ANNAL. BIOL. TIHANY | 41 | 357–362 | HUNGARIA 1974

ON THE SEASONAL FLUCTUATION IN THE FOOD INCORPORATION OF *EUDIAPTOMUS GRACILIS*

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Received: 14th March, 1974

The effect of temperature on the nutrition of crustaceans under experimental and field conditions has been investigated by several authors. Experiments were performed to throw light especially on the connection between filtering, i.e. food ingestion, and temperature (NAUWERCK, 1963; BURNS, 1968; KIBBY, 1971). Studies on temperature dependent incorporations are rather scarce and most of the results are contradictory. While investigating the biology of feeding of *Daphnia pulex* and *Diaptomus*, a close connection was found between the rate of incorporation and temperature (BELL and WARD, 1970; PAVELJEVA and SOROKIN, 1971). The effect of temperature on the assimilation of *Daphnia magna* is not significant (SCHINDLER, 1968). Experiments with *Calanus* and *Cyclopida*, however, did not prove this observation at all (CONOVER, 1966; PAVELJEVA and SOROKIN, 1971).

Investigating the feeding of *Eudiaptomus gracilis* we established that a fluctuation in the temperature of 5—20 °C does not significantly influence the rate of assimilation, either fed on algae, obtained from pure cultures, or on naturally occurring phytoplankton (KIBBY, 1971).

In the course of our investigating the food selectivity of *Eudiaptomus gracilis* (P.-ZÁNKAI and PONYI, 1974) we realized that the rate of consumption must be connected to a certain extent with the fluctuation of temperature. We intend to analyse this phenomenon in detail.

Methods

We carried out our investigations in all the four seasons; in the summer and autumn only under laboratory, in spring and winter under laboratory and natural conditions. The latter means that the samples compounded, according to the experiment in the laboratory, were placed back into the lake, at a depth of about one meter. This time the animals newly collected, after rinsing them with filtered Balaton water, directly got into the formerly ready-made experimental dishes from the collecting flasks. The algae used for food *(Chlorococcum infusionum* belonging to the Chlorophyta and the Chrysophyta *Botrydiopsis minor)* were obtained from the phyla used earlier. The way of their

cultivation, labelling, etc. was identical as described before (P.-ZÁNKAI, 1973; P.-ZÁNKAI and PONYI, 1974). This also refers to the composition of samples compounding of sample series, measuring the activity, calculating the results, etc.

We digressed from the earlier method only in one point, i.e. we let the animals feed on the labelled food for 20—22 h in "natural environments" (at low temperature), while in the earlier experiments in the laboratory we allowed only 2—4 h. This relatively long exposure was necessary for creating a great activity in the crustaceans for a good measuring.

When calculating the results we used SOROKIN's assimilation formula (Ca/C%). This means the ratio of the organic carbon content of the food incorporated by the animal (μg) and the organic carbon content of the body of animal counted for a 24-hour period.

$$Ca = \frac{r \cdot Cr \cdot 24 \cdot S}{t},$$

where, r = activity of one crustacea (dpm),
Cr = reciprocal of the specific activity of the food,
S = self-absorbtion,
t = time of feeding on labelled food.

Results and discussion

Between January 19 and April 10, 1973 the mean organic carbon content of 641 adult specimens of male and female, without eggs, *Eudiaptomus gracilis* was 4.53 μg (P.-ZÁNKAI and PONYI, 1974).

We fed the *Eudiaptomus gracilis* on *Chlorococcum* algae in the laboratory, October, 1972 and May, 1973 (temperature of the Balaton water 9—10 °C, and 17 °C) with a mean rate of incorporation of 18% *(Fig. 1)*. When this experiment was repeated in a 4—5 °C water (February 20, 26; March 5, 12) the mean rate of incorporation dropped to 1.6%. To eliminate the effect of low temperature, the animals sampled in the lake (March 20, 26) were placed at the experimental temperature for 4—6 days to allow them to become acclimatized to the experimental conditions. The rate of incorporation somewhat increased (3.2%), but amounted to only one-sixth of the value obtained in summer and autumn. The results were similar when feeding on *Botrydiopsis*. The rate of incorporation in early spring was about one-eighth of that in summer (temperature of Lake Balaton 9—10 °C) *(Fig. 2)*.

We investigated the fluctuation in incorporation depending on the concentration of food, at low temperatures, in winter and early spring. We used *Chlorococcum* and *Botrydiopsis* algae for feeding. Several experiments (February 26; March 5, 12; April 18) performed at a temperature identical with the lake's (4—5 °C, 10 °C), prove that the nutrition of crustaceans is optimal at an alga concentration of 0.2—0.4 mg C/l. This latter value often means the saturation concentration *(Fig. 3)*, but the saturation may ensue at 0.27 mg C/l, too (experiment on February 26). In the case of crustaceans sampled from cold-water and kept under conditions suitable for them to be-

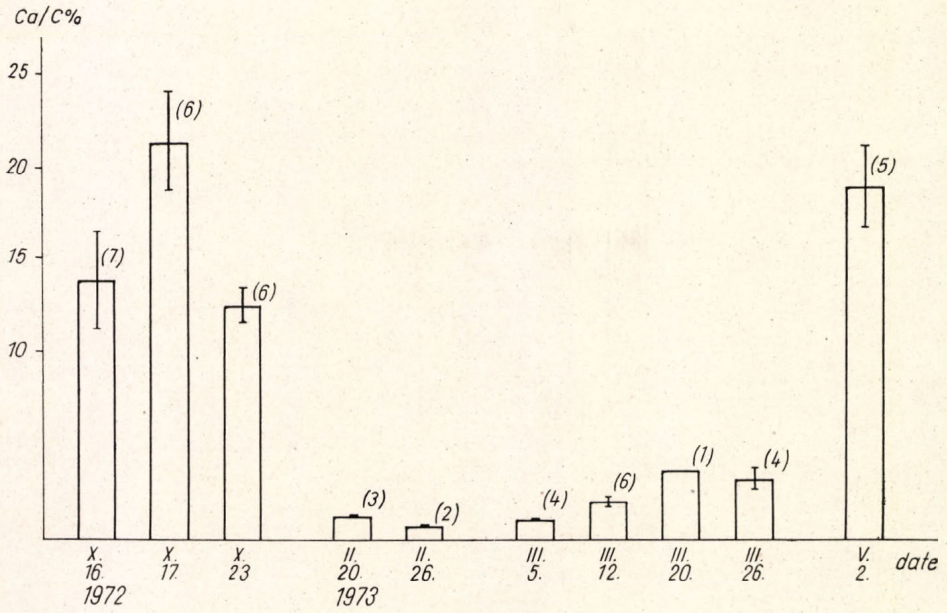

Fig. 1. The incorporation of *Eudiaptomus gracilis* fed on *Chlorococcum* algae at various temperatures (in parenthesis the number of samples and the S. E. M. are shown)

come acclimatized, the saturation ensued at an alga concentration of 0.4 mg C/l too.

Experimental investigation into the connection between incorporation and temperature, results the following conclusions:

The incorporation of *Eudiaptomus gracilis* sampled in the cold-water period (winter and early spring) does not fluctuate significantly if a few days before the experiment the animals are placed under conditions of much higher temperature than the sampling place. Either decreasing or increasing the temperature for a while, the speed of filtering and respiration changes following the Krogh curve (PAVELJEVA and SOROKIN, 1971), but does not conspicuously influence the rate of incorporation. At the same time, a slow change in temperature (e.g. between two seasons) influences it to a great extent *(Fig. 1)*. The rate of the consumption of *Chlorococcum* measured at 17 °C in May, nearly equalled to those of the animals sampled in Balaton water of 10 °C on October 17 and kept for one day in the laboratory to become acclimatized (Ca/C% in May amounted to 19.03, SD = ±2.28; in October amounted to 21.42, SD = = ±6.42). The difference in temperature was 7 °C. If we compare this October value with that obtained on February 20, the difference is nearly 20-fold, while that of the temperature is only 5—6 °C. The consumptions of *Botrydiopsis* in the summer (August) and spring (March, April) differ similarly. The differences in standard errors of the mean (S. M. E.) showed in the columns of *Fig. 1* draw the attention to the fact that the rate of incorporation in the autumn and spring, the seasons of "transitory temperature", is more varied than in the season of "more constant temperature". This can be attributed to

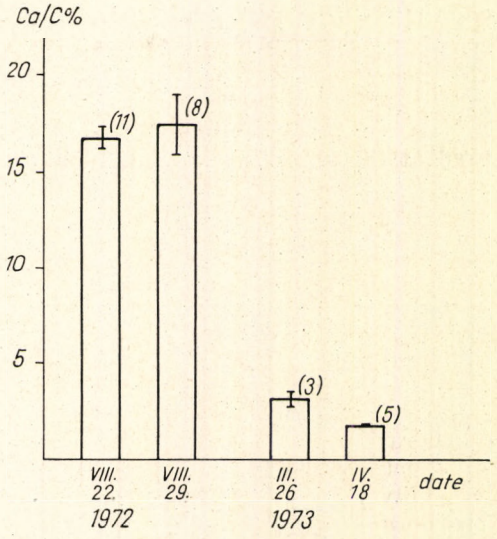

Fig. 2. The incorporation of *Eudiaptomus gracilis* fed on *Botrydiopsis* in the various seasons (in parenthesis the number of samples and S. E. M. are shown)

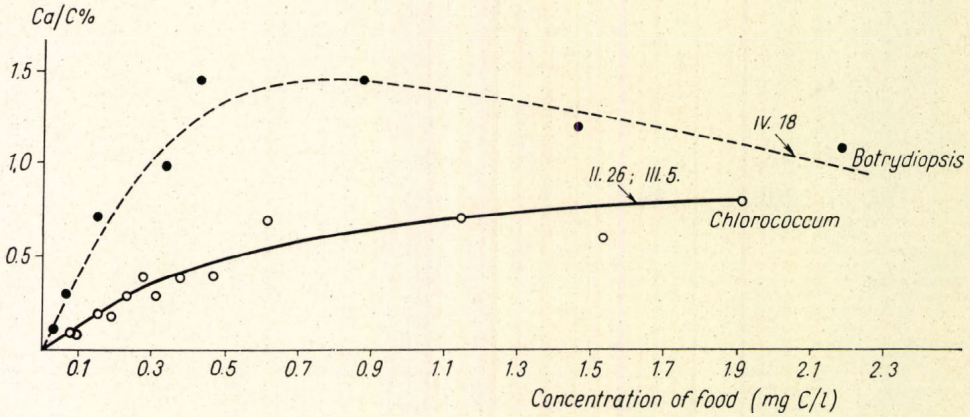

Fig. 3. The incorporation of *Eudiaptomus gracilis* depending on the concentration of food

the various states of acclimatization of the animals, consequently, their rate of incorporation differs. Furthermore, this may be explained by the seasonally changing metabolic conditions of the animals. KIBBY's investigations (1971) on the respiration of *Eudiaptomus gracilis* also seems to support this idea.

We may suppose that there are two types within the population of this crustacean species. One dominates in the summer with low fat and organic carbon content, the other one in winter with high fat and organic carbon content. In spring and autumn, depending on temperature, the populations may be mixed. The specimens of the two populations incorporate the food ingested to different extents because of the quantitative and qualitative difference in the food stored up in their bodies (FARKAS and HERODEK, 1960).

As for incorporation of *Eudiaptomus gracilis*, the optimal food concentration in winter is lower than in summer (P.-ZÁNKAI, 1973; P.-ZÁNKAI and PONYI, 1974). The saturation always ensued at a lower concentration of algae in winter. Under experimental conditions, however, the values of optimal food concentration both in winter and summer were much higher than the biomass values measured at the same time in Lake Balaton (HERODEK and TAMÁS, 1973; 1974).

Summary

The authors investigated the incorporation, at different temperatures, of *Eudiaptomus gracilis* fed on two species of algae *(Chlorococcum infusionum* and *Botrydiopsis minor)* obtained from pure cultures. They established:

1. The rate of incorporation, fed on both species of algae, varied between 17—18% in August and October (temperature 10—18 °C). From February to mid-April this rate was only 1—2% (temperature 4—10 °C).

2. The rate of incorporation of the animals sampled in winter and kept to become acclimatized to the experimental temperature, does not change essentially (3.2%).

3. In the cold-water period, the rate of incorporation of *Eudiaptomus gracilis* in Lake Balaton was optimal at a concentration of 0.2—0.4 mg C/l algae.

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AZ *EUDIAPTOMUS GRACILIS* TÁPLÁLÉKÉRTÉKESITÉSÉNEK ÉVSZAKOS VÁLTOZÁSAIRÓL

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Összefoglalás

A szerzők az *Eudiaptomus gracilis* táplálékértékesítését 2 tiszta tenyészetből származó algafaj etetése mellett *(Chlorococcum infusionum* és *Botrydiopsis minor)* vizsgálták eltérő hőmérsékleten.

Megállapították, hogy:

1. A táplálék értékesítés mindkét algafajjal való táplálás mellett augusztus, október és május hónapokban (hőmérséklet 10—18 °C) 17—18% között változott. Februártól áprilisig közepéig (hőmérséklet 4—10 °C) csak 1—2% volt.

2. A télen gyűjtött állatokat 4—6 napig laboratóriumi hőmérséklethez adaptálva a táplálék beépítésének mértéke nem változott lényegesen (3, 2%).

3. Hidegvízi időszakban a balatoni *Eudiaptomus gracilis* táplálékértékesítése 0,2—0,4 alga C mg/l koncentrációnál volt optimális.