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RESULTS OF AN ARTIFICIAL FEEDING OF EGGS OF TAENIA SAGINATA GOEZE, 1782 TO VARIOUS BEETLE SPECIES

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Abstract. We confirmed in experiments with four beetle species —*Carabus granulatus* L., *Pterostichus vulgaris* (L.), *Aphodius fimetarius* (L.) and *A. luridus* (L.) — that these can carry and disseminate eggs of *Taenia saginata*. The eggs pass the digestive tract of these beetle species. Difficulties in entering the digestive tube proper have been explained by the presence of filtrating and triturating organs in the mouth parts of the beetles.

During studies on the epizootology and epidemiology of a mass incidence of cysticercosis in bovine animals, we considered among other factor insects as possible carriers of the eggs of *Taenia saginata*.

There is evidence in the earlier literature (Nicolle 1911 — ex Pawlowski and Shultz 1972, Shircore 1916, Sytsevskaya and Petrova 1958, Round 1961 and Nadzhafov 1967) that flies of the group Acalyptrata carry eggs of *Taenia saginata* both on their body surface and in their digestive tract, and that these remain infectious even after their passage through the tract. Other insect species examined from this point of view were two cockroach species (*Periplaneta americana* and *Blattella germanica*). Macfie (1922 — ex Pawlowski and Shultz 1972) and Round (1961) found that both cockroach species were capable of carrying eggs of *T. saginata* in their digestive tract.

Although a number of authors (Miller 1961, Miller et al. 1961, Szelagiewicz—Czosnek 1972, Kullmann and Navabi 1971, Kullmann et al. 1975, Bílý and Prokopič 1977) provided conclusive evidence for a carriage of eggs of other helminth groups in the digestive tract of beetles, there is little information in the literature on the importance of beetles in the epizootology of bovine cysticercosis.

In the present study we have concentrated mainly on the most common beetle species which any time may come into contact with the excrements of man. Apart from dung beetles, the most likely ones to acquire infection, we considered predatory (carnivorous) species attracted to faeces of various origin by an increased moisture and the presence of food (dung beetle larvae and flies). Of these species, we encountered at the sites investigated for a mass incidence of cysticercosis the species *Aphodius fimetarius* (L.), *A. luridus* (F.) and *Pterostichus vulgaris* (L.).

A direct infection might be acquired by several species of the families Carabidae and Histeridae in that they ingest a proglottid or part of it. This mode of infection has been demonstrated in earlier feeding experiments with eggs of *Moniezia expansa* to *Carabus granulatus*. Theoretically, these beetles might be infected by ingesting larave of dung beetles harbouring cestode eggs in their digestive tract. We took into consideration that the mouth parts of beetles are variously modified for filtration and trituration of the food in that they possess, e.g., ciliae or comminuting structures either catching or destroying helminth eggs and in this way preventing their entrance into the digestive tract (Bílý and Prokopič 1977).

MATERIALS AND METHODS

In the present experiments, we used two species of the family Carabidae: *Carabus granulatus* L. and *Pterostichus vulgaris* (L.), and two species of dung beetles of the family Scarabaeidae: *Aphodius fimetarius* (L.) and *A. luridus* (F.). In central Europe, these beetle species are among the most common members of their families, and were most abundant at the sites investigated for the mass incidence of cysticercosis. We used 100 specimens of each species. The beetles were placed on dry filter paper in Petri dishes and held for 24 hr at room temperature. Then, we transferred them in batches of 10 specimens to dry petri dishes. Eggs were fed differently to members of the two families. The first group of beetles (Carabidae) were fed in that a complete, mature proglottid of *T. saginata* was placed in each Petri dish containing 10 beetles. Having been held for 24 hr in a warm and dry environment, all beetles started to drain and ingest the proglottid. The feeding procedure chosen for the second group of beetles (Scarabaeidae) consisted in that a wohle proglottid was mixed with 1 cm^3 of human faeces, and the mixture was added to each Petri dish containing 10 beetles. Having consumed completely the mixture after 2—3 hr, all beetles were dissected and their digestive tract was examined with the microscope.

RESULTS

The results of our examination of experimentally infected beetles are given in Table 1. We found 5 positive specimens of the species *Carabus granulatus* (5 %). Of these, two contained one egg each of *Taenia saginata* in their digestive tract, two specimens two eggs each and one specimen 4 eggs.

Eggs of *Taenia saginata* were found in the digestive tract of 4 specimens of *Pterostichus vulgaris* (4 %) and that one egg each in three specimens, two eggs in one specimen.

We found 5 positive specimens of the species *Aphodius fimetarius* (5 %); of these, the digestive tract of one specimen contained 3 eggs, that of one specimen 2 eggs, one egg in one specimen and a destroyed egg each in the remaining 3 specimens. There were two positive cases (2 %) of *Aphodius luridus*, one carrying one egg, the other two eggs.

As a result of the mode chosen for the feeding of eggs to the beetles, the resulting indicence of infection and its intesity were 2—5 % and the maximum was 4 eggs in one specimen. Two specimens of *Aphodius fimetarius* contained destroyed eggs. Evidently various parts of the mouth of the beetles specialized for the filtration and trituration of

Table 1. Results of dissections of 4 beetle species infected experimentally with eggs of *Taenia saginata*

Species	No. of infected individuals	No. of positive individuals	No. of eggs recovered
Carabidae			
Carabus granulatus (L.)	100	(5) 1	1
		1	1
		1	2
		1	2
		1	4
Pterostichus vulgaris (L.)	100	(4) 1	2
		1	1
		1	1
Scarabaeidae		1	1
Aphodius fimetarius (L.)	100	(5) 1	3
		1	2
		1	1
		1	1 (destr.)
		1	1 (destr.)
Aphodius luridus (F.)	100	(2) 1	2
		1	1

the food prevented the helminth eggs from entering the digestive tract or assisted in their mechanical destruction. This was the case with four of the beetles examined which possessed in their mouth parts various organs designed for either filtration or destruction (ciliae, spines, small comminuting areas) (Plate I—IV). Oncospheres of *T. saginata* were not found in the digestive tract of these beetles.

DISCUSSION

As indicated by our results, the eggs of the cestode *Taenia saginata* fed experimentally to beetles entered sporadically the digestive tube proper of these beetles; in several cases, they were even destroyed. This has to be ascribed to activities of the well-developed filtrating and triturating organs in the mouth parts of these beetles. A similar situation, i.e., the destruction of helminth eggs or an impeded passage through the digestive tube of bettles (vectors and intermediate hosts) was described earlier by Miller (1961), Miller et al. (1961) and Bílý and Prokopič (1977).

We feel that even the rather low values obtained for the incidence and intensity of infection in beetles, although so far confirmed in experiments only, might also be of importance under natural conditions. An occasional incidence of cysticercosis in cattle with a low intensity of infection as reported, e.g., by Koudela (1969) and Koudela and Trefný (1971) might be explained by the fact that beetles or other invertebrates carrying eggs of *T. saginata* in their digestive tract are ingested by cattle on the pasture or by those fed with fresh fodder. Several other beetle species, e.g., the two species of the genus *Aphodius* used in our experiments, may carry eggs of *T. saginata* to distant sites because they are known to cover long distances in their flight. In this way, they participate in the spreading of the infection. Our findings suggest that also beetles may constitute a secondary source of infection. Our view has been supported by Pawlowski (personal communication) who suggested that the high percentage of cases recording a weak or medium high incidence of cysticercosis in cattle may be explained by an involvement of beetles.

РЕЗУЛЬТАТЫ ИСКУССТВЕННОГО КОРМЛЕНИЯ РАЗНЫХ ВИДОВ ЖУКОВ ЯЙЦАМИ *TAENIA SAGINATA* GOEZE, 1782

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Резюме. При экспрIментальном кормлении 4 видов жуков (*Carabus granulatus* L., *Pterostichus vulgaris* (L.), *Aphodius fimetarius* (L.) и *A. luridus* (E). яйцами *Taenia saginata* Goeze, 1782 было доказано, что последние могут проходить через пищеварительный тракт жуков и рассеиваться через их посредство. Трудное проникание яиц в пищеварительную трубку объясняется присутствием фильтровальных и разрушительных органов в ротовой полости изучаемых жуков.

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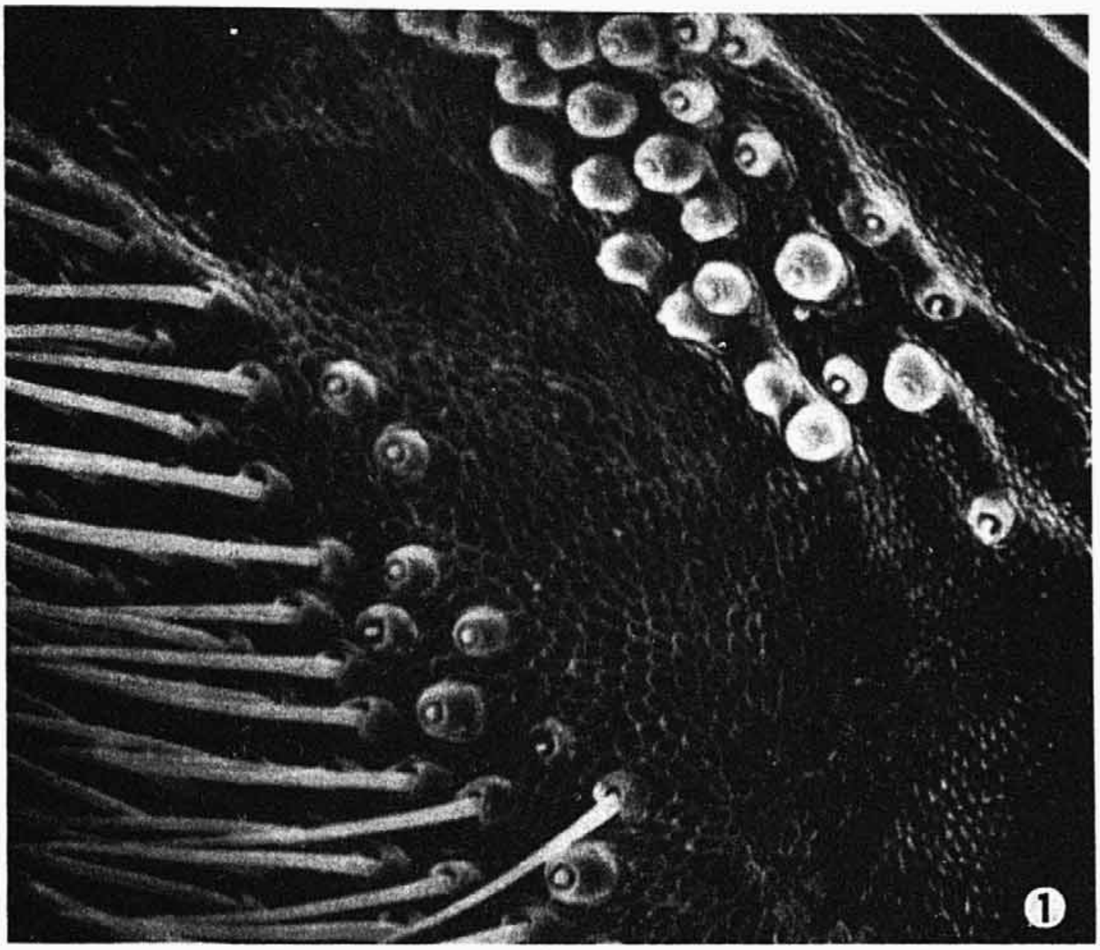


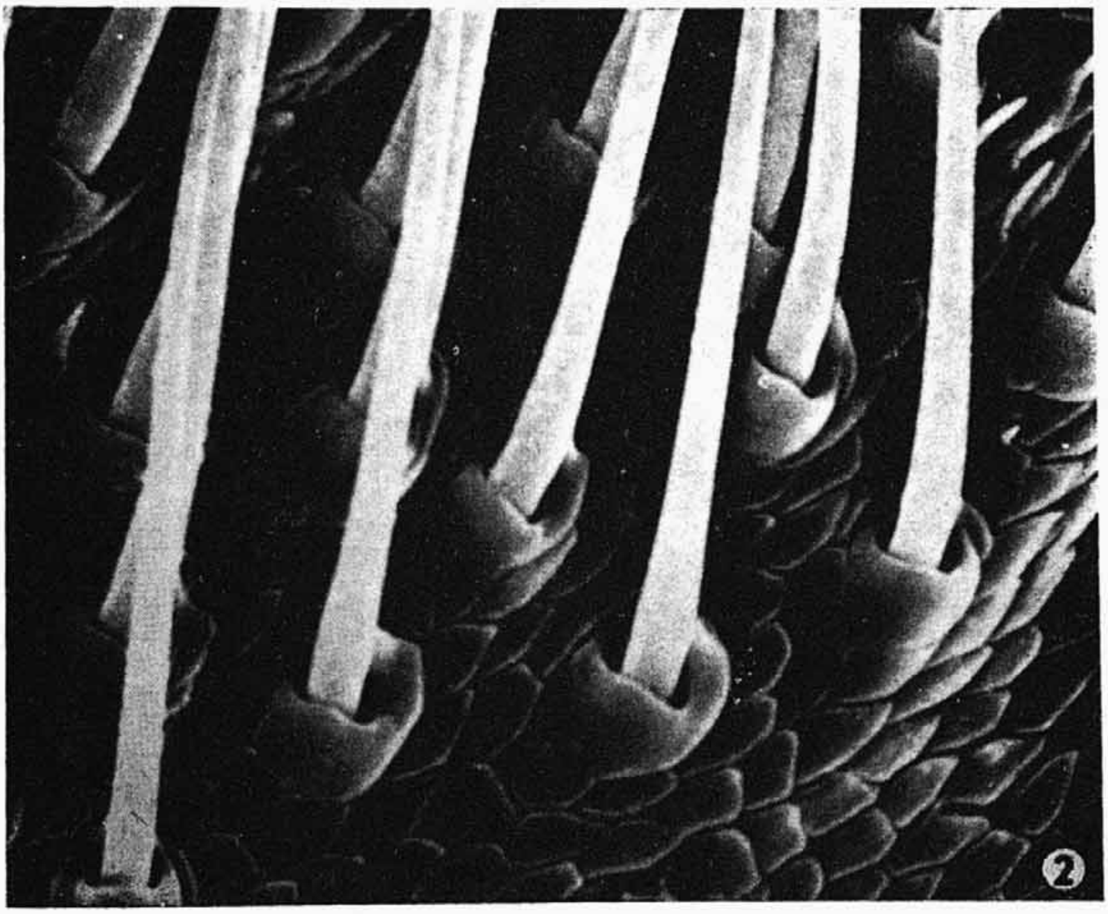
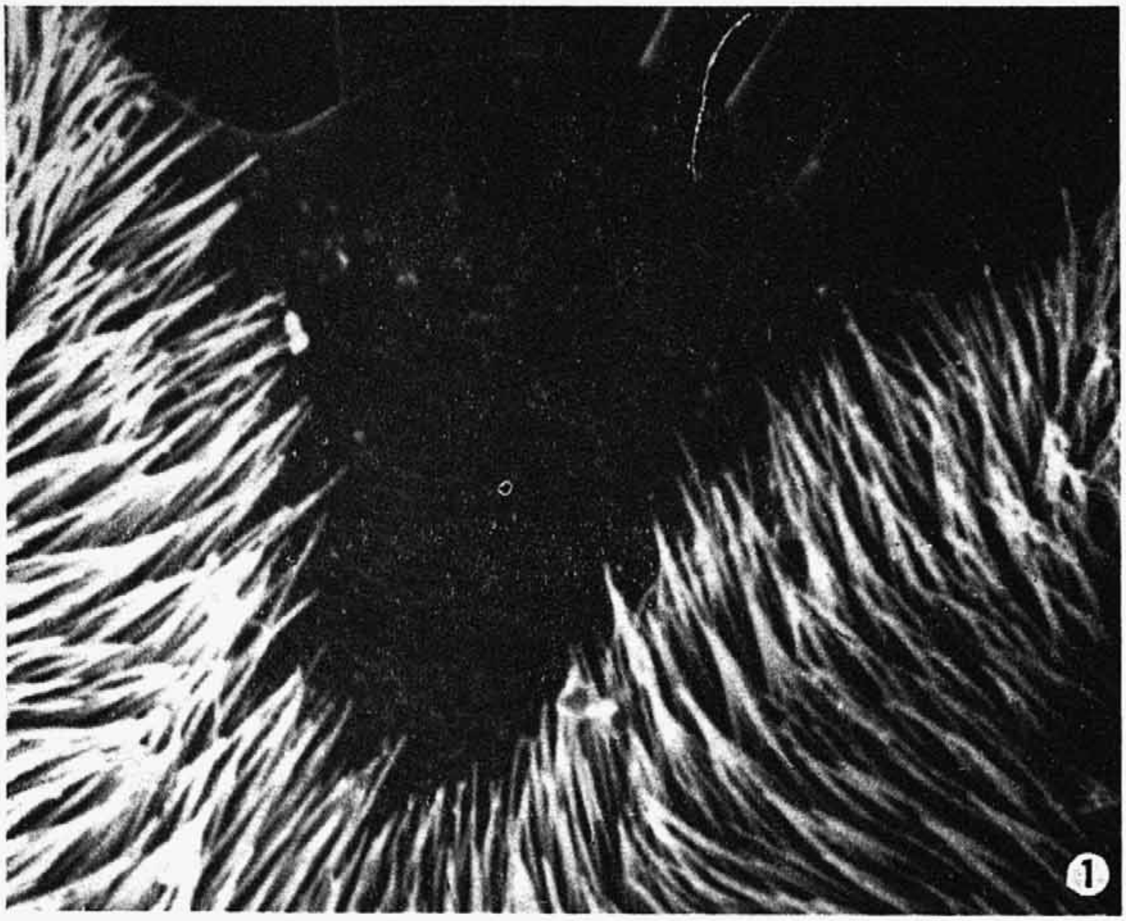


Fig. 1. *Carabus granulatus*, dorsal surface of epipharynx (660×).
Fig. 2. *Carabus granulatus*, dorsal surface of epipharynx (1100×).



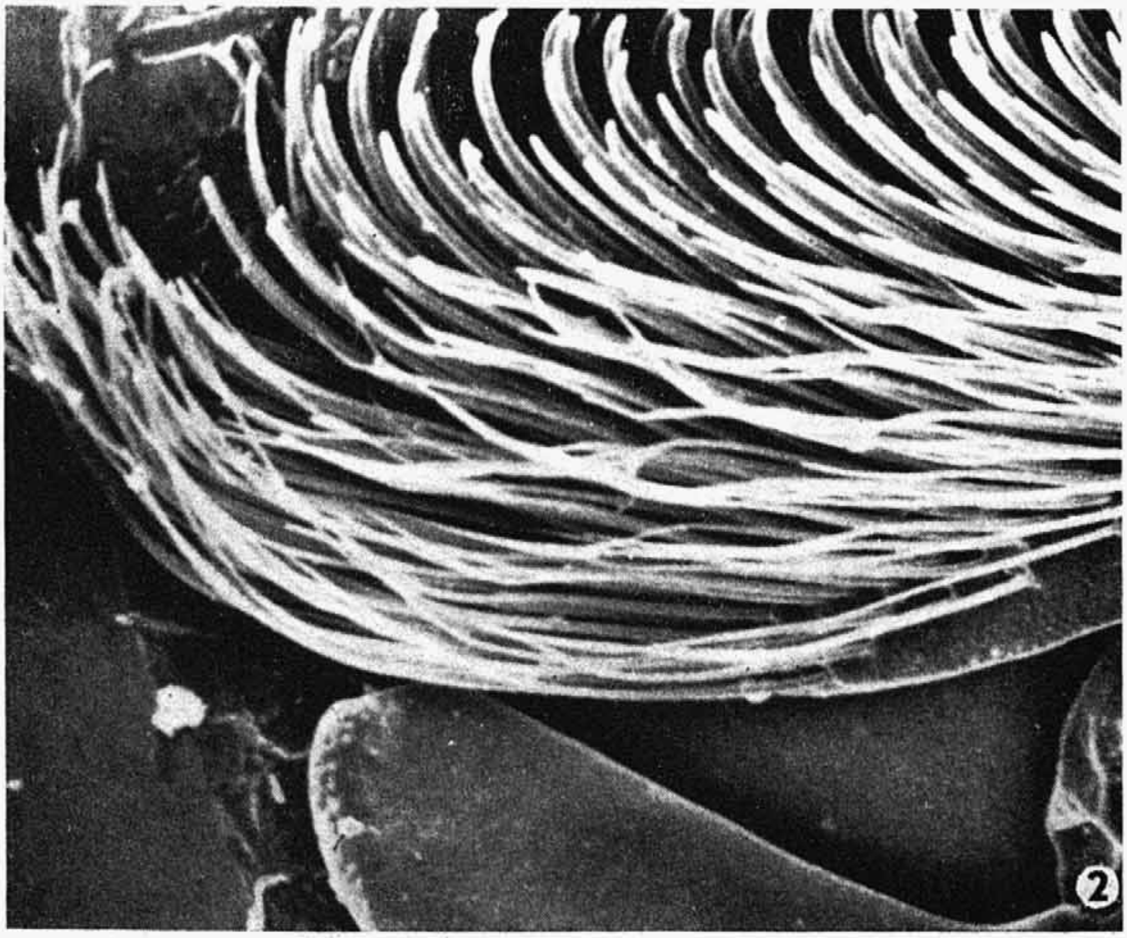
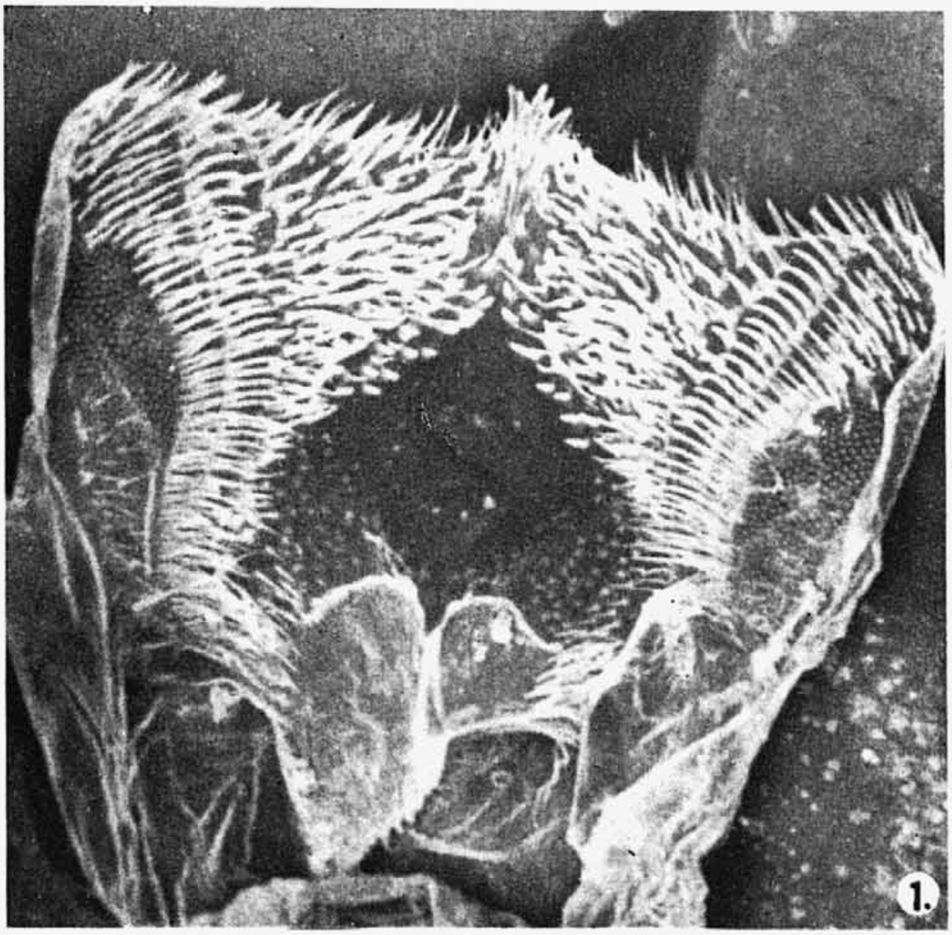


Fig. 1. *Carabus granulatus*, labium (585×). **Fig. 2.** *Carabus granulatus*, dorsal surface of maxilla (365×).



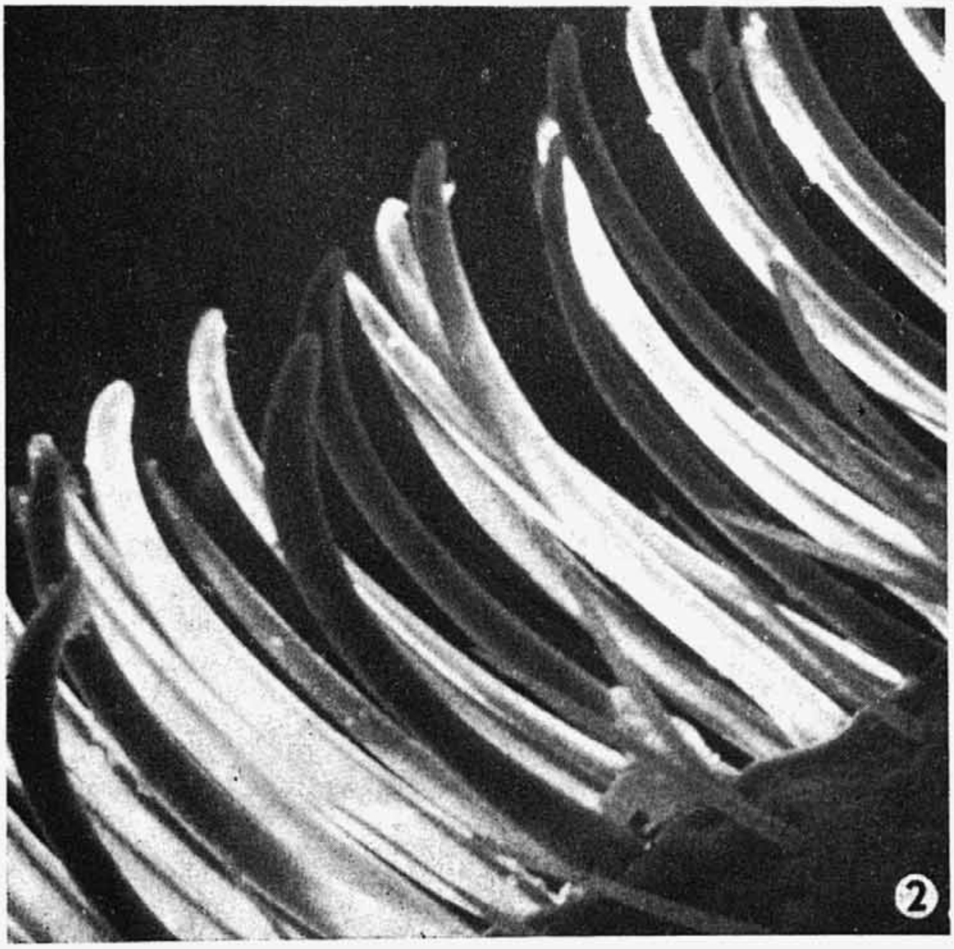
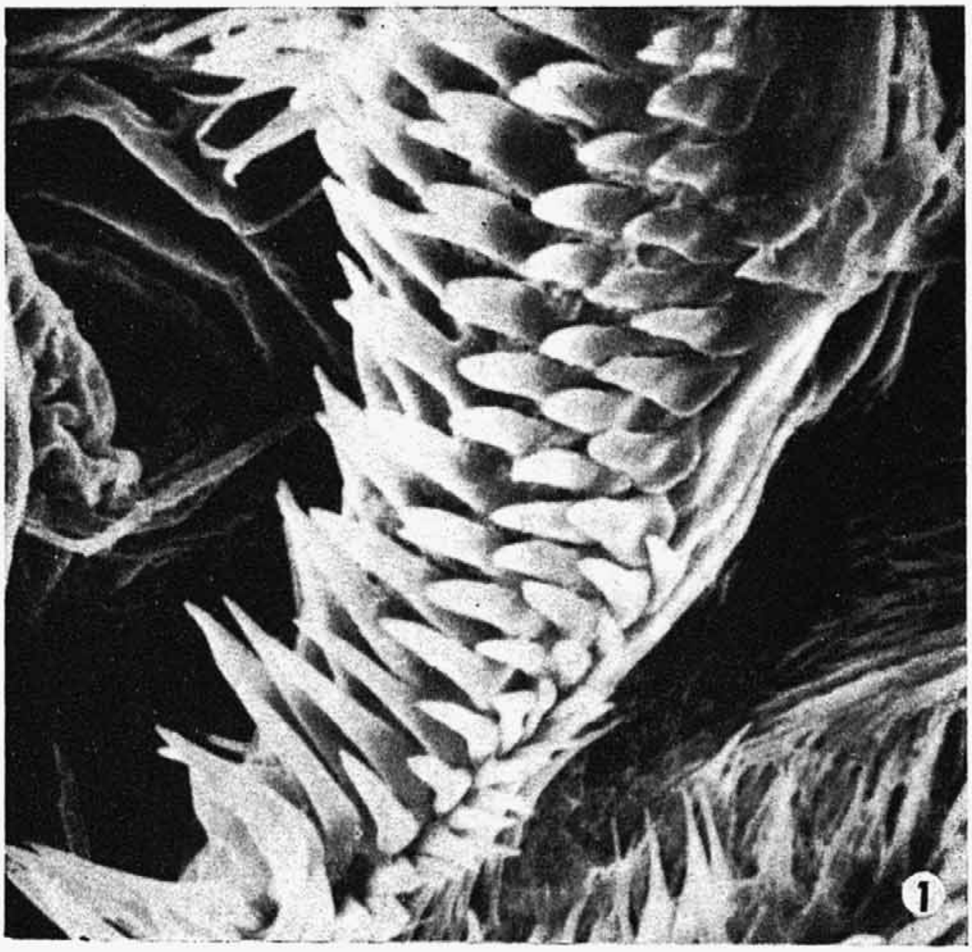


Fig. 1. *Carabus granulatus*, inner margin of maxilla (685×). **Fig. 2.** *Aphodius fimetarius*, dorsal surface of hypopharynx (610×).



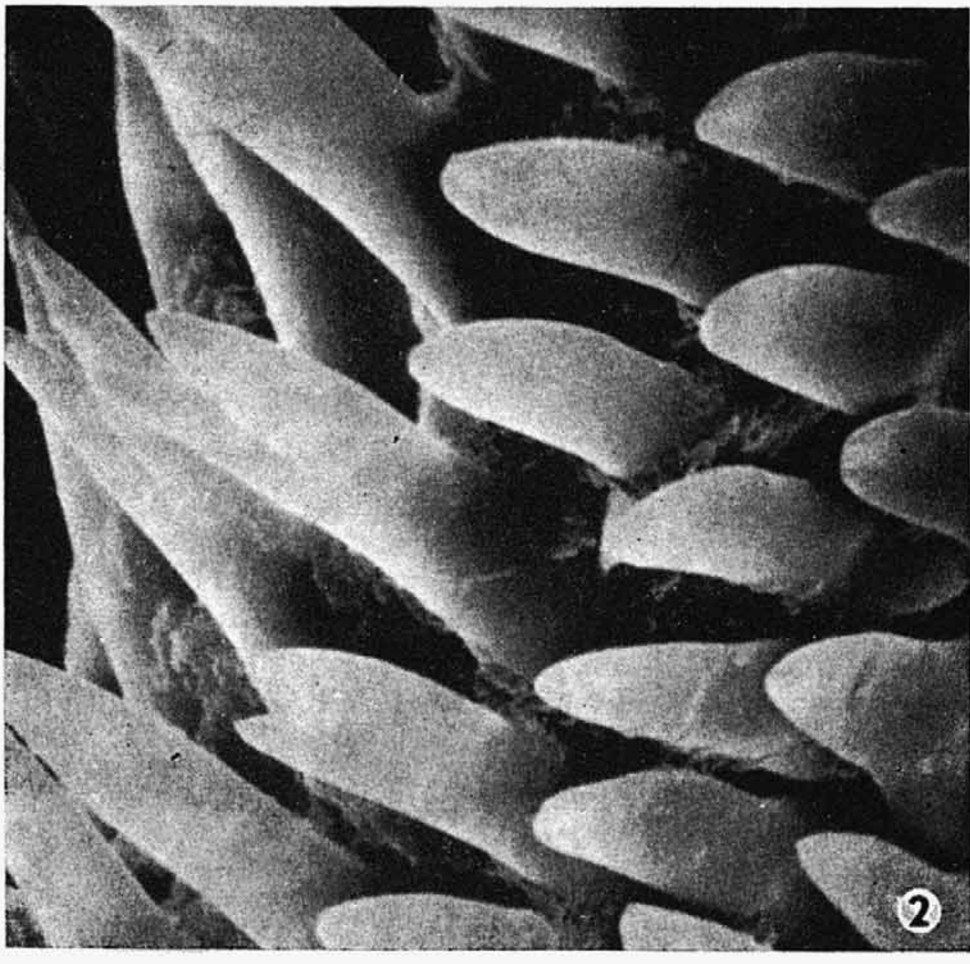


Fig. 1. *Aphodius fimetarius*, middle part of epipharynx (895×). **Fig. 2.** *Aphodius fimetarius*, middle part of epipharynx (1120×).