Paleontology

Richard Monastersky reports from Drumheller, Alberta, at the annual meeting of the Society of Vertebrate Paleontology

You *can* take a fish out of water

From dinosaurs to dogs, all land vertebrates trace their ancestry back to the water. Sometime around 350 million years ago, fish-like amphibians crawled out of the water and established for the first time a foothold, or perhaps a fin-hold, on *terra firma.* While paleontologists believe these amphibians evolved from some primitive fish that had developed the ability to breathe air, they have debated for years which kind or kinds of fish spawned the earliest amphibians. Most theories have held that the ancestral fish must have had special organs, such as lungs, to help them breathe air directly. Yet a new study suggests this argument may not hold water.

Physiologist Karen Martin reports that some modern fish lacking special organs can breathe air quite well. Martin, of the University of California, Los Angeles, placed different near-shore marine fish in a dry chamber and passed air over them while measuring the levels of oxygen and carbon dioxide in air leaving the chamber. She found that for up to an hour, many types, including sculpin and a form of toadfish, called midshipman, could pull in oxygen and discharge carbon dioxide – the two key elements of respiration.

Modern lungfish and certain fish with gas bladders are well known for their ability to breathe air, but the sculpin and toadfish apparently use the tissue in their gills or mouths to respire, according to Martin. She chose to test these fish because they are found in tidal pools or lagoons, a logical place to look for fish that might be able to breathe, she says. During the day, when tides drop and the sun warms these shallow areas, levels of dissolved oxygen can fall drastically, making it more difficult for fish to absorb oxygen from the water.

Martin's findings do not reveal which ancient fish actually evolved into amphibians, but it opens up the possibilities in the search, she says. Air breathing does not seem to be a unique adaptation, and amphibians may have evolved from fish that lacked special breathing organs.

Finding the evidence in excrement

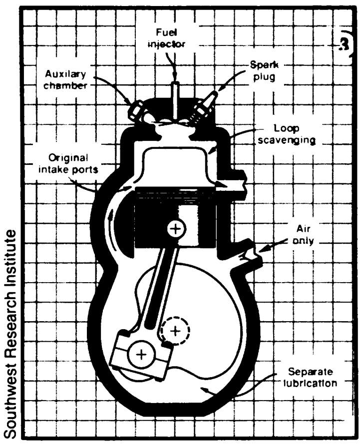
There's just no pretty way to skirt the issue. James McAllister studies feces – fossilized forms of fish feces, to be frank. "It's quite often ignored; people tend to laugh at you if you work on this," says the paleontologist from the University of Kansas in Lawrence. Yet, in spite of the traditional nose-turning attitude toward his subject, McAllister and others are focusing anew on excrement by showing how these remains can open a window into the past.

In his study, McAllister looked at fossil feces – called coprolites – and regurgitation pellets found in the Hamilton quarry in Greenwood County, Kans., which contains roughly 300-million-year-old rock. While characteristic swirl patterns on the coprolites indicate they came from some type of fish, the tiny fossils provide much more information about what was being eaten rather than what was doing the eating. The excretions contain material from two types of fish: acanthodians, which had several long, protruding spines; and palaeoniscoids, which lack external spines.

Analysis revealed that the acanthodians appeared in regurgitated material more often than the palaeoniscoids, but the reverse was true for the coprolites. This makes sense, says McAllister, since fish would be more apt to spit up spiny prey and digest the softer catch. Also interesting are the results of a close study of the acanthodian scales within the excrement. While acanthodian specimens found in the quarry range from 54 to 410 millimeters long, the excretions contain only scales from acanthodians that would have measured between 80 and 165 mm long, indicating that both small and large acanthodians escaped predation – at least from animals that left behind coprolites and regurgitation pellets.

Technology

New incarnation for two-cycle engine



Southwest Research Institute

Automobile makers use a complex array of moving parts – valves, rocker arms and rods – to make the powerful "four-cycle" engine, which combusts fuel on every fourth stroke of each piston. The "two-cycle" engine, on the other hand, does without those mechanisms. And although it is notorious for slurping fuel and exhaling a blue-smoke miasma of unburned fuel and oil, the two-cycle's simple design still makes it desirable for low-power use in lawnmowers, outboard motors and small motorcycles.

The lowly two-cycle engine may never replace its well-bred four-cycle cousin, but researchers at the Southwest Research Institute (SwRI) in San Antonio, Tex., have just sent the two-cycle engine to finishing school.

In traditional two-cycle engines, a gas, oil and air mixture that is pulled into the crankcase through a one-way valve lubricates the engine. As the piston descends after combustion it forces this mixture out of the crankcase and into the combustion chamber through an intake port, driving out the newly burned gases from the last stroke at the same time. But combustion in the two-cycle engine isn't very clean or complete because a lot of oil is incompletely burned with each stroke. In addition, some of the fresh fuel mixture rushes out the exhaust with the burned gases when both exhaust and intake ports are open.

The engine developed by SwRI researcher Susumi Ariga and colleagues (see diagram) uses a fuel injector rather than a carburetor to mix fuel with air for combustion. Because only air passes through the crankcase, no oil need be mixed in for lubrication, which is provided by a separate system. Because the exhaust port is closed before new fuel is injected, little unburned fuel escapes. Ariga also uses diesel fuel instead of gasoline in the engine.

A good burn depends on thorough mixing of air and fuel, though, and fuel injectors allow little time for mixing before combustion. Ariga solved this problem by adding an auxiliary chamber that catches a bit of diesel fuel from the injector. As combustion begins, a hot jet of gas from fuel burning in the auxiliary chamber increases mixing, and therefore combustion efficiency, in the main chamber.

MIT wins first American solar car race

The Solectria V, a solar-powered car built and raced by the Massachusetts Institute of Technology and sponsored by Dow Chemical U.S.A and Arco Solar, blazed to the finish of the first U.S. solar car race last month. Looking like a high-tech soapbox racer topped with a flat board, the Solectria V finished ahead of the only other competitor – the Mana La – which is sponsored by John Paul Mitchell Systems of Hawaii. The Mana La, designed to use wind power as well as solar power, broke down and didn't finish the race.

The American Solar Cup race was held Sept. 17 in Visalia, Calif., over a 159.3-mile course, on public roads among regular traffic. This year's race is seen as a prelude to a much different race in 1989, says race director Robert Cotter. Plans for next year's solar race include a long-distance portion that could last as long as five days, and a race at a "major motor speedway" to test speed, efficiency and/or mileage, Cotter says.