

## Feeding in *Neobisium muscorum* (Leach) (Arachnida:Pseudoscorpiones)

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### Summary

The results of laboratory feeding experiments with *N. muscorum*, using *Drosophila* as the prey species, are discussed and compared with other similar work. Mean food consumption of adult female *N. muscorum* at 15°C was 0.45 cal/ind/24h, 0.15 cal/mg/24h live weight. Assimilation efficiencies are also discussed.

### Introduction

Pseudoscorpions are predatory arthropods living in many diverse terrestrial habitats. They feed on other arthropods which they capture with their palpal chelae. Information on their predators and prey has been collected by Jones (1975), and Gilbert (1951) has studied food capture and feeding in four British species. In *Neobisium muscorum* (Leach) poison glands are present in the fixed finger of the chela, and the secretion from these glands serves to anaesthetise the prey when caught. When immobilized, the prey is transferred to the chelicerae, where mastication occurs and a digestive fluid is produced which serves to liquify prey tissue for ingestion. The cuticle of the prey is not utilized. After digestion, waste material is taken up by the post diverticular mid-gut epithelial cells, and transformed into excretory crystals which are thought to be composed of guanine (Gilbert 1952). These crystals are stored in a rectal pocket from which they are voided at intervals.

It would be expected from the knowledge of feeding and digestion in pseudoscorpions, that the assimilation efficiency, i.e. the ratio ( $\times 100$ ) between energy ingested as food and the energy eliminated as rejecta, would be high in *N. muscorum*. An attempt

was made to estimate the assimilation efficiency of this species by a series of feeding experiments which measured food intake, and by comparison with other data. The results are reported in this paper.

### Methods

Adults of *N. muscorum* were obtained from the field by extraction from beechwood leaf litter in a modified heat extractor. The litter was collected from Pond Wood (Grid. Ref. SP 835046) in the Chiltern Hills in southern England. The pseudoscorpions were kept singly in culture jars of the design recommended by Weygoldt (1969). Male vestigial wing *Drosophila melanogaster* Meigen were used as food, and every 24 h, 3-5 adult male *Drosophila* were weighed and placed in each culture jar. Any prey not seized within 24 h was removed and the number of *Drosophila* eaten was noted. The remains of the prey which had been attacked were removed, dried in a vacuum oven at 60°C and weighed. All weighings were made with an electro-microbalance sensitive to 0.1 µg. The individual pseudoscorpions were weighed each day.

The live weight: dry weight relationship for male *Drosophila* adults was found to be linear ( $y = 0.186 + 3.011x$ ,  $p > 0.001$ ) and an estimate of the dry weight of *Drosophila* offered daily to each pseudoscorpion was made. The feeding experiments were carried out at 5°C, 7°C and 15°C over a period of five weeks during the spring of 1973.

### Results and Discussion

Sufficient data for discussion were obtained only from the feeding experiment at 15°C (Table 1); at the lower temperatures feeding did not take place under the experimental conditions. Five adult female *N. muscorum* were kept for 35 days under the experimental conditions described above, and the results are given as an average over the period of the experiment. Of the five individuals used, three gained and two lost weight during the experiment. However, of the three that gained body weight, two died before the end of the experimental period.

The average daily calorific intake of the five adult female *N. muscorum* was calculated in the following way. The dry weight of *Drosophila* eaten by the pseudoscorpions was determined from the live weight: dry weight relationship previously calculated.

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Initial live weight of pseudo-scorpion mg	Final live weight pseudo-scorpion mg	Weight increase mg	Duration of experiment in days	Food killed dry weight mg	Food remains dry weight mg	Food consumed dry weight mg	Food consumed dry weight mg/24h	Calories consumed during experiment	Calories consumed per 24h	Calories consumed per mg per 24h
2.506	3.074	0.568	22 (died)	6.351	3.416	2.935	0.133	13.442	0.611	0.219
3.276	2.902	—	35	8.372	4.902	3.470	0.099	15.892	0.454	0.147
2.898	3.016	0.118	17 (died)	5.305	3.710	1.595	0.094	7.305	0.429	0.145
3.144	3.596	0.452	35	7.000	4.526	2.474	0.071	11.330	0.323	0.096
3.220	2.964	—	35	8.157	4.821	3.336	0.095	15.270	0.436	0.141
							Mean		Mean	Mean
							0.098		0.447	0.150

Table 1: Results of the feeding experiment at 15°C using 5 *Neobisium muscorum* adult females

In terms of dry weight, the food consumed by individual females ranged from 0.071 to 0.133 mg/24h over the period of the feeding experiment with an average of 0.98 mg/24h/ind. The calorific value of this food was calculated using a value of 4.65 cal/mg dry weight for male *Drosophila* given by Edgar (1971). This value was used by Edgar in similar feeding experiments with a wolf spider *Pardosa lugubris* (Walckenaer). The value of 4.27 cal/mg for the remains of *Drosophila* left after feeding was also used (Edgar 1971). Using these values, it was calculated that the mean calorific daily intake of *N. muscorum* adult females at 15°C was 0.45 cal/ind/24h, or 0.15 cal/mg/24h. Also the pseudoscorpions used in the experiments consumed 38.8% by weight of the food killed. It was also noted during the period of the experiment, that the pseudoscorpions did not feed regularly and would occasionally seize and kill prey, then reject it without feeding.

From an evaluation of the feeding experiments, and observations on pseudoscorpions kept in the laboratory on a mixed diet of soil arthropods, it is concluded that a feeding regime consisting entirely of *Drosophila* was not adequate for *N. muscorum*. Simon (1969) observed that *N. muscorum* adults took Collembola, particularly *Tomocerus* sp., in preference to any other food offered. Unfortunately, he did not state the choice of food offered, or the

order of preference in which it was taken.

During the present study, it was observed that the feeding response of the pseudoscorpions was initiated by the movement of the prey. The failure of the feeding experiments at 5°C and 7°C was probably due to the immobilisation of the *Drosophila* at these temperatures. Simon (1969), using *Tomocerus* sp. as prey, found that adults of *N. muscorum* did not feed below 5°C in the laboratory. Above this temperature, he estimated that the adults took three prey organisms each day. He calculated the daily food intake of adult *N. muscorum* as 2.7 mg fresh weight of *Tomocerus* sp. As the live weight: dry weight ratio for *Tomocerus* sp. is 3.9:1 (Block pers. comm.), and the calorific value is 6063 cal/g ash free dry weight (Cummins & Wuycheck 1971), Simon's data were used to find the mean calorific daily intake of *N. muscorum* fed on *Tomocerus* sp. This was calculated using the value found in the present study of 38.8% of food killed being ingested, and was 1.63 cal/ind/24h. This value was over 260% higher than the value of 0.45 cal/ind/24h calculated for the present study.

However, Simon's data do not distinguish between male and female *N. muscorum*, nor does he state the temperature at which his feeding studies were conducted. It is difficult, therefore, to evaluate if his feeding experiments using *Tomocerus* sp. gave a more

realistic value for the mean daily calorific intake than the value calculated in the present study for *N. muscorum* adult females.

During the present study, faecal output of *N. muscorum* was so small that it could not be measured, thus precluding an empirical estimate of assimilation efficiency. Some indication of assimilation efficiency in pseudoscorpions may be obtained by comparison with other invertebrate predators.

Lawton (1971) noted that high assimilation efficiencies were a general feature of invertebrate carnivores, and he recorded assimilation efficiencies of 83-91% for the larvae of the damsel fly *Pyrhosoma nymphula* (Sulzer), when fed on a variety of natural prey. Edgar (1971) was unable to estimate the energy lost as faeces and nitrogenous waste in *Pardosa lugubris*, and considered this loss to be negligible. *P. lugubris* feeds in a similar way to *N. muscorum*, i.e. there is preliminary digestion of the prey externally, and the food is ingested as a semi-fluid. Edgar argued that with this method of feeding only food that can be assimilated is ingested, and he assumed, therefore, that the assimilation efficiency of *P. lugubris* is 100%.

On this basis, very high assimilation efficiencies are to be expected for *N. muscorum*. However, to claim an assimilation efficiency of 100% cannot be justified, as both the wolf spider and pseudoscorpions possess functioning systems for the elimination of waste material. Due to the low elimination rates observed both for *P. lugubris* and *N. muscorum*, it is suggested that assimilation efficiencies in the region of 90-95% are feasible for both species.

These results emphasise the difficulties of laboratory feeding studies of small predatory arthropods

such as pseudoscorpions. For *N. muscorum*, it is concluded that *Drosophila* is not a satisfactory prey, and that future work on food consumption by pseudoscorpions must be undertaken using prey species from their natural habitat.

#### Acknowledgements

This work was financed by a Research Studentship from the N.E.R.C. I would like to thank Dr W. Block for his supervision and comments on this paper.

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