

# When Lizards Do Push-Ups

## Humans aren't the only ones inclined to athletic displays in love and war

By SUSAN MILIUS

**L**izards don't sing. Instead, they do push-ups.

Much as birds chirp their threats and come-ons and commentaries, sagebrush lizards in the western United States communicate through little flex fests. Both male and female lizards rise off their bellies and bob up and down, quick as a recruit slamming into the ground at the feet of a bellowing marine sergeant.

During the past decade, Emilia P. Martins of the University of Oregon in Eugene has led a search to decode sagebrush lizard athletics. "They're incredibly complex," she marvels. Depending on the details, a set of push-ups may indicate something like "Get your presumptuous rear off my rock this instant" or "Be mine, you gorgeous creature."

The nuances of all this bobbing and flexing give scientists another world of communication to explore, with intriguing comparisons to bird songs and bee dances.

The latest work from Martins and her colleagues shows regional differences in push-up styles, a bit like dialects in human speech. The lizards in California have a special athletic flamboyance that may help scientists observe how one species splits into two. All in all, it gets pretty deep for a push-up.

**T**he group of reptiles called Iguania, which includes sagebrush lizards, relies heavily on visual displays. Hundreds of small, tropical *Anolis* species, for example, do push-ups as well as fanning out skin flaps with eye-popping colors under their chins. Iguanas bob their heads in elaborate patterns.

The observation of lizard push-ups turned into a science during the 1960s,

when Charles Carpenter of the University of Oklahoma demonstrated that he could tell species apart by the patterns of their push-ups. Other researchers began decoding displays and musing about speciation in a variety of these animals.

When Martins entered the field in the late 1980s, the few studies of the sagebrush lizard, or *Sceloporus graciosus*, had focused on head motions of captive males. She instead turned to southern California woodlands to watch both male and female lizards in the wild.

Analyzing more than 1,500 displays, Martins concluded that three aspects combine to reveal the inner meaning of a push-up: the pattern of head bobs, the overall body posture, and the number of legs flexing and stretching.

At one extreme, sagebrush lizard displays include simple strings of head bobs without any noticeable extension of the legs—what Martins' graduate student Ahrash N. Bissell describes as "a funky jerk." At the other extreme, the lizards perform complex patterns of single and double head bobs with four legs pumping, all the while holding some flashy body pose, such as a raised tail.

Giving a quick lesson in how to speak basic push-up, Martins explains the fundamental conversation topics: wooing, warring, and arriving at a really great rock. If you're a male and want to convey romantic intentions, do five to nine push-ups in a hurry and keep your scary blue belly patch from showing.

Occasionally, you might add a bit more body language. Move as if doing push-ups and trying to walk at the same time—a distinctive courtship gesture known as the shudder bob.

For territorial spats, face off with the intruder and give a long, vigorous performance, Martins advises. Now's the time to raise your tail or suck in that gut and flash some blue.

What Martin calls "broadcast displays," perhaps serving the function of a bird's territorial call, don't have to be strenuous. At a conspicuous spot in the territory, just dart to the top of a log or

*A western U.S. sagebrush lizard, Sceloporus graciosus, communicates by varying its push-ups with head bobs and leg flexes.*

rock and bob up and down one to four times—no special effects required. Don't worry about an audience; Martins often sees lizards broadcasting without any obvious watchers.

There's no need to mimic the other lizards exactly. Martins' statistical analysis found repeatable individual quirks, such as variation in the number and timing of head bobs. Such differences might simply reflect some physical state, like youthful zip or a nasty infection. Still, the analysis raises the possibility of personal signatures in push-up styles. "I could easily tell the lizards apart" by watching three or four displays, Martins says.

Martins also noticed that the lizards avoided certain combinations of elements as if they were nonsensical or somehow bad language. For example, displays with a lot of leg action did not stop with a few head bobs but always involved a great number. Nor did lizards that arched their backs rely on head motion alone for the rest of the display. Instead, they flexed at least two, and usually four, legs.

"There seems to be a grammatical rule requiring that the three components increase or decrease together," Martins says.

Yes, she referred to grammar. She acknowledges that "conventional wisdom might deem it absurd to conclude that lizards have language." Yet the animals do seem to follow rules in their push-up display system. "It has a syntax," Martins says.

**T**o compare push-ups with other animal communication systems, Martins has drawn on standardized measures developed by information theorists. Push-ups don't have as much organization as some other forms of animal communication, yet the lizards make a respectable showing.

The measure of organization Martins calculated, called maximum entropy, depends on the number of possible words or signals in the system. Push-ups, with 6,864 possibilities for mixing and matching components, give an index of almost 13. The honeybee dance gives 25; the "chick-a-dee" call of the black-capped chickadee, 48; and written English, 1,908.

That ranking fits the expectations of



Tom A. Thrusell/University of Oregon

Jack P. Hailman of the University of Wisconsin-Madison, who made the chickadee calculations. "I think it highly unlikely that lizards could say as much as birds, even if they had as much to say—which they don't," he remarks.

However, from another perspective, the lizards get the top rating. Martins calculated a measure that information theorists call evenness of a communication code, which roughly relates to efficiency. Smaller evenness values suggest that only a few parts of the communication system do most of the work. In spoken English, "the," "you know," and "impeachment" get a lot more use than "autantitypy" and "Hudeket."

Looked at this way, the lizard language, at 0.48, outranks the chickadee call, at 0.14. Both leave written English back in the inefficient dust at 0.01.

One dramatic finding from Martins' research came from studying a quality of communication systems called openness. She found an unexpected similarity between lizard push-ups and human speech.

In an open system, there's no limit to the new communication signals, like words or sentences, that may be created. Until 1985, researchers judged openness intuitively, and in the prevailing opinion,



Making sure that other lizards know his territory, a male *Anolis conspersus* on Grand Cayman flares out a blue dewlap.

only human language achieved it. Then, while pondering chickadee data, Hailman had what he calls "a gee-whiz moment" and developed an objective test. It indicated that the chickadee call he studied counts as an open system.

When Martins tried the same thing with lizard push-ups, she found an open system. In fact, the lizard results matched the chickadees'.

"I see no particular reason that this type of openness would be restricted to human language and chickadee calls," Hailman says.

The latest work Martins and her colleagues have done on lizard displays reveals one of the less obvious differences between California and Oregon: Their lizards tend to do push-ups differently. Both styles differ from Utah lizards'.

"It's like telling somebody from Louisiana from somebody from New

York," Bissell says.

For example, 21 percent of push-ups from the Californian lizards include exaggerated body attitude, such as performing a Halloween-cat back arch. Only 2 percent of the displays recorded from Oregon had an exaggerated posture. And as far as the researchers could tell, in Utah it's just not done.

Sandra L. Vehrencamp of the University of California, San Diego resists the temptation, without more research, to call these patterns dialects. Traditionally, dialects have sharp borders, she says. Just finding variation among distant populations does not reveal whether characteristics shift gradually or abruptly.

Dialects are certainly known in animals besides humans, Vehrencamp explains. A coauthor with J.W. Bradbury of the 1998 book *Principles of Animal Communication* (Sinauer Associates), she studies bird songs and calls, which clearly have regional oddities. For example, Timothy F. Wright of the University of Maryland in College Park has documented dialects in the calls of Amazonian parrots. At the border between dialect zones, birds don't use some intermediate form. Instead, Vehrencamp says, "the parrots are bilingual."

But what if such regional dialects get so far apart that a female can't figure out what a suitor is talking about? Martins asks. The female may quickly dismiss her admirer as Mr. Wrong. "It's a fast way to create new species," Martins speculates.

The communications-breakdown theory of species formation sounds plausible to Jonathan B. Losos of Washington University in St. Louis. Thanks to the magic of paint, he switched the color of throat flaps, called dewlaps, in members of two otherwise similar-looking *Anolis* species. The color change alone, which showed clearly in territorial displays, fooled the lizards into wasting a full-scale, aggressive display—normally reserved only for same-species encounters—on members of the other species.

Having seen how a fairly simple color kink in a display foiled the animals' attempts to identify their own kind, Losos says he can believe that body-language snafus matter in speciation.

However, a test of that notion didn't turn out as predicted, says Thomas A. Jenssen of Virginia Polytechnic Institute and State



An adult male *Anolis sagrei* on Grand Cayman asserts home ownership.



A male *Cyclura carinata* in the Turks and Caicos Islands strikes a tough pose.

University in Blacksburg, Va. He watched lizard flirtations in a part of Haiti where the ranges of two sister species of *Anolis*, *websteri* and *caudalis*, met. The courtship displays of the males looked plenty different to Jenssen, so he suspected that the style differences helped maintain the separation between species. Not so. "*Websteri* females didn't care," he said. They were just as likely to mate with the wrong species as they were with their own kind.

Another puzzle for the speciation theorists, he says, comes from lizard displays that don't seem to vary much despite great variation in geography. The lizard Jenssen studies, *Anolis carolinensis*, shows astonishingly uniform display behavior across a wide range of geography in the southeastern United States.

He even checked out a group of lizards whose ancestors were introduced into Hawaii in the 1950s. He expected that 40 or so generations later, the lizards would have a unique aloha style. Not so. What little variation Jenssen saw didn't even amount to the difference between populations of this species in Georgia versus Florida.

The behavior "is just rock solid," he says. "It's an enigma. It goes against all the things I've been trained to expect." The evolution and effects of lizard display behavior might hold a lot more surprises for researchers.

Understanding regional differences in communication could make a big difference in conservation, Martins points out. She's recently studied *Cyclura* lizards on small Caribbean islands. Differences in head-bob displays from island to island for the same species often rival differences between species.

Such variation could sabotage attempts to preserve a species, she warns. What if a zoo trying to breed rare lizards gets a male from some far-flung place whose eccentric displays don't make sense to the female? Or what if a cross-cultural pair produce offspring but can't pass on the right dialect to make it in the real world? Martins is just beginning to explore whether young lizards learn local variations or are born with them.

The thought of a silent spring without bird songs has galvanized conservationists for decades. Would a motionless spring, without the rich variety of bobbing, arching displays of lizards, be just as melancholy? □