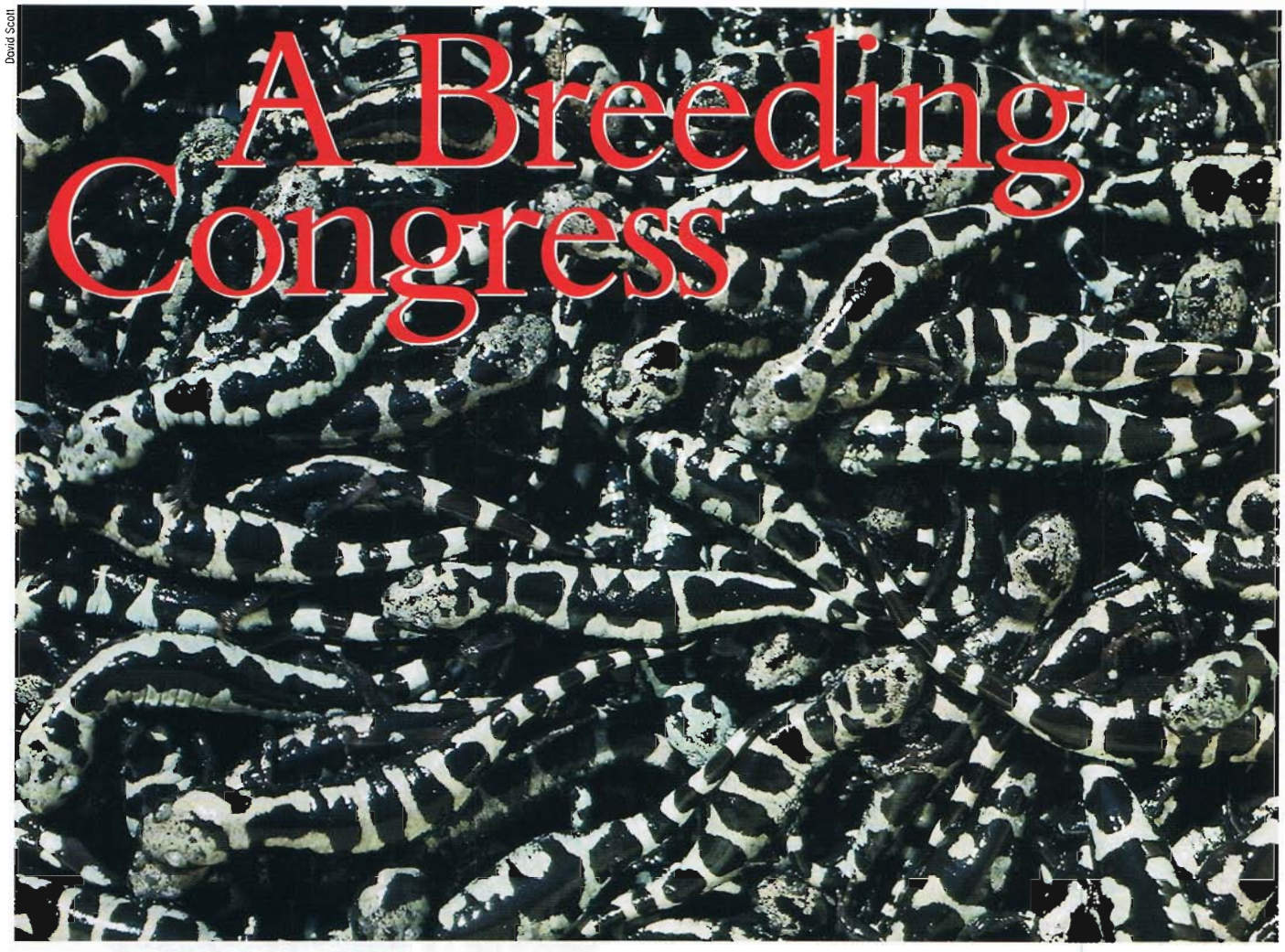

David Scott

A Breeding Congress

There's mayhem and mating as thousands of marbled salamanders march into a shrubby wetland called Ginger's Bay.

By David Scott

Had I given it much thought, I never would have expected to actually *hear* them. But there I was, standing in a quiet rain on a cool October night, listening to the marbled salamanders coming. Over leaves. Around logs. Tumbling off clumps of sedges. A few hundred had even crossed a nearby highway. Sometimes while conducting field research on amphibians my hearing has played tricks on me. Was this my imagination? No. The marbled salamander herd thundered in as only salamanders can thunder, arriving by the thousands at a small, shrubby wetland in South Carolina called Ginger's Bay.

But first, what should we call this approaching horde? "Herd" is a bit misleading, with its connotation of trampling and mayhem. I prefer the term coined by a biologist decades ago: a breeding congress. Forget the trampling but keep the mayhem. And instead of lobbyist-filled hallways, picture low-lying depressions that fill with water part of the year—ephemeral wetlands called Carolina bays.

Marbled salamanders inhabit much of the eastern United States, but the coastal plain of the Carolinas—home to hundreds of these bays—is a hot spot. The marbled salamander's breeding cycle begins with a late summer or early autumn migration to the wetland site. Most of its close relatives (mole, tiger, and spotted salamanders) mate later, when the bays have filled with water, but marbled salamanders do their mating at the dry pond sites. After the animals breed, females deposit their eggs in nest cavities under vegetation and logs and in crayfish holes. They stay with the eggs for as long as a month. Once the ponds start to fill and the nests are flooded, the eggs hatch.

From there, marbled salamanders follow a relatively typical amphibian life cycle: aquatic larvae, a period of transition, then adult life on land. Typical, perhaps, but never dull. And fascinating enough that most of my rainy October nights during the last twelve years have been spent watching individuals of this one species, *Ambystoma opacum,* move from woodlands to wetlands on their annual breeding migration.

How the adults find the sites is a mystery—to us, not to them. At migration time, there is usually no water in the wetlands. The ponds fill later, with the onset of winter rains, so these pond-breeding salamanders are not cued by the presence of water. Males of the species have no mating calls (unlike male frogs and toads). Some scientists suspect that chemical signals are important because many individuals return to the pond in which they were born; perhaps they act as salmon do. Others suspect that the earth's magnetic field provides a cranial road map. I don't have a clue how they do it. Just call it radar love.

Marbled salamanders differ from many other salamanders, not only in their breeding time (early fall) and location (dry sites), but also in the predictability of their breeding efforts. Because they don't require the ponds to be filled, the timing of their migrations doesn't vary from year to year. Forget an explanation using scientific analyses and jargon. A few years ago, two British filmmakers asked to follow the migrations. With our assurances, of salamander regularity, they were able to book cheap airline seats several months in advance. We suggested they arrive on October 2, which they did. By 8:00 P.M. that night, the first pulse of several thousand males began to enter Ginger's Bay. There is no other species that I'd venture such a guarantee for, even with someone else's money at stake.

In many species of salamander, courtship activities are elaborate, with behavioral signals and mating dances that last for up to an hour before both individuals are "ready." At the peak of sexual stimulation, the male deposits a spermatophore—a packet of sperm on a jellylike base. At the appropriate stage of receptivity, the female salamander straddles a packet, squats, and incorporates the sperm mass into her cloaca. In describing this behavior, Lynne D. Houck, an ecologist at Oregon State University and a past president of the Society for the Study of Amphibians and Reptiles, actually managed to have the term "spermatophore play" published in a respected scientific journal. Such prolonged courtship, however, is not the case with marbled salamanders. The frenzied activity of the congress results in spermatophores being deposited everywhere; Houck called it a "minefield of spermatophores." Females hardly need to squat—they just pick up a spermatophore on the run. Such indiscriminate mating is a bit curious for a salamander species, although not unprecedented in the amphibian world. After all, a male southern toad "in the mood" will mate with your thumb.


Stephen Kirkpatrick

These salamanders don't have a prolonged courtship: males deposit their spermatophores everywhere. A female can just pick one up on the run.

On the right night, marbled salamander males are quite in the mood. From lab analyses of blood samples, we learned that these four-to-five-inch-long males have testosterone levels far exceeding mine. Males "dance" (their movements have been described as a waltz with a touch of slam dancing) with females and can deposit more than ten spermatophores in thirty minutes. Males also court other males, depositing spermatophores galore. Chin-rubbing with this animal, tail whipping with that one—gender doesn't seem to matter. What gives here? *A. opacum* has been around for far more than a million years. It must be doing something right. Last year at Ginger's Bay (which is about half the size of a football field), we caught almost 12,000 adults coming in to breed. Using mathematical models, we estimate the local population in the hardwood forest surrounding Ginger's Bay at close to 40,000 salamanders.

As you might expect, all the frenzy of searching for mates during the congress (which includes U-whipping tails, a male courtship behavior in which the animal jerks its tail to one side, temporarily changing its shape to that of the letter U) is energetically expensive. When male and female marbled salamanders enter the breeding site, they are fat and ready. Both sexes spend six to eight weeks at the wetland site without feeding. Many have close to 15 percent body fat, which appears, in females, to enable them to produce a clutch of 30–150 eggs, and in males, to fuel searching and courtship activities. A high proportion of the salamanders apparently don't survive; in some years the mortality during the breeding season is close to 50 percent. The reasons are not obvious. Skin toxins make adult marbled salamanders distasteful to many predators, so they aren't being eaten up. Some may die of old age—at eight, nine, or ten years, they've gone about as far as they can go. Adults that do survive the breeding season generally depart the wetland lean and hungry. Be-

cause future reproduction is contingent on accumulating adequate fat stores, some animals may take two or more years to prepare to breed again.

For newly hatched young, the food of choice is zooplankton—microscopic animals, such as daphnids and copepods, that live in the water. And there's not always enough to go around in the pond habitat. Many experiments have demonstrated that larval salamanders compete with one another for food. Jim Petranka, of the University of North Carolina at Asheville, manipulated numbers of larvae in entire ponds by adding or removing them (try catching several thousand slippery baby salamanders the size of shoelace tips). He found that more larvae mean smaller larvae. A higher density of babies in a pond results in slower growth and a longer development time (or larval period). These larvae emerge from the pond smaller, and that means fewer survive. I was amazed that salamanders that metamorphosed and left their natal pond at a small body size were still relatively small five or six years later, when they returned as prospective parents. Their larval environment had set a course for the rest of their ten-year lives.

I decided years ago that my personal goal in ecological research was to truly understand a single species well enough to make meaningful predictions. Just one species! At the Savannah River Ecology Laboratory, my colleagues and I have studied marbled salamanders from eggs to adulthood and beyond. In our experiments, we have manipulated females on their nests, numbers of larvae, aquatic predators (such as dragonflies and spiders), prey levels, timing of hatchings, water levels, and populations of coexisting amphibian species. We have studied salamander nest sites, salamander genetics, salamander metabolism, and salamander fat. At Rainbow Bay, another ephemeral wetland study site, we have collected data for twenty years on the natural population fluctuations of twenty-five amphibian species. It is the world's longest-running observational study of an entire amphibian community. The Rainbow Bay project provides a model for long-term ecological studies at a time when many amphibian species, particularly frogs, are thought to be in decline or in danger of disappearing. Using the data we gathered while observing natural populations in conjunction with our experiments, we have developed insights into the driving forces behind the commonly observed ups and downs of amphibian populations.

John M. Burnley; Bruce Coleman, Inc.

When the marbled salamanders enter the breeding site, they are fat and ready; they'll spend six to eight weeks there without feeding.

So you'd think I would know marbled salamanders by now. Yet I still owe my ex-office mate more pitchers of beer than I could ever repay due to errant predictions. Perhaps I'll get it right someday. It is encouraging to have learned so much, discouraging still to know so little, and disheartening that time and money are in short supply. Folks today (*my* Congress) attach too little importance to basic questions of ecology. If a critter is contaminated with mercury, exposed to radioactivity, or eliminated from vast stretches of habitat so that we have but a few left, then it may get some attention, especially if it is furry or pretty. As well it should. But what about understanding how to maintain "healthy" habitats and avoid costly fix-it plans in the first place? What about the value of understanding animal and plant populations that are relatively free from human disturbance?

Many questions remain, even for a species not in apparent decline. How do marbled salamanders find that wetland, anyway? What happens when it is destroyed, as is, sadly, often the case? We know that for this species a forested area around the wetland is essential, but we don't know how big this "buffer" strip must be. How "connected" must populations be if all are to survive? I hope I'll be able to help others answer these questions. But you'll know where to find me on a rainy October night: watching hormonally charged salamanders marching into Ginger's Bay. Once across the highway, they reach the safety of the wetland, and the tail-slapping mayhem begins. Finally, a congress I can relate to.

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