

Zeitschrift:	Acta Tropica
Herausgeber:	Schweizerisches Tropeninstitut (Basel)
Band:	35 (1978)
Heft:	3
Artikel:	Excretion of uric acid and amino acids during diuresis in the adult female "Glossina morsitans"
Autor:	Moloo, S.K.
DOI:	https://doi.org/10.5169/seals-312387

Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

Conditions d'utilisation

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

Download PDF: 29.01.2026

ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>

Tsetse Research Laboratory, University of Bristol, School of Veterinary Science,
Langford, Bristol BS18 7DU, England

Excretion of uric acid and amino acids during diuresis in the adult female *Glossina morsitans*

S. K. MOLOO

Summary

Radiometric analysis was carried out on the urine collected for one hour following feeding of the adult female *Glossina morsitans* on day 1 of a pregnancy cycle, which had previously received haemocoelic injections of U-¹⁴C labelled arginine, histidine, leucine, lysine, phenylalanine, threonine, tyrosine or valine. Mean radioactivity in the urine was quite high after labelled arginine (17.4% of injected activity) and histidine (21.8%) administration, most of the activity being in the amino acid fractions. With the remaining six labelled amino acids, mean radioactivity in the urine varied between 1.6 and 7.2% of injected activity, most of this activity occurred in a non-amino acid fraction (probably uric acid), though low radioactivity was also detected in a range of essential as well as non-essential amino acids.

Key words: *G. morsitans*; diuresis; excretion of uric acid and amino acids.

Introduction

Although uric acid is the main nitrogenous waste product in *Glossina*, the amino acids arginine and histidine also make up a substantial proportion of the dry weight of its excreta (Bursell, 1965). This observation has since been confirmed in other tsetse species, and it has further been demonstrated that amino acids other than arginine and histidine are also present in the excreta of this insect though in very small amounts (Moloo et al., 1974; Balogun, 1974a; 1974b). After the ingestion of a blood-meal a substantial amount of water is excreted very rapidly (Lester and Lloyd, 1928; Bursell, 1960; Moloo and Kutuza, 1970), and the present study examines the elimination of uric acid and

Correspondence: S. K. Moloo, International Laboratory for Research on Animal Diseases (ILRAD), P.O. Box 30709, Nairobi, Kenya

amino acids during this diuretic process which continues for about one hour after feeding.

Materials and methods

G. morsitans were obtained from the self-supporting goat-fed colony maintained in this laboratory (Nash et al., 1971). The experiments were undertaken with female flies on day 1 of their second pregnancy cycle, which were collected as previously described by Langley and Pimley (1974). All experimental flies were fed on goats and kept at 25° C.

Adult female flies, five in each case, were individually injected through the thoracic cuticle with 2 μ l of U-¹⁴C labelled arginine (specific activity = 318 mCi/mmole), histidine (324), leucine (311), lysine HCl (318), phenylalanine (477), threonine (232), tyrosine (522) or valine (265) (Radiochemical Centre, Amersham). The radioactive concentration of the above labelled amino acids was the same at 0.05 μ Ci/ μ l. Following injections, the flies were fed and kept singly in scintillation vials each containing a filter paper disc for the collection of urine. One hour after feeding, the urine was individually eluted from the filter paper discs with 2 ml of distilled water. Total ¹⁴C-activity was determined in each sample, after which the amino acid fraction was separated using a column of Zerolit 225 and radioactivity determined. As this insect is largely uricotelic (Bursell, 1965), the difference between the total radioactivity and that in the amino acid fraction of the urine was taken to be the activity in the uric acid. Details of the general procedure have been described elsewhere (Moloo, 1976a).

In another series of experiments, using three flies for each labelled amino acid, urine was eluted from the filter paper discs with 50% methanol, filtered (Millipore, 0.45 μ m), and the pooled sample was dried in vacuo. The dry sample was redissolved in 100 μ l of 80% methanol; a 50 μ l sample was subjected to chromatographic separation of amino acids. Another 50 μ l sample was co-chromatographed with a standard mixture of amino acids and radioactivity in various amino acids was determined using liquid scintillation techniques as previously described (Moloo, 1976a).

Results

Table 1 shows radioactivity in the urines, expressed as mean counts/min/fly, collected for one hour after feeding which followed the haemocoelic administration of different labelled amino acids. This table also shows the distribution of radioactivity between uric acid and amino acid fractions of the urines. It is apparent that ¹⁴C-activity in the urine was considerably higher after the administration of arginine (17.4% of the injected activity) or histidine (21.8%) than that recorded for the remaining six labelled amino acids. Of the latter, the elimination of threonine-derived radioactivity in the urine was relatively quite high while ¹⁴C-activity recorded after injections of the other five labelled amino acids was low at between 1.6 and 3.1% of the injected activity. Almost all the radioactivity was in the amino acid fraction after labelled arginine or histidine administration. Proportionate radioactivity in the amino acid fraction was markedly high after labelled valine administration (14.6% of the total recovery in the urine), but in the case of the remaining five amino acids more than 90% of the radioactivity was in the uric acid fraction of the urine. Amino acids identified in the pooled urine were alanine, arginine, glycine, histidine, leucine/ isoleucine, lysine, methionine, proline and valine.

Table 1. Radioactivity in the urine of *G. morsitans* females and its distribution in the uric acid and amino acid fractions after haemocoelic injections individually of eight U-¹⁴C amino acids followed by feeding

U- ¹⁴ C amino acid injected	Counts/min in urine $\bar{x} \pm se$	Per cent of injected activity	Uric acid %	Amino acid %
Arginine	30,473 \pm 5,542	17.4	0.4	99.6
Histidine	38,060 \pm 4,625	21.8	0.1	99.9
Leucine	3,320 \pm 226	1.6	97.0	3.0
Lysine	3,387 \pm 357	1.9	93.5	6.5
Phenylalanine	3,069 \pm 272	1.6	96.8	3.2
Threonine	12,938 \pm 1,939	7.2	94.2	5.8
Tyrosine	4,396 \pm 565	2.3	98.6	1.4
Valine	6,249 \pm 646	3.1	85.4	14.6

Table 2. Distribution of ¹⁴C-activity in various amino acid fractions from the pooled urine of *G. morsitans* females, co-chromatographed with a standard mixture of amino acids, after haemocoelic injections individually of eight U-¹⁴C amino acids followed by feeding

Amino acid	Counts/min**	%
Alanine	180	0.5
Arginine*	16,760	48.9
Aspartic acid	80	0.2
Cystine/Cysteine	—	—
Glutamic acid	90	0.3
Glycine	100	0.3
Histidine*	13,900	40.6
Leucine*/Isoleucine	400	1.2
Lysine*	180	0.5
Methionine	—	—
Phenylalanine*	160	0.5
Proline	520	1.5
Serine	60	0.2
Threonine*	100	0.3
Tyrosine*	210	0.6
Valine*	1,500	4.4
Total	34,240	100.0

* U-¹⁴C amino acids injected

** Radioactivity above background

Table 2 shows the distribution of radioactivity in various amino acid fractions from the 50 μ l sample of the pooled urine (co-chromatographed with a standard mixture of amino acids) of 24 female flies. The highest ¹⁴C-activity was recorded in arginine (48.9% of total recovery) followed by that in the histidine fraction (40.6%). Apart from methionine and cystine/cysteine, radioactivity was also detected in the other amino acids, of which that in valine (4.4%) and proline

(1.5%) was higher than in the remaining fractions. It is of interest that radioactivity was recorded in a range of non-essential amino acids in the urine within about one hour after administration of the labelled essential amino acids.

Discussion

The elimination of large quantities of arginine and histidine is a characteristic feature of the excretory physiology of *Glossina*. These two amino acids are eliminated quantitatively in relation to their concentration in blood-meals ingested by male tsetse, supposedly because the metabolic cost of their deamination is quite high (Bursell, 1965). In the female fly, however, these two amino acids are utilized in the synthetic processes associated with larval nutrition, there being a smaller surplus for elimination during late pregnancy when protein synthetic activity is high (Moloo, 1977a). In the present study the female flies used were on day 1 of a pregnancy cycle when there was little metabolic demand for these two amino acids (Moloo, 1976b; Moloo, 1977a), so that substantial amounts of the injected radioactive arginine and histidine were eliminated very rapidly in the urine during diuresis. This is suggestive of a rapid diffusion of arginine and histidine into the Malpighian tubules during diuresis. It is likely that other amino acids also diffuse into the urine, but that these would be resorbed by the rectal glands for return to the haemolymph, hence the very low radioactivity recorded in amino acids other than arginine and histidine in the urine.

The excretion of specific amino acids is probably an adaptation to specific diets. In the carpet beetle, *Attagenus piceus*, the sulphur-containing amino acid, cystine, accounts for a considerable proportion of excretory nitrogen (Powning, 1953), but since its keratin diet has a high cystine content its presence in the excreta probably represents a faecal material rather than excretory product (Bursell, 1967). Haematophagous insects, whose diet contains a high proportion of nitrogen-rich amino acids may eliminate these unchanged as is the case with tsetse (Bursell, 1965; Balogun, 1974; Moloo, 1977a) and to some extent with mosquito species (Irreverre and Terzian, 1959). However, in the case of the blood-sucking hemipteran, *Rhodnius prolixus*, a number of amino acids have been detected in the excreta but together making up only 0.2% of the total dry weight, with histamine and histidine predominant among them (Wigglesworth, 1931; Harrington, 1956; 1961).

The present study has also revealed that the metabolism of other amino acids, such as leucine, lysine, phenylalanine, threonine, tyrosine and valine, results in the elimination of uric acid as nitrogenous waste. After their injections into the haemolymph, radioactivity was detected mainly in the uric acid fraction of the urine within one hour of diuresis though low activity was also recovered in the amino acid fraction. In view of the fact that the food of this insect is vertebrate blood which contains about 95% proteins by dry weight, the

appearance of very small quantities of a variety of amino acids other than arginine and histidine in the urine probably represents a loss rather than an excretion of amino acids, particularly at diuresis when copious amounts of water from the blood-meal is eliminated. It has been demonstrated that this insect can synthesize a range of non-essential amino acids from leucine, lysine, phenylalanine, threonine, tyrosine or valine (Moloo, 1976c; 1977a; 1977b; 1977c), but not from arginine or histidine (1977a). It is of interest that a small proportion of most of the non-essential amino acids synthesized from at least a few of the injected former ones were also lost during diuresis. The present study has thus served to illustrate that during diuresis *G. morsitans* excretes nitrogen-rich arginine and histidine, loses very small quantities of a range of other amino acids, and excretes a non-amino acid material (probably uric acid) which has been formed from several of the amino acids studied.

Acknowledgments. I thank Dr. P. A. Langley for his comments on the manuscript, and am grateful to the U.K. Ministry of Overseas Development for a research grant.

- 1 Balogun R. A.: Amino acids in the excreta of the tsetse fly, *Glossina palpalis*. *Experientia* (Basel) 30, 239–240 (1974a).
- 2 Balogun R. A.: Studies on the amino acids of the tsetse fly, *Glossina morsitans*, maintained on *in vitro* and *in vivo* feeding system. *Comp. Biochem. Physiol.* 49A, 215–222 (1974b).
- 3 Bursell E.: Loss of water by excretion and defaecation in the tsetse fly. *J. exp. Biol.* 37, 689–697 (1960).
- 4 Bursell E.: Nitrogenous waste product of the tsetse fly, *Glossina morsitans*. *J. Insect Physiol.* 11, 993–1001 (1965).
- 5 Bursell E.: The excretion of nitrogen in insects. In: *Advances in insect physiology*, Vol. 4, 33–67 (1967).
- 6 Harrington J. S.: Histamine and histidine in excreta of the blood-sucking bug, *Rhodnius prolixus*. *Nature* (Lond.) 178, 268 (1956).
- 7 Harrington J. S.: Studies on the amino acids of *Rhodnius prolixus*. II. Analysis of the excretory material. *Parasitology* 51, 319–326 (1961).
- 8 Irreverre F., Terzian L. A.: Nitrogen partition in excreta of three species of mosquitoes. *Science* (N.Y.) 129, 1358–1359 (1959).
- 9 Langley P. A., Pimley R. W.: Utilization of U-¹⁴C amino acids or U-¹⁴C protein by adult *Glossina morsitans* during *in utero* development of larva. *J. Insect Physiol.* 20, 2151–2170 (1974).
- 10 Lester H. M. O., Lloyd L.: Notes on the process of digestion in tsetse flies. *Bull. ent. Res.* 19, 39–60 (1928).
- 11 Moloo S. K.: Nutrition of *Glossina morsitans*: metabolism of U-¹⁴C glucose during pregnancy. *J. Insect. Physiol.* 22, 195–200 (1976a).
- 12 Moloo S. K.: Storage of nutriments by adult female *Glossina morsitans* and their transfer to the intra-uterine larva. *J. Insect. Physiol.* 22, 1111–1115 (1976b).
- 13 Moloo S. K.: Nutrition of *Glossina morsitans*: metabolism of U-¹⁴C threonine during pregnancy. *Acta trop.* (Basel) 33, 133–142 (1976c).
- 14 Moloo S. K.: Aspects of the metabolism of U-¹⁴C arginine, U-¹⁴C histidine and U-¹⁴C lysine by adult female *Glossina morsitans* during pregnancy. *Comp. Biochem. Physiol.* 57B, 23–26 (1977a).
- 15 Moloo S. K.: Metabolism of U-¹⁴C leucine and U-¹⁴C valine by adult female *Glossina morsitans* during pregnancy. *J. Insect Physiol.* 23, 491–495 (1977b).

- 16 Moloo S. K.: Metabolism of U-¹⁴C-phenylalanine and U-¹⁴C-tyrosine by females of *Glossina morsitans* Westwood (Diptera: Glossinidae) during pregnancy. Bull. ent. Res. 67, 651–657 (1977c).
- 17 Moloo S. K., Kutuza S. B.: Feeding and crop emptying in *Glossina brevipalpis* Newstead. Acta trop. (Basel) 27, 356–377 (1970).
- 18 Moloo S. K., Langley P. A., Balogun R. A.: Amino acid synthesis from glucose-U-¹⁴C in *Glossina morsitans*. J. Insect Physiol. 20, 1807–1813 (1974).
- 19 Nash T. A. M., Jordan A. M., Trewern M. A.: Mass rearing of tsetse flies (*Glossina* spp.): recent advances. In: Sterility principle for insect control or eradication, p. 99–110. IAEA, Vienna 1971.
- 20 Powning R. F.: Studies on the digestion of wool by insects. VIII. The significance of certain excretory products of the clothes moth, *Teneola bisselliella*, and the carpet beetle, *Attagenus piceus*. Aust. J. biol. Sci. 6, 109–117 (1953).
- 21 Wigglesworth V. B.: The physiology of excretion in a blood-sucking bug, *Rhodnius prolixus* (Hemiptera, Reduviidae). J. exp. Biol. 8, 411–451 (1931).