PHYSIOLOGY

Minimum Heart Rates of Marsupials

STUDIES of the nutrition and nitrogen metabolism of some macropod marsupials (kangaroos and wallabies) suggested that the level of energy metabolism of marsupials may be lower than that of eutherian mammals¹.

In the absence of facilities for direct study of the energy metabolism of marsupials, we have sought additional indirect evidence. One readily accessible measure is that of basal or minimum rate of heart beat, which in mature eutherian species has been shown to be related to metabolic body size ($W_{kg}^{0.75}$), as is basal energy metabolism^{2,3}. We have observed the minimum heart rates of fourteen species of marsupial.

The leads from an electrocardiograph were attached to the animals by small silver coated safety pins inserted subcutaneously in the chest region. The animals were fasted for at least 24 h and the kangaroos up to 48 h and the heart beat was monitored at intervals during this time. The koala bear was monitored for only 3 h after a light meal, and so it is unlikely that minimum heart rates were recorded. The smaller animals were placed in bags to limit their activity.

Table 1 lists the species used, their body weights and the minimum heart rate recorded. Only small numbers of animals could be tested because many species of marsupials are difficult to obtain. Some species are represented by only one animal.

Table 1. BODY WEIGHTS AND MINIMUM HEART BEAT RATES

Family	Binomen	Common name	Body weight (kg)	Minimum heart rate (beats/min)
Dasyuridae	<i>Antechinus flavipes</i>	Marsupial mouse	0.019	292
	<i>Phascogale tapoatafa</i>	Brush tailed phascogale	0.096	210
	<i>Myrmecobius fasciatus</i>	Numbat	0.36	102
	<i>Dasyurus geoffroyi</i>	Western native cat	0.80	89
	<i>Sarcophilus harrisii</i>	Tasmanian devil	(1) 4.26	54
			(2) 5.93	66
Peta- melidae	<i>Isodon obesulus</i>	Short nosed bandicoot	1.31	84
Phalan- geridae	<i>Petaurus breviceps</i>	Sugar glider	(1) 0.112	183
	<i>Pseudocheirus occidentalis</i>	Ring-tail possum	(2) 0.119	312
			0.095	102
	<i>Trichosurus vulpecula arnhemensis</i>	Kimberley brush-tail possum	0.950	99
	<i>Trichosurus vulpecula</i>	Brush-tail possum	(1) 1.36	62
			(2) 1.51	98
	<i>Phascogale cinereus</i>	Koala	6.84	87
Macro- podidae	<i>Setonix brachyurus</i>	Quokka	(1) 2.72	119
	<i>Macropus eugenii</i>	Tammar	(2) 2.38	121
			(1) 3.55	73
			(2) 4.60	73
			(3) 5.30	63
	<i>Petrogale lateralis</i>	Rock wallaby	5.45	86
	<i>Macropus robustus</i>	Euro or hill kangaroo	(1) 12.7	40
			(2) 17.1	40
	<i>Macropus giganteus</i>	West Australian grey kangaroo	(3) 19.8	39
			18.7	47
	<i>Macropus rufus</i>	Red kangaroo	19.8	40

The relationship between minimum heart rate and body weight (line B, Fig. 1) when plotted on a logarithmic grid was:

$$F = 106 W^{-0.27}$$

where F is the minimum heart beat rate and W is the body weight in kg.

This relationship is compared, in Fig. 1, with the relationship between heart beat rate and body weight for eutherian species given by Brody² of $F = 217.8 W^{-0.27}$ (line A). The average minimum heart beat rate of the fourteen species of marsupials observed is a little less than half that given for eutherian species on the basis of metabolic body size.

Fig. 1. Relationship between minimum heart rate and body weight in marsupials (line B), compared with eutherian mammals (line A).

Bartholomew and Hudson⁴ have reported a minimum heart rate of 300 beats/min for Tasmanian pigmy possums (*Cercartus nanus*) of about 50 g body weight, which correlates with the results presented here (line B).

The marked reduction in the heart rate of marsupials, compared with that of eutherians of similar body weight, suggests either a difference in metabolic activity or an equally marked difference between the haemodynamics of marsupials and eutherian mammals. Maxwell *et al.*⁵ reported that the cardiac output of two macropod marsupials investigated under anaesthesia was similar to that of a dog when corrected for differences in body weight. The authors point out, however, that under anaesthesia the heart rates of the macropods were elevated when compared with the resting conscious state (no values given).

Handling and restraint can substantially increase the heart rate of an animal, but the use of an electrocardiograph over an extended period can minimize such effects. Brody's² curve is derived from data collected before electrocardiography came into widespread use; it is possible that line A may not be basal for eutherians.

Other parameters related to the level of energy metabolism are, however, lower, at least for some macropods studied. Brown and Main¹ have shown that the minimum output of urinary nitrogen of macropod marsupials is markedly less for each unit of metabolic body size than that of eutherian species, and that the voluntary feed intakes of these macropods were also less than those of ruminants. The water requirement and insensible water loss of the tammar wallaby (*Macropus eugenii*) are low in relation to those of eutherians (our unpublished results).

In the light of the available evidence, therefore, it seems probable that the low heart rates of the marsupials observed here imply a lower level of energy metabolism compared with that of most eutherian species.

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