Leaping frogs maximize muscle potential

In Mark Twain's tale about the notorious jumping frog of Calaveras County, frog owner Jim Smiley tries to win some money by betting that his pet, Dan'l Webster, can outjump all others.

Now, biologists have trained high-speed cameras on frogs wearing electrodes and simultaneously monitored the animals' muscle movement and activity. By catching the frogs' motion on film and also studying isolated frog-muscle fibers, they have learned more about why frogs like Dan'l are such great leapers.

For each bound, these animals rev up their muscles and put every fiber to maximum use, Lawrence C. Rome and Gordon J. Lutz of the University of Pennsylvania in Philadelphia report in the January 21 SCIENCE.

"It seems that [frogs] are designed to give all that they can give," says Lutz. To do this, "many things had to evolve in a coordinated, concerted way," he adds.

With this setup, the researchers saw that muscles wait about 26 milliseconds after they receive a signal to contract. During that time, they set in motion all the chemical reactions that prepare the force-generating units inside the muscle fiber for shortening. If these units, called sarcomeres, shorten too little or too much – or too slowly or too quickly – then a muscle fails to achieve its maximum potential.

Lutz, Douglas A. Syme/Univ. Penn.

But these amphibians shorten their sarcomeres by just the right amount at just the right velocity for an explosive takeoff, says Lutz. What's more, the frogs' muscles attach to joints in just the right places. This placement ensures that the muscles shorten just the right amount to create a given change in the angle of the joint.

The biomechanics of leaping frogs contrast sharply with those involved in the cyclical movements of swimming fish (SN: 7/17/93, p.39), says Rome. Frogs give their all with each jump, whereas fish have to back off with each swing of the tail in order to keep opposing muscles from fighting each other.

– E. Pennisi

Los Angeles quake: A taste of the future?

The deadly earthquake that struck the San Fernando Valley this week represents the latest in a string of tremors that have rattled southern California in the last decade, causing seismologists to wonder if the Big One is on the way.

Preliminary information indicates the Jan. 17 quake measured magnitude 6.6 and originated 12 kilometers below the hard-hit town of Northridge, says David Oppenheimer of the U.S. Geological Survey in Menlo Park, Calif. Although it was more than 100 times weaker than the magnitude 8 earthquake expected on the San Andreas fault, the Northridge temblor caused significant damage because it hit in a densely populated region 35 kilometers northwest of downtown Los Angeles.

Since 1986, more than a half dozen quakes measuring magnitude 5.5 or greater have shaken the region around Los Angeles, a sharp increase over the activity in previous decades. "There very clearly is a much greater rate of energy release by earthquakes in southern California in the last decade than there was in the three prior decades," says Thomas McEvilly of the University of California, Berkeley.

The trend concerns seismologists because it resembles the cycle of frequent quakes that preceded the great 1906 earthquake in San Francisco. Some experts believe the numerous moderate shocks in the late 1800s were a sign that accumulating crustal stress in the Bay Area had reached a high level capable of triggering a great quake. Stress in California stems from friction generated as the Pacific plate slides to the northwest past the North American plate.

The 1906 quake measured an estimated magnitude 8 and occurred on the northern section of the San Andreas fault — a 1000-kilometer tear in the crust that runs through California and separates the two gigantic tectonic plates. The southern section of the San Andreas has also generated great quakes in the past, most recently in 1857.

Since then, the part of San Andreas running past Los Angeles has remained quiet, storing stress that could be released in a series of magnitude 7 quakes or one big magnitude 8 shock. The recent unrest could signal that the stress is strong enough to generate a large earthquake, says seismologist Lynn Sykes of the Lamont-Doherty Earth Observatory in Palisades, N.Y. He adds that scientists do not know whether the disaster lies five years or decades in the future.

A great San Andreas quake would shake the ground for a longer period of time and would damage a much wider region than the Northridge tremor did.

This week's quake occurred on what appears to be an unknown fault running east-west in the San Fernando Valley. Over millions of years, movement on this and nearby faults absorbs stress from plate movement by narrowing the valley. During the recent tremor, rock on one side of the fault rode up over rock across the fault, a so-called thrust quake that shortened the north-south dimension of the valley very slightly. Scientists in coming months will measure how much movement actually occurred during the quake.

Although experts have long warned of the dangers of great San Andreas tremors, scientists have in the last five years started emphasizing the hazard of smaller thrust quakes in the Los Angeles region. This recognition follows in the wake of a magnitude 5.9 quake that caused considerable destruction in 1987. Such earthquakes are dangerous because they occur in populated regions on unknown or poorly studied faults hidden beneath thick layers of sedimentary cover. The Northridge quake appears to be the latest example of such a hidden thrust event.

"I think people in the Los Angeles area have to live with the fact that there could be faults anywhere," says Ronald Hamburger, a structural engineer in San Francisco specializing in earthquake risk assessment.

– R. Monastersky