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Feeding biology of bleak, *Alburnus alburnus*, in Lake Koronia, northern Greece

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The feeding of bleak, *Alburnus alburnus* (L.), was studied in a natural eutrophic lake of northern Greece by an analysis of gut contents. Feeding was more intense during the first half of the day. Monthly analyses showed temperature-dependent feeding intensities, which were high during summer and the beginning of autumn and showed a decline in winter. The low feeding intensity in April coincided with the maximal value of the GSI. Bleak is a zooplankton feeder mainly, consuming Copepoda and *Bosmina* all the year round. During the hot period the diversity of its food increased. Other Cladocera, mainly *Diaphanosoma*, but also *Moina*, *Daphnia* and other less abundant genera, were found also. Meanwhile, Hydracarina and insect nymphs were found frequently, but in very low quantities. The size of bleak did not play an important role in its food composition. The stenophagic nature of its feeding could be explained in terms of the abundance of zooplankton in the environment. The influence of feeding intensity on the condition factor of the species is discussed.

Key words: *Alburnus alburnus*; feeding; Lake Koronia; temperature; condition factor; reproduction.

I. INTRODUCTION

Even though bleak, *Alburnus alburnus* (L.), is a common species in many European lakes and rivers, its feeding biology has not been studied intensively. Some information is given by Bohl (1980, 1982), who studied the diel feeding rhythms of young cyprinids (including bleak) in small Bavarian lakes, as well as prey selection in the laboratory. In addition, some general information is given by Vøllestad (1985) in a study of resource partitioning of roach, *Rutilus rutilus* (L.) and bleak of Norway and by Chappaz *et al.* (1987) in a study of bleak in southern France.

The present work examines the feeding phenology of bleak in northern Greece, a region representing the southernmost limit of its distribution. Information is given on diel feeding rhythms, monthly qualitative and quantitative diet, and diet in relation to fish size. These data are considered indispensable for the understanding of the biology and dynamics of the bleak.

II. STUDY AREA, MATERIALS AND METHODS

The fish examined in this study were collected from Lake Koronia by means of gillnets. Lake Koronia lies 12 km north-east of Salonika (Macedonia, Greece) at an altitude of 75 m. Its surface area is 46·2 km^2 and its mean depth 4 m (maximum depth 8·5 m). It is a eutrophic lake of low transparency and high phytoplanktonic biomass dominated by

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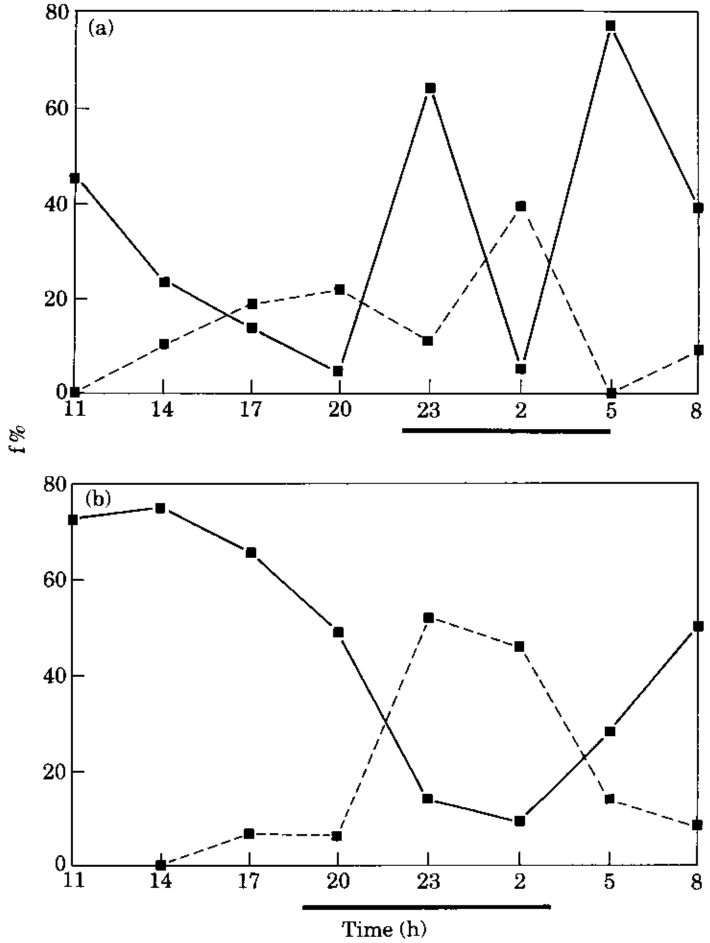

FIG. 1. Diel variation of feeding activity of bleak (the hours of darkness are underlined). (– – – –) Empty guts; (——) full guts. (a) 7/87; (b) 8/88.

blue-green algae, green algae and diatoms (Kilikidis *et al.*, 1984). It is characterized by high temperatures during the summer [Fig. 2(a)], but rarely freezes in winter. The littoral region is divided into two zones of vegetation: the interior zone of floating and submerged macrophytes and the exterior zone of reeds [mainly *Phragmites australis* (Cav.) Trin. ex Steud.], which is particularly developed in some areas (Pavlidis, 1984). Bleak, roach, carp, *Cyprinus carpio* L. and perch, *Perca fluviatilis* L., represent the dominant and commercially most important fish species.

Sampling was conducted monthly from February 1987 to January 1988. The nets were placed in the water between 10.30 and 11.30 hours and were left for 1 h. Additionally, two 24 h samplings were conducted in July 1987 (361 specimens) and August 1988 (442 specimens) in order to study the diel rhythm of feeding activity. Samples were taken every 3 h for a complete 24 h cycle.

Fish were preserved in 5% formalin solution immediately after capture. From the preserved fish the following data were obtained: total length (T.L.), total weight, gonad weight, gut weight, net weight (=total weight minus gonad and gut weight), sex and maturity stage. Total length ranged from 8·6–14·8 cm (S.D. ± 1·29). For the analysis of stomach contents the anterior third of the gut was used, where food organisms were recognizable. The frequency of occurrence and the numerical method, as described by Hyslop (1980), were chosen for the analysis. Results were expressed as percentage of the

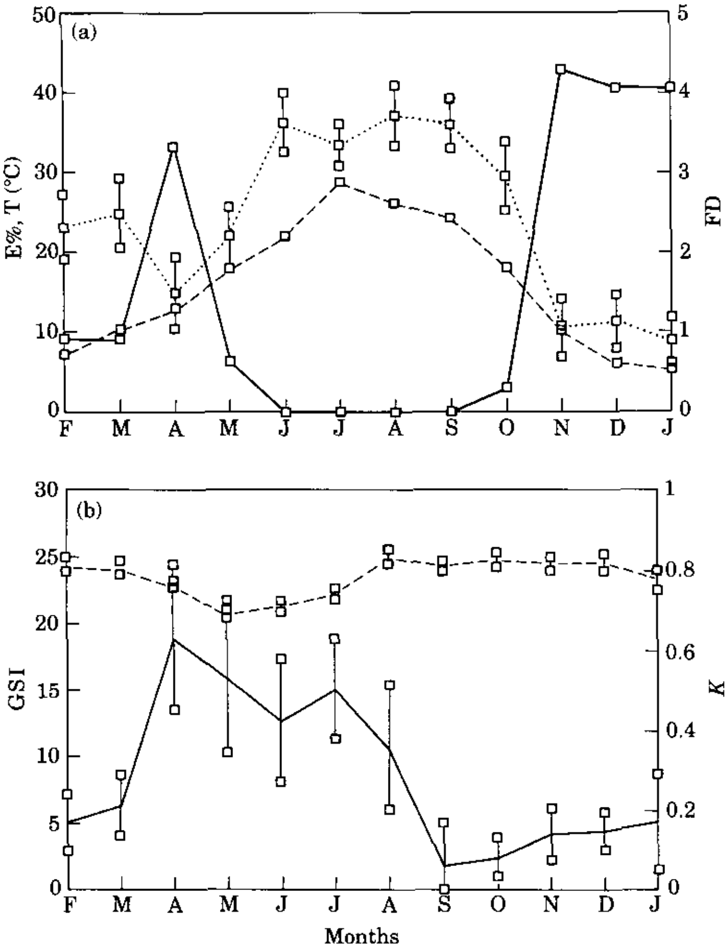

FIG. 2. Monthly variation of (a) E% (——), percentage of empty guts; FD (· · · ·), fullness degree of the gut; and T (– – – –), water temperature (°C); (b) GSI (——); *K* (– – – –), condition factor of bleak. 95% Confidence limits are given.

total number of fish examined (f%), and as percentage of the total number of prey (N%) or mean number of ingested organisms per fish (m). The degree of gut fullness (FD) was examined according to a subjective scale ranging from 0 (empty) to 5 (gut fully distended with food) (Fig. 2).

The condition factor and GSI were calculated according to the following formulae:

$$\text{Condition factor } (K) = \text{net body weight} \times 100/\text{T.L.}^3$$
$$\text{GSI} = \text{gonad weight} \times 100/\text{net body weight.}$$

III. RESULTS

DIEL FEEDING RHYTHMS

In July, feeding activity peaked (0% empty, 77% full guts) during dawn (Fig. 1). The percentage of fish with full guts decreased sharply during the day, indicating a high digestion rate. At the start of the night a high percentage of bleak again

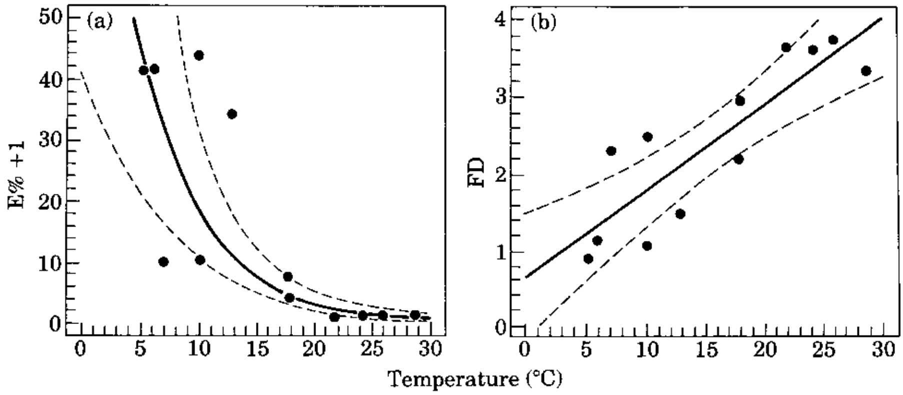

FIG. 3. Relationships between temperature and (a) percentage of empty guts of bleak [(E%)+1] and (b) gut fullness degree (FD). 95% Confidence limits are given. Regression equations are given in the text.

had full guts. The highest percentage of empty guts and a low percentage of full guts were observed in the middle of the night.

In August, feeding activity also begun at dawn. However, it was higher in the middle of the day (0% empty, 75% full guts). Later, the percentage of fish with full guts decreased gradually, whereas the percentage of fish with empty guts increased. The rhythm of digestion seemed to be slower in August than in July, probably because of the lower temperature of the water [Fig. 2(a)], whereas there was no second peak of feeding activity observed as night started. However, similarly to the cycle of July, the highest percentages of empty guts and the lowest of full ones were found during the night.

MONTHLY RHYTHMS OF FEEDING ACTIVITY

Feeding activity was intense during the summer and early autumn [Fig. 2(a)]. The percentage of empty guts was high from November to January, whereas the fullness degree was lowest in January. Feeding activity increased from February to May, with an interruption in April, which coincided with the peak of the GSI [Fig. 2(b)].

A cross-correlation analysis performed between the monthly feeding intensity and the abiotic factors showed that the percentage of fish with empty guts (E) and the gut fullness degree (FD) were significantly correlated with the water temperature ($r=-0{\cdot}77$, $P<0{\cdot}005$, $n=12$, and $r=0{\cdot}86$, $P<0{\cdot}001$, $n=12$, respectively), at 0 lag. E and FD were also significantly correlated with the O_2 content of the water ($r=-0{\cdot}69$, $P<0{\cdot}02$, $n=12$, and $r=0{\cdot}71$, $P<0{\cdot}01$, $n=12$, respectively) at 0 lag. No significant correlation was found between feeding intensity and water transparency, pH, salinity and conductivity (for all cases $-0{\cdot}33<r<0{\cdot}48$, $0{\cdot}1<P<1$, $n=12$). In a stepwise multiple regression analysis, using the significant parameters, only temperature was retained and oxygen content was rejected as insignificant ($F=3{\cdot}15$, $P<0{\cdot}05$). Consequently, the following exponential and linear regressions were obtained (Fig. 3):

(a) $E+1=e^{(4{\cdot}665-0{\cdot}177\,T)}$, $r^2=0{\cdot}83$, $P<0{\cdot}0001$, $n=12$.
(b) $FD=0{\cdot}6445+0{\cdot}112\,T$, $r^2=0{\cdot}75$, $P<0{\cdot}001$, $n=12$.

TABLE I. Total diet of bleak (February 1987–January 1988) in Lake Koronia, northern Greece

Prey taxa	N%	f%
Copepoda	46·75	73·75
Copepoda/Copepodids	46·68	73·50
Nauplii	0·07	10·25
Cladocera	53·12	80·50
Bosmina longirostris	38·56	70·50
Diaphanosoma sp.	11·78	38·00
Sida crystallina	0·01	0·50
Moina sp.	1·95	16·75
Daphnia sp.	0·72	17·00
Ceriodaphnia pulchella	0·00	0·75
Alona sp.	0·05	7·75
Leptodora kindtii	0·04	9·25
Chydorus sphaericus	0·00	1·25
Iliocryptus sordidus	0·00	1·00
Rotifera	0·04	2·75
Brachionus sp.	0·04	2·25
Keratella quadrata	0·00	1·00
Asplachna sp.	0·00	0·25
Ostracoda	0·00	1·25
Hydracarina	0·06	15·00
Insecta	0·02	8·50
Larvae Chironomidae	0·00	1·25
Larvae *Chaoborus*	0·00	0·50
Larvae Trichoptera	0·00	0·25
Nymphs Insecta	0·02	7·00
Nymphs Odonata	0·00	0·75
Nymphs Ephemeroptera	0·00	0·75
Nymphs Diptera	0·00	0·50
Nematoda	0·00	1·00
Oligochaeta	0·00	0·25
Decapoda	0·00	0·50

The condition factor was not affected by the decrease of feeding activity during the cold season, with the exception of January (Fig. 2). On the contrary, the condition factor was negatively correlated ($r = -0{\cdot}72$, $P<0{\cdot}05$, $n=12$) with the GSI.

QUALITATIVE AND QUANTITATIVE ANALYSIS OF GUT CONTENTS

General trends

The food of bleak was mainly composed of zooplankton: Cladocera and Copepoda (mainly Cyclopoida), whereas Rotifera were seldom found (Table I). The Cladocera exceeded slightly the Copepoda both in number and in frequency of occurrence. They were mainly composed of *Bosmina longirostris* (O. F. Mueller) and secondly of *Diaphanosoma sp.* Additionally, Cladocera of genera *Moina, Daphnia, Alona* and *Leptodora* were found frequently, whereas *Chydorus sphaericus* (O. F. Mueller), *Iliocryptus sordidus* Lieven, *Sida crystallina* (O.F.M.) and *Ceriodaphnia pulchella* Sars were consumed rarely.

All the other prey categories were less than 1% by number (Table I). Ostracoda, Nematoda, Oligochaeta and Decapoda were found in negligible quantities. However, Hydracarina and insects were found frequently, but in low quantities. The insects were mainly insect nymphs, which were present in the water seasonally, and chironomid larvae.

Monthly variation

The food of bleak in the winter months was composed almost exclusively of *Bosmina* and Copepoda, which were consumed in low quantities with low frequency (Tables II and III).

The quantity and diversity of food increased with the rise in water temperature. After the Copepoda and *Bosmina, Diaphanosoma* was the prey eaten most frequently and in the largest quantities during the warm months and particularly in August. Other important zooplanktonic organisms in the food of bleak were *Moina* sp., the consumption of which was highest in September, and *Daphnia* sp., with a peak in June. From the middle of spring until the middle of autumn, a more or less frequent ingestion of Hydracarina and emerging insect nymphs was observed in parallel with the high consumption of zooplankton.

Feeding variation in relation to fish size

The size of bleak had little effect on food composition. As can be seen in Table IV, younger bleak (< 10 cm) ingested lower quantities of food, probably because of the smaller size of their gut. Their food was composed mainly of *Bosmina* and secondly of Copepoda and *Diaphanosoma.* Even though these groups remained the dominant ones, the number of prey categories participating in the diet of bleak increased with fish size. Larger size-classes also consumed larger organisms, such as *Leptodora,* Hydracarina and insect nymphs, which, however, were not found in high frequencies and their quantities were very small.

IV. DISCUSSION

In studies of feeding phenology, the results may be affected by an ignorance of feeding times and digestion rhythms in combination with the influence of sampling time, mainly during the warm months, when the rate of digestion is high (Elliott, 1972; Persson, 1979, 1982).

This study showed a mainly diurnal feeding activity of bleak. This contrasts with the observations of Bohl (1990) in small Bavarian lakes, where planktivorous cyprinids fed at a maximal rate before midnight. These observations were interpreted by Bohl (1980) both as a protective behaviour against predators, which were abundant, and as a result of the diel pattern of zooplankton distribution. The peak of feeding activity observed in Lake Koronia in the first half of the day might be due to a different prey behaviour or higher abundance and also to a lower risk of predation faced by bleak. According to fisheries statistics, the population size of its main predator, perch, has declined in recent years (Economidis *et al.*, 1988; Sinis, pers. obs.). Otherwise, diurnal feeding may be advantageous for a visual predator such as bleak (Ivlev, 1961) in this lake of low water transparency and reduced visibility of plankton animals. The second peak of full guts observed in the beginning of the night in July must be the result

TABLE II. Monthly composition of the diet of bleak (numerical method: mean number of prey items per fish) in Lake Koronia

Months	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.
Number of examined fish	33	33	33	32	31	33	31	30	33	42	32	37
Copepoda	10·3	10·1	17·3	40·1	213·2	520·3	837·8	420·9	1489·5	15·0	19·1	2·1
Copepoda/Copepodids	9·9	10·0	17·1	38·9	212·3	520·3	836·7	420·4	1488·9	15·0	19·0	2·0
Nauplii	0·4	0·0	0·2	1·2	0·9	—	1·1	0·5	0·6	0·1	0·1	0·1
Cladocera	197·8	376·5	99·7	132·3	688·7	87·8	463·6	1041·5	844·3	81·9	87·0	18·3
B. longirostris	197·8	371·3	98·6	126·6	422·0	0·2	27·6	698·9	826·3	81·8	87·0	18·3
Diaphanosoma sp.	—	—	—	0·8	163·7	87·5	432·9	240·4	13·9	—	—	—
Sida crystallina	—	—	—	0·2	0·7	—	—	—	—	—	—	—
Moina sp.	—	—	—	—	55·5	0·1	—	100·3	2·3	—	—	—
Daphnia sp.	—	5·0	1·0	4·4	46·6	0·0	0·0	—	0·0	—	—	—
C. pulchella	—	0·0	—	0·1	—	—	—	—	—	—	—	—
Alona sp.	—	—	—	—	—	—	1·1	0·8	1·7	0·0	—	—
Leptodora kindtii	—	—	—	—	0·0	0·0	1·8	1·1	0·0	—	—	—
Chydorus sphaericus	—	0·2	0·0	—	—	—	—	—	—	—	—	—
I. sordidus	—	—	—	—	—	—	0·1	—	—	—	—	—
Rotifera	—	—	1·5	—	—	0·0	0·8	0·6	0·2	—	—	—
Brachionus sp.	—	—	0·2	—	—	—	—	0·1	—	—	—	—
Keratella quadrata	—	—	1·3	—	—	—	0·8	0·5	0·2	—	—	—
Asplachna sp.	—	—	—	—	—	0·0	—	—	—	—	—	—
Ostracoda	—	—	—	0·3	—	0·0	0·0	—	—	—	—	—
Hydracarina	—	—	0·0	2·1	0·4	0·2	0·6	1·1	0·1	—	—	—
Insecta	—	—	0·5	0·5	0·0	0·4	0·1	0·1	0·1	—	—	0·0
Larvae Chironomidae	—	—	0·0	0·2	—	—	—	0·0	—	—	—	0·0
Larvae *Chaoborus*	—	—	—	—	—	0·1	—	—	—	—	—	—
Larvae Trichoptera	—	—	—	—	0·0	—	—	—	—	—	—	—
Nymphs Insecta	—	—	0·5	0·4	—	0·3	0·1	0·0	0·1	—	—	—
Nymphs Odonata	—	—	—	0·0	—	0·1	—	—	—	—	—	—
Nymphs Ephemeroptera	—	—	0·0	0·1	—	—	—	—	—	—	—	—
Nymphs Diptera	—	—	—	—	—	—	—	—	0·1	—	—	—
Nematoda	0·0	—	—	—	0·0	—	0·0	0·0	—	—	—	—
Oligochaeta	—	—	—	—	—	—	—	—	—	—	—	0·0
Decapoda	—	—	—	—	—	—	0·0	0·0	—	—	—	—

Table III. Monthly composition of the diet of bleak (frequency of occurence) in Lake Koronia

Months	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.
Number of examined fish	33	33	33	32	31	33	31	30	33	42	32	37
Copepoda	78·8	69·7	45·5	71·9	100·0	100·0	100·0	100·0	93·9	57·1	55·1	29·7
Copepoda/Copepodids	75·8	69·7	45·5	71·9	100·0	100·0	100·0	100·0	93·9	57·1	53·1	29·7
Nauplii	15·2	3·0	15·2	34·4	19·4	—	9·7	10·0	3·0	4·8	6·3	5·4
Cladocera	87·9	93·9	54·5	78·1	100·0	100·0	100·0	100·0	93·9	47·6	65·6	59·5
B. longirostris	87·9	90·9	51·5	78·1	96·8	6·1	83·9	100·0	93·9	47·6	65·6	56·8
Diaphanosoma sp.	—	—	—	21·9	93·6	100·0	100·0	100·0	66·7	—	—	—
Sida crystallina	—	—	—	3·1	3·2	—	—	—	—	—	—	—
Moina sp.	—	—	—	—	93·6	6·1	—	96·7	21·2	—	—	—
Daphnia sp.	—	54·6	27·3	37·5	83·9	3·0	3·2	—	3·0	—	—	—
C. pulchella	—	3·0	—	6·3	—	—	—	—	—	—	—	—
Alona sp.	—	—	—	—	—	—	22·6	43·3	30·3	2·4	—	—
Leptodora kindtii	—	—	—	—	3·2	3·0	51·6	60·0	3·0	—	—	—
Chydorus sphaericus	—	12·1	3·0	—	—	—	—	—	—	—	—	—
I. sordidus	—	—	—	—	—	—	12·9	—	—	—	—	—
Rotifera	—	—	9·7	—	—	3·0	6·5	13·3	6·1	—	—	—
Brachionus sp.	—	—	9·1	—	—	—	—	3·3	—	—	—	—
Keratella quadrata	—	—	6·1	—	—	—	6·5	10·0	6·1	—	—	—
Asplachna sp.	—	—	—	—	—	3·0	—	—	—	—	—	—
Ostracoda	—	—	—	9·4	—	3·0	3·2	—	—	—	—	—
Hydracarina	—	—	3·0	53·1	25·8	18·2	25·8	56·7	9·1	—	—	—
Insecta	—	—	18·2	31·3	3·2	30·3	6·5	6·7	6·1	—	—	2·7
Larvae Chironomidae	—	—	3·0	6·3	—	—	—	3·3	—	—	—	2·7
Larvae *Chaoborus*	—	—	—	—	—	6·1	—	—	—	—	—	—
Larvae Trichoptera	—	—	—	—	3·2	—	—	—	—	—	—	—
Nymphs Insecta	—	—	18·2	25·0	—	24·2	6·5	3·3	6·1	—	—	—
Nymphs Odonata	—	—	—	3·1	—	6·1	—	—	—	—	—	—
Nymphs Ephemeroptera	—	—	3·0	6·3	—	—	—	—	—	—	—	—
Nymphs Diptera	—	—	—	—	—	—	—	—	6·1	—	—	—
Nematoda	3·0	—	—	—	3·2	—	3·2	3·3	—	—	—	—
Oligochaeta	—	—	—	—	—	—	—	—	—	—	—	2·7
Decapoda	—	—	—	—	—	—	3·2	3·3	—	—	—	—

TABLE IV. Diet composition of bleak according to its length in Lake Koronia

L. (cm)	<10		10–11		11–12		12–13		≥13	
umber of examined fish	37		32		105		131		95	
	m	f%	m	f%	m	f%	m	f%	m	f%
opepoda	24·0	51·4	127·1	71·9	169·4	82·9	329·7	71·0	520·5	76·8
Copepoda/Copepodids	24·0	51·4	126·5	71·9	169·1	82·9	329·1	70·2	520·2	76·8
Nauplii	0·0	2·7	0·5	9·4	0·3	14·0	0·6	9·9	0·3	9·5
ladocera	138·4	73·0	251·8	78·1	265·1	84·8	363·4	79·4	447·2	81·1
B. longirostris	113·5	90·9	161·2	65·6	187·5	76·2	261·2	66·4	335·6	72·6
Diaphanosoma sp.	19·9	21·6	60·7	46·9	59·6	41·0	83·6	41·2	96·7	31·6
Sida crystallina	—	—	0·2	3·1	0·2	1·0	—	—	—	—
Moina sp.	4·7	—	15·8	21·9	13·8	18·1	12·3	18·3	11·1	12·6
Daphnia sp.	0·1	5·4	13·5	15·6	3·5	14·3	5·7	19·8	2·5	18·9
C. pulchella	—	—	—	—	0·0	1·0	0·0	0·8	0·0	1·1
Alona sp.	0·1	5·4	0·1	6·3	0·1	7·6	0·2	7·6	0·7	9·5
Leptodora kindtii	—	—	0·1	9·4	0·3	15·2	0·2	8·4	0·3	7·4
Chydorus sphaericus	—	—	—	—	0·0	1·9	0·0	2·3	—	—
I. sordidus	—	—	0·1	6·3	—	—	—	—	0·0	2·1
otifera	0·7	2·7	1·1	9·4	0·2	1·9	0·1	3·8	0·0	1·1
Brachionus sp.	0·1	2·7	1·0	6·3	0·2	1·9	0·1	2·3	0·0	1·1
Keratella quadrata	0·7	2·7	—	—	0·1	1·0	0·0	1·5	—	—
Asplachna sp.	—	—	0·0	3·1	—	—	—	—	—	—
stracoda	—	—	—	—	0·0	1·0	0·0	2·3	0·0	1·1
ydracarina	—	—	0·3	12·5	0·2	16·2	0·5	16·0	0·4	18·9
nsecta	0·0	2·7	0·1	6·3	0·0	2·9	0·2	13·7	0·2	10·5
Larvae Chironomidae	0·0	2·7	—	—	—	—	0·0	2·3	0·0	1·1
Larvae *Chaoborus*	—	—	—	—	0·0	1·0	0·0	0·8	—	—
Larvae Trichoptera	—	—	—	—	—	—	0·0	0·8	—	—
Nymphs Insecta	—	—	0·1	6·3	0·0	1·9	0·1	9·9	0·2	10·5
Nymphs Odonata	—	—	—	—	—	—	0·0	1·5	0·0	1·5
Nymphs Ephemeroptera	—	—	—	—	—	—	0·0	1·5	0·0	1·5
Nymphs Diptera	—	—	—	—	—	—	0·0	0·8	0·0	1·1
ematoda	—	—	—	—	0·0	1·0	0·0	1·5	0·0	1·1
ligochaeta	—	—	—	—	—	—	—	—	0·0	1·1
ecapoda	—	—	—	—	0·0	1·0	—	—	0·0	1·1

of rapid digestion due to the high temperature of the water, probably in combination with the length of the day, which permitted the fish to raise its feeding activity again just before nightfall.

The analysis of the gut contents of bleak showed a high and constant consumption of zooplankton. The monthly composition of its food reflected to some extent the abundance of prey organisms. Copepoda (mainly Cyclopoida) and *Bosmina*, which were consumed during all months and on an almost exclusive basis in winter, are among the most abundant zooplanktonic organisms in the lake and are present throughout the year (Karvounaris, 1979). On the other hand, the increased diversity of the food of bleak with the rise of temperature coincided with an increase of the available prey in the lake. *Diaphanosoma*, the most abundant planktonic animal during the warm season (Karvounaris, 1979), was consumed in high quantities, but Copepoda or *Bosmina* remained the most numerous organisms in the gut contents. Other Cladocera, like *Moina* and *Daphnia*, where also found in large quantities in some months of this season. Meanwhile, other non-zooplanktonic organisms, such as Hydracarina and emerging insect nymphs, were of low importance to the food of bleak. There is no information available on the abundance of different non-planktonic organisms, with the exception of benthic organisms (Kilikidis *et al.*, 1984), which are considered to be abundant with a biomass ranging from 1·3 g m^{-3} in winter to 5·7 g m^{-3} in summer (mainly larvae of Diptera).

By contrast, Vøllestad (1985) observed that bleak in Norwegian lakes also consumed high quantities of surface insects and blue-green algae, besides Cladocera and Copepoda. Bohl (1980), mentioned that all the adults cyprinids in Bavarian lakes fed on insects, plants or other material and not on zooplankton. Chappaz *et al.* (1987) maintained that the simultaneous consumption of other organisms (mainly insect imagines) by bleak in southern France was due to the low abundance of zooplankton. The same authors reported a high presence of algal debris in the guts of bleak.

The stenophagy of bleak in Lake Koronia might be attributed to the high abundance of zooplankton. Kilikidis *et al.* (1984) gave a dry zooplankton biomass range of 0·5–3·8 g m^{-3} of water, depending on season. In Lake Koronia, Zarfdjian (1989) noted that zooplankton was not overpredated and that large Cladocera were never absent. When animal food is in short supply, roach (another zooplanktivorous cyprinid) switches to the less nutritious algae and detritus (Persson, 1983). The complete absence of algae or algal debris in the food of bleak in Lake Koronia supports the assumption that the zooplankton there is surplus to the bleak's needs.

The feeding activity of bleak depended directly on water temperature. In winter, low temperature resulted in limited feeding activity, while in summer and autumn high temperature permitted high food consumption. Low feeding intensity in winter had a negative effect on condition factor only in January.

Reproductive activity, although extended over a long period [Fig. 2(b)], did not seem to affect food intake except in April, when the GSI attained its highest value and the ventral space was reduced because it was occupied by the gonads. The decrease of condition factor in April [Fig. 2(b)] must be attributed to the combined effects of low food intake and the high proportion of energy allocated to reproduction in that month. Furthermore, the energy allocated to reproduction seemed to be limiting for the condition factor during the warm season, even though food intake was high after April. This high feeding intensity must have permitted the peak in condition factor at the end of the summer (end of the reproductive season).

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