin, North-eastern Anatolia, Turkey, Turk. J. Zool., 31: 185-192.
- Çetinkaya O (1999). Çatak Çayı (Dicle Nehri) dağ alabalıklarının (*Salmo trutta macrostigma* Dumeril, 1858) bazı biyolojik özelliklerinin incelenmesi. İstanbul Üniv. Su Ürün. Derg, 9-13: 111-122.
- Çiftçi Y (2006). Türkiye alabalık (*Salmo trutta* L., 1758 ve *Salmo platycephalus*, Behnke, 1968) populasyonlarının genetik yapısının mtDNA-RFLP analiz yöntemiyle belirlenmesi. Doktora tezi. KTÜ Fen Bilimleri Enstitüsü, Balıkçılık Teknolojisi Mühendisliği A.B.D. Trabzon.
- Demirsoy A (1990). Yaşamın Temel Kuralları, Omurgasızlar / Böcekler Entomoloji. Hacettepe Üniversitesi yayınları, Cilt 2 Kısım 2, p. 941.
- Edmondson WT (1959). Freshwater Biology. 2nd ed. John Wiley and Sons, Inc., New York, p. 1248.
- Elliott JM (1997). Stomach contents of adult sea trout caught in six English rivers. J. Fish. Bio., 50: 1129-1132.
- Fochetti R, Amici I, Argano R (2003). Seasonal changes and selectivity in the diet of brown trout in the River Nera (Central Italy). J. Freshwater Ecol., 18(3): 437-444.
- Geldiay R (1968). A study on trout (*Salmo trutta* L.) populations in the streams of Kazdağı, (in Turkish). VI. Milli Türk Biyoloji Kongresi Tebliğler, p. 65-77.
- Geldiay R, Balık S (1988). Türkiye Tatlısu Balıkları, Ege Üniv. Fen Fak. Kitaplar Serisi No: 97, Ege Üniversitesi Basımevi, İzmir. 519 s.
- Gunn JS, Milward NE (1985). The food, feeding habits and feeding structures of the whiting species *Sillago sihama* (Forsskal and *Sillago analis* Whitley from Townsville, North Queensland, Austr., J. Fish. Biol., 26: 411-427.
- Hyslop EJ (1980). Stomach content analysis-a review of methods and their application. J. Fish. Biol. 17: 411-429.
- Joadder MAR (2007). Food and feeding habits of *Gagata youssoufi* (Rahman) from the river Padma in Rajshahi. Univ. J. Zool., 25: 69-71.
- Karataş M (1990). Determination of the fecundity *Salmo gairdneri* R., 1836 and *Salmo trutta macrostigma* D. 1858 in the Gürün-Gökpinar conditions (Master thesis), (in Turkish). Ankara Üniversitesi Fen Bilimleri Enstitüsü, Su Ürünleri Anabilim Dalı, p. 61.
- Karataş M (1997). Investigations on the Reproduction Properties of Trouts (*Salmo trutta* L.) Inhabiting in Ataköy (Tokat) Dam Lake. Turk. J. Vet. Anim. Sci., 21: 439-444.
- Karataş M (1999). Age at sexual maturity, spawning time, sex ratio, fecundity of population of trouts (*Salmo trutta* L.) in habiting in Tifi brook (Tokat-Turkey). Symposium Development and Growth of Fishes. 5-8 July 1999. Andrews, England.
- Küçük F, Özbaş M, Demir O (1995). Köprüçayı (Antalya) kaynağındaki *Salmo trutta macrostigma* populasyonu ve üreme zamanının tesbiti. [Determination of spawning season of *Salmo trutta macrostigma* population in Köprüçayı (Antalya)]. SDÜ Eğirdir Su Ürünleri Fakültesi Dergisi 4: 99-111 (in Turkish).
- Lebedev NY (1946). Elementary populations of fish. Zool. Zhurn. 25: 121-135.
- Lehane BM, Walsh B, Giller PS, O'Halloran J (2001). The influence of small-scale variation in habitat on winter trout distribution and diet in an afforested catchment. Aquatic. Ecol. 61: 61-71.
- Mequilla AT, Campos WL (2007). Feeding relationships of dominant fish species in Visayan Sea, 19: 35-46.
- Nakipoğlu H (1992). Yukarı Karasu Havzası alabalıklarının biyoekojileri üzerine arařtırmalar (Yüksek Lisans Tezi). Atatürk Üniversitesi Fen Bilimleri Enstitüsü Su Ürünleri Anabilim Dalı.
- Svalastog D (1991). A note on maximum age of brown trout, *Salmo trutta* L. J. Fish Biolo., 38: 967-968.
- Tabak Ü, Aksungur M, Zengin M, Yılmaz C, Aksungur N, Alkan A, Zengin B, Mısır DM (2002). Karadeniz alabalığı (*Salmo trutta labrax*

Pallas, 1811) 'nın biyoeolojik özelliklerinin tesbiti ve kültüre alınabilirliğinin araştırılması projesi. Sonuç Raporu (TAGEM/HAYSUD/98/12/01/007). Su Ürünleri Merkez Araştırma Enstitüsü Müdürlüğü, Trabzon, p.194.

Tortonese E (1954). The trouts of Asiatic Turkey. İstanbul Üniv. Fen Fak. Hidrobiyol. Enst. Derg, 1: 1-26.

Yıldırım A (1991). Barhal Havzası alabalıklarının (*Salmo trutta labrax* Pallas 1811) biyoeolojileri üzerine araştırmalar (Yüksek Lisans Tezi). Atatürk Üniversitesi Fen Bilimleri Enstitüsü Su Ürünleri Anabilim Dalı.

Yüksel AY, Kocaman EM (1998). Some of the properties of brown trout (*S.t.macrostigma* Dumeril 1858) in Tekederesi (Erzurum), (in Turkish). III. Fisheries Simposium of east Anatolia, Erzurum, pp. 361-372.