Preliminary data on the diet of *Garra rufa* (Cyprinidae) in the Asi basin (Orontes), Turkey

by

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ABSTRACT. - Between April and November 1997, a total of 208 specimens of *Garra rufa* (Heckel, 1843) were caught from the Asi River and its tributaries. It was observed that 68.3% of the guts were empty. The ratio of emptiness of the guts at age 3 and older was low when compared to younger specimens. *Garra rufa* grazes on aquatic plants and mainly feeds on plant materials that mostly consist of benthic chrysophytes and phytoplankton, except for a few rotifers and protozoa. Two specimens were infected by parasitic nematodes. *Navicula* sp., *Gomphonema* sp. and *Nitzschia* sp. were abundant as 34.2%, 17.3% and 12.0% and frequent as 66.7%, 63.6% and 42.4%, respectively, in the samples and *Cymbella* sp., *Cyclotella* sp., *Scenedesmus* sp., *Rhoicosphaenia* sp., *Cocconeis* sp. and *Oscillatoria* sp. were also very frequent food organisms in the gut contents of samples. The distribution of food organisms in the gut content appeared to depend on the location (higher occurrence and abundance of the different food items in downstream locations). However, it was concluded that season was the most important factor influencing *G. rufa* diet.

RÉSUMÉ. - Données préliminaires sur le régime alimentaire de *Garra rufa* (Cyprinidae) dans le bassin de l'Oronte (Turquie).

Entre avril et novembre 1997, 208 spécimens de *Garra rufa* (Heckel, 1843) ont été pêchés pour cette étude dans l'Oronte et ses affluents, dans la province de Hatay en Turquie. Les premières observations ont montré que 68,3% des tubes digestifs étaient vides. La proportion de tubes digestifs vides chez les individus âgés de 3 ans et plus était plus faible que pour les individus plus jeunes. *G. rufa* broute des plantes aquatiques et se nourrit principalement de végétaux, surtout des chrysophytes et du phytoplancton, à l'exception de quelques rotifères et protozoaires. Deux individus étaient infectés par des nématodes parasites. Parmi les organismes consommés, *Navicula* sp., *Gomphonema* sp. et *Nitzschia* sp. étaient abondants, avec une proportion respective de 34,2%, 17,3% et 12,0% du total alimentaire, et fréquents avec respectivement 66,7%, 63,6% et 42,4% du total. *Cymbella* sp., *Cyclotella* sp., *Scenedesmus* sp., *Rhoicosphaenia* sp., *Cocconeis* sp. et *Oscillatoria* sp. étaient également très fréquents dans les contenus des tubes digestifs. La localisation géographique semble influencer le régime alimentaire (fréquence et abondance des différents groupes ingérés plus élevées dans les zones aval). Cependant, les variations saisonnières sont la principale source de variation du régime alimentaire chez *G. rufa*.

Key words. - Cyprinidae - *Garra rufa* - Turkey - Asi basin - Feeding habits - Vacuity index - Phytoplankton grazer.

Garra rufa (Heckel, 1843) is one of the most abundant species in the Asi River, the largest river in northern Levant. *G. rufa* is locally called 'kurbati', which means 'gypsy' as they can cope with and survive rather hard ecological conditions. This fish is also found in the Ceyhan, Firat-Dicle (Tigris-Euphrates) and the Quwayq and Jordan basins and coastal drainages of the eastern Mediterranean, as well as in those of southern Iran and Syria (Coad, 1980; Krupp and Schneider, 1989). *G. rufa* is known to occur in hot ponds (36°C), in Sivas Kangal Balikli Çermik, central Anatolia, where they feed on skin and scales of bathers, whereby curing certain illnesses such as psoriasis and neurodermatitis (Kuru, 1987).

Local fishermen mostly catch African catfish, European eel, and some cyprinids such as *Barbus* spp. *Capoeta* spp. by using fyke and cast nets, traps and hooks throughout the Asi River in Turkey. *G. rufa* are caught accidentally and seldom consumed by residents.

The ecological role of *G. rufa* in the Asi River, largely related to its feeding habits, based on analyses of gut contents, will provide reliable data about diet of *G. rufa* populations in the Asi River. In addition to the gut contents analyses, the ontogenetic diet shift was studied in many kinds of fish species (Labropoulou *et al*., 1997; Morato *et al*., 2000; Muñoz and Ojeda, 2000). Krupp and Schneider (1989) described the habitat structure and food preferences of this species in the Jordan Basin; however, there is no specific ecological research on this species. There are a few studies about feeding ecology of some fish species such as *Clarias gariepinus, Capoeta barroisi, Anguilla anguilla* in the Asi River (Yalçın *et al*., 2001a; Baran 2004). The main goal of this study is to provide preliminary information on the gut contents of *G. rufa* and also, to indicate the spatial, temporal and ontogenetic changes on diet of *G. rufa* in the Asi River.

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Study area

The Asi River originating from El-Bekaa Valley, between Lebanon and Antilebanon Mountains, crosses Syria and empties its waters in Samandağí, Hatay, Turkey. The length of the river in Turkey is 97 km while its total length is 380 km. The Afrin and the Karasu, two important creeks, feed the Asi River in Turkey. The Asi River is also fed by many small creeks throughout its way (Ízbirak, 1996). Total catchment area of this basin is 22,300 km^2 and the water surface is 1,650 ha. It is reported that the mean yearly amount of rain is 1131.5 mm, 943.8 mm and 566.2 mm in the upper part (Antakya), lower part (Samandağí), and the creeks (Tahtaköprü), respectively (Anonymous, 1982). Discharge of the river fluctuates within a year, depending on heavy precipitation and notable droughts. From autumn to spring, water discharge rises up to 100 m^3 per second, even higher under unusual circumstances and the river causes floods in this area; on the other hand, during dry and hot conditions, especially between July and September, discharge decreases to lower than 2 m^3 per second and the river nearly dries up and looks like a small creek. Therefore the depth of the river decreases to almost zero and some isolated pools occur along the river in arid summer months. The long-term mean discharge of the Orontes River was calculated to be 5.04 m^3 per second (Ozdilek, 2003).

MATERIALS AND METHODS

A total amount of 208 fish were collected by using various nets and electro-fishing between April 1997 and November 1997. Eleven sampling locations were grouped into three regions namely (I) the upper part of the river, (II) lower part and (III) the creeks. A map of the sampling area is illustrated in figure 1. Some characteristics of sampling were given in table I. The samples were fixed in 4% buffered formalin immediately after removing scales for ageing in for later gut contents analyses. The scales in between anterior part of dorsal fin and upper part of the lateral line were used for age determination (Bagenal and Tesch, 1978). After making the scale preparation, ages were read under stereo microscope (20x and 45x) by the two authors. Steinmetz and Müller (1991) and Baglinière and Louarn (1987) were taken into account as the criteria for confirming the presence of annulus. The samples were then measured in the laboratory to the nearest mm (FL) and weighed to the nearest 0.1 g. The whole gut was removed and conserved in 4% buffered formalin again. Thereafter, guts were opened and cleaned up. Volumes of individual contents were measured. Contents were then diluted by adding a known amount of 4% formalin into 5-30 cc samples. Food items were identified to the lowest possible taxonomic level. The following references were used to identify food items (Edmondson, 1959; Prescott, 1964; Belcher and Swale, 1978; Streble and Krauter, 1988, Cirik and Gökpinar, 1993). Rotifers and protozoan taxa were given in phyla level. However, they could not be identified later on as they had been almost digested. After each sample was homogenized by shaking, a few drops from the sample were taken into a Thoma slide. Microscopic organisms, mostly algae, were counted in Thoma slide square (magnification x400), which had 0.1 mm^3 volume. Then the number of total organisms in each gut contents was calculated by using the gut volume.

The vacuity index (%VI) – the percentage of empty guts –, the frequency of occurrence (%F_i) – percentage of all filled guts in which the food item *i* was found – and the percentage of abundance (% N_i) – percentage of food item *i* in relation to the total number of food items – were calculated in all the guts containing food (Hureau, 1970; Windell, 1971; Hyslop, 1980). The preferences were then presented according to the total population and for different age groups, seasons and three locations.

Statistical analyses

Statistical analyses in basic diet composition and gut vacuity index as a function of age (classified as annual basis) and season (months) were launched a chi-squared test to the measured values. The correlations between monthly %VI-temperature and %VI-discharge were also calculated (Dev-

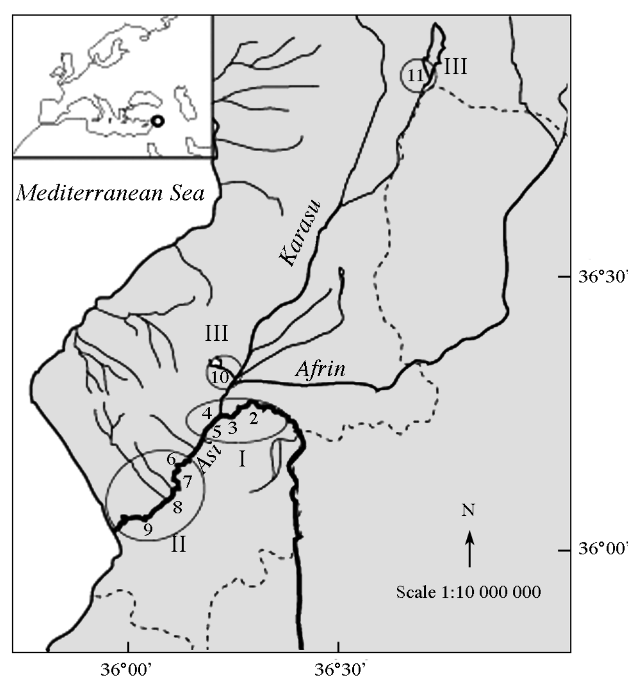

Figure 1. - Map showing the area where the specimens were collected. Upper part of the Asi River (I): 1: Demirköprü, 2: Üzümdalı, 3: Güzelburç, 4: Narlica, 5: Ašağiokçular. Lower part of the Asi River (II): 6: Çekmece, 7: Turunçlu, 8: Tavlaköyü, 9: Samandağí, and Creeks (III): 10: Serinyol, 11: Tahtaköprü. *[Carte indiquant les sites sur la rivière Oronte où les spécimens ont été capturés.]*

Table I. - Some characteristics of sampling (NT = Total sample number. NF = Number of full guts. FLF = fork length (cm) of NF samples). *[Quelques caractéristiques des échantillons (NT = Nombre total d'échantillons. NF = Nombre d'estomacs pleins. FLF = longueur à la fourche (cm) des échantillons NF.]*

Date	Season	N_T	N_F	FL_F (cm) min-max	Location		(°C)	Discharge m^3/s	Catching method
4 Apr. 97	Spring	19	3	6.9-10.7	Demirköprü	upper	18	34.5	Bag net 12,17,25,40 mm
2 May 97	Spring	10	1	8.9	Demirköprü	upper	19	16.6	Bag net 12,17,25,40 mm
3 May 97	Spring	18	9	7.9-11.2	Üzümdalı	upper	19	16.9	Fyke net
14 Jun. 97	Summer	18	4	10.4-12.2	Çekmece	lower	25	22.6	Fyke net
24 Jun. 97	Summer	10	5	11.8-13.8	Ašağiokçular	lower	25	8.3	Fyke net
09 Jul. 97	Summer	30	12	7.8-14.5	Ašağiokçular	lower	26	1.8	Fyke net
16 Jul. 97	Summer	7	1	10.0	Tavla	lower	26	1.0	Fyke net
13 Aug. 97	Summer	4	4	11.0-12.3	Turunçlu	lower	26	1.0	Fyke net
25 Aug. 97	Summer	3	-	-	Samandağí	lower	26	1.2	Fyke net
8 Sep. 97	Autumn	21	6	9.3-11.3	Güzelburç	upper	24	2.3	Fyke net
17 Sep. 97	Autumn	1	-	-	Güzelburç	upper	24	6.1	Fyke net
4 Oct. 97	Autumn	10	1	9.7	Narlıca	upper	22	6.2	Cast net (17x17mm)
13 Oct. 97	Autumn	11	5	3.8-7.9	Serinyol	creek	22.5	-	Electroshock
15 Nov. 97	Autumn	45	15	3.3-10.8	Tahtaköprü	creek	22	3.9	Electroshock
29 Nov. 97	Autumn	1	-	-	Güzelburç	upper	22	13.1	Electroshock
	Total	208	66						

ore, 1995). An affect of age, season and locations (grouped into three types I, II and III) on food abundance were tested using one-way ANOVA. The U of Mann-Whitney test was applied in order to exhibit if there is a statistically meaningful effect of food abundance on ages, seasons and locations of fish examined (Sokal and Rohlf, 1997). SPSS 10.0 and Excel 7.0 versions were used in calculations.

RESULTS

Approximately one third of the gut samples (31.73%) of *G. rufa* were found to be full. The sample ages varied from 0^+ to 5. The specimen fork length varied between 3.3 and 14.5 cm. The relationship between total and fork length (TL-SL) was TL = 1.073 FL + 0.053 (r^2 = 0.998).

Feeding intensity

Feeding intensity was measured by gut %VI. Out of 208 analyzed guts, 142 were completely empty (%VI = 68.3). The analyses of %VI of the guts took into consideration ages and seasons as possible variation factors (Fig. 2). The percentage of VI of guts was found to vary significantly when fish ages were taken into account on annual basis ($\chi^2_{0.005,5}$ = 16.75 < χ^2 = 22.44). The age 3 group of the population fed more intensively than the younger groups.

The feeding intensity was observed to be higher in hot summer months. However, the overall effect of months on % VI of guts was not significant ($\chi^2_{0.05,7}$ = 14.07 > χ^2 = 14.04). There are weak correlations between water temperature-%VI (r = -0.61. $t_{0.01,6}$ = 3.14 > t = 1.88) and discharge-%VI (r = 0.65

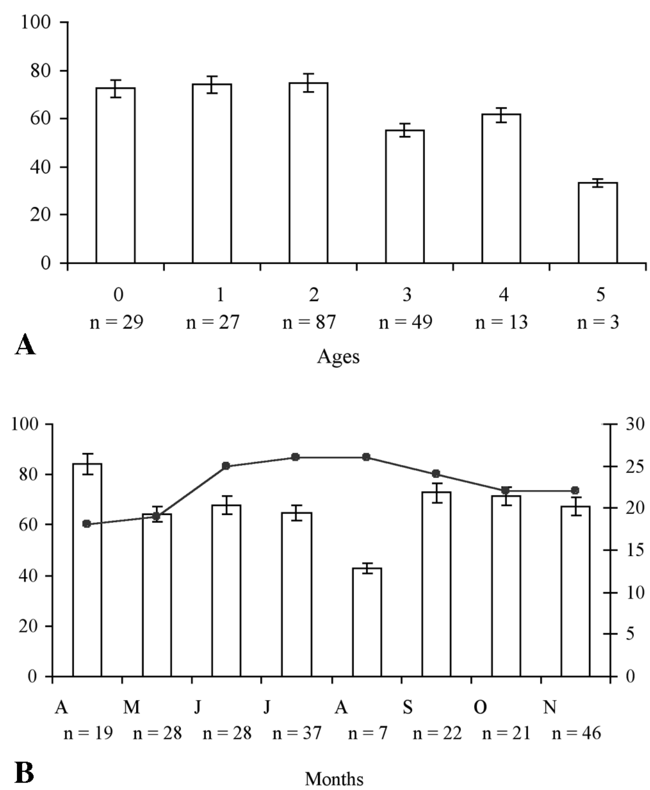

Figure 2. - Variation in the percentage of empty guts (% VI) for *G. rufa*. **A**: Related to fish age; **B**: Related to months (number of samples in each age group and in each month is given below x axis). *[Variation dans le pourcentage d'estomacs vides pour* G. rufa. ***A*** *: Par âge ;* ***B*** *: Par mois (le nombre d'individus par âge et par mois est donné sous l'axe des abscisses.]*

$t_{0.01,6} = 3.14 > t = 2.1$) based upon for eight pairs of temperature-% VI and discharge-%VI values measured for this study.

Diet composition

G. rufa feeds mainly on benthic plant materials, which are Cyanobacteria, Chrysophyta and Chlorophyta members, in the Asi Basin (Tab. II). Chrysophyta members play the most important role as a food organism in percentage abundance and frequency in *G. rufa* diet. *Navicula* sp., and *Gomphonema* sp. were both abundant and frequent in the samples and *Nitzschia* sp., *Cymbella* sp., *Cyclotella* sp., *Cocconeis* sp., *Rhoicosphaenia* sp., *Scenedesmus* sp., and *Oscillatoria* sp. were also frequent food organisms in the gut contents.

Food in relation to fish age

It was observed that the primary food for each age group were mainly Chrysophyta members that were more abundant than the Cyanobacteria and Chlorophyta members. Mainly *Navicula* sp. was found to be the most abundant food in all age groups as tabulated in table III. Because of limitation in specimen numbers, only age groups 2 and 3 could be compared, only abundance of *Navicula* sp. as a food organism, SPSS U of Mann-Whitney $p < 0.05$, was differed between these two (age 2 and age 3) age groups.

The 15 samples from 0^+ and 1 age groups were compared with two individuals that were one year old, 5.4 and 7.9 cm length, and remarkably larger than the average of the 15 samples (5.16 ± 1.77 cm for mean fork length). Only the *Oscillatoria* sp. and *Crucigenia* sp., which belong to Cyanobacteria and Chlorophyta phyla, were found in gut contents of these two large specimens. The rest (13) of the specimens were probably immature and no Cyanobacteria and Chlorophyta members were found in their gut contents.

The members of *Amphora* and *Cymbella* were dominant food organisms in the 0^+ and 1 age groups, and *Achnantes* sp. was observed in only 1 age group fish gut contents. The percentages of abundance of chrysophyts were also found in decreasing order in 2 and 3 age groups. In addition to Chrysophyta, Cyanobacteria and Chlorophyta members were found in 2 and 3 age groups of *G. rufa* specimens (see gut contents in figure 3).

The Asi River populations of 0^+ and 1 age groups were considered as juveniles and samples of age 2 and older were grouped as the adults (Yalçın-Özdilek and Ekmekçi, unpubl. data). Gut contents of both juvenile and adult samples caught in autumn were compared and significant difference was found in their food preferences (ANOVA, $p < 0.001$). As shown in figure 3 and table III, the juveniles mostly prefer chrysophytes while the older ones prefer also cyanophytes and chlorophytes.

Seasonal variation in diet composition

Seasonal variation of *G. rufa* diet is given in figure 4. The

Table II. - Percentage contribution of food item groups in genus level in *Garra rufa* diet (%N_i = percentage of abundance, %F_i = frequency of occurrence). *[Contribution en pourcentage des différents types d'aliments par genre, dans l'alimentation de* Garra rufa.*]*

	Food items category	%N*i*	%F*i*
Cyanobacteria %Ni = 10.0 %Fi = 40.9	*Chroococcus* sp.	< 0.1	1.5
	Anacystis sp.	< 0.1	1.5
	Merismopedia sp.	< 0.1	1.5
	Dactylococcopsis sp.	2.1	4.6
	Tetrapedia sp.	< 0.1	1.5
	Oscillatoria sp.	7.8	36.4
Chrysophyta %Ni = 81.4 %Fi = 97.0	*Synedra* sp.	0.2	6.1
	Melosira sp.	0.9	12.1
	Achnanthes sp.	0.4	1.5
	Amphora sp.	0.5	12.1
	Fragilaria sp.	0.1	3.0
	Diatoma sp.	0.7	1.5
	Gyrosigma sp.	0.3	7.6
	Gomphonema sp.	17.3	63.6
	Cocconeis sp.	2.1	31.8
	Nitzschia sp.	12.0	42.4
	Navicula sp.	34.2	66.7
	Rhoicosphenia sp.	1.4	27.3
	Cyclotella sp.	5.9	39.4
	Cymatopleura sp.	1.4	9.1
	Pinnularia sp.	< 0.1	1.5
	Cymbella sp.	4.0	39.4
	Surirella sp.	0.2	6.1
Chlorophyta %Ni = 8.1 %Fi = 40.9	*Selenastrum* sp.	0.1	6.1
	Coelastrum sp.	0.2	7.6
	Staurastrum sp.	< 0.1	3.0
	Dictyosphaerium sp.	< 0.1	1.5
	Stigeoclonium sp.	0.3	6.1
	Actinastrum sp.	< 0.1	1.5
	Westella sp.	< 0.1	1.5
	Crucigenia sp.	0.6	7.6
	Tetrastrum sp.	< 0.1	1.5
	Excentrosphaera sp.	0.5	1.5
	Tetraedron sp.	0.1	4.6
	Nautococcus sp.	< 0.1	1.5
	Asterococcus sp.	< 0.1	1.5
	Chlorococcum sp.	0.4	3.0
	Scnedesmus sp.	5.1	37.9
	Cladophora sp.	0.2	3.0
	Chaetophora sp.	0.2	3.0
	Pediastrum sp.	0.4	13.6
Protozoa		0.4	4.6
Nematoda		< 0.1	3.0
Rotifera		< 0.1	1.5

Chrysophyta members were obviously abundant in all seasons. Many food organisms such as *Anacystis* sp., *Diatoma* sp., and *Stigeoclonium* sp. were present in the gut contents only in one season. A comparison of the abundance percentage of other food types in the diet indicates that some components differed according to the season (U of Mann-Whit-

Table III. - The %N_i (percentage of abundance) and %F_i (frequency of occurrence) of food composition of *G. rufa* in different age groups. *[Pourcentage d'abondance (%N_i) et fréquence (%F_i) de la composition de la nourriture de* G. rufa *par groupes d'âges.]*

	0⁺ age N = 8		1 age N = 7		2 age N = 22		3 age N = 22		4 age N = 5		5 age N = 2	
Food organisms	%N*i*	%F*i*	%N*i*	%F*i*	%N*i*	%F*i*	%N*i*	%F*i*	%N*i*	%F*i*	%N*i*	%F*i*
Cyanobacteria	-	-	1.5	14.3	14.7	54.6	13.7	50.0	5.8	40.0	2.6	50.0
Chroococcus sp.	-	-	-	-	-	-	100.0	100.0	-	-	-	-
Anacystis sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Merismopedia sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Dactylococcopsis sp.	-	-	-	-	-	-	72.4	66.7	27.7	33.3	-	-
Tetrapedia sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Oscillatoria sp.	-	-	1.1	4.2	70.5	45.8	19.7	41.7	3.4	4.2	5.3	4.2
Chrysophyta	100.0	100.0	95.8	100.0	71.2	100.0	76.5	90.9	91.3	100.0	94.1	100.0
Synedra sp.	-	-	-	-	43.1	50.0	56.9	50.0	-	-	-	-
Melosira sp.	-	-	-	-	7.5	25.0	41.7	50.0	2.8	12.5	48.1	12.5
Achnanthes sp.	-	-	100.0	100.0	-	-	-	-	-	-	-	-
Amphora sp.	37.1	50.0	23.3	25.0	-	-	30.3	12.5	9.4	12.5	-	-
Fragilaria sp.	-	-	-	-	-	-	67.7	50.0	32.3	50.0	-	-
Diatoma sp.	-	-	-	-	-	-	100.0	100.0	-	-	-	-
Gyrosigma sp.	14.8	20.0	14.8	20.0	14.1	20.0	56.2	40.0	-	-	-	-
Gomphonema sp.	9.7	14.3	6.7	7.1	20.7	33.3	29.0	31.0	15.4	9.5	18.5	4.8
Cocconeis sp.	4.2	10.0	41.2	25.0	25.2	40.0	29.4	25.0	-	-	-	-
Nitzschia sp.	1.1	10.7	7.6	3.6	33.1	35.7	14.6	32.1	0.9	10.7	42.7	7.1
Navicula sp.	1.3	11.4	1.6	11.4	42.8	38.6	15.1	25.0	28.7	9.1	10.6	4.6
Rhoicosphenia sp.	18.6	27.8	13.9	16.7	45.6	33.3	16.2	11.1	5.8	11.1	-	-
Cyclotella sp.	-	-	1.4	4.2	27.2	41.7	37.6	41.7	0.6	4.2	33.2	8.3
Cymatopleura sp.	-	-	-	-	98.2	75.0	1.8	25.0	-	-	-	-
Pinnularia sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Cymbella sp.	34.0	30.8	24.9	15.4	13.0	23.1	11.6	19.2	6.3	7.7	10.2	3.9
Surirella sp.	-	-	69.9	50.0	14.8	25.0	15.3	25.0	-	-	-	-
Chlorophyta			1.1	14.3	13.4	59.1	9.1	63.6	2.9	60.0	3.3	50.0
Selenastrum sp.	-	-	-	-	56.3	50.0	12.1	25.0	31.7	25.0	-	-
Coelastrum sp.	-	-	-	-	79.8	60.0	4.3	20.0	15.9	20.0	-	-
Staurastrum sp.	-	-	-	-	-	-	100.0	100.0	-	-	-	-
Dictyosphaerium sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Stigeoclonium sp.	-	-	-	-	33.9	25.0	25.8	50.0	-	-	40.3	25.0
Actinastrum sp.	-	-	-	-	-	-	100.0	100.0	-	-	-	-
Westella sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Crucigenia sp.	-	-	10.2	20.0	84.9	40.0	5.0	40.0	-	-	-	-
Tetrastrum sp.	-	-	-	-	-	-	100.0	100.0	-	-	-	-
Excentrosphaera sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Tetraedron sp.	-	-	-	-	72.1	66.7	27.9	33.3	-	-	-	-
Nautococcus sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Asterococcus sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Chlorococcum sp.	-	-	-	-	100.0	100.0	-	-	-	-	-	-
Scnedesmus sp.	-	-	-	-	56.8	40.0	28.6	48.0	6.5	8.0	8.2	4.0
Cladophora sp.	-	-	-	-	38.9	50.0	61.1	-	-	-	-	-
Chaetophora sp.	-	-	-	-	80.5	50.0	19.5	50.0	-	-	-	-
Pediastrum sp.	-	-	-	-	28.2	33.3	63.7	55.6	8.1	11.1	-	-
Protozoa			1.5	14.3	0.6	4.6	0.7	4.6	-	-	-	-
Nematoda	-	-	-	-	< 0.1	4.55	0.08	4.55	-	-	-	-
Rotifera	-	-	-	-	< 0.1	4.55	-	-	-	-	-	-

ney, $p < 0.05$). The percentage abundance of each type of food showed that *Cocconeis* sp. were dominant in the spring, *Oscillatoria* sp., *Cyclotella* sp., *Scenedesmus* sp. were dominant in the summer and *Cymbella* sp. were dominant in the autumn (Tab. IV). However, the abundance of those food organisms in the river could not be counted due to laborato-

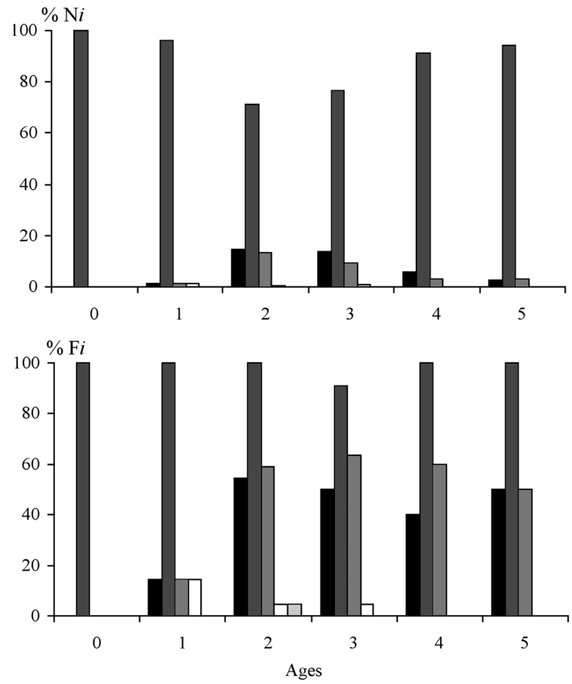

Figure 3. - Percentage of abundance (%N_i) and frequency (%F_i) of food item groups in the level of phyla in different age groups of *G. rufa* in the Asi basin. *[Pourcentage d'abondance et de fréquence des groupes d'aliments dans le niveau de phyla par groupe d'âge de* G. rufa *dans le bassin de l'Oronte.]*

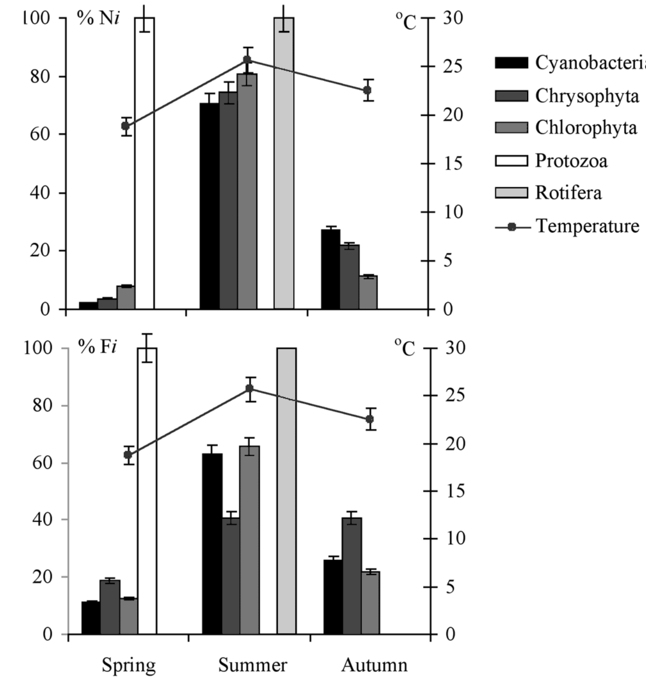

Figure 4. - Seasonal variation (percentage of abundance, %N_i and frequency %F_i) of *G. rufa* diet in Asi Basin. *[Variation saisonnière de l'alimentation de* G. rufa *dans le bassin de l'Oronte.]*

rial limitations but the seasonal change of food organisms in the gut contents may be related to the abundance of food organisms in the environment of fish.

Spatial variation in the diet composition

The distribution of diet of *G. rufa* specimens from three regions of the Asi Basin is given in table V. Food items of *G. rufa* show a variation according to the different parts of the Asi River. The abundance of some species such as *Amphora* sp., *Gomponema* sp. *Navicula* sp., *Rhoicosphaenia* sp., *Cyclotella* sp., *Cymbella* sp., *Surirella* sp., depended on locations (ANOVA, $p < 0.05$). The abundance rates of *Oscillatoria* sp. *Gomphonema* sp., *Cocconeis* sp., *Surirella* sp., *Scenedesmus* sp., *Cyclotella* sp., *Rhoicosphenia* sp., *Navicula* sp., *Nitzschia* sp., were significantly different between upper and lower part of the Asi River; the abundance of *Melosira* sp., *Amphora* sp., *Gomphonema* sp., *Rhoicosphenia* sp., *Cymbella* sp., and *Surirela* sp., were different between upper part of the Asi River and creeks flowing to the River Asi; *Oscillatoria* sp., *Amphora* sp., *Rhoicosphenia* sp., *Cyclotella* sp., *Cymbella* sp., *Scenedesmus* sp., *Pediastrum* sp., were significantly different between lower part of the river and creek (U of Mann-Whitney $p < 0.05$). *Oscillatoria* sp., *Nitzschia* sp., *Navicula* sp., *Cyclotella* sp. and *Scenedesmus* sp. were abundant in the lower part of the Asi River. The members of *Dactylococcopsis* sp., *Cocconeis* sp., were abundant in the upper part of the river. *Gyrosigma* sp., *Rhoicosphenia* sp. and *Cymbella* sp. were also abundant in the creeks (Tab. V). Besides, all cyanophytes, chlorophytes and also chrysophytes were the most frequent (%F_i = 63.0, %F_i = 65.6 and %F_i = 39.1, respectively) and abundant (%N_i = 70.7, %N_i = 80.8 and %N_i = 74.2, respectively) food organisms in the lower part of the Asi River (Fig. 5). Significant differences based upon both %N_i and %F_i values of these food groups were found among the three locations (ANOVA, $p < 0.05$).

DISCUSSION

The diet of *G. rufa* was mainly of plant origin, mostly benthic chrysophytes and phytoplankton except a few rotifers and protozoa. As the ventral mouth structure of this fish is suitable for benthic feeding, most food organisms of *G. rufa* are composed of periphyhic algae. It can be said that this fish species grazes the substrate (epilithic and epiphytic, for instance *Cladophora* sp.). Froese and Pauly (2004) also state that this species feeds mainly on periphyton.

Xie (1999) indicates that some stomachless filter-feeding species such as silver carp digests green algae and Cyanobacteria efficiently. The juveniles, which prefer mostly chrysophytes that have hard digestible frustle, might digest their food faster than the adults in the Asi River. The fact that juveniles do not prefer cyanophytes and chlorophytes may

Table IV. - Seasonal variation in the $\%N_i$ (percentage of abundance) and $\%F_i$ (frequency of occurrence) of each type of prey in the diet of *G. rufa*. *[Variation saisonnière dans le pourcentage d'abondance ($\%N_i$) et la fréquence ($\%F_i$) de chaque type de proie dans l'alimentation de* G. rufa.*]*

Food organisms	Spring, N = 13		Summer, N = 26		Autumn, N = 27	
	%N*i*	%F*i*	%N*i*	%F*i*	%N*i*	%F*i*
Cyanobacteria						
Chroococcus sp.	-	-	100.0	100.0	-	-
Anacystis sp.	-	-	100.0	100.0	-	-
Merismopedia sp.	2.8	12.5	88.2	66.7	9.0	20.8
Dactylococcopsis sp.	-	-	100.0	100.0	-	-
Tetrapedia sp.	-	-	100.0	100.0	-	-
Oscillatoria sp.	-	-	3.6	33.3	96.4	66.7
Chrysophyta						
Synedra sp.	-	-	88.2	75.0	11.8	25.0
Melosira sp.	-	-	55.6	37.5	44.4	62.5
Achnanthes sp.	-	-	-	-	100.0	100.0
Amphora sp.	-	-	-	-	100.0	100.0
Fragilaria sp.	-	-	100.0	100.0	-	-
Diatoma sp.	-	-	100.0	100.0	-	-
Gyrosigma sp.	-	-	14.1	20.0	85.9	80.0
Gomphonema sp.	2.5	14.3	62.7	50.0	34.7	35.7
Cocconeis sp.	58.0	45.0	19.3	20.0	22.6	35.0
Nitzschia sp.	0.2	3.6	85.8	57.1	14.0	39.3
Navicula sp.	1.7	20.5	87.6	43.2	10.7	36.4
Rhoicosphenia sp.	34.1	27.8	-	-	65.9	72.2
Cyclotella sp.	2.1	12.5	93.7	70.8	4.3	16.7
Cymatopleura sp.	-	-	98.2	75.0	1.8	25.0
Pinnularia sp.	100.0	100.0	-	-	-	-
Cymbella sp.	0.4	3.6	18.2	21.4	81.4	75.0
Surirella sp.	84.8	75.0	-	-	15.3	25.0
Chlorophyta						
Selenastrum sp.	-	-	100.0	100.0	-	-
Coelastrum sp.	-	-	60.5	40.0	39.5	60.0
Staurastrum sp.	-	-	-	-	100.0	100.0
Dictyosphaerium sp.	-	-	100.0	100.0	-	-
Stigeoclonium sp.	-	-	100.0	100.0	-	-
Actinastrum sp.	-	-	-	-	100.0	100.0
Westella sp.	-	-	-	-	100.0	100.0
Crucigenia sp.	-	-	84.9	40.0	15.1	60.0
Tetrastrum sp.	-	-	-	-	100.0	100.0
Excentrosphaera sp.	-	-	100.0	100.0	-	-
Tetraedron sp.	-	-	72.1	66.7	27.9	33.3
Nautococcus sp.	-	-	100.0	100.0	-	-
Asterococcus sp.	-	-	100.0	100.0	-	-
Chlorococcum sp.	100.0	100.0	-	-	-	-
Scnedesmus sp.	0.3	4.0	91.5	76.0	8.2	20.0
Cladophora sp.	-	-	100.0	100.0	-	-
Chaetophora sp.	80.5	50.0	19.5	50.0	-	-
Pediastrum sp.	-	-	40.9	66.7	59.1	33.3
Protozoa	100.0	100.0	-	-	-	-
Nematod	-	-	100.0	100.0	-	-
Rotifera	-	-	100.0	100.0	-	-

be a consequence of their mouth structure (they may graze the chrysophytes much more easily than other foods). The relative abundance of Chrysophyta may also be increased in their habitat. All juvenile samples were caught from the upper part of the Asi River and from the creeks where the depth and discharge is lower than in the main river. Furthermore, the ratios of both abundance and frequency of cyanophytes as well as chlorophytes as food organisms of *G. rufa* were low in these locations.

In general view of the distribution of food items in the level of high taxon, members of all taxa are the most abundant food organisms in the summer. In the autumn the water temperature is still high and the temperature drop in the autumn is relatively slow compared with the increase in water temperature in the spring. Therefore, particularly Chlorophyta and Cyanobacteria members were more abundant in autumn than in spring. In autumn the water temperature was high (22°C), which was found to be close to the water temperature in summer and the water level was extremely low, nearly zero discharge in many areas, especially downstream of Demirköprü region, due to the fact that the water is excessively used for irrigation purpose in both Syria and Turkey during arid summer season and that untreated wastes at many locations are discharged into the river. This high water temperature coupled with low water level and high rate of nutrients added into the river *via* sewage and waste materials result in abundance of Cyanobacteria and Chlorophyta members in the river.

The distribution of food organisms in gut content depended on the location (higher occurrence and abundance of the different food items in the lower part of the Asi River). However, the samples examined in those locations were caught mostly during hot summer season (25-26°C) and our results clearly indicated that the *G. rufa* diet depends on the season. The %VI of empty guts support that *G. rufa* feeds better at high temperature (higher than 25°C in this study). Yalçın *et al.* (2001a) stated that hot summer days played an important role in feeding of African catfish, another species living in the Asi River. Thus, the actual effect of location on diet may be limited.

Cyanophyta members take their place in *G. rufa* diet and lots of Cyanophyta members like *Oscillatoria* spp., some of which are harmful algae blooms species, have toxic effects on fish and on other organisms taking these toxins as food. It could not be known exactly whether there are any toxic algae in *G. rufa* gut contents and this could be the aim of another study to solve a remarkable issue that whether *Oscillatoria* spp. in the Asi Basin are toxic or not and, if toxic, how this affects *G. rufa* life.

Since the Asi River is the main river of Orontes basin, drains to the Levant coastline, building up a bridge between Mesopotamia and Arabic regions, of the Mediterranean, this region plays an important role as the means of biodiversity and zoogeography. Unfortunately, a serious problem, water scarcity particularly during summer months due to various dams, exists in the basin. In addition to high evaporation water withdrawal from the river, groundwater for agricultural production in both Syria and Turkey drastically decreases the river water discharge, resulting in drying up some of the tributaries in arid summer season. Furthermore, the Asi River is polluted with all types of wastes that are caused by agrarian, industrial and urban activities, including cities such as Hama and Humus in Syria and Antakya in Turkey, which are notably densely populated urban areas (Özdilek, 2003). All these contaminants may concentrate on the riverbed sediments during dry seasons. These immense factors have an effect on the aquatic living resources, such as African catfish, in the Asi basin during dry season (Yalçın *et al.*, 2001b, 2002). It is not yet known how such factors, namely sewage, insecticides, and lack of water, affect, in a positive or in a negative way, the reproduction and growth of *G. rufa*. Nonetheless, this species finds suitable conditions to feed in this contaminated river. It is known that periphytic algae are abundant in organically enriched wastewater discharges into a river (Dyer *et al.*, 2003). Such liquid wastes, as explained above, discharged into the river cause notable algae growth, which in turn leads to eutrophication (Haslam, 1995). *G. rufa* has important role in reducing this unfavorable circumstances by consuming the algae in the Asi River. Moreover, African catfish and European eel feed on cyprinids including *G. rufa* and this is an important food resource for them. The consumption of both species is widely popular among the local people and this, consequently, serves liquid wastes to be converted into consumed fish species. Hence, *G. rufa* stands in the middle of an important aquatic food chain in the Asi River. In the basin, *G. rufa* shares its feeding habitat with species such as *Barbus luteus, Lisa abu, Capoeta barroisi, C. damascina, Anguilla anguilla, Clarias gariepinus* and *Cobitis levantina* and some members of Balitoridae family *Nemacheilus namirii, N. hamwii* (Krupp and Schneider, 1989, 1991; Yalçın, 1997),

Table V. - The %N_i (percentage of abundance) and % F_i (frequency of occurrence) of each type of prey of *G. rufa* in three locations. *[Pourcentage d'abondance (%N_i) et fréquence (%F_i) de chaque type de proie dans l'alimentation de* G. rufa *dans trois endroits.]*

	Upper Asi		Lower Asi		Creeks	
	% N*i*	% F*i*	% N*i*	% F*i*	% N*i*	% F*i*
Cyanobacteria						
Chroococcus sp.	-	-	100.0	100.0	-	-
Anacystis sp.	-	-	100.0	100.0	-	-
Merismopedia sp.	-	-	100.0	100.0	-	-
Dactylococcopsis sp.	96.4	66.7	3.6	33.3	-	-
Tetrapedia sp.	-	-	100.0	100.0	-	-
Oscillatoria sp.	10.6	25.0	88.2	66.7	1.2	8.3
Chrysophyta						
Synedra sp.	11.7	25.0	88.2	75.0	-	-
Melosira sp.	44.4	62.5	55.6	37.5	-	-
Achnanthes sp.	-	-	-	-	100.0	100.0
Amphora sp.	-	-	-	-	100.0	100.0
Fragilaria sp.	-	-	100.0	100.0	-	-
Diatoma sp.	-	-	100.0	100.0	-	-
Gyrosigma sp.	8.5	20.0	14.1	20.0	77.4	60.0
Gomphonema sp.	3.1	21.4	62.5	47.6	34.5	31.0
Cocconeis sp.	58.0	45.0	19.3	20.0	22.6	35.0
Nitzschia sp.	2.9	17.9	85.7	53.6	11.4	28.6
Navicula sp.	2.9	29.6	87.3	40.9	9.8	29.6
Rhoicosphenia sp.	34.1	27.8			65.9	72.2
Cyclotella sp.	2.9	25.0	93.7	70.8	3.4	4.2
Cymatopleura sp.	1.8	25.0	98.2	75.0	-	-
Pinnularia sp.	100.0	100.0	-	-	-	-
Cymbella sp.	1.2	11.5	17.8	19.2	81.0	69.2
Surirella sp.	100.0	100.0	-	-	-	-
Chlorophyta						
Selenastrum sp.	-	-	100.0	100.0	-	-
Coelastrum sp.	20.2	40.0	60.5	40.0	19.7	20.0
Staurastrum sp.	100.0	100.0	-	-	-	-
Dictyosphaerium sp.	-	-	100.0	100.0	-	-
Stigeoclonium sp.	-	-	100.0	100.0	-	-
Actinastrum sp.	100.0	100.0	-	-	-	-
Westella sp.	-	-	-	-	100.0	100.0
Crucigenia sp.	5.0	40.0	84.9	40.0	10.2	20.0
Tetrastrum sp.	100.0	100.0	-	-	-	-
Excentrosphaera sp.	-	-	100.0	100.0	-	-
Tetraedron sp.	27.9	33.3	72.1	66.7	-	-
Nautococcus sp.	-	-	100.0	100.0	-	-
Asterococcus sp.	-	-	100.0	100.0	-	-
Chlorococcum sp.	100.0	100.0	-	-	-	-
Scnedesmus sp.	7.9	20.0	91.5	76.0	0.6	4.0
Cladophora sp.	-	-	100.0	100.0	-	-
Chaetophora sp.	80.5	50.0	19.5	50.0	-	-
Pediastrum sp.	59.1	33.3	40.9	66.7	-	-
Protozoa	100.0	100.0	-	-	-	-
Nematoda	-	-	100.0	100.0	-	-
Rotifera	-	-	100.0	100.0	-	-

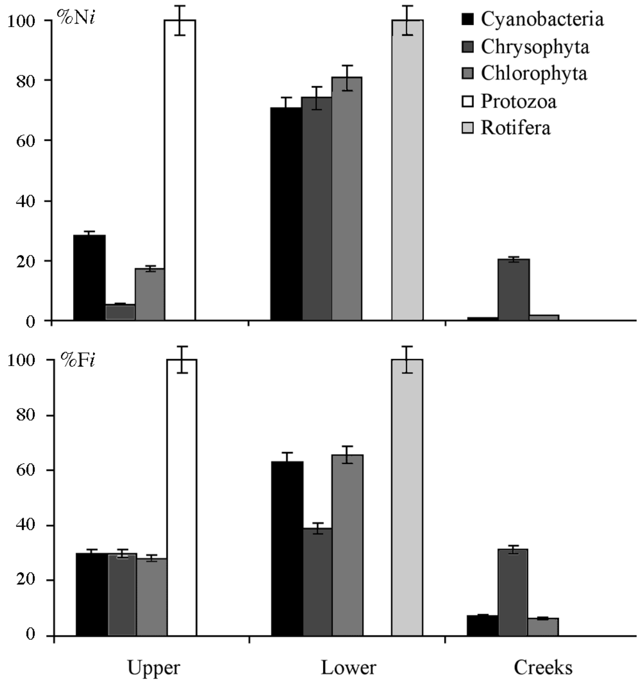

Figure 5. - Main food distribution (percentage of abundance, $\%N_i$ and frequency $\%F_i$) in the three locations. *[Répartition de la nourriture principale dans les trois sites.]*

which are also bottom dwellers. The feeding relationship between these species should also be investigated for evaluation of the food ecology, from the aspects of competition and predation in the Asi River basin.

Acknowledgements. - Authors wish to express their sincere thanks to Mr. Orçun Bozkurt for his help in laboratory studies, the two anonymous referees for their valuable contributions to the manuscript, Mr. Aybek Vurmay for his linguistic corrections and to Pr. Catherine Kuzucuoğlu (CNRS-Paris) for translation of the abstract into French.

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Reçu le 22 mars 2004.
Accepté pour publication le 3 janvier 2005.