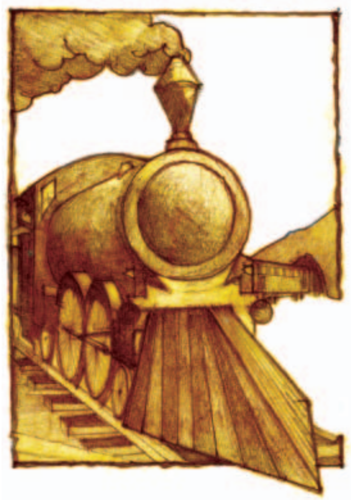
BALLISTIC LOCOMOTION



## LEAPING LIZARDS

Although frogs may first come to mind when we think of ectothermic vertebrates with a proclivity for jumping, it should be noted that many arboreal lizards are no strangers to this mode of locomotion. What makes a lizard a good jumper? What trade-offs might good jumping impose? In a recent paper, Esteban Toro, Anthony Herrel and Duncan Irschick explore the relationships among morphology, ecology and jumping in Caribbean *Anolis* lizards to answer such questions and to address more generally the evolution of ballistic locomotory behavior within this clade.

As a genus, *Anolis* is huge, encompassing over three hundred species of lizard, many of which live among the islands of the Caribbean. What has made these Caribbean animals so attractive to evolutionary biologists (in addition to necessitating a tropical field-site visit) is that in their radiation across the islands, convergent evolution has molded many species into six identifiable ‘ecomorphs’: species that share common features related to their habitat use and morphology, but have largely evolved these ecological and anatomical similarities independently. Presumably, some of the anatomical traits that are characteristic of a particular ecomorph represent adaptations to a specific habitat, or way of life. A number of scientists have taken advantage of this system to begin to study the process of adaptation by examining the links between performance, structure and ecology. In this most recent example, Toro and colleagues explore the mechanics of jumping across *Anolis* ecomorphs to understand how jumping function relates to limb morphology.

Up to ten individuals from each of 12 species comprising all six ecomorphs were studied while jumping off a custom-made force plate. Performance variables, such as take-off angle, distance, peak velocity, acceleration and power, were measured from each individual’s best jump. Morphometric variables were also determined for each animal. The results showed that the lizards, on average, used significantly lower take-off angles (~36°, range=31–40°) than predicted for optimal jump distance (39–42°), and the authors did not find a strong correlation between the animals’ take-off angles and their preferred habitat. As the authors point out, jump distance may not be the only relevant variable for a jumping lizard. Minimizing flight time might also be important and, indeed, at these slightly lower take-off angles, lizards forsake only a small loss in distance (~1%) for a more substantial reduction in air-time (~7%). Perhaps the use of lower-than-optimal take-off angles represents a balance between maximizing jump distance while simultaneously minimizing flight time.

Among the morphological variables, only hind-limb length was a positive predictor of take-off velocity (which, in turn, is directly related to jump distance). This makes intuitive sense as longer limbs increase the time and distance over which the body can be accelerated before take-off. Previous work on Caribbean anoles has shown that relative limb length can impact running ability on narrow surfaces, such as thin branches. Specifically, long-limbed animals perform poorly on narrow surfaces. Thus, evolving long limbs may improve jumping distance, but probably at the cost of reduced running agility along small tree branches. Intriguingly, some shorter-limbed species may have solved this trade-off by increasing hind-limb extensor-muscle mass, allowing enhanced acceleration despite short limbs.

10.1242/jeb.01302

**Toro, E., Herrel, A. and Irschick, D.** (2004). The evolution of jumping performance in Caribbean *Anolis* lizards: solutions to biomechanical trade-offs. *Am. Nat.* **163**, 844-856.

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FEEDING BEHAVIOUR

## PERFECT ISN’T NECESSARILY BEST

One of the most basic tasks that animals have to undertake in their everyday business is that of finding and eating their next meal. Charles Horn and his colleagues in Philadelphia and New York have been looking at the system that controls the cycle of biting, swallowing and the possible rejection of food in *Aplysia* – a purple sea slug that slithers around on the ocean floor devouring pieces of seaweed. A bundle of neurons in the central nervous system, called the central pattern generator, sends out a regular rhythm to the muscles of the radula – a hard, tongue-like structure covered in small teeth that *Aplysia* uses to feed. Any variability in this rhythm, or in the muscles it controls, has usually been dismissed as experimental error. However, Horn and his colleagues thought that this variation may affect how a hungry *Aplysia* gets its next meal; they decided to take a closer look.

First they isolated the part of the central nervous system containing the central pattern generator – the buccal ganglia – and the radula muscles from the rest of the animal. They then stimulated the oesophageal nerve, which connects to the buccal ganglia, with regular pulses to activate the central pattern generator to produce cycles of signals that would cause feeding behaviour. They also recorded from two motor neurons that controlled one of the radula muscles to chart the feeding behaviour and, finally, recorded the force generated in this muscle. What the team found surprised them. When they had controlled for sources of error in the experiment, and analysed their results mathematically, the signals generated in the nerves, neurons and muscles were still unexpectedly variable. But would they find