

Studies on the Rate of Excretion of *Aulacophora foveicollis* Lucas., the red pumpkin beetle (Coleoptera: Chrysomelidae)

Several workers (particularly NATION and PATTON¹ and RAMSAY²) have worked on the various aspects of excretory physiology of insects. But no extensive work seems to have been done on the rate of excretion. The rate of excretion of *A. foveicollis*, a phytophagous beetle, causing severe damage to the leaves of pumpkin (*Lagenaria siceraria* Standl.) has been studied.

Material and method. Individuals were collected from the field and kept in cages having green leaves, the peduncles of which were embedded in water kept in petri dishes. Experiments were conducted on both normally fed as well as on 24 h-starved insects separately at various temperatures ranging from 25 to 35°C. In both conditions, i.e. in normal and starved insects, 10 replicates (1 replicate = 10 individuals) were conducted. In each replicate individuals were kept in separate petri dishes.

Results and discussion. The beetle's rate of excretion depends on the rate of taking up food. It excretes continuously with intervals of 4–10 min. It commonly excretes all the 3 types of excreta: namely (a) liquid, (b) semi-solid and (c) solid. The first excretion is given out in the form of liquid drops which may be pure urine. After 5 min of urinal excretion, the beetle produces semi-solid and after 15–20 min solid excreta. The sequence: liquid, semi-solid and solid is not always true, because after a first sequence it can excrete either of the 3 types.

In normally fed individuals the following observations were made. (1) The frequency of solid excretion is higher than that of the other 2 types. (2) The total number of excretions in one replicate is approximately 44/h. (3) The mean interval between excretions is approximately 4–6 min. (4) The rate of excretion depends upon the temperature fluctuation in nature. At 35°C the rate was highest. (5) At 35°C only solid excreta are produced. This is due to the conservation of water, assisted by the cryptonephridial system of the insect³.

In 24 h-starved individuals, which become very sluggish, the following observations were made. (1) Only one type, i.e. solid excreta, is produced. (2) The number of solid excreta in one replicate is approximately 4/h. (3) The mean interval between excretions is about 13–16 min.

It is evident that this phytophagous beetle produces 3 types of excreta if normally fed, whereas starved individuals produce only solid excreta. Furthermore, all normally fed individuals produce excreta and at a higher rate than starved individuals of which only few excrete, probably as a consequence of the lack of food.

Zusammenfassung. Exkretionsrate und Konsistenz der Excreta normal gefütterter und hungertnder Individuen des phytophagen Käfers *Aulacophora foveicollis* Lucas. wurden untersucht. Alle normal gefütterten Käfer produzieren Excreta, normalerweise flüssige, halbfeste und feste, bei 35°C aber nur feste. Die Exkretionsrate gefütterter Käfer ist bedeutend höher als jene von Hungertieren, die entweder keine oder dann nur feste Exkreme ausscheiden.

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¹ J. L. NATION and R. L. PATTON, J. Insect Physiol. 6, 229 (1961).

² J. A. RAMSAY, J. exp. Biol. 35, 871 (1955).

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⁴ The authors are indebted to Prof. H. S. CHAUDHRY for providing necessary facilities for the work.

Flow Rate and Lipid Content of Thoracic Duct Lymph after Haemorrhage in Dogs

During the course of experiments on graded haemorrhage in dogs, it was noticed that after the loss of 45% of the blood volume the thoracic duct lymph became increasingly cloudy. No change was seen in the lymph of dogs bled 30% of their blood volume. This suggested a change in lipid content of the lymph in the former group. We have therefore measured the phospholipid, cholesterol and triglyceride concentrations in the thoracic duct lymph of dogs before and after these two grades of haemorrhage.

Method. Five healthy adult male mongrel dogs, which had been splenectomized 2 weeks previously, and which weighed between 15 and 20 kg, were used. Following a 24 h fast, each dog was anaesthetized as previously described by FURNEAUX¹. The thoracic duct of each dog was isolated at its junction with the jugular vein and cannulated with PVC tubing (O.D. 1.52 mm, I.D. 0.86 mm) for a distance of 1 cm.

The blood volume of each dog was estimated during an initial 2 h control period of observation; then 2 dogs were bled 30%, and 3 were bled 45%, of this blood volume via an arterial catheter over a period of 10 min.

Each dog received heparin (3 mg/kg of body weight) 2 h before, and again 1 h after the haemorrhage. Lymph

was collected for 30 min before and for three 30 min periods after the haemorrhage. The volume of each sample was measured, 0.5 ml aliquots were taken, and the remainder was injected i.v. into the dog.

The lymph samples were stored at –20°C until assayed. The methods of ZILVERSMIT and DAVIS², VAN HANDEL and ZILVERSMIT³, and BROWN⁴ were used to measure the phospholipid, triglyceride and cholesterol concentrations.

Results. The results are summarized in Tables I and II. In the 2 moderately bled dogs, the rate of lymph flow following the haemorrhage was unchanged from the control period (see Table I). The phospholipid and cholesterol concentrations were also unchanged, but the triglyceride concentrations fell.

¹ R. W. FURNEAUX, Am. J. vet. Res. 29, 1631 (1968).

² D. B. SILVERSMIT and A. K. DAVIES, J. Lab. clin. Med. 35, 155 (1950).

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Table I. Thoracic duct lymph lipid content and flow before and after haemorrhage

		Phospholipid mg/100 ml	Cholesterol mg/100 ml	Triglyceride mg/100 ml	Lymph flow ml/30 min
Dog 1	Control	131	154	31.3	15.3
	0-3 min	128	143	19.2	15.5
	30-60 min	122	147	19.6	14.9
	60-90 min	136	163	19.0	15.2
Dog 2	Control	123	135	33.8	14.8
	0-30 min	132	148	12.8	15.1
	30-60 min	124	136	15.6	14.7
	60-90 min	116	130	12.5	15.3

Table II. Thoracic duct lymph lipid content and flow before and after 45% blood volume haemorrhage

		Phospholipid mg/100 ml	Cholesterol mg/100 ml	Triglyceride mg/100 ml	Lymph flow ml/30 min
Dog 1	Control	126	166	10.6	15.2
	0-30 min	224	279	103.0	25.3
	30-60 min	169	208	10.4	16.5
	60-90 min	126	172	4.9	15.1
Dog 2	Control	128	125	366.0	14.8
	0-30 min	227	222	1690.0	24.7
	30-60 min	186	191	1060.0	17.3
	60-90 min	155	132	640.0	15.2
Dog 3	Control	178	196	18.1	14.7
	0-30 min	280	265	160.0	20.2
	30-60 min	202	207	19.0	26.4
	60-90 min	110	109	18.1	17.3

The results in the 3 severely bled dogs were strikingly different (Table II). In each dog the rate of lymph flow and the concentrations of all 3 lipid fractions increased after the haemorrhage. These changes were most marked in the sample taken during the 30 min period immediately following the haemorrhage. The peak triglyceride concentrations were between 4 and 10 times the corresponding values in the control period. The absolute quantities of each lipid fraction in the lymph were greatly increased after the haemorrhage.

Discussion. The reasons for the marked changes in the severely bled dogs are uncertain. In the normal animal, the lipoproteins in lymph are derived from the intestine after the ingestion of fat, from liver synthesis, and from capillary loss. In the anaesthetized, fasted animal, MORRIS⁵ found that the greater proportion of thoracic duct lymph comes from the liver and the intestine. It is possible that after severe haemorrhage the increase in lymph flow, and in its lipid content, is due to an increased rate of loss from capillaries. However, this mechanism would not account for the striking rise in the triglyceride concentration during the 30 min after the severe haemorrhage (Table II).

CHALMERS et al.⁶ have demonstrated a marked fall in the rate of blood flow through the portal vein after haemorrhage in the rabbit. In this laboratory, we have observed similar changes in the dog using the same experimental model as in the present study. Thus it seems probable that the present findings are associated with an acute reduction in the rate of intestinal and hepatic blood flow following loss of 45% of the blood volume.

Such acute, severe changes in blood flow through both of these regions may increase the rate of release of triglyceride as lipoprotein into the lymph – from hepatic synthesis, capillary transudation, or as a result of cellular damage. The first two possibilities seem unlikely, since similar but less marked changes would be anticipated in the moderately bled animal. These were not found. We therefore believe that the changes were associated with cellular damage within the liver or intestine.

Zusammenfassung. Die Fließgeschwindigkeit der Lymphe im ductus thoracicus und der Gehalt an Phospholipiden, Cholesterin und Triglyceriden wurde vor und nach akutem Blutverlust in anaesthetisierten, splenektomierten Hunden bestimmt. Vor allem nach grossen Blutverlusten wurde eine starke Erhöhung des Lipidgehaltes der Lymphe nachgewiesen.

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