Living upside-down shapes spiders for energy saving

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An interdisciplinary team of researchers from Spain and Croatia led an investigation into the peculiar lifestyle of numerous spider species, which live, feed, breed and 'walk' in an upside-down hanging position. According to their results, such 'unconventional' enterprise drives a shape in spiders that confers high energy efficiency, as in oscillatory pendulums. These results will appear in this week's issue of *PLoS ONE.*

The great majority of land animals evolved to use the ground as the main support for their motion. Accordingly, they evolved legs capable of supporting the weight of their whole bodies, enabling them to move around with their heads above their feet. However, many spider species found it more convenient to literally turn their world upside down. They spend most of their lives hanging suspended by their legs, and 'walk' by swinging under the influence of gravity.

Intrigued by this evolutionary phenomenon, a team of biologists from the Estación Experimental de Zonas Áridas (CSIC, Almería) in Spain, joined by an astrophysicist from the University of Split, Croatia, conducted an inquiry into biological advantages and caveats of such a peculiar lifestyle by studying over a hundred spider species. One of their focal questions was the evolutionary importance of 'bridging' – the technique many spiders use to move between remote plants by building their own silk bridges, which they cross by 'walking' suspended upside-down from them. Earlier research by other authors indicated that for monkeys this suspensory way of locomotion might be a more energetically efficient way of transportation than 'regular' walking on the ground. To this end, the authors took several spider species into the laboratory and compared how they handle two different types of movement - walking on the ground and bridging from branch to branch.

“We discovered that spiders that live upside-down have evolved disproportionately longer legs relative to ‘normal’ spiders, which enables them to move faster while bridging than while ‘normally walking’ on the ground. Particularly ‘clumsy’ walkers are larger spiders, because their long legs – otherwise so convenient for bridging – do not allow an easy lifting of their relatively large body mass” says Dr. Jordi Moya-Laraño from Spain, the principal investigator on this project.

For Dr. Dejan Vinković, astrophysicist from Croatia, this research is more than a biology study. “As a physicist, I was particularly interested in the energetics of upside-down locomotion” he says. “With this research we finally proved that the energetic efficiency of such motion stems from the same physical principle used to run the grandfather’s clock – motion of a pendulum under the influence of gravity.”

Dr. Eulalia Moreno, co-author of the study, adds: "We started this collaboration with Dr. Moya-Laraño because I had studied the form and function of legs in tits, birds that, similarly to spiders, hang upside-down while foraging. Now, we have a much better understanding of how an animal shape should evolve when animals spent most of their lifetime hanging upside-down"

These results have implications for the evolution and ecology of spiders. For example, small spiders that hang from their webs should be able to leave their webs in search for prey by walking on the ground, as found in some tiny spiders, something that large spiders will be unable to do efficiently.

Citation: Moya-Laraño J, Vinković D, De Mas E, Corcobado G, Moreno

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