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Journal of Animal Ecology
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Mon Jun 18 09:15:10 2001
Daily energy expenditure and water flux of free-living Blanford's foxes (Vulpes cana), a small desert carnivore

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Summary

1. The Blanford's fox, Vulpes cana (Blanford 1877) is a small canid (mean body mass = 956 g) that inhabits rocky mountains and canyons in the deserts of Israel, where it feeds mainly on invertebrates and fruits.

2. We hypothesized that the energy expenditure of Blanford's foxes would be higher than that of a small canid that inhabits flat terrain, all else being equal. To test this hypothesis, we measured daily energy expenditure and water intake of free-living Blanford's foxes and compared the results with those of the kit fox, Vulpes macrotis (Say 1823). We also estimated dietary intake and seasonal activity periods.

3. Blanford's foxes maintained water and energy balances on a diet of invertebrates and fruits without the need to drink. Metabolism during activity was 8-4 times higher than at rest, and daily energy expenditure of Blanford's foxes was, on average, 30-1% higher than that of the kit fox. This result was compatible with our prediction that activity is more energetically expensive for Blanford's foxes in their mountainous habitat than in another desert fox species that inhabits flat terrains.

Key-words: Blanford's fox, Vulpes cana, desert carnivore, daily energy expenditure, water flux.


Introduction

Mammals that inhabit deserts, where food and water availability may be very limited, have lower rates of energy expenditure and water influx than related non-desert species. Many desert rodents which feed on a diet of dry seeds are capable of survival without free drinking water (Schmidt-Nielsen 1964; Withers, Loud & Henschel 1982; MacMillen 1983). This has also been reported for a seed-eating desert fox Dusicyon securaev (Thomas 1900) (Asa & Wallace 1990).

Desert carnivores, especially those species that occupy habitats where free drinking water is scarce, may face difficulties with water balance during hot periods. Although their prey is rich in water it also contains much protein which, when metabolized, produces nitrogenous waste. In mammals, such nitrogenous waste is excreted as urea in urine which requires water as a solvent. Furthermore, carnivores need to forage over a larger range than granivores or herbivores because of the distribution of their food (Davis & Houston 1984). These daily extensive movements increase energy expenditure needed for foraging and water loss needed for evaporative cooling during warm seasons.

Several species of fox occupy arid, hot deserts. The kit fox (Vulpes macrotis; Golightly & Ohmart 1983, 1984) and the fennec (Fennecus zerd) (Zimmermann 1780); Noll-Banholzer 1979a,b) can survive in deserts because they have low metabolic rates, low rates of evaporative water loss and are capable of survival on a diet of rodents without drinking water. Golightly & Ohmart (1983, 1984) concluded for kit foxes eating their usual diet, that their energy requirements are met before their water requirements, and therefore these foxes may be foraging more for dietary water than for dietary energy.

The Blanford's or Afghan Fox, Vulpes cana, occurs in warm, mountainous regions of Pakistan, Afghanistan, Iran and south-western Russia (Roberts 1977). Recently it was also discovered in Israel, Sinai, Oman and Saudi-Arabia (Mendelssohn et al. 1987; Harrison & Bates 1989). In Pakistan,
Blanford’s fox is confined to warm mountainous regions characterized by barren, rocky hills (Roberts 1977) while in Israel it occupies steep, rocky, mountain slopes and canyons in the Judean and Negev Deserts (Mendelsohn et al. 1987). This small (c. 1 kg) canid consumes mainly invertebrates and also some fruits (Roberts 1977; Geffen et al., in press a).

The distribution of the Blanford’s fox in Israel spans over extremely hot, arid desert regions where water is generally available for only several months as small rock pools. The kit fox of south-western United States also inhabits extreme desert. However, the habitats of these conspecific foxes are quite different. Blanford’s foxes inhabit rocky mountains and canyons while kit foxes inhabit stony or sandy flats (Mendelsohn et al. 1987; O’Farrell 1987). Because of the steep rocky habitat of Blanford’s foxes, we predicted that their energy expenditure for foraging would be relatively higher than that of small canids (e.g. kit fox) that inhabit relatively flat terrain. We are aware that other factors (e.g. temperature regime, food availability, predator avoidance) may affect energy expenditure; however, both species follow similar life-history trends and the most prominent difference between them is their habitat (steep slopes versus flats). We used double-labelled water to measure daily energy expenditure (DDE) of free-living Blanford’s foxes, and we tested our prediction by comparing our results with those available for kit foxes.

Methods

STUDY SITE

The study was conducted during 1987–88 at the Central Judean Desert Reserve, in the vicinity of Ein Gedi (31°28’N, 35°23’E, elevation 350–100 m below sea level) and in the Eilat Mountains Nature Reserve in the vicinity of Netafim Creek (29°35’N, 34°53’E, elevation 500–800 m above sea level). Study areas at Ein Gedi and Eilat covered 25 km² and 36 km², respectively. Both locations were characterized by steep, rocky, mountain slopes, deep canyons and sheer cliffs. The dominant rock formation at Ein Gedi was limestone whereas at Eilat it was a mixture of limestone, sandstone, metamorphic rock and granite (Karta 1985).

The sites differed markedly with respect to water supply: at Ein Gedi there were four large springs and two canyons with permanent water. The vegetation was typically Saharo-Arabic and tropical in origin (Zohary 1980). Along the water courses, vegetation cover reached 100% but was only 0.5–10% on the surrounding slopes and cliffs. At Eilat there was only one dripping spring. The water from that spring collected into a concrete basin built by bedouin people. Mean air temperatures at 20.00 h during August were 34.3°C and 30.0°C, and in September 32.1°C and 27.5°C (summer), at Ein Gedi and Eilat respectively. During winter mean air temperatures at 20.00 h were substantially lower (December 18.6°C and 12.7°C, January 16.5°C and 8.6°C, and February 18.4°C and 11.0°C), respectively. To accommodate Blanford’s foxes strict nocturnality, we provide monthly mean air temperatures at 20.00 h. Mean annual precipitation was 81 mm at Ein Gedi and 25 mm at Eilat.

FIELD TECHNIQUES

Ten collapsible Tomahawk traps (80 × 22 × 22 cm) were employed at each study site. The traps were placed in canyons and on rocky slopes, and sheltered by large boulders. Most traps were left in situ for 2–3 years. The traps were set at approximately monthly intervals for 3–6 days at a time, baited with dead chicks and monitored during the mornings of each trapping session. Captured foxes were sexed, fitted with numbered ear-tags and released. Eleven adult foxes in Ein Gedi and five in Eilat were fitted with radio-collars (transmitter mass 60 g, Wildlife Material, Inc.) equipped with motion-sensitive switches. Each tracking session involved radio-tracking one individual, starting an hour before sunset (before activity starts) and ending an hour after sunrise (or later if the fox was still active), with fixes being taken every 15 min. Each fox was radio-tracked monthly. The rugged terrain required all tracking to be done on foot, with the help of a headlamp. It was possible to stay within a few hundred metres of focal individuals. Fixes were generally accurate to ±20 m, as proven by frequent sightings, but when foxes travelled particularly inaccessible areas their locations were allocated to a 100 × 100 m square. From each tracking night’s data we calculated the total duration of activity.

During August–September (summer) and December–February (winter), 1988–1989, each captured fox was weighed to 0.05 kg (Pesola 2.5 kg) and then injected subcutaneously with 1.8–2.0 ml of water containing 97 atoms % 18O and 50 μCi tritium per ml. After allowing 3 h for equilibration of the isotopes with body fluids, we collected a blood sample (1 ml) from the femoral vein and then released the animal at the capture site. Foxes that were recaptured 3–15 days later were weighed, a second blood sample was taken and then they were released. All foxes at both seasons were non-breeding adults. Except one male in Eilat that was sampled in February, all the other foxes in the winter group were sampled during December. In our study sites the breeding season started at the end of February and the pups were first observed foraging during June (Geffen & Macdonald, in press).

Blood samples were kept frozen until they were micro-distilled (Wood et al. 1975) to obtain pure
water for analysis. Tritium levels were determined by liquid scintillation spectrometry (LKB-Wallac, model-1211 Rackbeta) and \(^{18}O\) levels by a Auto-gamma counting system (Packard) after converting \(^{18}O\) to gamma-emitting \(^{18}F\) by cyclotron-generated proton activation (Wood et al. 1975).

**Calculations of Water Flux and Energy Expenditure**

Total body water (TBW) volume of each fox was calculated from the dilution space of \(^{18}O\), water flux was estimated using the decline over time in specific activity of tritium, and \(\text{CO}_2\) production was estimated using the decline over time in specific activity of tritium and \(^{18}O\) (Lifson & McClintock 1966; Nagy 1980; Nagy & Costa 1980).

Geffen et al. (in press a) studied diet habits of Blanford’s foxes at Ein Gedi and Elat by analysis of scats and concluded that the foxes fed mainly on invertebrates and fruits. We collected invertebrates that consumed and fruits of cappurbush (Capparis spinosa at Ein Gedi and Capparis cartilaginea at Elat), the most common fruit eaten, and calculated the water content of each food item by drying at 70°C until constant mass.

We calculated the invertebrate and fruit intake of foxes using the method of Degen et al. (1986). We assumed that fruits contained 6.4 kJ metabolizable energy per g dry matter, and that 20.8 J of heat energy and 0.637 \(\mu\)L metabolic water were produced per ml \(\text{CO}_2\) produced from a fruit diet (Nagy & Milton 1979). For insects, the values we used were 20.3 kJ metabolizable energy per g dry matter, and 25.7 J of heat energy and 0.660 \(\mu\)L metabolic water produced per ml \(\text{CO}_2\) production (Nagy 1983).

The proportions and amounts of invertebrate and plant matter that were consumed were calculated from field measurements of \(\text{CO}_2\) production and water influx. \(\text{CO}_2\) production per g dry matter was calculated as:

Invertebrates: 
\[
\frac{20300 \text{ J g}^{-1}}{25.7 \text{ J (ml CO}_2\text{)}^{-1}} = \frac{789.9 \text{ ml CO}_2\text{ g}^{-1}}{}
\]

\[\text{eqn 1}\]

Fruits: 
\[
\frac{6400 \text{ J g}^{-1}}{20.8 \text{ J (ml CO}_2\text{)}^{-1}} = \frac{308.7 \text{ ml CO}_2\text{ g}^{-1}}{}
\]

\[\text{eqn 2}\]

We assumed that foxes did not drink water during the study in both seasons. This assumption was reasonable since we never observed foxes drinking, and because measured rates of water influx were completely accounted for by preformed water in dietary invertebrates and fruits without drinking (see Results). From the water content in invertebrates (60%) and in fruits (80%) that we sampled, we calculated that invertebrates and fruits contain 1.5 and 4.0 ml water per g dry matter, respectively. We calculated the combined preformed and metabolic water produced per g dry matter as:

\[
\text{Invertebrates: } 1.500 \text{ ml} g^{-1} + 0.521 \text{ ml} g^{-1} \]

\[= 2.021 \text{ ml} g^{-1} \quad \text{eqn 3}\]

\[
\text{Fruits: } 4.000 \text{ ml} g^{-1} + 0.196 \text{ ml} g^{-1} \]

\[= 4.196 \text{ ml} g^{-1} \quad \text{eqn 4}\]

Therefore combining equations 1, 2, 3 and 4:

\[
789.9X + 308.7Y = \text{ ml CO}_2\text{ production}\]

\[2.021X + 4.196Y = \text{ ml H}_2\text{O influx}\]

Where \(X\) = g dry matter of invertebrates consumed, and \(Y\) = g dry matter of fruits consumed. By solving for \(X\) and \(Y\), we calculated the mass (and percentage of diet) of insects and fruits consumed by each fox in each season to satisfy energy expenditure and water influx. These values were plotted against the ratio of \(\text{CO}_2\) production to water influx (ml H\(_2\)O) in order to evaluate seasonal changes in diet.

For an estimate of resting metabolic rate (RMR) of Blanford’s foxes we used the measurements for *Fennecus zerda* (Noll-Banholzer 1979a). The fennec (1106 g) and the Blanford’s fox (956 g) are similar in body mass and both species occupy the Arabian deserts. Furthermore, although traditionally considered separate genera, a recent study using molecular techniques showed that genetically these foxes are more closely related to each other than to any other species of fox (Geffen et al., in press c).

Because most of the variation in metabolic rate of mammals can be explained by body mass and habitat (Kleiber 1975; McNab 1989), and because of the close genetic relatedness between these two species we feel that this substitution was justified.

For seasonal comparisons of daily water influx we used two-way analysis of variance (ANOVA), and we averaged seasonal repeated measures where more than one measurement was made per fox.

**Results**

Ten Blanford’s foxes at Ein Gedi and two at Elat were injected with doubly labelled water and recaptured 1–4 times within 2–34 days later. Reliable concentration readings of tritium were obtained up to about 20 days post injection but \(^{18}O\) readings were reliable only for about 12 days post injection. Thus, \(^{18}O\) and tritium readings from measurement intervals longer than 12 days and 20 days, respectively, were discarded.

There were no significant differences in initial and final body masses within any of the seasons and therefore the foxes were in near steady-state energy and water balance during measurement intervals (mean change = −0.73% day\(^{-1}\); Table 1). Body mass of Blanford’s foxes tended to be lower during summer than during winter at Ein Gedi (Table 1). Total body water volume as a percentage of body mass of Blanford’s foxes at Ein Gedi were higher in summer than in winter (73.3% vs. 66.1%; Mann-Whitney test, \(Z = 2.66, P < 0.05\)).
Table 1. Means (±SD) of body mass, daily change in body mass, total body water, CO₂ production, water influx (WI), daily energy expenditure (DEE) and estimated intake of fruits and invertebrates by Blanford’s foxes at Ein Gedi and Eilat during summer (August–September) and winter (December–February)

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ein Gedi</td>
<td>Eilat</td>
</tr>
<tr>
<td>Number of measurements</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Number of individuals</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Body mass (g)</td>
<td>874.1 ± 87.1</td>
<td>999.0 ± 45.9</td>
</tr>
<tr>
<td>Change in body mass (% day⁻¹)</td>
<td>-0.53 ± 1.60</td>
<td>-1.62 ± 2.00</td>
</tr>
<tr>
<td>Total body water (%)*</td>
<td>73.3 ± 5.0 (9)</td>
<td>62.1 ± 1.6 (2)</td>
</tr>
<tr>
<td>CO₂ (ml g⁻¹ day⁻¹)</td>
<td>26.1 ± 8.1</td>
<td>27.7 ± 4.9</td>
</tr>
<tr>
<td>WI (ml g⁻¹ day⁻¹)</td>
<td>0.11 ± 0.02</td>
<td>0.13 ± 0.01</td>
</tr>
<tr>
<td>DEE (kJ g⁻¹ day⁻¹)</td>
<td>249.0 ± 65.2</td>
<td>219.2 ± 23.1</td>
</tr>
<tr>
<td>Fruit intake (g dry matter day⁻¹)</td>
<td>9.8 ± 5.1</td>
<td>16.1 ± 1.4</td>
</tr>
<tr>
<td>Fruit intake (% of diet)</td>
<td>30.1 ± 17.0</td>
<td>36.4 ± 6.6</td>
</tr>
<tr>
<td>Invertebrates intake (g dry matter day⁻¹)</td>
<td>24.6 ± 9.2</td>
<td>28.8 ± 7.1</td>
</tr>
<tr>
<td>Invertebrates intake (% of diet)</td>
<td>69.9 ± 17.0</td>
<td>65.6 ± 6.6</td>
</tr>
</tbody>
</table>

* Sample size in parentheses.

Daily energy expenditure (kJ g⁻¹ day⁻¹; Table 1), on a mass-specific basis, did not differ significantly between seasons (t = 1.01, P > 0.05). Percentage fruit intake was significantly higher during summer (31.5% versus 13.4%; Mann-Whitney test, Z = 2.52, P < 0.05; Table 1). Concomitantly, percentage invertebrate intake showed an increase during winter compared to summer (86.5% versus 69.5%; Mann-Whitney test, Z = 2.52, P < 0.05). Histogram of seasonal fruit intakes, based on the ratio of CO₂ production to water influx (Fig. 1), showed that the foxes consumed more fruits during the summer.

Water influx for the average size fox (956 g) was 105.2 and 76.5 ml per day for summer and winter at Ein Gedi, and 124.28 and 97.5 ml per day at Eilat. Mean water influx (ml g⁻¹ day⁻¹) was significantly higher at both locations (37.5% at Ein Gedi and 27.5% at Eilat) during summer (F₁,2₃) = 5.25, P < 0.05) than during winter.

Foxes at both locations were active about 8–9 h per night, regardless of seasonal changes in night length (Table 2). Seasonal nightly periods of activity were not significantly different at both locations (t₉₀ = 1.602 and t₉₀ = 0.704 for Ein Gedi and Eilat,

Fig. 1. Frequency distribution of seasonal dry matter intake of (a) fruit and (b) invertebrates in the diet of Blanford’s foxes in Eilat and Ein Gedi in ■ summer (n = 14) and □ winter (n = 13).
Table 2. Means of daily energy expenditure (DEE), estimated resting metabolic rate (RMR*), and time-energy budgets of free-ranging Blanford's foxes at Ein Gedi and Eilat during summer (August–September) and winter (December–February)

<table>
<thead>
<tr>
<th></th>
<th>Summer Ein Gedi</th>
<th>Summer Eilat</th>
<th>Winter Ein Gedi</th>
<th>Winter Eilat</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEE (kJ g⁻¹ day⁻¹)</td>
<td>0.652</td>
<td>0.689</td>
<td>0.630</td>
<td>0.668</td>
</tr>
<tr>
<td>DEE – RMR (kJ g⁻¹ day⁻¹)*</td>
<td>0.479</td>
<td>0.516</td>
<td>0.457</td>
<td>0.495</td>
</tr>
<tr>
<td>Mean activity time (h day⁻¹)</td>
<td>8.885</td>
<td>8.643</td>
<td>9.468</td>
<td>9.750</td>
</tr>
<tr>
<td>Number of nights sampled</td>
<td>39</td>
<td>7</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>DEE</td>
<td>3.768</td>
<td>3.982</td>
<td>3.642</td>
<td>3.861</td>
</tr>
<tr>
<td>RMR</td>
<td>2.502</td>
<td>2.769</td>
<td>2.487</td>
<td>2.708</td>
</tr>
<tr>
<td>Cost of activity = (DEE – RMR*) / RMR*</td>
<td>8.479</td>
<td>9.282</td>
<td>7.696</td>
<td>8.043</td>
</tr>
</tbody>
</table>

* RMR of Fennecus zerda (Noll-Banholzer 1979a) = 0.173 (kJ g⁻¹ day⁻¹).

respectively). Field metabolic rates of Blanford’s foxes were approximately 3-7 times that of their estimated resting metabolic rate (RMR). Furthermore, energy expenditure during activity of free-ranging Blanford’s foxes was 8-4 times that of RMR (Table 2).

Discussion

We compared daily energy expenditure for desert eutherians calculated using Nagy’s (1987) equation (DEE (kJ day⁻¹) = 3·21 (body mass in g⁰.⁷⁷⁸⁶) with observed values. For Blanford’s foxes (mean body mass = 956 g) the expected DEE was 0·739 kJ g⁻¹ day⁻¹. The mean observed DEE (0·646 kJ g⁻¹ day⁻¹) was 12·5% lower than the expected. Golightly (1981) calculated DEE for free-ranging kit foxes (mean body mass = 1850 g) as 0·403 kJ g⁻¹ day⁻¹ during summer and 0·461 during winter. The mass-adjusted, mean DEE for the Blanford’s fox (2·81 kJ g⁻⁰.⁷⁸⁶ day⁻¹) was, on average, 30–1% higher than the value for the kit fox (2·16 kJ g⁻⁰.⁷⁸⁶ day⁻¹). We suggest that the higher observed daily energy expenditure in the Blanford’s fox was due to costlier movements in its mountainous habitat versus desert flats which are occupied by the kit fox. Therefore this result supports our hypothesis. However, we are unable here to exclude the possibility that other factors (e.g. food availability) may be responsible for part of the difference in energy expenditure between the two species.

We have shown that the activity period of the foxes is rather constant throughout the year. Calculations in Table 2 indicated that activity of Blanford’s foxes is very costly (about 8 times more energy than at rest). Degen et al. (1986) showed that for three species of rodents living in the same habitat of Blanford’s foxes, the energy required for activity was only five times the level at rest. Although the cost of activity per unit of body mass is lower for larger animals, the ratio between metabolism during activity and rest reflects diet and foraging strategies. Granivorous and herbivorous rodents usually forage within a short radius from their burrow and are able to survive year round by feeding on a few bushes. On the other hand, foxes feed on small food items (e.g. invertebrates) which are scattered over a large area. Therefore, foraging cost is higher in the Blanford’s fox, particularly when considering the effort of negotiating its difficult mountainous habitat.

Diet proportions of an animal can be estimated from rates of CO₂ production and water influx, provided that the animal does not drink water and that the dominant foods are known (Degen et al. 1986). Geffen et al. (in press a) studied diet habits of Blanford’s foxes using analysis of scats and revealed that the major foods were invertebrates and fruits. That study, however, failed to show significant overall seasonal shifts in the diet. Significant differences in diet composition were found only between sites. In this study we showed that the foxes fed more on fruit during summer, which was in agreement with percentage occurrence of fruit in scats collected during summer and winter at each study site (Geffen et al., in press a).

Furthermore, Geffen et al. (in press b) showed from repeated measures of 14 foxes at Ein Gedi and four at Eilat that both sexes of Blanford’s fox were heavier during winter. Decline in body mass and diet shift to succulent fruits may indicate stress of water shortage. In addition, fractional total body water volumes of foxes at Ein Gedi were higher during summer. This indicated that foxes had lower fat content during summer which may be attributable to the observed lower body mass during this season.

The expected ratio of ml CO₂ production to ml water influx in a physiologically balanced fox that consumed only invertebrates was 390:8. We can expect that an animal that fed only on invertebrates was more likely to face dehydration because this food contained less water (60%) than fruits (80%). When the observed ratio of CO₂ production to water influx was compared to the expected value, we observed only three cases that slightly deviated...
above our expectation. On the other hand, we have not observed foxes that had a ratio of CO₂ production to water influx less than 73-6 (ratio for diet of fruits). These data indicated that steady-state in energy and water were easily achieved on fruit and invertebrate diets without drinking. A mean size fox (956 g) that fed only on invertebrates required 24.569-8 ml CO₂ day⁻¹ (25.7 ml CO₂ g body mass⁻¹ day⁻¹ × 956 g) or 631.4 ml day⁻¹ (2456.8 ml CO₂ day⁻¹ × 25.7 ml CO₂ g⁻¹) or 77.8 g of invertebrates per day (631.9 kJ day⁻¹/20.3 kJ g dry matter⁻¹, and adjusted for water content of 0-6 in fresh matter) to satisfy energy requirements. On the other hand, a 956 g fox required 94.3 ml H₂O day⁻¹ (based on 0.0755 ml H₂O g⁻¹ day⁻¹). Considering a similar type of diet and a conversion factor of 0.796 ml H₂O g⁻¹ of invertebrates (0-6 preformed water +0.196 metabolic water; see equation 4 in Methods), the fox required 118.4 g of invertebrates per day to keep body water balanced. These calculations of an extreme situation may suggest that Blanford’s foxes forage more for water than for energy as suggested for the kit fox (Golightly & Ohmart 1984).

Free-ranging Blanford’s foxes showed similar water influxes (0.08–0.13 ml g⁻¹ day⁻¹) as kit foxes in natural and semi-natural conditions (0.07–0.11 ml g⁻¹ day⁻¹; Golightly & Ohmart 1984). Fennec foxes in the laboratory had a water influx substantially lower (mean of 0.06 ml g⁻¹ day⁻¹; Noll-Bahnozler 1979b), although the mean body mass of the fennec foxes (1245 g) was slightly higher than the mean body mass for the Blanford’s fox in this study (956 g). This difference emphasizes that laboratory studies of water turnover in desert carnivores may underestimate the energetic cost and water influx of foraging efforts.

In conclusion, our results are compatible with the hypothesis that locomotion of Blanford’s foxes in their mountainous habitat is more costly than in another desert fox that occupies flat terrain. The fact that Blanford’s foxes do not drink has an important impact on their distribution. This species was discovered in the Middle East only in 1981 (Israel), and since has been reported from two locations in the Arabian peninsula (Asir province, Saudi Arabia; D.L. Harrison, personal communication and Dhofar, Oman; Harrison & Bates 1989). Our results suggest that the distribution of the Blanford’s fox in the Arabian peninsula is not limited by access to water. This is in contrast to the Arabian wolf, Canis lupus pallipes (Sykes 1831), that inhabits deserts and is dependent on free water (Afik & Pinshow 1989).

Acknowledgments

We would like to thank Prof. Y. Yom-Tov for providing box traps and other accessories. O. Shani, J. Bakker and A. Rotem assisted with the field work and U. Marder provided us regularly with the bait. The project was supported and funded by the Nature Reserves Authority of Israel, the Society for Protection of Nature in Israel, the Fauna and Flora Preservation Society and the People’s Trust for Endangered Species.

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Received 9 October 1991; revision received 24 January 1992