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SOME ASPECTS OF THE NATURAL FEEDING OF ARCTIC CHARR (*Salvelinus alpinus* (L.)) DURING THE SUMMER PERIOD, IN A HIGH-MOUNTAIN LAKE (MITTLERER PLENDERLESEE, TYROL, AUSTRIA)

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Nahrungsaufnahme des Seesaiblings (*Salvelinus alpinus* (L.)) während des Sommers in einem Hochgebirgssee (Mittlerer Plenderlesee, Tirol, Österreich)

Zusammenfassung: Aus dem Mittleren Plenderlesee wurden in den Monaten Mai, Juli und August Seesaiblinge gefangen und auf ihr Nahrungsspektrum untersucht. Dabei wurden sowohl qualitative als auch quantitative Unterschiede des Magen- und Darminhaltes in Abhängigkeit von Größenklassen, Geschlecht und Markierung der Fische beobachtet. Die im Winter dominierende autochthone benthische Fauna in der Nahrung, wird im Sommer in zunehmendem Maße von allochthoner Diät ersetzt. Dabei scheinen kleinere Fische gegenüber größeren bevorzugt benthische Fauna aufzunehmen.
Mit steigender Wassertemperatur nimmt die Menge der aufgenommenen Nahrung und damit auch der Konditionsfaktor zu. Die Hauptaktivität der Nahrungsaufnahme liegt offensichtlich in der Morgen- und Abenddämmerung. Dabei fressen die kleinen Fische vor den größeren. Markierte Fische scheinen ihren Freßrhythmus umzustellen. Der Vergleich der Aktivitätskurven mit dem Nahrungsspektrum ergab, daß die Fische aktiver bei der Aufnahme von allochthonem Futter sind.

Introduction:

Due to the general lack of knowledge regarding the ecology of high-mountain lakes, and due to the fact that they are relatively simple ecosystems, the study of these lakes constitutes a very promising field of research from which some basic laws governing more complex water bodies could be learned.

As fish play a very important role in lake production, being the final link of the trophic chain, it is of special interest to gain some knowledge on their natural feeding.
In the particular case of Mittlerer Plenderlesee, which is now studied for the first time, *Salvelinus alpinus* is the only fish species present, and it is not able to reach the standard size which is usual under more favorable environmental conditions.
The present research, together with parallel studies on digestive enzymes secretion, population dynamics and limnochemistry, will contribute to explain the implied factors on the development of dwarf individuals.
Some of the Kühtai lakes, to which Mittlerer Plenderlesee belongs, have already been studied, but little has been published on fish. Among these studies , a complete annual feeding period of fish has been covered by PECHLANER et al. (1972) in Vorderer and Hinterer Finstertaler See, where charrs and brown trouts (*Salmo trutta fario* L.) were living together, therefore making the data of relative comparative value for the present study.

Description of the lake

Mittlerer Plenderlesee is situated in the Southern Stubai Alps, at about 30 km from Innsbruck, WSW direction, at an elevation of 2317 m a.s.l.. It is a moraine dammed lake, excavated in crystalline rocks (grain-diorite and biotite-gneiss). The surroundings have a poorly developed grass cover and some shrubs, but it is mainly a naked stony area, above the timber line.

The lake has no superficial inlet, but it has a constant subterranean supply of snow melting water. The lake has its outlet in a small brook.
The surface of the lake is only 15.810 m^2, and its volume 45.579 m^3. The maximum depth is 5,7 m and the mean depth 3,14 m. The shoreline development is 1,31 (LEINER, 1972).

The lake is cold monomictic, winter cover lasting from the end of October till the beginning of July, which means around seven months of isolation from the external environment and poor light conditions.
The maximum temperatures are registered during August and September (13 - 14° C). During the summer period the pH oscillated around 6, while the conductivity (20° C) was approximately 10 µS. The alkalinity was around 0,01 meq/l.
The whole lake was oversaturated with O_2 during summer, having values between 110 and 120 % of saturation. The wind is surely the main mixing agent, as the lake is greatly exposed to its action. The calculated critical depth applying BERGER's rule (fourth root of the surface area), is 10,9 m.
The water transparence reaches the bottom of the lake, which is characterized by the presence of big stones and no macrophytes. The littoral zone is also very poor, with only some isolated moss pads.

Material and methods

The fish studied were caught at irregular intervals, during the summer months of 1981 (31 May, 15 July and 4 - 6 August), using angling due to the ice cover only for the first sampling, and tanglenets (20 mm mesh size) and gillnets (9 - 22 mm mesh size) on the subsequent dates. The nets were placed transecting the lake in different areas and depths to cover both open and deep water. The nets were distributed at the beginning of the sampling period, and revised afterwards in one and a half to 4 hour intervals. The capture was immediately killed and placed into snow, and under this condition was transported to the laboratory to be processed. Most fish were measured and weighed in fresh condition; the rest after 2 to 6 days of deep freezing.

The complete digestive tract was fixed in 70 % alcohol and analyzed after complete fixation had taken place, in order to facilitate the separation of mucus from food items.
The stomach contents were analyzed considering two separated portions, anterior and posterior, so as to investigate partial gastric evacuation. The gut contents were also analyzed to assess the digestibility of the different food items.
The wet weight in mg of these 3 fractions of the digestive tract, was taken after removal of excess water using filter paper (WINBERG, 1971). The proportion of the different food items was estimated after sorting under a dissecting microscope, and forming layers of uniform thickness, of which the surfaces were calculated representing the respective volumes (HYSLOP, 1980; HELLAWELL & ABEL, 1971). This technique even if belonging to subjecitve methodologies is widely used and gives quite accurate results. The sensitivity was 5 %; under this amount only the item's presence was stated.
The sorting categories considered were: Allochthonous invertebrates (including some autochthonous organisms which leave the lake in the imaginal stage having the meaning of "Anflug" in German); benthic invertebrates; chironomidae pupae; zooplankters (littoral forms); stones and sediments. The mucus proportion was also estimated to be deducted in the calculation of the degree of stomach fullness, assuming that the specific weight of both mucus and food items equals in average to one (WINDELL & BOWEN, 1978).

The stomach fullness degree (SF) expressed as percentage of fish body weight, was calculated as follows:

$$SF = \frac{\text{stomach content wet W (mg)} \cdot 100}{\text{(fish wet W - digestive tract content wet W) (mg)}}$$

In order to get some comparative idea, condition factors (K) of the fish were estimated according to FULTON's coefficient:

$$K = \frac{W\ (g) \cdot 100.000}{L^3\ (mm)}$$

Owing to the fact that parallel studies on population size were carried out, using the tagging-capture and recapture method a high percentage of the charrs belonging to the last sampling period was marked. As the influence of this injuring technique on the physiological condition of the fish was unknown, these individuals were analyzed separately to be compared. These fish were caught 20 to 22 days after tagging. Part of the capture belonging to August was only included in the calculation of the diel activity pattern, as it was processed with other purposes than stomach contents analysis.

Results and discussion

I. Diet composition, SF and K values during summer

Four size classes are considered for the analysis, as the stomachs contents differed both quantitatively and qualitatively (table 1). The approximated age for each size class was estimated from data published by PECHLANER et al. (1972) for Vorderer Finstertaler See, a quite near and similar lake to Mittlerer Plenderlesee.

May sampling:

During this period the winter ice cover was still present. The main food source for the whole sampled population was the benthic fauna, particularly Sialidae- and Nemouridae-larvae (Table 2). The dominant Chironomidae-larvae were those of *Micropsectra*. It is interesting to consider the relatively high proportion of little stones in the stomachs (separately weighed), which could indicate the difficulty to sort prey on the lake bottom.
Younger fish seem to be restricted to feed on benthic organisms, while older fish were also eating littoral zooplankton and some terrestrial coleopterans (Scarabaeidae, Carabidae and Curculionidae) (Fig.1).
Between males and females, no qualitative dietary difference appeared, except the one related to size classes.
Among bigger fish, the SF of females was higher than of males, while among smaller fish the opposite thing was found; the number of individuals however was too low and the variability too high to support any conclusion (Table 4).

July sampling:

A drastic change occurred in the feeding behaviour of the fish population (Fig.1). Due to the disappearance of the ice cover, one more source of energy supply was available in the form of various allochthonous invertebrates (Table 2), among which the most abundant in the diet were dipterans and coleopterans.
From the benthal, the larvae of Sialidae and Nemouridae were again the main food items. The dominant Chironomid-larva was the predator *Zavrelimyia punctatissima*.

During July 4 size classes were distinguished (Table 1). Size classe A fish were mainly feeding on benthic fauna, size class B shifted from only benthal to a more varied diet including allochthonous organisms. The individuals belonging to the size class C had the most diversified diet (Fig.1). All size classes showed a considerable consumption of chironomid-pupae.
The size class D, which was represented by only 2 fish, of a very low condition factor ($\overline{K}$ = 0,58 ± 0,01), exhibited empty stomachs.
It was not possible to compare the diet of males and females, due to the reduced number of fish in each subsample.

August sampling:

The shifting towards allochthonous arthropods was even more important than in the previous month (Fig.1), and the correlation with the emergence period of the benthic insects is absolutely clear. At least this holds for chironomidae, which according to published data emerge from June to September in similar lakes of the same region of Mittlerer Plenderlesee, where it was also proved that the total zoobenthos biomass is minimum in summer and maximum in winter (BRETSCHKO, 1975).
Even if data on the actual availability of different food sources are lacking for Mittlerer Plenderlesee, it seems that the electivity of prey in general is very low, but conditioned by the size of fish.
The size class A showed a striking change in the diet composition, replacing benthic by terrestrial arthropods.
The size class B behaved in the same way, while C shifted almost completely to the allochthonous food supply, whose diversity was similar to that in July. The benthic fauna appearing in the diet, was poor in chironomid-larvae and no mollusc was found, while the presence of hydracarina increased.

No difference between the diet composition of males and females appeared among the same size class, but as it happened in previous months, size class B females showed a lower $\overline{SF}$ than males, while among bigger fish (size class C) females exhibited higher $\overline{SF}$ than males (Table 4).
Considering marked fish, no appreciable difference appeared in the qualitative aspect, when compared with unmarked fish (Fig.1). The SF was in average lower for marked fish than for unmarked fish, but the individual variation is very high; $\overline{K}$ values were equal for both groups (Table 5, fig. 2).

Comparison between different months:

From the qualitative point of view, there is a definite tendency from May to August to replace the benthic winter diet by allochthonous organisms, as their availabilities change.

The smaller fish seem to prefer the benthic fauna always, while bigger fish prey mainly on allochthonous items if they are available; this might be understood as a mechanism to reduce intraspecific competition. Surprisingly zooplankton is utilized as food only by bigger fish and not by the smaller ones. This fact could be related with the littoral origin of the zooplankton, which is therefore exploited by fish swimming near the water surface.
From the terrestrial invertebrates consumed, the most important energetic supply are dipterans, as they are fully digested, while coleopterans which are the most abundant item, are only partially digested (about 50 % of the animals found in the intestinal contents was not utilized), and the same thing happens with wasps.

During the whole sampling period no cannibalism or fish egg-consumption was registered, as it has been found in Vorderer and Hinterer Finstertaler lakes (PECHLANER et al. 1972). The dominance of chironomid-pupae registered in the diet of July in those lakes, was not found in Mittlerer Plenderlesee, and during August the proportion of allochthonous invertebrates was higher in Mittlerer Plenderlesee than in the compared lakes, due perhaps to the lacking of competition with brown trout.
Comparing these findings with published data for charrs in other lakes, it appears that in more eutrophic lakes planktonic cladocerans constitute a very important part of the summer diet, especially large forms, such as Daphnia, Bythotrephes and Leptodora, and the same importance is assigned to chironomidae-pupae (FROST, 1977). In Schwarzsee ob Sölden in Austria it was also found that zooplankters were dominant items in the diet (STEINBÖCK, 1949). In these lakes it was also observed that smaller fish feed on the lake bottom (FROST, 1977).
It is interesting to remark that the zooplankton species found in the fish stomach contents in Mittlerer Plenderlesee, are the same present in other lakes of the Kühtai area (EPPACHER, 1968 and PECHLANER et al., 1972), and that they are very small in size.
Comparing the SF for the considered 3 months, and correlating it with the registered temperatures during the sampling days, even if there is a considerable individual variation, it is possible to observe that there is an increase in the food intake, as the season is advancing (Table 3, fig.2 & 4).
The increase in the metabolic activity of fish at higher temperatures, and therefore of the food intake, is well known in brown trout from ELLIOTT's works (1975a, 1975b, and 1976), but not in charr.
From May to August, K values increased markedly in all fish sizes, which reflect the weight gained by fish during this part of the limited growing period. The youngest fish showed the highest $\overline{K}$, while the oldest had the lowest $\overline{K}$ values (Table 3, fig.3), as it was also found in similar lakes of Kühtai (unpublished data). This could be related with the presence of senile

individuals of a diminished physiological condition, due to the lack of predation.

II. Diel pattern of feeding and locomotory activity

During August the capture was separated according to hours, to assess the diel pattern of food intake, and the locomotory activity reflected in the quantity of fish tangled in the nets during different sampling periods.

Diel cycle of locomotory activity:

In general the activity rhythm curves presented 2 peaks, one at 20.00 and the other at 05.30 hr, that means at around dusk and dawn, which indicates that during the sampling period fish behaved as crepuscular. *Salmo trutta* is a known crepuscular species, and the most important factor influencing this pattern is the alternation of periods of light and darkness, while water temperature is only of secondary importance (MÜLLER, 1978).

Size class C seemed to have an absolute maximum of activity at dawn, while size class B was a transitional step towards an absolute maximum at dusk in size class A. Asynchronized behaviour of age groups is a known phenomenon in fish, which also tends to reduce the intraspecific contact, and separate niches within the population to diminish competition (STAPLES, 1978). Asynchrony usually happens during the most productive time in food limited environments, such as arctic lakes.
Comparing the behaviour of unmarked fish with marked fish, the curves showed that they are quite similar (Fig.5 and 6), and therefore it seems that the tagging did not affect this rhythmic activity.

Diel cycle of food intake:

The stomach fullness (SF) and anterior stomach fullness (ASF), used to build up the curves of the diel feeding pattern, had very high standard deviations (derived from the very high individual variation in the SF), which do not allow to arrive to any definite conclusion, but the means plotted in the graphs could indicate a certain trend, specially when compared with the activity cycle curves (Fig.7, 8 and 5).
This high variance of the stomach contents (Table 6), is associated to several factors, which are known from the literature. One of them is the herogeneity of the diet, which influences the evacuation rates of the stomach (THORPE, 1977 and ELLIOTT, 1972). The underestimation of food level in the stomachs associated with the cessation of feeding and the continuance of gastric evacuation while fish are retained by the nets, could be reduced shortening the sampling periods and accelerating the fixation of the material (EGGERS, 1977), but at 13° C, the evacuation time could - if similar to brown trout - be as long as 20 hours for total emptying, or considering the maximum of 4 hour periods used in the present work, the remaining digestible organic matter could be around 45 % (ELLIOTT, 1972), which undoubtfully introduces a bias in the results.
The problem of gastric evacuation is particularly important in predator fish, as the food consumed is only animal matter, and it is assimilated to a very high degree; the gut content therefore being closely dependent on how long the process advances till fixation takes place (HOFER & NIEDERHOLZER, 1980).
From other studies on daily feeding periodicity it is possible to observe that the high variability of the SF, is a common feature for many species which were, nevertheless, considered to present a cycle (KEAST & WELSH, 1968).
The following part is mainly speculative, not only due to the high variance, but also due to the limited number of fish available (Table 6).
The big fish of the size class C, which were the most abundant at any time, had their minimum SF at 9 o'clock p.m., and a marked

increase of it during the dark period, interrupted at dawn, to continue afterwards to reach an absolute maximum at 8.30 o' clock a.m. (Fig.7). The same pattern was observed from the anterior part of the stomach fullness (ASF) (Fig.8).
Size classes A and B, which were not represented during the complete 24-hours period, showed another pattern with a re-gistered maximum of SF and ASF at 2 o'clock a.m. and then a minimum in the morning (Fig.7 and 8). The shape of these curves could indicate that smaller fish start to feed before dusk; that means earlier than bigger fish.
Marked fish showed quite different results, the size class C was more similar to those of small normal fish, and the size class B, did not have any appreciable variation of SF or ASF during the day (Fig.10). It is also possible to see the lower SF and ASF reached by marked fish, when compared with normal fish. Therefore if these curves are reflecting some trend, they could indicate that tagging had a physiological effect on fish, which present an alteration of their food intake and daily rhythm, in the short term after tagging.
Correlating peaks of activity and food intake, for the size class C, it is possible to see that the maximum activity at dusk, coincided with the starting time of the feeding period; and at dawn with the absolute maximum of SF.
Analyzing the curves of SF and total SF (including mucus), for size class C, it was possible to observe an increased quantity of mucus during the minimum SF, and a marked decrease of its amount during the supposed period of food intake (Fig. 10).
The change of the diet composition along the daily period, was estimated considering 56 fish from the size class C and the biggest from size class B, which presented homogeneous contents, close in average item's proportion to size class C (fig.1). Correlating these curves (Fig.9) with those of lo-comotory activity, it was possible to see that the minimum of

swimming activity coincided with the minimum percentage of allochthonous material, while during the same period the intake of benthic fauna increased. Apparently the peaks of maximum allochthonous intake correspond to those of maximum motility (Fig.9 and 5).

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SIZE CLASS / DATE	A (2 to 4)			B (4 to 6)			C (6 to 11)			D (11 to ?)			
	n	$\bar{L}$	$\bar{W}$	n	$\bar{L}$	$\bar{W}$	n	$\bar{L}$	$\bar{W}$	n	$\bar{L}$	$\bar{W}$	n
31 May				9	147,9 ± 5,4	21,7 ± 2,9	10	166,3 ± 5,6	25,8 ± 3,6				19
15 July	6	110,3 ± 6,9	10,9 ± 2,1	6	147,5 ± 7,1	25,8 ± 2,9	5	167,0 ± 6,2	32,1 ± 5,9	2	224,5 ±19,1	66,2 ±16,1	19
4-6 Aug. not mark.	17	116,5 ± 8,6	14,8 ± 3,5	29	147,9 ± 6,4	28,1 ± 4,4	37	174,1 ± 1,0	41,4 ± 6,6				83
4-6 Aug. marked				38	145,8 ± 9,6	25,7 ± 4,2	16	168,6 ± 9,0	38,7 ± 9,7				54
4-6 Aug. p.proc.	4	118,8 ± 8,5	16,0 ± 4,7	8	146,5 ± 8,1	27,3 ± 3,7	13	170,0 ± 7,9	39,1 ± 7,1				25

Table 1: Characterization of the captures, given as mean values and standard deviations, for total length (L) in mm and total weight (W) in g.
The capture for August is divided into not marked, marked and partially processed.
The values in brackets, for each size class indicate the approximate age in years according to PECHLANER et al. (1972).

Table 2: List of the organisms found in the summer period diet of *Salvelinus alpinus* (L.) in Mittlerer Plenderlesee. The items belonging to each group are ordered according to their abundance in the diet, and only the main families are included.

Allochthonous invertebrates:

Insecta:
- Coleoptera: Scarabaeida (Aphodiinae), Staphylinidae, Carabidae, Curculionidae, Chrysomelidae, Hydrophilidae (from other water bodies).
- Diptera: Muscidae, Syrphidae, Tipulidae, Trichoceridae, Chironomidae, and several other Nematocera.
- Hymenoptera: Formicidae, Vespidae, Braconidae.
- Plecoptera: Nemouridae (*Nemourella picteti*).
- Lepidoptera: imagines und larvae
- Trichoptera: imagines
- Megaloptera: Sialidae (*Sialis* sp.)
- Homoptera: Aphididae, Cicadoidae, Jassidae
- Neuroptera: Chrysopidae, Hemerobiidae
- Heteroptera: Corixidae (from other water bodies)
- Psocoptera

Arachnida:
- Araneae

Benthic invertebrates:

Insecta:
- Plecoptera: Nemouridae (nymphs of *Nemourella picteti*).
- Diptera: Chironomidae (larvae and pupae of *Micropsectra* spp., *Zavrelimyia punctatissima* and *Corynoneura scutellata*), Tipulidae (larvae).
- Megaloptera: Sialidae (larvae of *Sialis* sp.).
- Trichoptera: larvae and pupae.

Table 2 (continued):

Crustacea:
    Amphipoda: Gammaridae

Mollusca:
    Pelecypoda: Sphaeriidae (*Pisidium casertanum*).
Arachnida:
    Hydracarina: larvae and adults

Zooplankters:

Crustacea:
    Cladocera: Chydoridae (*Biapertura affinis affinis*, *Chydorus sphaericus latus*).
    Copepoda: Cyclopidae (*Cyclops abyssorum tatricus*).

Miscellanea:

Daphnia (*Daphnia*) ephippia.
Bryozoa floatblasts.

SIZE CLASS / DATE	A			B			C		
	n	$\overline{K}$	$\overline{SF}$	n	$\overline{K}$	$\overline{SF}$	n	$\overline{K}$	$\overline{SF}$
31 May				9	0,67 ±0,07	0,65 ±0,42	10	0,57 ±0,08	0,80 ±0,97
15 July	6	0,81 ±0,05	0,83 ±0,25	6	0,80 ±0,04	1,77 ±0,70	5	0,69 ±0,11	1,43 ±1,15
4-6 Aug.	17	0,92 ±0,05	0,93 ±0,97	29	0,88 ±0,12	1,30 ±1,29	37	0,79 ±0,11	2,73 ±2,09

Table 3: Condition factor means ($\overline{K}$) and stomach fullness means ($\overline{SF}$) and their respective standard deviations for different size classes and dates.

SIZE CLASS / DATE	B						C					
	females			males			females			males		
	n	$\overline{K}$	$\overline{SF}$	n	$\overline{K}$	$\overline{SF}$	n	$\overline{K}$	$\overline{SF}$	n	$\overline{K}$	$\overline{SF}$
31 May	5	0,68 ±0,07	0,47 ±0,29	4	0,66 ±0,08	0,89 ±0,48	4	0,51 ±0,06	1,60 ±1,15	6	0,56 ±0,13	0,26 ±0,22
4-6 Aug.	18	0,89 ±0,11	1,12 ±1.24	11	0,86 ±0,12	1,60 ±1,38	24	0,80 ±0,11	2,74 ±1,93	13	0,77 ±0,13	2,17 ±2,45

Table 4: Condition factor means ($\overline{K}$) and stomach fullness means ($\overline{SF}$) for females and males, with their respective standard deviations, according to size classes and dates.

SIZE CLASS / 4-6 Aug.	B			C		
	n	$\overline{K}$	$\overline{SF}$	n	$\overline{K}$	$\overline{SF}$
not mark.	29	0,88 ±0,12	1,30 ±1.29	37	0,79 ±0,11	2,73 ±2,09
marked	38	0,83 ±0,09	1,09 ±0,92	16	0,79 ±0,10	2,01 ±1,93

Table 5: Condition factor means ($\overline{K}$) and stomach fullness means ($\overline{SF}$) for not marked and marked fish with their respective standard deviations, according to size classes.

SIZE CLASS / HOUR	not marked									marked					
	A			B			C			B			C		
	n	$\overline{SF}$	$\overline{ASF}$	n	$\overline{SF}$	$\overline{ASF}$	n	$\overline{SF}$	$\overline{ASF}$	n	$\overline{SF}$	$\overline{ASF}$	n	$\overline{SF}$	$\overline{ASF}$
12.00													1	3,05 ----	1,19 ----
14.15				1	0.72 ----	0,22 ----	2	3,26 ±3,30	1,11 ±1,56						
17.00							2	2,17 ±2,40	0,86 ±1,22	2	1,02 ±0,81	0,41 ±0,49	1	1,18 ----	0 -
20.00	9	1,07 ±1,10	0,60 ±0,73	17	1,33 ±1,46	0,62 ±0,79	19	1,94 ±1,66	0,75 ±0,95	20	1,04 ±1,08	0,41 ±0,48	8	2,06 ±2,68	0,81 ±1,02
02.00	2	1,75 ±0,50	0,90 ±0,19	4	1,86 ±1,48	0,67 ±0,70	3	3,65 ±3,20	1,86 ±1,76	4	1,08 ±0,34	0,42 ±0,28	2	2,51 ±0,25	1,01 ±0,23
05.15				3	0,37 ±0,79	0,55 ±0,30	7	3,49 ±2.14	1,70 ±1,22	3	1,15 ±0,59	0,44 ±0,24	2	0,82 ±0,23	0,25 ±0,04
08.30	5	0,55 ±0,69	0,28 ±0,35	4	0,71 ±0,78	0,06 ±0,06	5	4,28 ±2,06	1,98 ±0,79	9	1,19 ±0,98	0,37 ±0,40	2	2,41 ±0,20	0,63 ±0,45

Table 6: Mean stomach fullness ($\overline{SF}$) and mean anterior stomach fullness ($\overline{ASF}$) for not marked and for marked fish, according to size classes and hour of catching, on 4 - 6 August. *Standard* deviations are indicated.

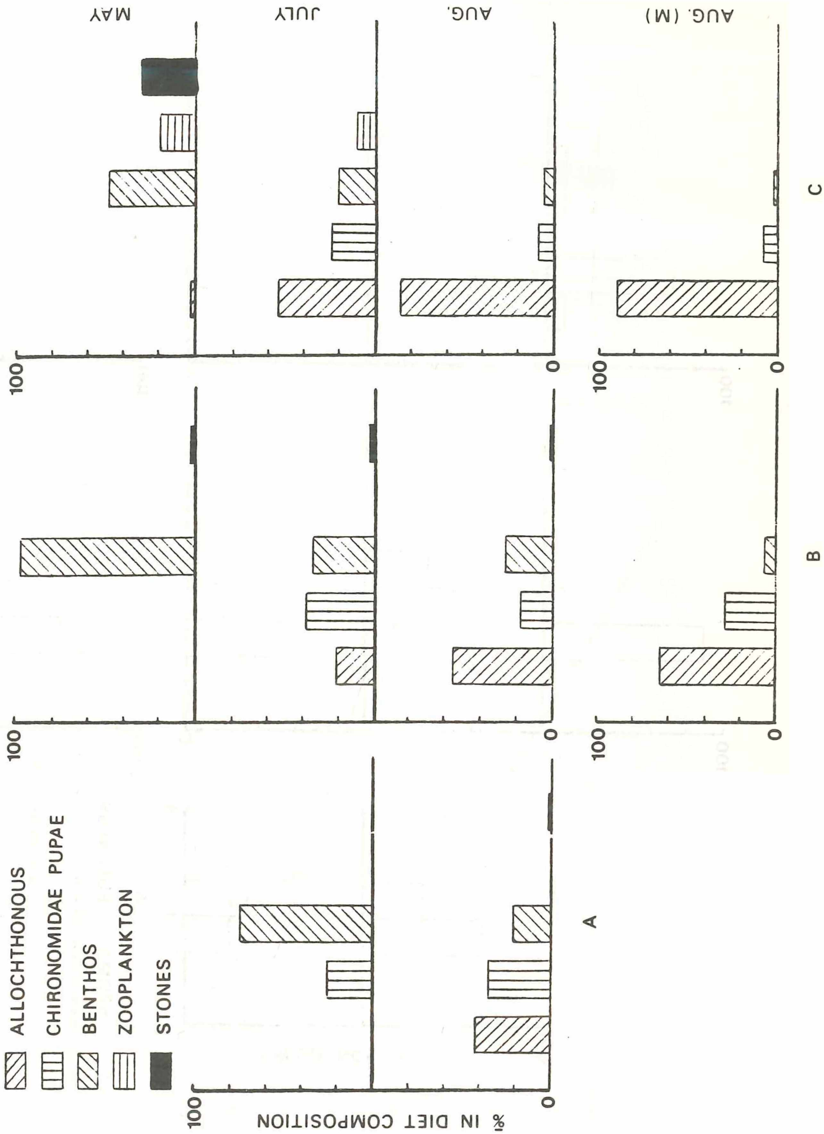

Fig.1: Monthly variation in the percentual composition of the diet according to size classes (A, B and C). In August marked fish are considered separately (M).

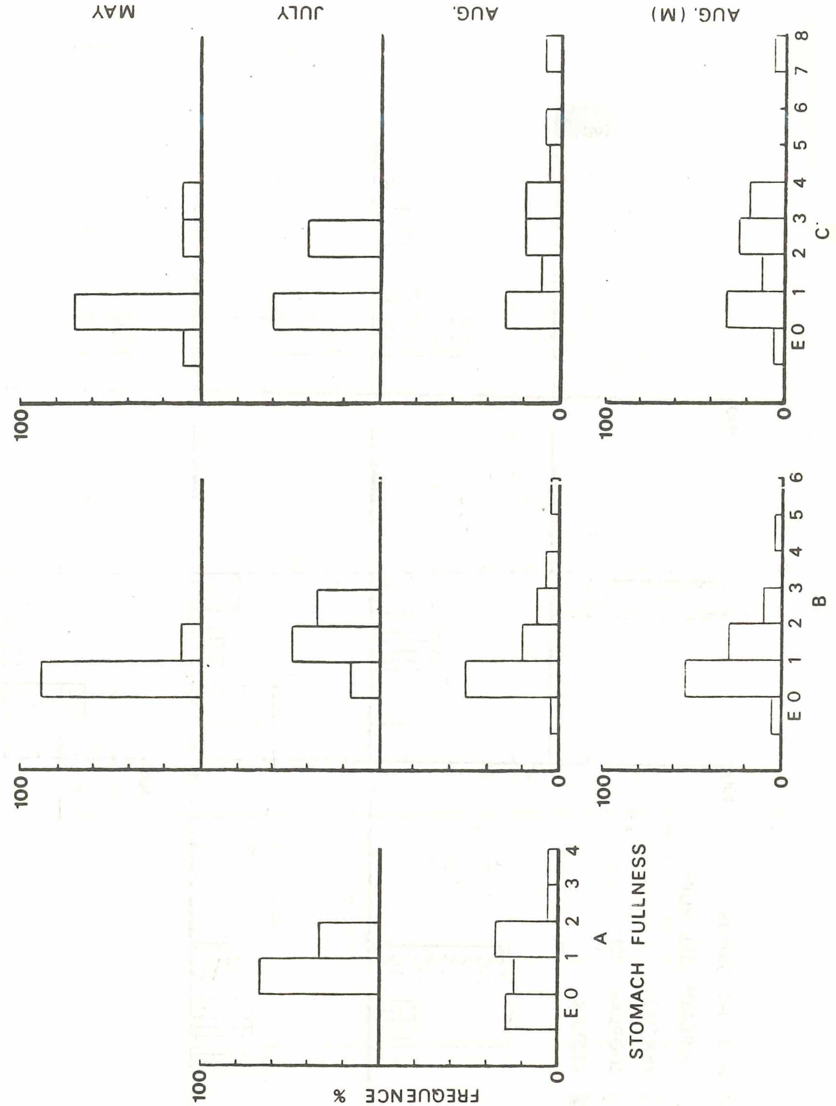

Fig.2: Monthly variation in the percentual frequency of SF (stomach fullness degree) classes, according to fish size classes (A, B and C). In August marked fish are considered separately (M). The first class of SF is "empty stomach" (E).

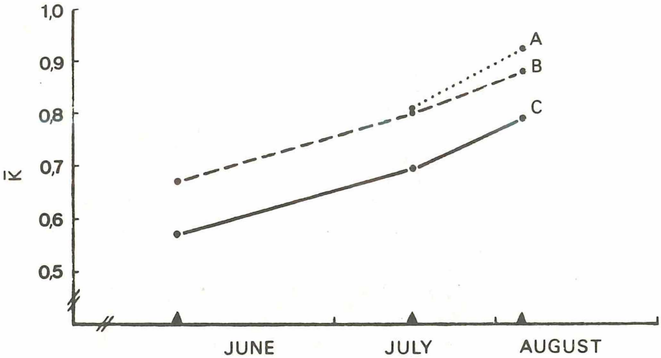

Fig. 3: Variation of condition factor means ($\bar{K}$) for the different size classes (A, B and C) during the sampling period. Only unmarked fish are indicated.

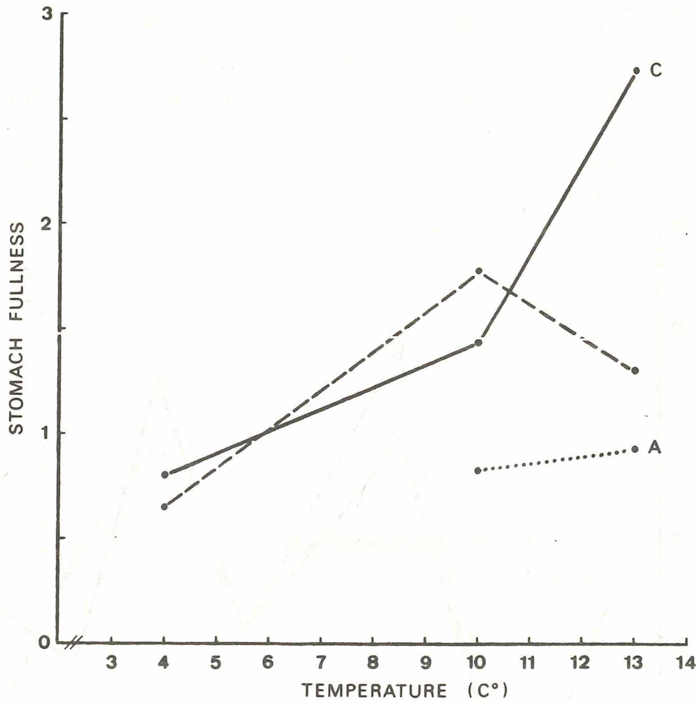

Fig. 4: Variation of the stomach fullness means ($\overline{SF}$) for the different size classes (A, B and C) correlated with the temperatures found during the sampling period. Only unmarked fish are included.

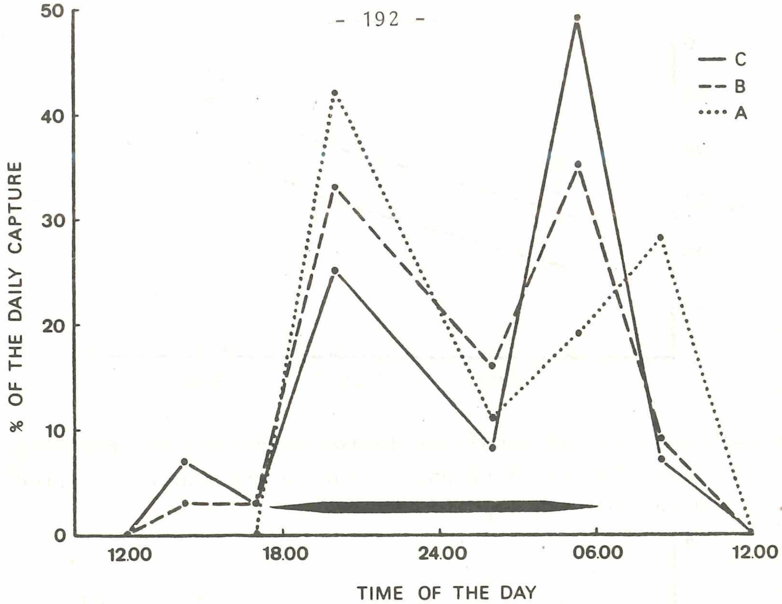

Fig.5: Percentual proportion of the daily capture, during different sampling periods, considering equal effort per hour, for different size classes of unmarked fish (A, B and C). August sampling.

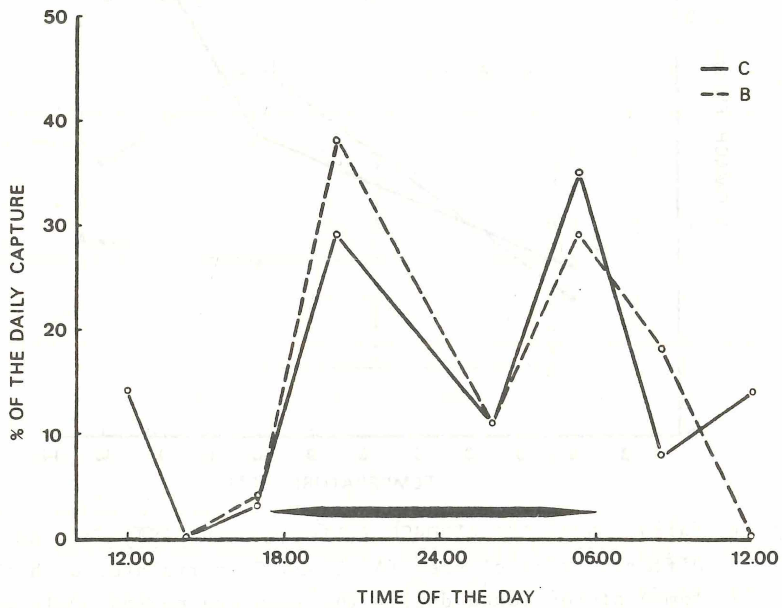

Fig.6: Percentual proportion of the daily capture, during different sampling periods, considering equal effort per hour, for different size classes of marked fish (B and C). August samplir

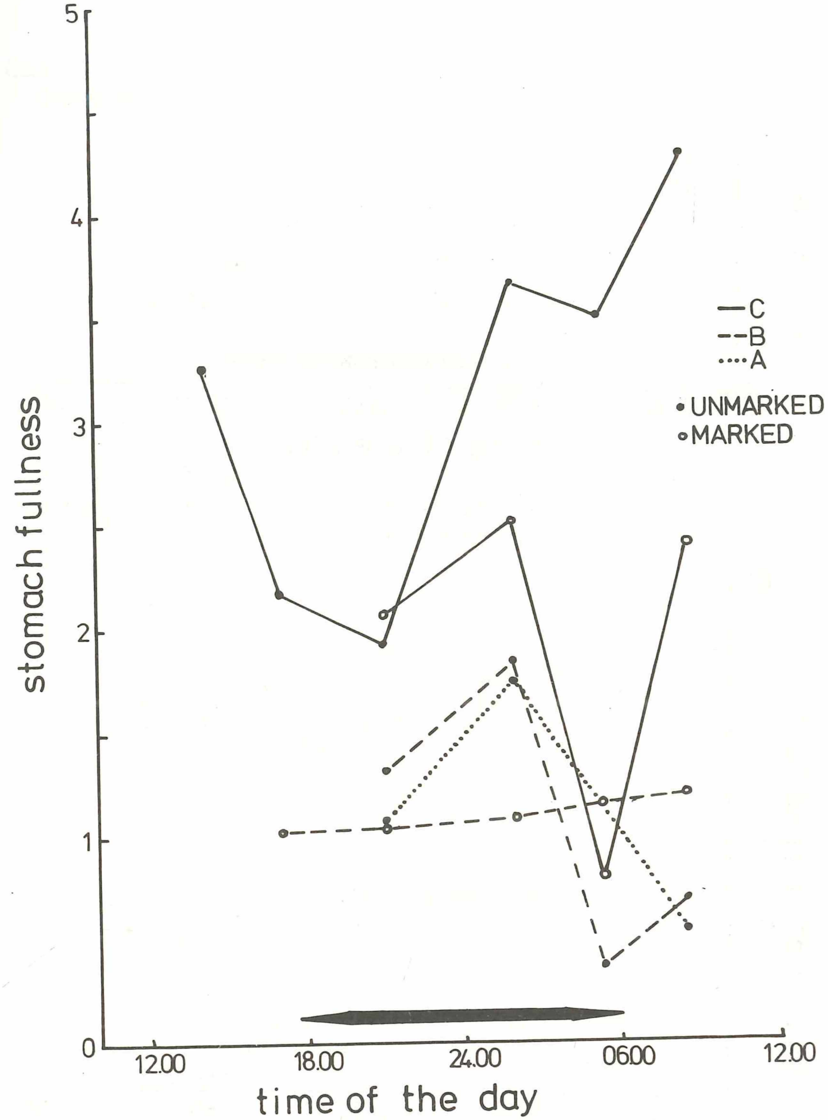

Fig.7: Diel fluctuation of the stomach fullness (SF) according to size classes of unmarked (A, B and C), and marked fish (B and C), during August sampling.

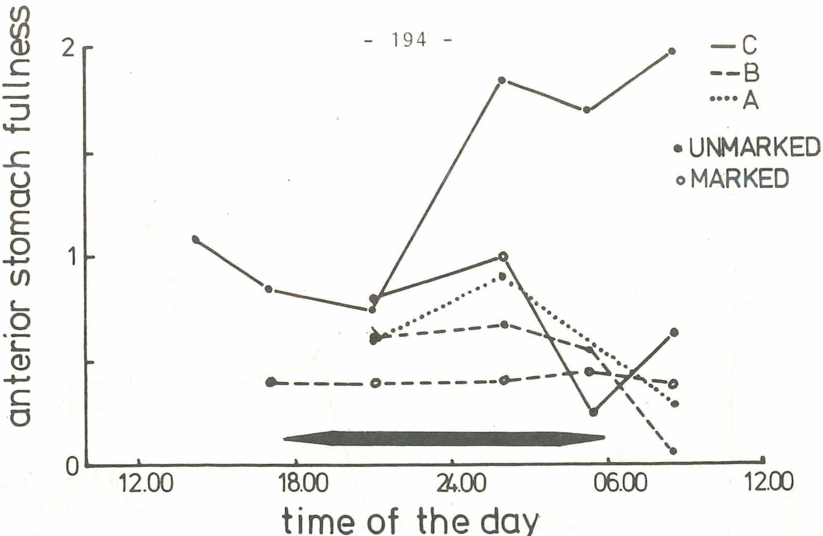

Fig.8: Diel fluctuations of the anterior stomach fullness (ASF) according to size classes of normal (A, B and C) and marked fish (B and C), during August sampling.

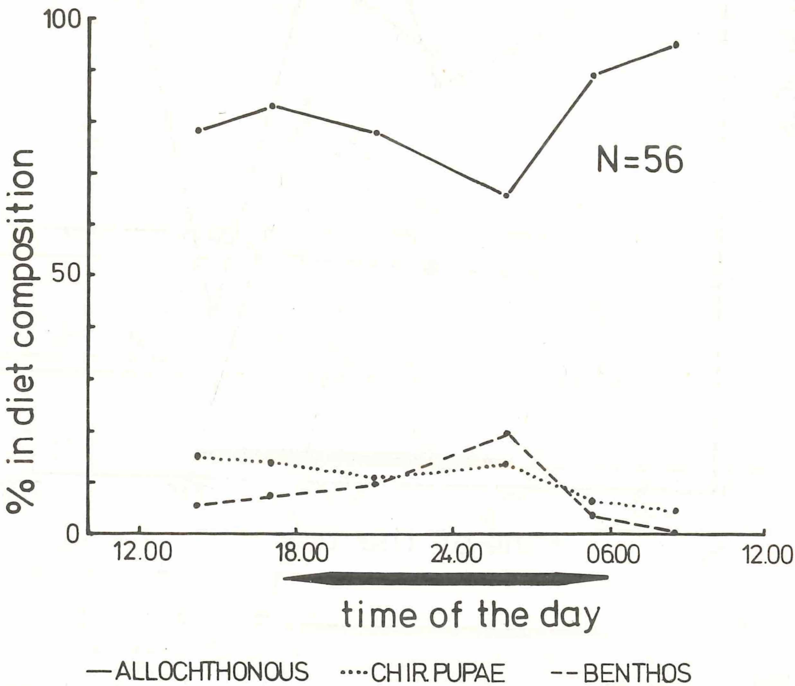

Fig.9: Diel fluctuation of the percentual composition of the diet for larger size fish, during August sampling.

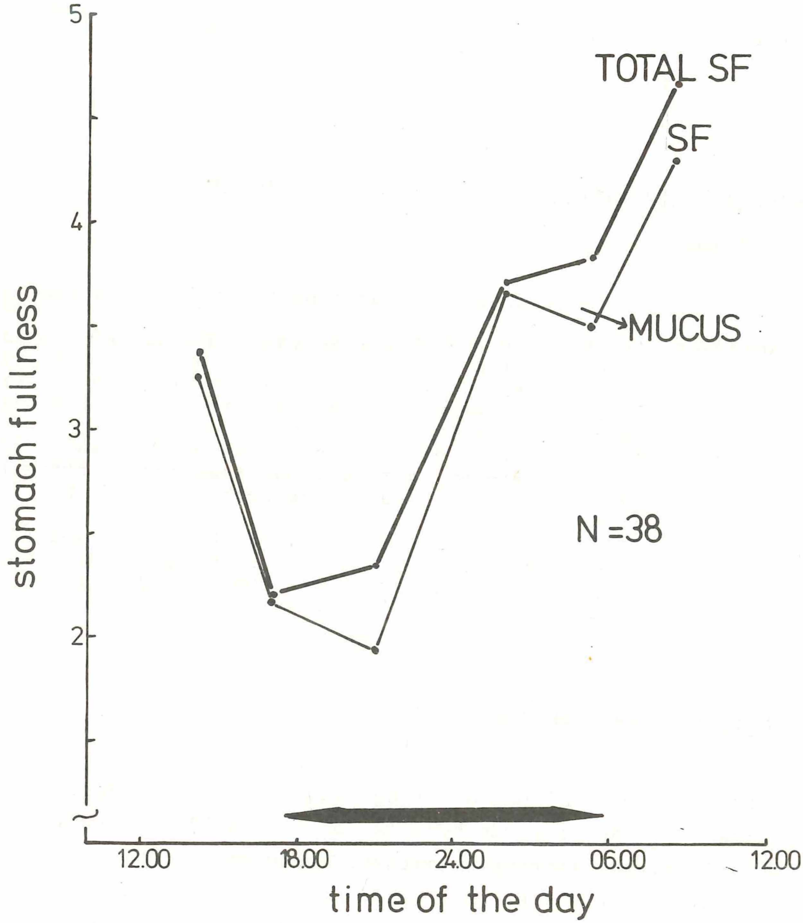

Fig.10: Diel fluctuation of the stomach fullness (SF) and the total SF (including mucus), for size class C, during August sampling.