**Supplementary tables**

**Supplemental Table 1. Summary statistics for the animals examined in this study (mean ± std. dev.).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Species | Breed | Sample (n: m,f) | Mass (kg) | Age (yrs) | Hindlimb length (m) |
| Virginia opossum | - | 4: 2,2 | 3.83 ± 0.71 | 0.67 | 0.21 ± 0.02 |
| Tufted capuchin | - | 3: 0,3 | 2.36 ± 0.15 | na | 0.35 ± 0.02 |
| Domestic dog | Northern | 9: 4,5 | 33.1 ± 11.4 | 5.9 ± 3.3 | 0.56 ± 0.09 |
| Hound | 7: 6,1 | 24.2 ± 2.38 | 6.0 ± 3.17 | 0.50 ± 0.05 |
| Retriever | 7: 5,2 | 33.2 ± 6.09 | 5.4 ± 3.17 | 0.61 ± 0.13 |

-Data not applicable

naData not available

**Supplemental Table 2.** Experimental parameters used for metabolic measurements and collection coefficients of variation () of stride cycle durations.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | Range of speeds measured (m s-1) | Chamber dimensions (m x m x m) | Chamber flow rate (L/min) | Oxygen consumption speed increment (m s-1) | Number of speed increments used for oxygen consumption trials | Respiratory quotient | speed increment  (m s-1) | Number of speed increments used for trials | Camera model | Recording speed (frames per second) |
| Virginia opossum | 0.45 – 1.61 | 0.87 x 0.23 x 0.51 | 50-75 | 0.09 | 14 | 0.8 | 0.045 | 27 | Sony AX100 4K Expert Handycam (Sony Corporation, Bolingbrook, IL, USA) | 120 |
| Tufted capuchin | 0.45 – 1.87 | 0.87 x 0.23 x 0.51 | 50-75 | 0.09 | 17 | 0.8 | 0.045 | 33 | Sony AX100 4K Expert Handycam (Sony Corporation, Bolingbrook, IL, USA) | 120 |
| Domestic dog | 0.45 – 4.56 | 1.6 x 0.5 x 1.0 | 230 | 0.04-0.18 | 69 | 0.82 | 0.47 | 9 | Casio EX-F1(Casio America, Inc., Dover, NJ, USA) | 300 |

**Supplemental Table 3.** The speed interval (m s-1) and the number of cycles within each speed interval used to calculate coefficients of variation () of stride cycle durations via our resampling protocol for the independently collected data. For data on the Australian water rat, stride cycle duration was reported as a single point at a specific speed rather than a mean and standard deviation at a specific speed interval. For these datasets, the range of locomotor speeds were broken up into equally distributed speed interval bins using the histogram and discretize function in MATLAB (MATLAB version 2017b; MathWorks, Natick, MA, USA). The mean speed of each bin was used for subsequent analyses. The range of speeds in each bin are presented in parentheses.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Speed interval | Brush-tailed bettong | Australian water rat | American mink | North American river otter | Svalbard rock ptarmigan | Common ostrich |
| 1 | 0.60: 5 | 0.33 (0.26-0.45): 5 | 0.28: 3 | 0.64: 2 | 0.21: 5 | 0.82: 5 |
| 2 | 0.80: 4 | 0.65 (0.60-0.66): 6 | 0.70: 2 | 0.75: 4 | 0.51: 5 | 0.98: 5 |
| 3 | 1.09: 5 | 0.93 (0.85-1.02): 4 | 0.89: 4 | 0.90: 4 | 0.75: 5 | 1.09: 5 |
| 4 | 2.00: 4 | 1.22 (1.18-1.3): 3 | 1.03: 4 | 1.10: 3 | 0.99: 5 | 1.52: 5 |
| 5 | 3.00: 5 |  | 1.30: 4 | 1.20: 9 | 1.12: 5 | 1.67: 5 |
| 6 | 4.10: 4 |  | 1.16: 3 | 1.35: 3 | 1.23: 5 | 1.80: 5 |
| 7 | 5.20: 4 |  | 1.45: 4 | 1.40: 3 | 1.38: 5 | 1.94: 5 |
| 8 | 6.20: 4 |  | 1.77: 4 |  | 1.50: 5 | 1.99: 5 |
| 9 |  |  |  |  |  | 2.21: 5 |
| 10 |  |  |  |  |  | 2.47: 5 |
| 11 |  |  |  |  |  | 2.77: 5 |
| 12 |  |  |  |  |  | 2.95: 5 |
| 13 |  |  |  |  |  | 3.03: 5 |
| 14 |  |  |  |  |  | 3.26: 5 |
| 15 |  |  |  |  |  | 3.13: 5 |
| 16 |  |  |  |  |  | 3.59: 5 |
| 17 |  |  |  |  |  | 3.90: 5 |
| 18 |  |  |  |  |  | 4.13: 5 |
| 19 |  |  |  |  |  | 5.50: 5 |
| 20 |  |  |  |  |  | 6.19: 5 |
| 21 |  |  |  |  |  | 6.66: 5 |

**Supplemental Table 4. Species mean best fit line equation and associated *R2-* values for each gait type**

|  |  |  |  |
| --- | --- | --- | --- |
| Species | Gait type | Best fit line equation | *R2* values |
| Virginia opossum | Walk | y = 66.99x2 - 119.79x + 67.50 | 0.68 |
| Trot | y = -2.0209x + 16.628 | 0.01 |
| Tufted capuchin | Walk | y = 15.81x2 - 27.70x + 20.70 | 0.50 |
| Trot | y = 10.04x2 - 33.98x + 39.32 | 0.02 |
| Domestic dog | Walk | y = 11.18x2 - 24.63x + 18.35 | 0.42 |
| Trot | y = 0.09x2 - 1.08x + 5.51 | 0.30 |
| Brush-tailed bettong | Quadrupedal bound | y = -49.87x + 74.94 | 0.74 |
| Bipedal hop | y = 1.16x2 - 11.70x + 35.70 | 0.92 |
| Australian water rat | Walk | y = -113.68x + 106.90 | 0.41 |
| Trot | y = -21.89x2 + 18.60x + 41.09 | 0.61 |
| American mink | Walk | y = 72.04x2 - 140.92x + 96.63 | 0.72 |
| Quadrupedal bound | y = -9.63x + 34.42 | 0.49 |
| North American river otter | Walk | y = -8.34x2 + 0.73x + 19.85 | 0.37 |
| Quadrupedal bound | y = -19.70x2 + 48.95x - 20.36 | 0.48 |
| Svalbard rock ptarmigan | Walk | y = 124.75x2 - 220.69x + 118.35 | 0.98 |
| Grounded run | y = 93.13x2 - 250.08x + 183.13 | 0.83 |
| Common ostrich | Walk | y = 1.42x + 0.18 | 0.97 |
| Grounded run | y = 0.05x2 - 0.51x + 3.58 | 0.62 |

**Supplementary Figure Legends**

**Supplemental Figure 1: A hypothetical schematic illustrating the underlying trigger for gait transitions based on the (A) the energy minimization hypothesis and (B) the dynamic stability hypothesis.** According to the energy minimization hypothesis, when the relationship between energy consumption per unit distance is plotted against locomotor speed, there is a set of intersecting curves characteristic of each specific gait type (e.g., walking, trotting, galloping). The peaks of these lines represent speeds with a high cost of transport, and the valleys are energetically optimal locomotor speeds. At self-selected speeds, animals tend to choose the most economical speeds within a given gait type and avoid speeds that are energetically costly. When animals are forced to accelerate, energy costs increase rapidly as animals adopt speeds near the peaks of a specific cost of transport curve. These energy costs continue to increase until it is no longer energetically efficient to maintain a specific gait type and making a gait transition drastically decreases energetic costs. The point at which the cost of transport curve for one gait type (e.g., walking) intersects the cost of transport curve of another (e.g., trotting) indicates the energetically optimal transition speed. The dynamic stability hypothesis can be modeled in a similar arrangement of peaks and valleys. The system is analogous to a ball rolling along the potential stability landscape for a given gait, so the system would theoretically settle in the local minimum for each gait type. As speed is increases, maintaining a walking gait becomes unstable, and after a stability threshold is crossed, the animal shifts to trotting, where a new local minimum can be reached.

**Supplemental Figure 2: Box plots showing (A) cost of transport (COT; J kg-1 m-1) and (B) coefficients of variation () of stride cycle durations before (black) and after a gait transition (white).** Data plotted as median, 10th, 25th, 75th, and 90th percentiles. Open circles represent outliers in the data. Results of non-parametric pairwise comparisons are plotted above each comparison. An asterisk (\*) represents *P* *<* 0.05, while “ns” represents a non-significant result (*P* > 0.05). Calculations of for each speed were based on 3-12 stride cycle durations depending on the species. Cost of transport for each speed was based on 3-15 trials depending on the species.

**Supplemental Figure 3: Coefficients of variation () of stride cycle durations (mean ± std dev) plotted against locomotor speed (m s-1) for the common ostrich (*Struthio camelus*) in the wild based off of data provided by Daley et al. (56).** Data consist of 25,786 cycles collected from seven individuals. The gray box represents the first and third interquartile range speeds where gait transitions occur. The dashed line indicates the median preferred transition speed. Calculations of for each speed interval were based on 2-546 cycles for each individual.