Inter-sexual differences in resting metabolic rates in the Texas tarantula, *Aphonopelma anax*

Cara Shillington *

Department of Biology, Oklahoma State University, Stillwater, OK 74078, USA

Received 20 May 2005; received in revised form 15 September 2005; accepted 16 September 2005

Available online 28 November 2005

**Abstract**

Intra-specific variation in life history and mating strategies can lead to differences in energy allocation and expenditure in males and females. This may, in turn, explain large-scale evolutionary patterns. In this study, I investigated the effects of body mass, temperature and sex on resting metabolic rates (RMRs) in sexually mature male and female tarantulas (*Aphonopelma anax* (Chamberlin)), a species that exhibits extreme inter-sexual differences in life history after reaching sexual maturity. RMRs were measured as rates of CO$_2$ production in an open-flow respirometry system at 20, 25, 30 and 35 °C. These temperatures are typical to what this species experiences under natural conditions. In addition, a respiratory quotient (RQ) of 0.92 was calculated from rates of CO$_2$ production and O$_2$ consumption in a closed, constant-volume respirometry system. As expected, RMRs increased with increasing temperature and body mass. However, after adjusting for the influence of body mass, males had substantially higher metabolic rates than females at each temperature. This higher metabolic rate is proposed as an adaptive strategy to support higher energetic demands for males during their active, locomotory search for females during the mating season.

© 2005 Elsevier Inc. All rights reserved.

**Keywords:** Arachnids; Resting metabolic rates; Sexual differences; Sexual selection

**1. Introduction**

The total energy available to animals is limited by resource abundance, thermal constraints on foraging time (especially among ectotherms), and physiological rates of food processing. Thus, variation in energy expenditure, which is strongly influenced both by environmental factors such as temperature and time of day, and by intrinsic factors such as body mass or sex (Bennett and Dawson, 1976; Beaupre, 1993; Beaupre et al., 1993; Zaidan, 2003), may in turn influence net energy allocation to growth, storage, and reproduction. Differences in these allocations within and among individuals may then affect behavior, life history, reproductive success and population dynamics (Dunham et al., 1989; Beaupre and Duvall, 1998; Secor and Diamond, 2000). Thus, understanding variation in metabolism and energetic requirements provides insight into functional relationships that define large-scale ecological and evolutionary patterns.

Sex differences in resting metabolic rates (RMRs) have been studied in various animals and the results vary considerably. Among invertebrates, differences have been found in some taxa but not others. Rogowitz and Chappell (2000) recorded higher RMRs in two species of male beetles compared to females (*Phoracantha* spp.), while no differences were found between male and female millipedes (*Psedonannolene tricolor*) (Penteado and Hebling-Beraldo, 1991). Two out of four intra-specific comparisons of metabolic rates in spiders indicated that males had higher metabolic rates than females (Tanaka and Ito, 1982; Watson and Lighton, 1994). In a comparison of mass-specific MRs, Kotiaho (1998) found that males had lower metabolic rates than females (*Hygrolycosa rubrofasciata*), and Humphreys (1977) suggests that MRs vary with season but there are no differences between male and female millipedes (*Psedonannolene tricolor*). Although sexual differences in basal metabolic rates are common in birds, the direction and magnitude of these differences are variable (Rintamaki et al., 1984; Kaiser and Bucher, 1985; Maloney and Dawson, 1993). The same is true for reptiles (Bennett and Dawson, 1976; Jameson et al., 1976; Beaupre, 1993; Beaupre et al., 1993; Beaupre and Duvall, 1998; Cullum, 1998). Some of the sexual
dimorphism in metabolic rates can be explained by size differences between males and females, reproductive condition, and proportions of different tissue types (Sanborn and Jankowski, 1994; Beaufort and Duvall, 1998; Cullum, 1998).

Spiders as a whole, exhibit much variability in rates of energy expenditure and, as with most organisms, body size accounts for most of this variation (Anderson, 1970, 1996; Greenstone and Bennett, 1980). However, differences can also be attributed to environmental factors and low rates of energy expenditure may be adaptive in an unstable environment where there may be periods of reduced prey availability (Seymour and Vinegar, 1973; Greenstone and Bennett, 1980; Anderson, 1994; Secor and Diamond, 2000). This idea is supported in comparative studies of the metabolic rates of comb-footed spiders (Anderson, 1994) and ticks (Lighton and Fielden, 1995). Higher rates of metabolism found in most orb-weavers (Anderson, 1994) and ticks (Lighton and Fielden, 1995) is suggestive of the idea of high metabolic rates in the field may also have high RMRs. This idea is supported in comparative studies of the metabolic rates of comb-footed spiders (Anderson, 1994) and ticks (Lighton and Fielden, 1995). However, differences can also be attributed to environmental factors and low rates of energy expenditure may be adaptive in an unstable environment where there may be periods of reduced prey availability (Seymour and Vinegar, 1973; Greenstone and Bennett, 1980; Anderson, 1994; Secor and Diamond, 2000). This idea is supported in comparative studies of the metabolic rates of comb-footed spiders (Anderson, 1994) and ticks (Lighton and Fielden, 1995). Higher rates of metabolism found in most orb-weavers (Anderson, 1994) and ticks (Lighton and Fielden, 1995) is suggestive of the idea of high metabolic rates in the field may also have high RMRs. This idea is supported in comparative studies of the metabolic rates of comb-footed spiders (Anderson, 1994) and ticks (Lighton and Fielden, 1995).

2. Materials and methods

2.1. Study animals

During May–July of 1999 and 2000, I collected male and female tarantulas at the Chaparral Wildlife Management Area which is approximately 13 km west of Artesia Wells, TX, USA. This 6.150-ha area is managed by the Texas Parks and Wildlife Department. Animals were transported to Oklahoma State University and maintained in the laboratory in individual 3.8-l containers under a natural photoperiod (14:10 light:dark) and at a room temperature of 24–27 °C. Water was constantly available and food (crickets and occasionally mealworms) was available ad libitum except during the week prior to metabolic measurements. All animals were sexually mature at the time of capture and, due to the lack of egg sac production it is assumed that none of the females were gravid. However, the age and sexual history of the individuals are unknown.

2.2. Resting metabolic rates

I used an open-flow respirometry system to measure rates of CO2 production ($\dot{V}_{\text{CO2}}$) of animals during rest over a 24-h period. Outside air was drawn at a flow rate of 100 mL/min (Sierra mass flow controller, Coastal Instruments, NC, USA) and initially passed through a Drierite/Ascarite/Drierite column to remove both CO2 and water from the air before passing into animal chambers and finally through a CO2 analyzer (LiCor 6251, LiCor Environmental Division, NE, USA). Eight chambers were available for simultaneous measurements and an eight chamber multiplexer (Sable Systems, Nevada) was used to sample each of these chambers sequentially over a 3-h period. Seven tarantulas were placed in air-tight, 235 mL chambers and the eighth chamber was left empty as the baseline reference. During each 3-h period, the baseline chamber was sampled first for 7.5 min and then each of the seven occupied chambers was sampled for 25 min, and finally the baseline chamber was resampled for another 7.5 min. Over a 24-h period, eight recordings were obtained for each individual animal.

For each animal, RMRs were measured at 20, 25, 30 and 35 °C and the order of temperatures was randomized. These experimental temperatures spanned the range of body temperatures measured in active male tarantulas at the field site (Shillington, 2002). To maintain these temperatures, each individual animal in their respiratory chambers was housed in an environmental chamber set at the appropriate temperature. The environmental chamber also maintained the same natural photoperiod. At the lower three temperatures (20, 25, 30 °C), RMRs were measured over a 24-h period (approximately eight recordings per animal per temperature). At 35 °C, RMRs were recorded only twice for each animal to reduce exposure to high temperatures (total time of approximately 6 h).

$\dot{V}_{\text{CO2}}$ was calculated from fractional concentrations of CO2 entering (Fi) and leaving (Fe) the respirometry chambers using the equation from Withers (1977):

$$\dot{V}_{\text{CO2}} = \frac{(\text{Fi}_{\text{CO2}} - \text{Fe}_{\text{CO2}})*\text{flow rate in mL.h}^{-1}}{C_0}$$

Fi was zero because incoming air was scrubbed of CO2 using Ascarite. RMRs were determined as the mean of the lowest 5
min of steady-state $\dot{V}_{CO_2}$ during each 25-min recording period.

To determine if there were nocturnal/diurnal cycles in RMRs (related to activity in the animal chambers), the 24-h RMR measurements were divided into periods of activity and inactivity based on field observations, i.e., 06:30–11:00 (diurnal 1/active), 11:00–18:30 (diurnal/inactive), 18:30–20:30 (diurnal 2/active), and 20:30–06:30 (nocturnal/active) (Shillington, 2002).

To linearize the relationship between $\dot{V}_{CO_2}$ and body mass prior to analysis of RMRs, these two variables were log$_{10}$ transformed. Additionally, because of the confounding effects of body mass on metabolic rate (i.e., $\dot{V}_{CO_2}$ increases with increasing body mass), I used residuals from the allometric regression line (all temperatures and all individuals combined) as a mass-corrected RMR response variable in further analyses to determine the effects of temperature, sex and year on RMRs. The slopes of log$_{10}$ $\dot{V}_{CO_2}$ and log$_{10}$ body mass (at each temperature and between males and females) were tested for heterogeneity before analyzing the residuals with repeated-measures analysis of variance (ANOVA).

To compare my results with representative arthropods, I computed mass-scaling equations using $\dot{V}_{CO_2}$ and also converted $\dot{V}_{CO_2}$ to rates of oxygen consumption ($\dot{V}_{O_2}$) and to metabolic rates in microwatts (μW). These conversions were based on measures of the respiratory quotient of relatively inactive males and females (see section below) and Joule-CO2 coefficients (for μW) (Gessman and Nagy, 1988). I used least-squares regression to construct predictive allometric equations for metabolic rates (in mL CO2 h$^{-1}$ and in μW) as a function of body mass. An equation in the form log$_{10}$ $\dot{V}_{CO_2} = X_1 \cdot \log_{10} M + y_0$ (where $\dot{V}_{CO_2}$ is in mL h$^{-1}$; $X_1$ and $y_0$ are the slope and y-intercept, respectively; $M$; body mass in g) can then be converted into the general form $\dot{V}_{CO_2} = a \cdot M^b$.

2.3. Respiratory Quotient (RQ)

RQ was calculated as the ratio of $\dot{V}_{CO_2}$ to $\dot{V}_{O_2}$ in a closed, constant-volume respirometry system. This constant-volume technique was necessary because $\dot{V}_{O_2}$ data were unreliable with flow-through respirometry due to low flow rates necessary to optimize the O$_2$ signal. Animals were placed in 235-mL containers each fitted with two stopcocks. One hour prior to starting each trial, these containers were placed in the environmental chamber at 25 °C. After an hour, containers were removed from the environmental chamber and a 10-mL air sample was collected from each animal chamber with a plastic syringe fitted with a stopcock. To ensure adequate mixing of the air sample, the syringe was pumped several times before drawing and sealing the syringe stopcock. The stopcocks on the animal chambers were then closed and the time was noted. Sealed animal chambers were then returned to the 25 °C environmental chamber where they were left undisturbed for approximately 4 h. After this period, another 10-mL air sample was drawn from the animal chambers.

O$_2$ and CO$_2$ content of the 10-mL samples were determined with an oxygen analyzer (FC-1, Sable Systems, Nevada) and a CO$_2$ analyzer connected in series. As described previously with the CO$_2$ analyzer, outside air was drawn at a flow rate of 100 mL/min through a Drierite/Ascarite/Drierite column and then into the two analyzers. The O$_2$ analyzer was interfaced with the same computer running an analog-to-digital data acquisition software. Both initial and final air samples for each animal were injected into a length of tubing immediately after the Drierite/Ascarite/Drierite column and O$_2$ and CO$_2$ contents were calculated by integrating fractional concentration over time and multiplying by flow rate (Bartholomew et al., 1985).

$\dot{V}_{CO_2}$ and $\dot{V}_{O_2}$ were calculated as:

$$ \dot{V}_{CO_2} (\text{mL CO}_2 \text{ h}^{-1}) = V_a *(\dot{V}_b/10 \text{ mL}) * r^{-1}$$

$$ \dot{V}_{O_2} (\text{mL O}_2 \text{ h}^{-1}) = V_c *(\dot{V}_b/10 \text{ mL}) * r^{-1}$$

where $V_a$ was the volume of carbon dioxide increase in the 10-mL air samples (determined from the difference between initial and final air samples), and similarly $V_c$ was the volume of oxygen depleted from the 10-mL air samples. $\dot{V}_b$ in both equations was the effective volume of the sealed chamber (235 mL — volume of animal). The volume of an animal was

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>females</th>
<th>Males:</th>
<th>N</th>
<th>Body mass (g)</th>
<th>MR (mL CO$_2$ h$^{-1}$)</th>
<th>RMR (mL CO$_2$ h$^{-1}$)</th>
<th>Intercept</th>
<th>Slope</th>
<th>Equation for RMR (mL CO$_2$ h$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 °C</td>
<td>12</td>
<td>12</td>
<td>43</td>
<td>7.62±0.34</td>
<td>0.33±0.02</td>
<td>0.13±0.01</td>
<td>−1.47±0.14</td>
<td>0.62±0.16</td>
<td>0.062 M$^{0.617}$</td>
</tr>
<tr>
<td>25 °C</td>
<td>10</td>
<td>10</td>
<td>38</td>
<td>7.78±0.36</td>
<td>0.21±0.01</td>
<td>1.26±0.13</td>
<td>0.64±0.14</td>
<td>0.056 M$^{0.644}$</td>
<td></td>
</tr>
<tr>
<td>30 °C</td>
<td>13</td>
<td>13</td>
<td>40</td>
<td>7.63±0.34</td>
<td>0.28±0.01</td>
<td>−1.30±0.09</td>
<td>0.86±0.11</td>
<td>0.050 M$^{0.860}$</td>
<td></td>
</tr>
<tr>
<td>35 °C</td>
<td>12</td>
<td>12</td>
<td>37</td>
<td>7.48±0.37</td>
<td>0.42±0.03</td>
<td>−1.23±0.11</td>
<td>0.86±0.13</td>
<td>0.075 M$^{0.860}$</td>
<td></td>
</tr>
</tbody>
</table>

This is based on results of least-squared regression of log$_{10}$ $\dot{V}_{CO_2}$ (mL h$^{-1}$) on log$_{10}$ body mass (g). Metabolic rates measured at 25 °C using the constant-volume technique$^a$ are included for comparison with flow-through RMR values.

$^a$ Values are means±S.E.M.

$^b$ Values include standard error of the slope and intercept.
estimated as 1.01 * body mass. Finally, t was the elapsed time in hours.

3. Results

3.1. Resting metabolic rates

Fifty-one male tarantulas and 14 females were used in this laboratory study. Metabolic rates varied randomly with time and did not show any nocturnal/diurnal cycle or any other predictable pattern at any of the lower three temperatures ($F_{6,151}=1.52$, $P=0.17$). In all further analyses I used the lowest RMR for each individual at each temperature (irrespective of time) after assessing and eliminating any data that were deemed unsuitable for estimates of RMR.

Comparison of raw (before log transformation or mass correction) RMRs of males and females showed that rates of CO₂ production were similar at each temperature; however, females were significantly heavier than males ($t=3.42$, $P<0.001$) (Table 1). After log transformation of the data, plotting $\dot{V}_{CO_2}$ versus body mass indicated that females typically had lower RMRs than males of similar mass (e.g., Fig. 1). These results were similar at 20, 30 and 35 °C. For both males and females, slopes were homogeneous across all temperatures (males: $F_{3,149}=0.91$, $P=0.44$; females: $F_{3,39}=0.82$, $P=0.61$). In addition, slopes of log-transformed RMR versus body mass (for all temperatures combined) were homogeneous between the sexes ($F_{1,200}=0.45$, $P=0.50$) and at each temperature slopes were homogeneous between the sexes (20 °C: $F_{1,100}=0.21$, $P=0.65$; 25 °C: $F_{1,44}=3.81$, $P=0.09$; $F_{1,49}=0.48$, $P=0.49$; $F_{1,45}=1.32$, $P=0.26$). However, observation of mass-scaling coefficients indicated that while both intercepts and slopes were highly variable among females, these variables were very consistent among males with a sample size almost 4-fold greater than females (Table 1).

The mass-corrected response variable (i.e., residuals of log$_{10}$ $\dot{V}_{CO_2}$ and log$_{10}$ body mass for all individuals at all temperatures) was calculated from the overall scaling equation (incorporating both sexes and temperatures):\

$$\dot{V}_{CO_2} = 0.40*\log_{10}M - 1.03$$

(where $M$ is body mass in grams).

Table 2
Repeated-measures analysis for the effects of sex and temperature and year and their interactions on log-transformed RMRs (mL CO₂ h⁻¹) of male and female tarantulas

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F-value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>1.68</td>
<td>46.73</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Year</td>
<td>1.67</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>Sex*year</td>
<td>1.68</td>
<td>1.34</td>
<td>0.42</td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>3.148</td>
<td>99.23</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Temperature*sex</td>
<td>3.148</td>
<td>0.60</td>
<td>0.61</td>
</tr>
<tr>
<td>Temperature*year</td>
<td>3.148</td>
<td>1.21</td>
<td>0.33</td>
</tr>
<tr>
<td>Temperature<em>sex</em>year</td>
<td>3.148</td>
<td>4.47</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Resulting data were analyzed using a repeated-measures ANOVA (Table 2).

$\dot{V}_{CO_2}$ increased with increasing temperature and, at each temperature, the residuals of log$_{10}$ $\dot{V}_{CO_2}$ were consistently higher for males than females (Fig. 2). In addition, the three-way interaction of temperature, sex and year influenced RMR. Examination of temperature by year plots indicated that although CO₂ production increased with temperature for both males and females, the magnitude of this increase varied by year (Fig. 3). Because the two-way interactions of temperature*year and sex*year were not significant, the significant three-way interaction indicated that one of the sexes had a different response to temperature in the two years. Comparisons of the mass-corrected variable by year for males and females at each temperature indicated that the differences were small. For females, sample sizes were small and variance was large. For males, the greatest difference in the means occurred at 20 and 25 °C. RMRs in males from 2000 tended to be slightly lower than 1999, leading to larger negative residuals that accounted for the three-way interaction (Table 3).

![Fig. 1. Metabolic rates versus body mass at 25 °C for male and female tarantulas. Axes are logarithmic and lines shown are least-squared linear regressions. Regressions slopes were not significantly different between the sexes. These results are typical for those obtained at the other three temperatures. Males exhibit elevated CO₂ production rates compared to females.](image)

![Fig. 2. Mean residuals (=mass-corrected variable for RMR) for male and female at 20, 25, 30 and 35 °C. Error bars correspond to 95% confidence intervals for the mean.](image)
Fig. 3. Mass-corrected RMR variable (residuals of log-transformed RMR) versus body mass (g) for male and female tarantulas separated by year. Closed symbols signify the year 1999 and open symbols the year 2000. Error bars correspond to 95% confidence interval of the mean.

Thermal coefficients ($Q_{10}$) for both sexes were determined between 20 and 30 °C and also between 25 and 35 °C. RMR data for each sex were pooled at each of the four temperatures and yielded $Q_{10}$ values of 2.0 (between 20 and 30 °C) and 2.3 (between 25 and 35 °C).

3.2. Respiratory quotient

$V_{CO2}$ measurements of 27 males and 14 females obtained from the constant-volume technique were slightly higher than those measured from open-flow respirometry (Table 1) because I could not control for activity of the animals. A mean RQ of 0.92 ($\pm$0.06) was calculated from data for all males and females combined. Using this RQ, I converted $V_{CO2}$ (mL CO$_2$ h$^{-1}$) to $V_{O2}$ (mL O$_2$ h$^{-1}$) and determined mass-scaling equations expressed in μW at all four temperatures (Table 4).

4. Discussion

4.1. Resting metabolic rates

As expected, RMRs for both males and females increased with body mass and temperature, with $Q_{10}$s in a normal physiological range. Metabolic rates in mL O$_2$ h$^{-1}$ were similar to previously published data on tarantulas (females: three unidentified species from Mexico, Anderson, 1970; Brachypelma smithi, Anderson and Prestwich, 1985; males: Aphonopelma hentzi, Seymour and Vinegar, 1973; unknown sex: Eurypelma californicum Paul et al., 1989).

In this study, sample sizes were smaller for females compared to males and this may explain some of the variability observed in the mass-scaling components for RMR. Because results for males appeared more consistent, I compared only mass-scaling equations of RMR for males with other arthropods (Table 5). Metabolic rates measured in this study for male A. anax were approximately 30% of the predicted MRs for spiders as a whole (Lighton and Fielden, 1995) at 25 °C. This is due both to a substantially reduced slope (log$_{10}$ MR versus log$_{10}$ body mass) and a lower intercept. At 30 and 35 °C, the allometric relationship between body mass and RMR for male tarantulas is more similar to that reported for many arthropods at 25 °C. In addition, RQ calculated for A. anax was higher than the value assumed by Lighton and Fielden (1995). Because this variable is used in the conversion from mL CO$_2$ h$^{-1}$ to μW, it will influence the mass-scaling equation. This calculated RQ is also different from that determined for the tarantula E. californicum (RQ=0.71; Paul et al., 1989). Reasons for this difference are uncertain but may be the result of differences in equipment, post-absorptive state or activity. The lower RQ may be more indicative of a fasting arthropod and tarantulas may need to be without food for more than one week to be truly post-absorptive.
Among the arachnids, tarantulas are presumed to have comparatively low metabolic rates (Anderson, 1970). Low RMRs are more likely related to their low energy lifestyle (Greenstone and Bennett, 1980; Lighton and Fielden, 1995; Lighton et al., 2001), which can include months of inactivity in a sealed burrow during the winter and during periods of molting, as well as periods of low food availability because of their sit-and-wait predatory strategy. Thus, they may have a low ratio of actively respiring tissue compared to overall body mass, leading to a low RMR (Lighton and Fielden, 1995).

4.2. Sexual dimorphism in RMR

The most interesting result of this study is that, after adjusting for body mass, RMRs at all temperatures were substantially higher for males than for females. Similar results have been found in two other intra-specific comparisons of metabolic rates in spiders (Tanaka and Ito, 1982; Watson and Lighton, 1994). In a third study, Kotiaho (1998) compared mass-specific RMRs and found that males had lower metabolic rates than females in a species of wolf spider. However, analysis of mass-specific variables can result in false conclusions (Packard and Boardman, 1988; Packard and Boardman, 1999). Humphreys (1977) found no differences in RMRs between male and female spiders. All four of the above studies used different species, so additional work is needed to address species differences in RMR.

Proximate causes for differences in RMRs between males and females may include differences in body composition, with females having a higher fat content (Brian et al., 1972; Cullum, 1998). In spiders, mature females accumulate yolk in two steps (see Foelix, 1995) and the first step is independent of mating. During the first step which occurs prior to copulation, yolk particles start to form while the egg grows (Foelix, 1996). Thus, even non-gravid females have larger proportions of protein and lipids in their abdomen than males and this may account for some of the differences in metabolic rates if the accumulated tissue has low metabolic activity (Carrel, 1990). Extraction and analysis of water, lipid and protein content of males and females in conjunction with metabolic studies may provide further insight. More studies are needed to fully explain these differences and to determine when and why they occur.

Adaptive explanations for sexual differences in RMR are perhaps best supported by the aerobic capacity hypothesis (see Reinhold, 1999) which suggests a link between RMRs and the maximum metabolic rate that an individual can attain. For sexually mature male tarantulas, there may be a significant advantage to increased locomotory activity which is likely to bring them into contact with more reproductive females. During the mating season males expend large amounts of energy searching for well-dispersed females. If individuals with higher active metabolic rates can sustain higher levels of activity during the mating season, this may increase their likelihood of finding more females (scramble competition). The physiological requirements for high levels of energy due to activity, in turn lead to higher RMRs. Alternatively, for female tarantulas that typically remain inactive throughout most of their entire life history, low RMRs are advantageous because, in the absence of the increased locomotory activity evident in males (see Shillington, 2002), RMRs constitute a large portion of their daily metabolic costs. Thus selection is likely to favor reduced RMRs in females, but higher RMRs in males to support increased levels of activity. An initial comparison of active metabolic rates and performance traits in male and female tarantulas in the laboratory did not find any differences between the sexes (Shillington and Peterson, 2002). However, we suggest that the males were past their prime. Subsequent studies with males undertaken at the start of the mating season (unpublished data) suggest substantial differences in their performance abilities. Additional work is needed to determine if there is a correlation between daily levels of locomotory activity and male RMRs. It would also be interesting to discover whether higher RMRs (and thus increased locomotory activity) translate into increased male reproductive fitness.

Acknowledgments

Thanks to C.C. Peterson for his suggestions throughout this study. I am grateful to D. Synatzke at the Chapparal Wildlife Management Area for allowing me access to the area and providing accommodations on site. Thanks also to D. Ruthven III and R. Kazmaier for their help in collecting tarantulas. This manuscript was improved — thanks to M.S. Ewing, S. Fox, C. C. Peterson, J. Sauer, C. Goad, and three anonymous reviewers. Partial funding for this study was provided by grants from the American Arachnological Society, Sigma Delta Epsilon and the Society of Integrative and Comparative Biology.

References


