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Fundamental aspects of the feeding of the amphipod Gammarus (R.) balcanicus (Crustacea, Amphipoda), Nauchn. Dokl. vyssh. Shkoly (Biol. Nauk.), No. 7, 12-16

Translated by J.E.M. Horne

The amphipods are major food items for many commercial fishes, and they are used as protein food for agricultural animals (3,10). Therefore the works of many authors are devoted to a study of the biology of this group of crustaceans, in particular the biology of their feeding. M.P. Borovitskaya (2), having studied the feeding of the amphipod Gammarus pulex, reports that it more willingly feeds on soft semi-decayed food, but consumes also fresh vegetation and midge larvae. Eating up leaves of trees, (primarily leaves of maple and lime), it eats out the pulp and leaves the fibres. A.S. Zybin (10) writes that G. lacustris, an omnivorous animal, feeds chiefly on decomposing plant residues, detritus, corpses of aquatic animals, daphnia, cyclopids, simple algae and higher plants. In experiments with G. lacustris (1) cannibalism is noted. According to the observations of N. Bikk (15), G. pulex fossarum in natural conditions eats leaves of trees: primarily large leaved lime, then hazel, black alder, and white beech. The feeding of the amphipod Gammarus balcanicus, widely distributed in water bodies of the Ukrainian Carpathians and the Pricarpathian, has not been adequately studied. Data on this problem lead to short communications by I.I. Dedyu (4) and N.S. Yalynskaya (14).

In the present paper are presented the results of four-year observations on the feeding of G. balcanicus in nature and in an aquarium. The experiments were carried out at a temperature of 17 - 18°C on animals adapted to laboratory conditions. Delivery and calculation of the food in the experiments were done by the method of V.I. Zhadin (5) and A.G. Kasymov (11), the weighing of the animals and maceration of the food by specially developed methods (7,9), with the error of weighing of the order of 1.93%.

Observations in the laboratory on young amphipods just emerged from the brood chamber determined that already by the end of the first day they usually found food - macerated leaves of lime, beech and other trees - and began to feed independently. Amphipods of two weeks growth, by our calculations, were able to eat 0.084 mg, and of a month's growth 0.21 mg of macerated beech leaves.

The consumption of food by adult amphipods depends on the sex and physiological state of the animal. The data of the experiments indicate this, as shown in Table 1. For the experiments in each group were selected 10 - 15 crustaceans which had lived under laboratory conditions for about a month. The mean weight of the crustaceans was 20 - 23 mg. Males, females without eggs and females with eggs, were transplanted separately and fed with macerated leaves of lime or beech.

Table 1

Dependence of daily food ration of adult amphipods on sex and physiological state.

Sex & physiological state of experimental animals	Consumption of food in 1 day, mg/g live wt of crustacean	
	Lime leaves	Beech leaves
Males	170 ± 60	32 ± 7
Females without eggs	695 ± 100	81 ± 10
Females with eggs	142 ± 30	19 ± 4

From Table 1 it follows that the greatest quantity of food was eaten by females without eggs. Possibly this is connected with the necessity of accumulation in the organism of energy reserves for the generation of eggs. The middle position in food consumption was taken by males. Therefore later experiments were carried out on males.

The rhythm of feeding of amphipods was studied in laboratory conditions on food of plant origin. For this we placed the animals under the objective of a stereoscopic microscope and conducted observations on the process of devouring food during 10 - 40 mins. The actual time of devouring the food and the duration of the rest period was recorded by a stopwatch, and with the help of analytical weights the quantity of food eaten was established. Besides this, experiments were conducted of duration from several hours to 26 days. Direct observations on feeding were conducted occasionally. The experiments showed that as with the young, so also the adult animals feed more or less rhythmically. Devouring of plant food lasts 10 - 20 min. In some cases during this time the animal has one or two one-minute rest periods. Then a pause sets in lasting from 20 min. to several hours. In all during a day the animal is eating plant food for 50 - 60 mins. Calculation based on 26 - day experiments on 228 animals (Table 2) shows that an adult male of weight 23 mg on average consumes in a day 4.99 mg of macerated lime leaves. At the same time direct observation under the microscope on five of the crustaceans showed that one animal during 20 mins of continued feeding on average was able to consume 1.85 mg of macerated lime leaves.

The minimum time for the passage of a lump of food through the whole alimentary tract is 45 mins. The speed of movement of the lump of food depends on the intensity of feeding of the animal, which in turn depends on the sort of food. The favourite kinds of food are eaten by the animal in the greatest quantity, and the speed of their passage through the alimentary tract increases. From observations in nature and laboratory experiments it was established that for the amphipod G. balcanicus the most suitable food was water-decayed leaves of lime, alder, hazel, hornbeam, poplar, maple, sycamore, beech, sometimes oak and others. The actual food coefficients* for several kinds of food were calculated. (Table 2). The data were treated statistically. Each of the values cited in the table appears as a weighted arithmetic mean, calculated by the formula for a compound population of mean arithmetic individual partial populations (13). Arising from this, that the value of normed deviation (t) characterizing the degree of confidence of the data even with 7 repetitions, attains 7.2, it is possible to affirm that the confidence of the food coefficient exceeds 99.9%.

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* weight of food consumed divided by increase in weight of an animal during a given time interval - Ricker [Translator's note]

Table 2

Feeding of amphipods on different kinds of plant food

Kind of food	Number of animals in experiment	Mean weight of 1 animal, mg	Daily consumption of food by 1 animal		Daily increase in weight by 1 animal		Daily consumption of food, mg per 1000 mg of wt of animal	Daily growth in wt mg per 1000 mg of wt of animal	Actual food coefficient			
			mg	% of body weight	mg	% of wt. of animal			Mean values (M)	No. of repetitions per day	Mean error	Normed deviation (t)
Macerated leaves of lime, alder, hornbeam & beech	166	24.85	4.52	18	0.22	0.88	182.33	8.86	34.84	13	4.7	7.4
Lime leaves	228	23.19	4.99	21	0.28	1.20	208.58	12.00	25.69	26	2.7	9.5
Alder "	265	32.63	5.45	17	0.37	1.13	167.70	12.12	24.66	22	3.4	7.2
Hornbeam "	199	31.47	2.86	9	0.28	0.88	91.12	9.21	12.40	25	1.4	8.9
Grey alder "	47	27.54	2.39	8	0.23	0.83	76.97	8.25	9.20	7	0.7	12.0

On the basis of the data of Table 2 it is possible to conclude that the amphipods prefer* mixed food, but of the different kinds of leaves, lime, then alder, hornbeam, and grey alder. The maximum daily growth in weight of the amphipods was recorded with feeding on leaves of lime and alder, the minimum on leaves of grey alder. This is indicated by the calculation of the consumption of food per 1000 mg weight of animals and the daily growth in weight of one animal as a percentage of its weight.

In a survey of leaves, skeletonised by amphipods, from different trees, it was noticed that at first the crustaceans eat the pulp, then the fine fibres, and only as a last resort the strong fibres. Leaves of sycamore and sharp-leaved maple which have fallen into the water are often infected with the fungus Rhitisma acerinum. In such cases the amphipods eat up just the place infected by fungus, and the more significantly infected and macerated the leaves, the greater the quantities in which the crustaceans eat them. This compelled us to verify whether the microorganisms themselves do not offer food value for the amphipods. In special experiments it was shown that the weight of microorganisms on the surface of leaves of lime, hornbeam and beech does not exceed 0.0003% of the weight of the leaves. Naturally, such a quantity of microflora cannot have food-value. Evidently, its role consists of softening the surface, above all of the thick layer of the leaf blade. This facilitates eating by the animals. Thus, the choice of plant food by the amphipods is dependent first of all on its mechanical toughness.

Besides food of plant origin, the amphipods G. balcanicus are also able to eat

* This appears to mean "do best on" (see mean value of actual food coefficient) in Table 2. [Translator's note]

animal food: they consume their own exuviae, corpses of amphipods and other animals. In the laboratory the amphipods always fed on animal food in the presence of the preferred kinds of plant food. As a distinctive feature the Balkan amphipod appears never to attack the preferred food actively, but eats only the food met in its path and touched with its antennae. Therefore it is difficult to visualize the amphipod attacking its victim. In the course of four years of observations on the life of the amphipods in the aquarium we must have seen only one case of an amphipod eating up another amphipod, alive, but motionless. Females often eat their own eggs from the brood chamber. Adult amphipods can eat young amphipods as yet slightly mobile, and also live larvae of chironomids and simulids.

The quoted cases of amphipods eating animal food were observed in the laboratory. But we think that also in nature these crustaceans from time to time feed on animal food. This confirms the data of I.I. Dedyu (4) and N.S. Yalynskaya (14). Unfortunately, we failed to show the importance of animal food for the amphipods. It is possible only to add that in laboratory conditions we raised the amphipods up to two months' growth only on one kind of plant food - macerated beech leaves.

Young amphipods, like the adults, are also able to feed on seston - pulverized food suspended in the water. We first drew attention to this, having seen that the alimentary tract in amphipods, which were not provided with plant or animal food, was always partially full of food. The water in the aquarium contained only the excrement of amphipods in a pulverized condition. In further experiments we placed amphipods in a weak solution of Indian ink. By the end of the 5th hour in all experimental animals the ink was filling half to three quarters of the whole length of the alimentary tract. For the first time the ability of amphipods to feed on seston was noted by Ponyi (16), having studied the feeding of G. roeseli. Later O.G. Reznichenko (12) showed that P. maeoticus can feed on food suspended in the water. Apparently also other representatives of the Gammaridae can feed on seston, although the structure of their mouth organs is not adapted for this.

The experiments showed that G. balcanicus has the ability for tropho-osmosis. They can absorb radio glucose from a medium, utilizing it with carbon dioxide, radiomethionine, included by means of biosynthesis in the composition of its soluble protein, and also a mixture composed of 15 different amino acids. In like manner are absorbed calcium-45 and phosphorus-32.

From what has been said, it follows that for the amphipod G. balcanicus and other studied gammarids, omnivorousness is characteristic. Usually they willingly feed on soft half-decayed plant residues; into their ration also enters food of animal origin. In contrast to other amphipods, G. balcanicus eats representatives of its own species very rarely, and only dead or immobile ones.

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Notice

Please note that these translations were produced to assist the scientific staff of the FBA (Freshwater Biological Association) in their research. These translations were done by scientific staff with relevant language skills and not by professional translators.