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Research Article

Feeding Habits and Diet Composition of Brown Trout (*Salmo trutta*) in the Upper Streams of River Ceyhan and River Euphrates in Turkey

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Abstract: The feeding habits and diet composition of the stream dwelling resident brown trout *Salmo trutta* in the upper streams of River Ceyhan and River Euphrates were investigated by examining the stomach contents of 611 specimens collected from May 2000 to April 2001. Analysis of monthly variations of stomach fullness indicated that feeding intensity was higher between February and June than that for the spawning season that covered the period from November to January. A total of 42 prey taxa representing Coleoptera, Trichoptera, Ephemeroptera, Plecoptera, Malacostraca, Diptera, Araneidae, Odonata, Gastropoda, Acridae, Acarii, Heteroptera, fish and fish egg was identified in the diet. The index of relative importance (IRI%) revealed that five food items together constituted more than 90% of the diet, with the most important being Gammarus sp. (49.72%), Hydropsychidae (14.61%), an unidentified dipteran species (9.21%), Nemoura sp. (8.98%) and Isoperla sp. (6.90%). The Overlap Index (OI) values indicated that the resident brown trout in the Stream Aksu, Söğütlü and Hurman differed in terms of their diet compositions, compared to the trout in other streams. The most important food item varied among the size classes of the brown trout, being Rhithrogena sp., Nemoura sp., Gammarus sp. and fish for the classes of trout with 40-80 mm, 81-120 mm, 121-280 mm, and >320 mm fork length, respectively. Diet composition of brown trout < 80 mm in length and >240 mm in length was different from the other length groups (OI < 0.7). High value overlap index was observed between female and male (OI = 0.989), while no significant dietary overlap was evident between immature and mature individuals (OI = 0.465 and OI = 0.472).

Key Words: Diet composition, brown trout, *Salmo trutta*, river Ceyhan, river Euphrates

Ceyhan ve Fırat Nehirlerinin Üst Kollarındaki Alabalıkların (*Salmo trutta*) Beslenme ve Besin Kompozisyonları

Özet: Mayıs 2000 ve Nisan 2001 tarihleri arasında Ceyhan ve Fırat nehirlerinin üst kollarından yakalanan 611 adet alabalığın mide içerikleri incelenerek besin kompozisyonları ve beslenmeleri araştırılmıştır. Mide Doluluk İndekslerine göre Şubat-Haziran ayları arasında beslenmenin, üreme sezonu olan Kasım-Ocak aylarına göre daha yoğun olduğu görülmüştür. İncelenen mide içeriklerinde 42 takson tanımlanmış ve bunların Coleoptera, Trichoptera, Ephemeroptera, Plecoptera, Malacostraca, Diptera, Araneidae, Odonata, Gastropoda, Acridae, Acarii, Heteroptera, balık ve balık yumurtası gruplarına dahil olduğu tesbit edilmiştir. Kısmi Önemlilik İndeksine (% IRI) göre 5 besinsel organizma grubu toplam besin kompozisyonunun % 90 dan fazlasını oluşturmuş ve bunlar Gammarus sp. (% 49,72), Hydropsychidae (% 14,61), teşhis edilemeyen bir dipteran türü (% 9,21), Nemoura sp. (% 8,98) ve Isoperla sp. (% 6,90) dir. Benzerlik İndekslerine (OI) göre, Aksu, Söğütlü ve Hurman çaylarındaki populasyonların besin kompozisyonları diğer derelerden farklılık göstermiştir (OI < 0,7). Besinsel organizmalar balık büyüklüğüne göre farklı olup 40-80 mm boya sahip alabalıklarda Rhithrogena sp., 81-120 mm boy gruplarında Nemoura sp., 121-280 mm boy gruplarında Gammarus sp. ve 320 mm'den büyük alabalıklarda ise en önemli besin grubu balıktır. Benzerlik İndekslerinde 80 mm'den küçük ve 240 mm'den büyük alabalıkların besin kompozisyonları diğer boydaki balıklardan farklıdır (OI < 0,7). Dişi ve erkek bireylerin besin içerikleri büyük ölçüde birbirine benzerken (OI = 0,989), ergin olmayan bireylerin besin içerikleri erginlerden farklı bulunmuştur (OI = 0,465, OI = 0,472).

Anahtar Sözcükler: Besin kompozisyonu, alabalık, *Salmo trutta*, Ceyhan nehri, Fırat nehri

Introduction

Three potential food groups for brown trout are available: substrate-associated preys, surface drift and suspended drift (1). It is generally believed that brown trout feed chiefly on drifting invertebrates (2-5); however, several reports have noted that dwelling salmonids can use benthic prey (6-10). Trout diet is mainly determined by the habitat (11,12), season (1,12-14), prey availability (10), ontogeny (12) and sex of the fish (15).

Salmo trutta forms resident populations in the upper streams of rivers and occurs in North Africa, Europe, West Asia and Anatolia (16,17) and it is an important potential species for recreational fishery. However, in most parts of these areas, river systems have undergone great changes in their ecology and morphology in recent years and river damming and degradation of spawning habitats have caused a decline in the stocks of *S. trutta*.

Scarce information is available on feeding activity of *S. trutta* populations in Turkey. In addition, natural food organisms used as feed by the brown trout have received little attention, except a recent study in which stomach contents of 24 *S. trutta* from the Stream Çatak of the River Tigris were examined for two months (18).

In this paper, we describe diet composition of the native resident brown trout in eight streams of River Ceyhan and River Euphrates in Turkey by analysis of stomach contents, with comparison by locality, season, size classes of fish, sex of fish and food diversity.

Materials and Methods

The study was conducted in the streams of Fırnız, Terbüzek, Kömür, Hurman, Söğütlü, Nergele and Aksu of the River Ceyhan, which runs into the eastern Mediterranean Sea, and in the Stream Göksu of the River Euphrates, which runs into the Persian Gulf (Figure 1). Some information about sampling stations is given in Table 1.

A total of 611 individuals of the brown trout was caught monthly at three selected sampling sites, 50 m apart from each other in each stream, between May 2000 and April 2001 by electrofishing. All the captured fish specimens were immediately preserved in a plastic barrel containing 4% formalin solution for later analysis. For each fish, total weight (g), fork length (mm) and sex were recorded. For each fish following the removal of digestive tract, stomach was opened, its content was flushed into a Petri dish and contents were weighed (g). Stomach content 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 of Edmondson (19), Demirsoy (20) and Geldiay and Balık (17). Food items were damp dried on paper towels and the number of individuals and total weight of each prey category were recorded. Tract contents having no food items were also recorded as empty stomachs.

The Fullness Index (FI) was calculated to investigate the variations in feeding intensity, using the equation: FI =(Weight of stomach contents/Total weight of fish)*10000 (21). One way analysis of variance and Tukey's test were used to test for deviations in feeding intensity among the different habitats, months and fish sizes.

Dietary importance of food categories was determined using the modified index of relative importance; IRI= (N% +W%) *FO% (22), where FO%: percentage frequency occurrence of stomachs in which a food item occurred relative to the total number of stomachs containing food items; N% is the numeric percentage of individuals of a food item relative to the total number of food items in the stomach and W% is the percentage weight of a food item relative to the weight of the total stomach contents. Percentage of weight (W%) was used instead of volumetric percentage (23)

Using the IRI% to compare diet composition between the pairs of locations, months, length groups or sex, an overlap index (OI) was estimated (24);

$$OI = \frac{\Sigma P_{ij}P_{ik}}{\sqrt{\Sigma P_{ij}^2 P_{ik}^2}}$$

where P_{ij} and P_{ik} are the proportional use of prey type i at locations, months, length groups or sex j and k, respectively. This index ranges from 0 (no overlap) to 1 (complete overlap). Overlap index values >0.7 are usually considered to indicate significant overlap (25).

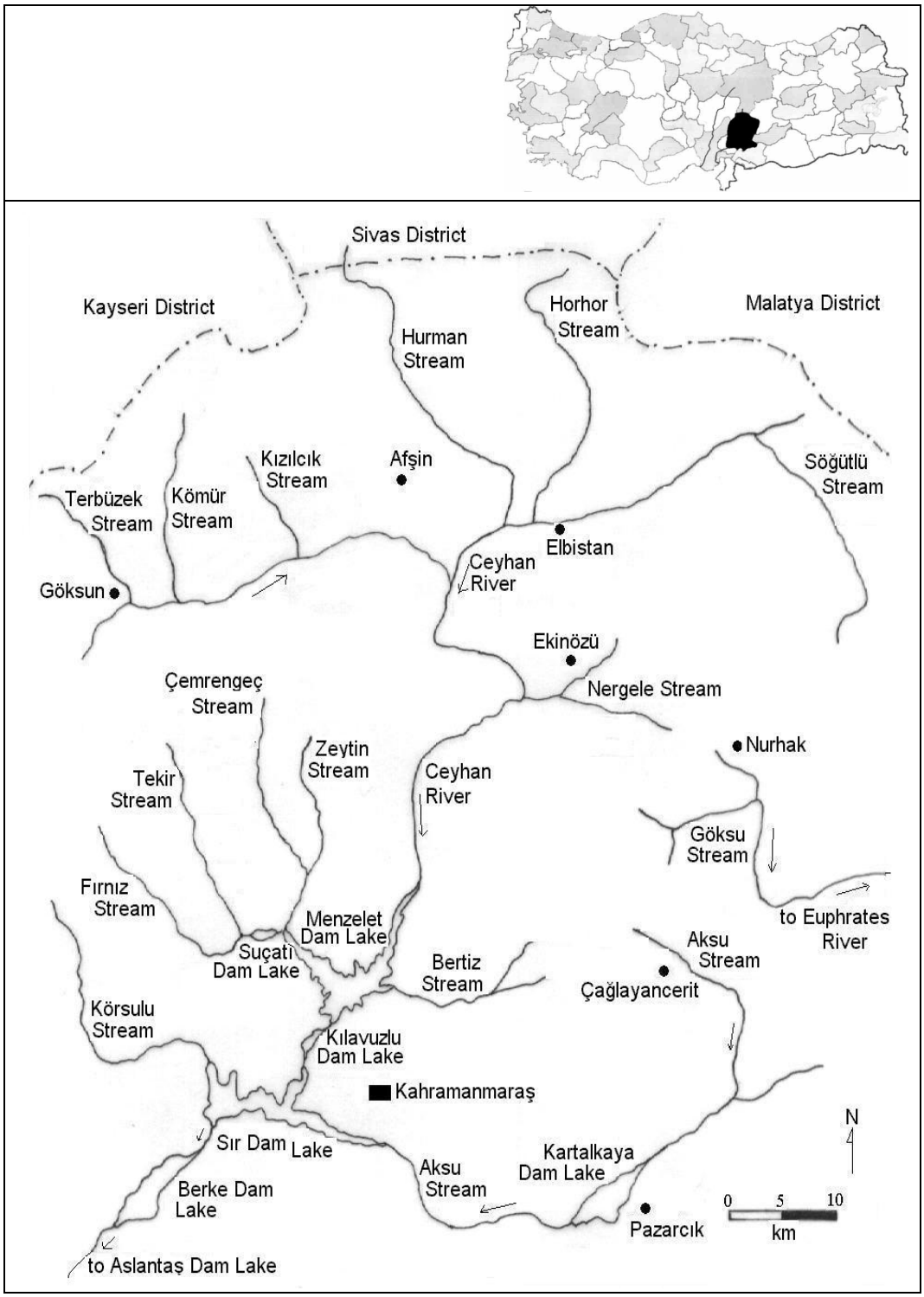

Figure 1. The map of the working area and streams locations.

Table 1. Geographic locations of the streams and number of the fish caught during the study, their fork length and total weight. (FL ± CI: The mean fork length ± Confidence interval (95%), W ± CI: Total weight ± Confidence interval (95%)).

Stream	River system	Latitude (N)	Longitude (E)	Altitude (m)	Number of fish	FL ± CI (Min-Max) (mm)	W ± CI (Min-Max) (g)
Fırnız	Ceyhan	37° 45´	36° 39´	720	186	162 ± 8.60 (80.1-395.0)	95.5 ± 9.66 (11.4-842.0)
Aksu	Ceyhan	37° 46´	37° 21´	1125	79	120 ± 7.70 (81.7-264.4)	33.8 ± 9.64 (8.4-256.8)
Nergele	Ceyhan	38° 00´	37° 13´	1213	32	115 ± 11.00 (76.8-179.8)	30.3 ± 8.86 (6.7-97.5)
Hurman	Ceyhan	38° 26´	36° 54´	1258	110	165 ± 8.80 (73.3-296.0)	80.2 ± 12.39 (5.7-344.7)
Göksu	Euphrates	37° 52´	37° 18´	1280	31	129 ± 16.40 (63.2-217.1)	46.1 ± 15.33 (3.6-152.0)
Terbüzek	Ceyhan	38° 04´	36° 27´	1390	92	120 ± 9.30 (57.5-260.1)	38.7 ± 8.87 (2.8-247.9)
Kömür	Ceyhan	38° 08´	36° 33´	1417	64	122 ± 12.10 (64.4-365.0)	41.8 ± 12.63 (3.9-549.0)
Söğütlü	Ceyhan	38° 09´	37° 36´	1474	17	193 ± 37.10 (67.0-369.0)	131.3±70.60 (3.7-548.0)

Results

Feeding intensity

Resident brown trout ranged from 57.5 mm to 395.0 mm in fork length (FL) with a mean value of 143.4 mm, and their total weight ranged from 2.8 g to 842.0 g, with a mean value of 65.64 g. The number of specimens, mean fork length and mean weights from different stream populations in the study are presented in Table 1. Of the 611 resident brown trout, 259 (42.39%) were females, 230 (37.64%) males and 122 (19.97%) immatures.

Of the total stomach analysed, 8.70% were empty. In the summer months most of the stomachs of resident brown trout were full, while 24.24% of the stomachs were empty in December during the spawning season [Figure 2 (a)]. The most empty stomachs were seen in the Stream Fırnız, Hurman and Söğütlü [Figure 2 (b)]. The empty stomachs between 40 mm and 240 mm in length varied from 4.88% to 10.26% [Figure 2 (c)]. Whereas, it was 18.82%, 25.0% and 50.0% in the length groups 240 – 280; 280 - 320 and 320 – 360 mm, respectively [Figure 2 (c)].

Significant monthly variation was found [$F_{(8, 602)}$ = 7.976; $P < 0.01$; January^{a}, February^{d}, April^{bc}, May^{cd}, June^{bcd}, July^{ab}, September^{a}, November^{abc}, December^{abcd}] in FI and it fluctuated throughout the year [Figure 2 (a)]. Maximum fullness index were observed in February, April, May and June, while the index showed a decline from September to January. The resident brown trout fed most intensively during spring and early summer (February–June). The results indicated that FI was also influenced by habitat [$F_{(7,603)}$ = 7.415; $P < 0.01$; Fırnız^{b}, Tebüzek^{ab}, Kömür^{ab}, Hurman^{ab}, Nergele^{ab}, Göksu^{ab}, Söğütlü^{a} and Aksu^{a}] and length groups [$F_{(8, 602)}$ =1.961; $P < 0.05$; 40-80^{ab}, 80-120^{ab}, 120-160^{b}, 160-200^{b}, 200-240^{b}, 240-280^{ab}, 280-320^{ab}, 320-360^{ab}, 360-400^{a} mm]. The trouts captured in the Stream Fırnız had the highest FI [Figure 2 (b)]. The fish between the size of 40 mm and 320 mm fed most intensively, whilst the intensity declined above 320 mm length [Figure 2 (c)].

Diet composition

A total of 42 prey was identified in the diets of the fish and they are presented in Table 2. Ephemeroptera were present in 214 (35.03%), Plecoptera in 208 (34.04%), Malacostraca in 192 (31.42%) stomachs,

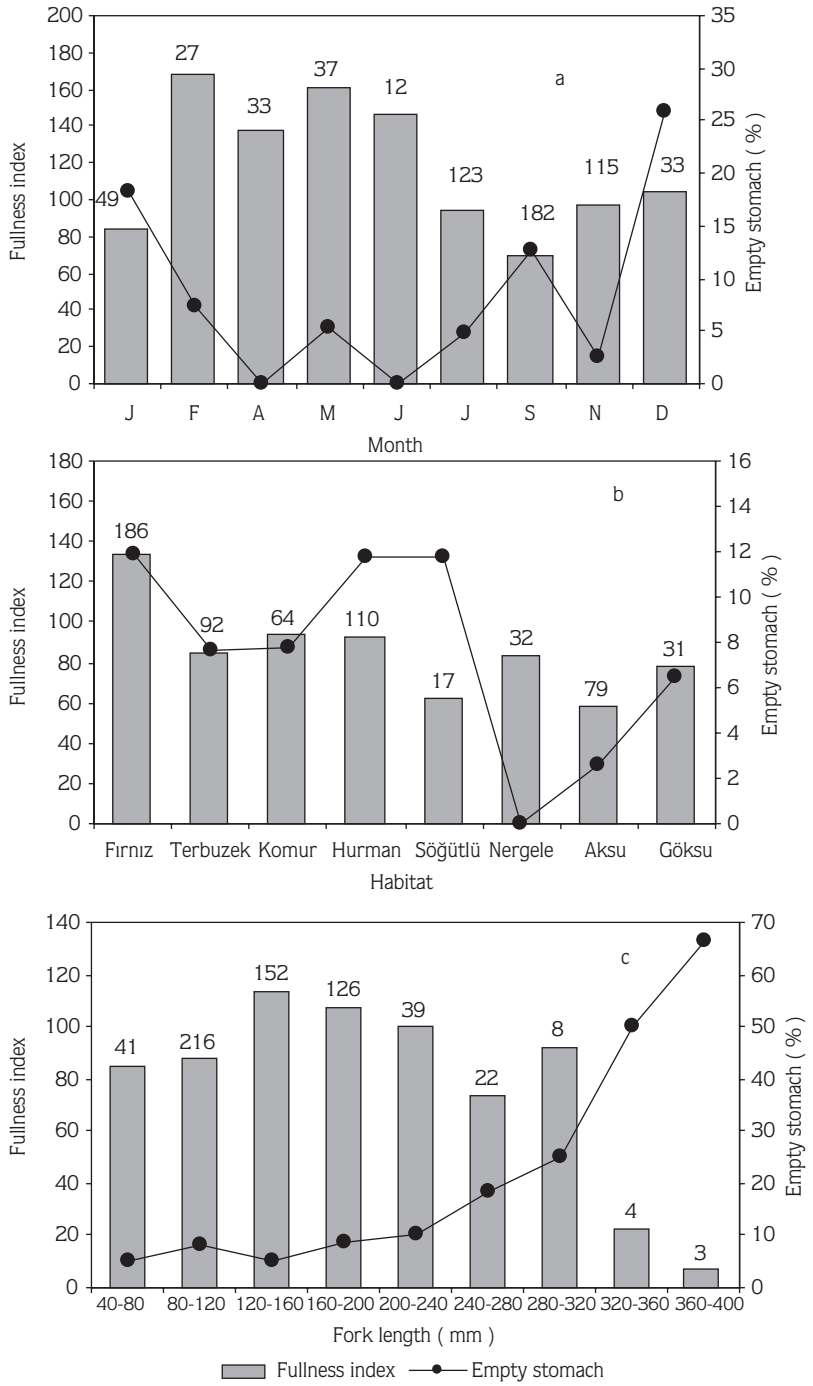

Figure 2. Variations in feeding intensity, fullness index and empty stomach, of brown trout: a) Monthly variations b) Variations in the habitat c) Variations in the length groups. Numbers above bars are sample size (n).

while Trichoptera, Diptera and Coleoptera were present in 155 (25.37%), 152 (24 88%) and 55 (9.00%) stomachs, respectively. In addition, fish, Araneidae, Odonata, Gastropoda, Acridae, Acarii, Heteroptera, fish eggs, plant seeds and stones were rarely present in the stomach contents (Table 2).

Table 2. Food items and their relative importance index in the diet composition of resident brown trout from the streams of River Ceyhan and River Euphrates.

Prey	FO	%FO	N	%N	W	%W	IRI	%IRI
Coleoptera	55	9.00	90	1.581	2.931	2.256		
Pyrochroa spp.	4	0.655	4	0.070	0.183	0.141	0.138	0.004
Hydrobius spp.	15	2.455	27	0.474	0.930	0.716	2.922	0.087
Enochrus spp.	3	0.491	6	0.105	0.457	0.352	0.224	0.007
Acilius spp.	34	5.565	50	0.878	1.228	0.945	10.145	0.302
Elmidae	2	0.327	2	0.035	0.089	0.069	0.034	0.001
Agabus spp.	1	0.164	1	0.018	0.044	0.034	0.009	0.000
Trichoptera	155	25.37	507	8.907	13.733	10.569		
Hydropsychidae	166	27.169	476	8.363	12.612	9.707	490.944	14.610
Leptocerus spp.	16	2.619	26	0.457	0.795	0.612	2.800	0.083
Sericostoma spp.	3	0.491	5	0.088	0.326	0.251	0.166	0.005
Ephemeroptera	214	35.03	1654	29.058	20.574	15.833		
Rhithrogena spp.	55	9.002	214	3.760	2.412	1.857	50.564	1.505
Ephemerella spp.	47	7.692	176	3.092	4.626	3.561	51.175	1.523
Caenis spp.	70	11.457	401	7.045	3.251	2.502	109.380	3.255
Isonychia spp.	7	1.146	17	0.299	0.188	0.145	0.509	0.015
Ecdyonurus spp.	21	3.437	564	9.909	7.563	5.821	54.064	1.609
Heptagenia spp.	7	1.146	19	0.334	0.385	0.296	0.722	0.021
Epeorus spp.	15	2.455	48	0.843	0.559	0.430	3.125	0.093
Ephemera spp.	12	1.964	16	0.281	0.686	0.528	1.589	0.047
Baetis spp.	7	1.146	199	3.496	0.904	0.696	4.804	0.143
Plecoptera	208	34.04	822	14.441	33.380	25.689		
Nemoura spp.	120	19.640	496	8.714	8.632	6.644	301.631	8.976
Perla spp.	38	6.219	94	1.651	4.110	3.163	29.938	0.891
Isoperla spp.	71	11.620	232	4.076	20.638	15.884	231.935	6.903
Malacostraca	191	31.42	1594	28.004	33.125	25.493		
Gammarus spp.	191	31.260	1593	27.987	33.077	25.458	1670.691	49.719
Mysid spp.	1	0.164	1	0.018	0.048	0.037	0.009	0.000
Diptera	152	24.88	930	16.339	9.918	7.633		
Unidentif Dipter	113	18.494	594	10.436	8.193	6.306	309.627	9.214
Corethra spp.	23	3.764	105	1.845	0.418	0.322	8.157	0.243
Chaoborus spp.	3	0.491	59	1.037	0.193	0.149	0.582	0.017
Chironomidae	25	4.092	172	3.022	1.114	0.857	15.873	0.472
Araneidae	1	0.164	1	0.018	0.012	0.009		
Aranedi	1	0.164	1	0.018	0.012	0.009	0.004	0.000
Odonata	2	0.327	2	0.035	0.076	0.059		
Calpoteryx spp.	2	0.327	2	0.035	0.076	0.059	0.031	0.001
Gastropoda	11	1.80	22	0.387	0.854	0.657		
Radix spp.	4	0.655	5	0.088	0.046	0.035	0.081	0.002
Lymnea spp.	6	0.982	16	0.281	0.791	0.609	0.874	0.026
Dressiana spp.	1	0.164	1	0.018	0.017	0.013	0.005	0.000
Acrididae	2	0.327	3	0.053	0.054	0.416		
Oedipoda spp.	2	0.327	3	0.053	0.540	0.416	0.153	0.005
Acarii	6	0.982	6	0.105	0.027	0.021		
Hydroacari	6	0.982	6	0.105	0.027	0.021	0.124	0.004
Heteroptera	3	0.491	4	0.070	0.210	0.162		
Notonecta spp.	3	0.491	4	0.070	0.210	0.162	0.114	0.003
Pisces	8	1.31	12	0.211	13.239	10.189		
Capoeta capoeta	3	0.491	3	0.053	1.048	0.807	0.422	0.013
Blennius spp.	1	0.164	3	0.053	0.597	0.459	0.084	0.003
Salmo trutta	1	0.164	3	0.053	1.479	1.138	0.195	0.006
Phoxinellus spp.	3	0.491	3	0.053	10.115	7.785	3.849	0.115
Other items								
Trout egg	4	0.655	7	0.123	0.280	0.216	0.223	0.007
Plant seed	14	2.291	19	0.334	0.369	0.284	1.416	0.042
Stone	7	1.146	19	0.334	0.666	0.513	0.971	0.029
Total			5692	100.000	129.94	100.000	3360.30	100.000

5692 individual preys were counted from 611 trout examined and their total wet weight was 129.94 g. The most representative prey were Gammarus sp. (27.99%), an unidentified dipteran species (10.44%), Ecdyonurus sp. (9.91%), Hydropsychidae (8.36%) and Nemoura sp. (8.71%). By weight, Gammarus sp. (25.46%) represented the largest proportion of the diet, followed by Isoperla sp. (15.88%), Hydropsychidae (9.70%) and Nemoura sp. (6.64%). The most frequent prey in the stomachs were Gammarus sp. (31.26%), Hydropsychidae (27.17%), Nemoura sp. (19.64%) and unidentified dipteran species (18.49%). According to IRI%, five food items represented more than 90% of the diet, with the most important being Gammarus sp. (49.72%), Hydropsychidae (14.61%), unidentified dipteran species (9.21%), Nemoura sp. (8.98%) and Isoperla sp. (6.90%) (Table 2).

IRI% indicate that Gammarus sp. was significantly more important in the streams Fırnız, Terbüzek, Nergele and Göksu, where it made up 43.99%, 59.15%, 33.67% and 94.32% of the diets, respectively (Table 3). Ephemeroptera were also consumed significantly more often in the streams Kömür (50.06%), Hurman (33.67%), Söğütlü (90.10%) and Aksu (76.60%). According to OI values, the resident brown trout in the Stream Aksu, Söğütlü and Hurman had different diet compositions from the others because of the low values of OI (OI < 0.7) (Table 4).

Temporal variation in the diet

IRI% of different food items in the stomachs of the resident brown trout varied by season (Figure 3). Resident brown trout had a similar feeding strategy in January, February and December because of high overlap

Table 3. Major food items (% IRI) of the brown trout from different stream populations during the study.

	Fırnız	Terbüzek	Kömür	Hurman	Söğütlü	Nergele	Göksu	Aksu
Coleoptera	0.00	1.12	1.57	1.05	0.00	0.00	0.00	1.59
Hydrobius spp.				1.05				1.59
Acilius spp.		1.12	1.57					
Trichoptera	13.46	13.49	9.56	17.80	2.09	31.25	1.02	0.00
Hydropsychidae	13.46	13.49	9.56	16.73	2.09	31.25	1.02	
Leptocerus spp.				1.07				
Ephemeroptera	0.00	7.22	50.06	33.67	90.10	22.60	0.00	76.60
Rhithrogena spp.		5.92	19.85	3.63	3.80	14.33		
Ephemerella spp		1.30	16.37	15.64				
Caenis spp.			11.14	2.39				66.87
Ecdyonurus spp.			1.21	12.01	86.30			
Epeorus spp.			1.49			8.27		
Baetis spp.								9.73
Plecoptera	31.80	13.58	1.80	8.16	0.00	0.00	0.00	0.00
Nemoura spp.	18.85			3.28				
Perla spp.		13.58	1.80	3.01				
Isoperla spp.	12.95			1.87				
Malacostraca	43.99	59.15	28.45	14.04	0.00	33.67	94.32	9.43
Gammarus spp.	43.99	59.15	28.45	14.04		33.67	94.32	9.43
Diptera	10.23	1.81	3.50	22.40	0.00	10.64	3.50	9.31
Unidentif Dipter	10.23			17.47		2.15		9.31
Corethra spp.			3.50	4.93				
Chironomidae		1.81				8.49	3.50	
Total	99.48	96.37	94.94	97.12	92.19	98.16	98.84	96.92

Table 4. Dietary overlap index for the resident brown trouts caught in different streams during the study.

OI (% IRI)	Fırnız	Terbuzek	Komur	Hurman	Söğütlü	Nergele	Goksu
Terbuzek	0.856*						
Komur	0.640	0.763*					
Hurman	0.601	0.520	0.652				
Söğütlü	0.007	0.011	0.059	0.358			
Nergele	0.740*	0.811*	0.758*	0.624	0.028		
Goksu	0.843*	0.949*	0.689	0.407	0.001	0.912*	
Aksu	0.143	0.132	0.356	0.190	0.011	0.007	0.375

* Significant overlap

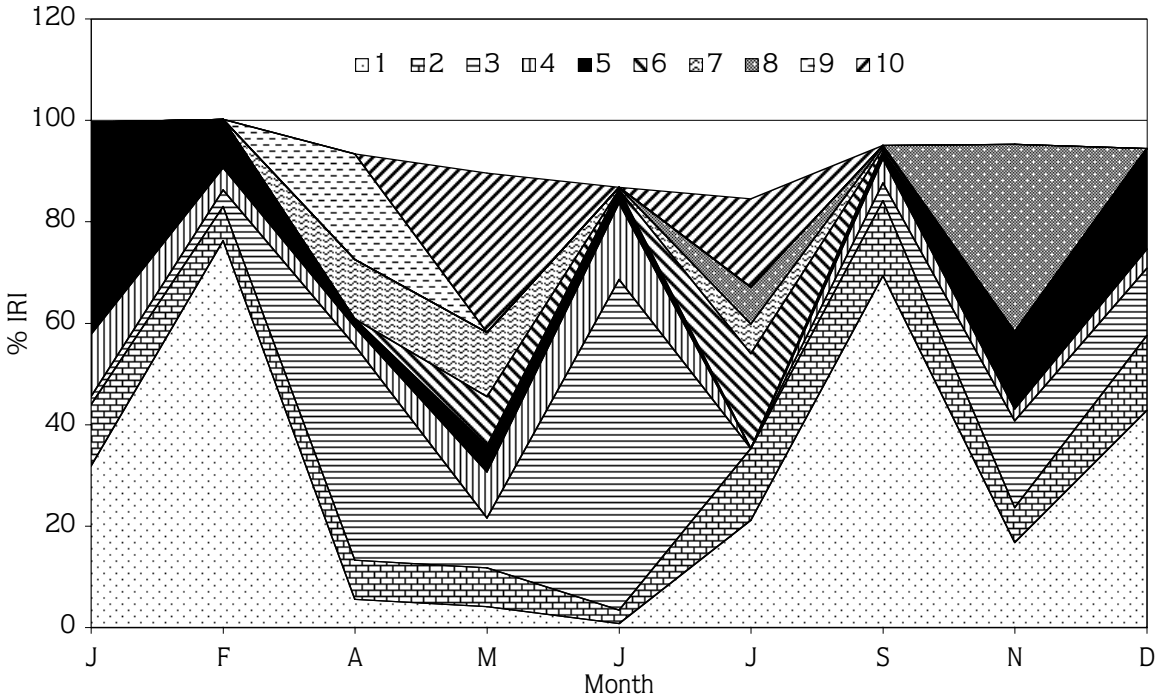

Figure 3. Monthly variations in the index of relative importance (% IRI) of the major food items of brown trout from the streams of River Ceyhan and River Euphrates. 1) *Gammarus* sp., 2) *Hydropsychidae*, 3) Unidentified dipteran species, 4) *Isoperla* sp., 5) *Nemoura* sp., 6) *Rhithrogena* sp., 7) *Ephemeralla* sp., 8) *Caenis* sp., 9) *Corethra* sp., 10) *Ecdynourus* sp.

index (OI > 0.7) (Table 5). Five food items, Hydropsychidae., Nemoura sp., Isoperla sp., Gammarus sp. and unidentified dipteran species, were present at every month.

According to IRI, Gammarus sp. were mainly eaten in February (76.25%), July (21.15%), September (69.38%) and December (42.75%), whereas Nemoura sp. was found to be most important in January (41.87%), unidentified dipteran species in April (42.33%), Ecdyonurus sp. in May (31.43%), Isoperla sp. in June (15.06%) and Caenis sp. was the most important food in November (36.96%). Hydropsychidae were present in all months, but were never found to be most important item in the diet (Figure 3).

Variation in the diet by size of the fish

Figure 4 shows a size-dependent variation in IRI% of the most important food items in the stomachs. Gammarus sp. was mainly eaten by the individuals in the

Table 5. Dietary overlap index for the resident brown trouts sampled in different months during the study.

OI (% IRI)	January	February	April	May	June	July	September	November
February	0.693*							
April	0.162	0.166						
May	0.259	0.159	0.353					
June	0.123	0.072	0.846*	0.308				
July	0.400	0.568	0.157	0.695*	0.025			
September	0.638	0.987*	0.188	0.175	0.085	0.611		
November	0.501	0.420	0.391	0.219	0.384	0.395	0.407	
December	0.855*	0.906*	0.372	0.274	0.300	0.559	0.894*	0.557

* Significant overlap

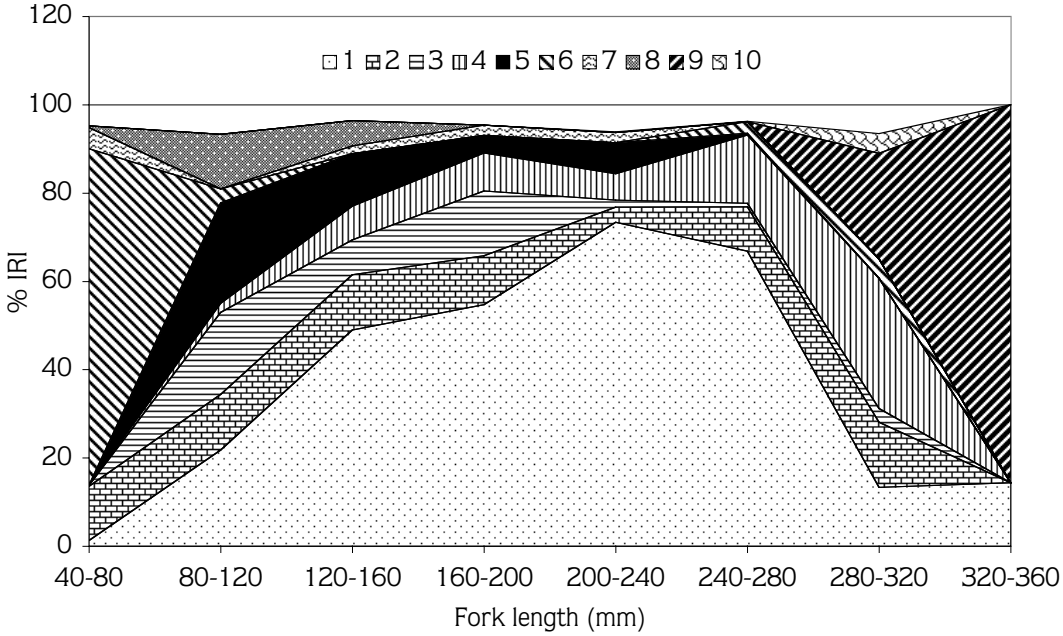

Figure 4. Variations in the index of relative importance (% IRI) of major food items of brown trout in relation to length groups. 1) *Gammarus* sp., 2) *Hydropsychidae*, 3) Unidentified dipteran species, 4) *Isoperla* sp., 5) *Nemoura* sp., 6) *Rhithrogena* sp., 7) *Ephemeralla* sp., 8) *Caenis* sp., 9) Fish, 10) *Lymnea* sp.

length groups between 120 and 280 mm, while Rhithrogena sp. was dominant food item in the length group of 40-80 mm (76.21%), Nemoura sp. in the length group of 80-120 mm (22.75%). The first uptake of fish by resident brown trout was observed in individuals of 160–200 mm in length groups but fish was the most important food for the resident brown trout larger than 320 mm in length.

Diet composition until 80 mm in length was different from the other length groups as OI was smaller than 0.7 (Table 6). Similarly, diet composition of the fish larger than 240 mm in length were different from the others.

Variation in the diet by sex of the fish

Of the 611 resident brown trout, 259 (42.39%) were females, 230 (37.64%) males and 122 (19.97%) immatures. According to OI, high value index was observed between females and males (OI = 0.989), while no significant dietary overlap was evident between immatures and females (OI = 0.465) and males (OI = 0.472). Gammarus sp. was the most important food item

Table 6. Dietary overlap index for the resident brown trouts with different size classes as fork length (mm).

OI (% IRI)	40-80	80-120	120-160	160-200	200-240	240-280	280-320	320-360
80-120	0.140							
120-160	0.060	0.793*						
160-200	0.055	0.718*	0.976*					
200-240	0.029	0.609	0.955*	0.959*				
240-280	0.077	0.582	0.952*	0.964*	0.979*			
280-320	0.160	0.343	0.466	0.468	0.378	0.499		
320-360	0.003	0.106	0.182	0.186	0.201	0.191	0.585	
360-400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.232

* Significant overlap

in female and male individuals, whereas Rhithrogena sp. was mainly eaten by immature individuals (Figure 5).

Discussion

The brown trout examined in the present study fed most intensively during the period between February and June [Figure 2 (a)]. Daily ratios of stream dwelling brown trout were reported to be highest between June and early August, declining sharply in September (14,26,27). Fullness index of the brown trout were also reported to be the lowest in autumn, then increased from winter to summer (11,28). Knutsen et al. (12), studying anadromous brown trout at sea, observed that sea trout fed most intensively in spring and early summer, and feeding declined from a high in May–June to a low in July. Lyse et al. (29) reported that sea trout fed intensively during May–June. Similarly, in our study, fullness index of the stomach was high between February and June, started to decline in July to the lowest in September. These variations in the feeding activity are related to water temperature, which influence fish

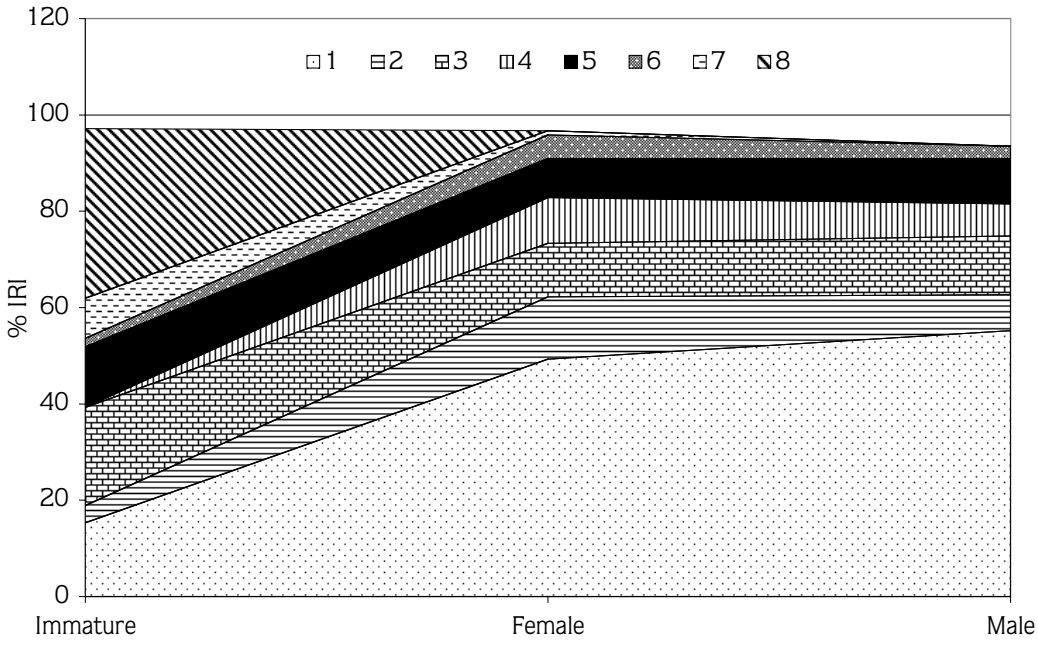

Figure 5. Most important food items (%IRI) in immature, female and male brown trout from the streams of River Ceyhan and River Euphrates. 1) *Gammarus* sp., 2) Unidentified dipteran species, 3) *Hydropsychidae*, 4) *Isoperla* sp., 5) *Nemoura* sp., 6) *Caenis* sp., 7) *Perla* sp., 8) *Rhithrogena* sp.

metabolism (30) and prey availability (11,28). In winter, fish adopt a cost-minimizing strategy, while in summer, when the energy requirements for metabolism and growth are highest, they maximize their net energy intake (14). Elliot (15) reported that there was a marked significant difference in feeding between male and female sea trout. In our study, there were not significant differences in feeding between male and female throughout the study.

Resident brown trout in the present study fed on a variety of prey items, and the diet changed with season, habitat and fish size. Most of the prey were found to be benthic organisms. A majority of the researchers suggest that brown trout feed chiefly on drifting invertebrates (3,5), although stream-dwelling salmonids can adjust their feeding behavior in response to changes in the abundance of prey (6,7) and can also use benthic prey (8-10). Lehane et al. (1) reported that Trichoptera species (30.4%) represented the largest proportion of the diet of brown trout in an afforested catchment in Ireland, followed by Ephemeroptera (26%), Plecoptera (13.9%), Coleoptera (7.3%), Gammarus sp. (6.9%), Mollusca (4%), Diptera (3.9%) and others (8%). Ecdyonurus sp., Hydropsychid sp., Baetis sp., Protonemura sp. and Gammarus sp. were the most important individual prey species and represented the most dependable food sources for trout (1). They also observed that not all of these were drift-prone species. The most frequent prey items of the brown trout in Stream Çatak 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%) (18). In our study, Ephemeroptera (37.971%), Plecoptera (37.480%) and Gammarus sp. (31.424%) were the most frequent prey items and Trichoptera has never been dominant food item in the examined populations. It is suggested that there may be some variations in the feeding patterns of salmonids in the wild, and brown trout chiefly feed on the most available prey items (10). The variation in trout diet composition and feeding strategy between the two macrohabitat types may be a result of the differences in food availability related to macro-invertebrate vulnerability (5). So the differences between our results and Stream Çatak brown trout population may have resulted from prey availability.

In the present study the fish had similar feeding habit in January, February and December. Gammarus sp. were most frequently found food item in February (76.25%), July (21.15%), September (69.38%) and December (42.75%), Nemoura sp. were found to be dominant in January (41.87%), unidentified dipteran species in April (42.33%), Ecdyonurus sp. in May (31.43%), Isoperla sp. in June (15.06%), while Caenis sp. were the most important food in November (36.96%). Heggenes et al. (13) suggested that trout follow different behavioral rules at different times of the year. In accordance with this statement, feeding behavior of the brown trout in the present study changed with season.

Elliot and Hurley (30) suggested that the diet of sea trout changed with ontogeny because young fish eat smaller food items than older ones. This finding is in agreement with our results because in the present study the fish <80 mm, 80-120 mm, 120-280 mm and >280 mm fed chiefly on Rhithrogena sp., Nemoura sp., Gammarus sp. and fish, respectively.

In the present study, the difference in the diet composition between female and male was not significant, while it was significant between immature and male or female individuals. Elliott (15) reported that the probability of feeding was significantly lower for male than female sea trout in rivers. The differences between Elliott's result and our findings may have resulted from the migration of the sea trouts. According to Elliott (15), after leaving salt water sea trout feed more intermittently and with a less robust appetite than brown trout. So probability of feeding is lower for male than female sea trout and decrease significantly for both sexes with increasing distance upstream from the normal tidal limit.

In conclusion, this study shows that stream dwelling resident brown trout, *S. trutta*, feed on a variety of prey items, and the diet and feeding behavior changes by season, habitat and fish size while does not differ by sex.

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