Z. Säugetierkunde 58 (1993) 191–193
© 1993 Verlag Paul Parey, Hamburg und Berlin
ISSN 0044-3468

WISSENSCHAFTLICHE KURZMITTEILUNGEN

Biometrics of the digestive tract of three species of Ctenodactylidae: comparison with other rodents

By P. Gouat

Laboratoire d'éthologie, Université C. Bernard, Lyon, France

Receipt of Ms. 1. 6. 1992
Acceptance of Ms. 6. 11. 1992

There are two major problems for rodents living in a hot desert. Firstly, high temperatures and secondly, the scarcity of water which necessitates a very careful conservation of body fluids. For these reasons, the majority of small mammals living in the Sahara desert are nocturnal (Happold 1984). One of the major exceptions to this are the gundis (*Ctenodactylus gundi, Ctenodactylus vali* and *Massoutiera mzabi*) which are diurnal (Gouat 1991). These species are primarily herbivorous (Gouat 1988). Grenot (1974) has suggested that gundis possess a very powerful renal function in order to maintain their water balance in equilibrium. The physiological studies performed on *C. vali* (Rouffignac et al. 1981) and *M. mzabi* (George 1987) have not shown major anatomical or physiological renal adaptations in these species when compared with other desert rodents. As suggested by George (1987), behavioural adaptations to temperature do exist but they are not sufficient to explain how these species can survive in an arid climate (Gouat 1991).

Considerable amounts of water may be lost with the faeces. As compared with other rodents and as a general rule, desert rodents emit dry faecal pellets (Ghobrial and Nour 1975). In fact, gundis defaecate very dry pellets (Gouat 1992), and this study suggests that water absorption along the large intestine is very important. The hypothesis concerning an adaptation of the digestive tract of ctenodactylids for this purpose was tested by an anatomical study. This study included comparisons with other rodents: a laboratory herbivorous rodent, the guinea pig (*Cavia porcellus*) and two omnivorous nocturnal rodents, *Meriones libycus*, a desert rodent, and *Meriones shawi*, a rodent living in a less arid climate (Petter 1961).

Animals were kept in the laboratory before being sacrificed for dissection. The specimens of *C. gundi, M. shawi, M. libycus* and *C. porcellus* were bred in the laboratory. The specimens of *C. vali* were captured in the Saoura basin (Algeria), and those of *M. mzabi* were collected in the Mzab (Algeria). The body length (measured from tip of nose to base of tail) of all specimens was determined prior to dissection. The mesentery was removed and the intestines unwound and placed outside the abdominal cavity. A photograph with two orthogonal scales was taken of each dissection. The lengths of three different sections were measured: the small intestine (from stomach to caecum); the caecum; the large intestine (from caecum to anus). Each intestinal section was measured from the picture using a curvometer adjusted by means of the two scales. The total length of the gut is defined as the sum of large and small intestine plus caecum. The number of animals used and absolute intestinal measurements are presented in table 1.

To allow for direct comparisons, these measurements were transformed into relative proportions (Perrin and Curtis 1980). Figure 1 shows the combination of the two most pertinent values of the analysis: relative total length of the gut as a proportion of body

U.S. Copyright Clearance Center Code Statement: 0044-3468/93/5803-0191 $ 02.50/0

Table 1. **Biometrics of the gut of five species of rodents**
All lengths are given in cm

		BL	LI	CA	SI
Ctenodactylus gundi	mean	18.41	91.97	13.20	65.35
N = 15	S.D.	3.25	20.41	3.05	16.28
Ctenodactylus vali	mean	14.90	81.13	10.37	51.73
N = 6	S.D.	1.97	13.97	3.75	6.08
Massoutiera mzabi	mean	18.33	95.73	12.13	42.72
N = 6	S.D.	1.14	17.23	1.74	16.02
Cavia porcellus	mean	24.98	91.77	14.31	143.66
N = 9	S.D.	4.16	17.87	3.88	2.72
Meriones libycus	mean	14.35	25.78	8.23	41.63
N = 6	S.D.	1.16	4.30	1.01	2.72
Meriones shawi	mean	15.46	21.80	7.06	46.39
N = 8	S.D.	0.69	2.55	0.57	5.77

BL = body length; SI = small intestine length; CA = caecum length; LI = large intestine length.

length; large intestine length expressed as a percentage of total length of the gut. Each symbol represents an animal. The horizontal line B divides the symbols into two groups according to their relative large intestine length. The two *Meriones* species and the guinea pigs are found below line B whilst the three species of gundis are found above line B. Statistical comparisons of the relative large intestine length between the species of the two groups are highly significant (two-tailed t test, $p < .001$ for each species/species comparisons). Clearly the gundis have proportionally a longer large intestine than the other rodents. Differences are found between the three species of gundis, *C. gundi*, the species living in a less arid climate, has proportionally a shorter large intestine (m = 53.9 %) when

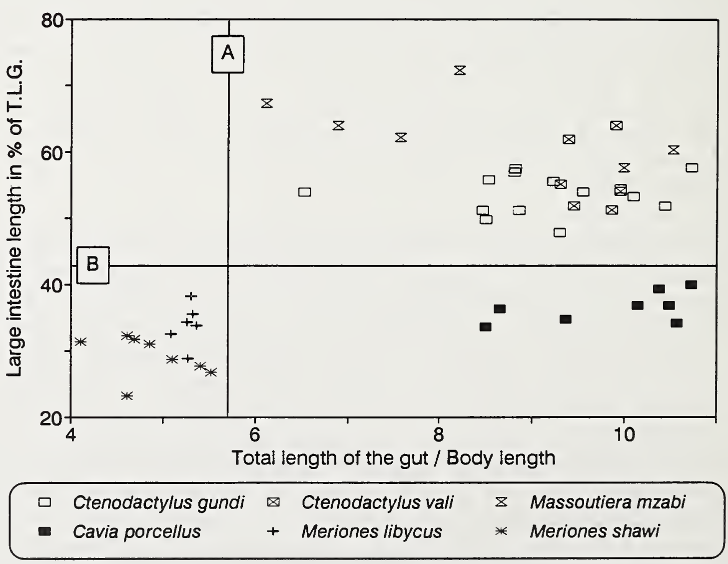

Fig. 1. Comparison of relative total length of the gut and of relative large intestine length of five species of rodents

compared with the two desert species *C. vali* (m = 56.3 %) or *M. mzabi* (m = 64.0 %). The differences between *M. mzabi* and each of the two species of *Ctenodactylus* are significant (two-tailed t test, $p < .05$ for each comparison). A similar difference is found between the two species of *Meriones, M. libycus*, the desert species, having a relatively longer intestine than *M. shawi* (respectively, m = 33.9 % and m = 29.1 %; p = .018, two tailed t test). The vertical line A divides the symbols into two groups of species. On the left the two *Meriones* species are found; both of them are omnivorous species with a short gut. On the right side a group of herbivorous species is found with a long gut, including the three species of gundis and the guinea pigs. It is interesting to note that gundis have proportionally a longer large intestine than both other types of rodents. These results are arguments for an adaptation of the large intestine to an arid climate. Nevertheless, "morphology is just one of several features upon which natural selection has operated in the evolution of different digestive system" (Karasov 1988). Cytological and physiological studies are required to confirm the role of the large intestine in water absorption in the gundis.

References

Ghobrial, L. I.; Nour, T. A. (1975): The physiological adaptations of desert rodents. In: Rodents in desert environments. Ed. by I. Prakash and P. K. Ghosh. The Hague: DR. W. Junk bv Publishers. Pp. 413–444.

George, W. (1987): *Massoutiera mzabi* (Rodentia, Ctenodactylidae) in a climatological trap. Mammalia **52**, 331–338.

Gouat, P. (1988): Etude socioécologique de trois espèces de rongeurs Cténodactylidés d'Algérie. Thèse d'état, Université C. Bernard, Lyon.

Gouat, P. (1991): Adaptation comportementale à la température chez trois espèces de Cténodactylidés sahariens. In: Le rongeur et l'espace. Ed. by M. Le Berre and L. Le Guelte. Paris: R. chabaud. Pp. 79–89.

Gouat, P. (1992): Faecal pellet size differences as a field criterion to distinguish between the two Ctenodactylus species (Mammalia, Rodentia). Z. Säugetierkunde **57**, 183–185.

Grenot, C. (1974): Sur la biologie d'un rongeur héliophile du Sahara, le "goundi" (Ctenodactylidae). Acta Tropica **30**, 237–250.

Happold, D. C. (1984): Small mammals. In: Sahara desert. Ed. by J. L. Cloudsley-Thompson. Oxford: Pergamon Press. Pp. 251–275.

Karasov, W. H. (1988): Nutrient transport across vertebrate intestine. In: Advances in Comparative and Environmental Physiology. Ed. by G. A. Ahearn. Berlin: Springer-Verlag. Vol. **2**, 131–172.

Perrin, M. R.; Curtis, B. A. (1980): Comparative morphology of the digestive system of 19 species of Southern African myomorph rodents in relation to diet and evolution. S.-Afr. Tydskr. Dierk. **15**, 22–33.

Petter, F. (1961): Répartition géographique et écologie des rongeurs désertiques de la région paléartique. Mammalia **25**, 1–219.

Rouffignac, C. de; Bankir, L.; Roinel, N. (1981): Renal function and concentrating ability in a desert rodent: the gundi (*Ctenodactylus vali*). Pflügers Arch **390**, 138–144.

Author's address: Patrick Gouat, L. E. E. C., URA 667, Université Paris Nord, F-93430 Villetaneuse, France