The *Search* for

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the Smoking Gun

by Tom Davis
Editor-at-Large

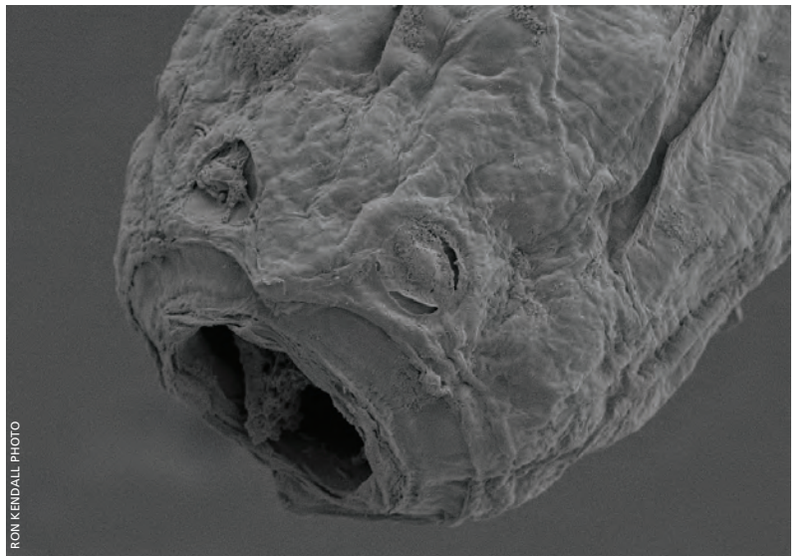
In the autumn of 2010, the camel's back finally broke. After suffering through years of poorer-than-expected bobwhite quail populations – and hearing the same company-line response from the scientific community that it was all due to loss, fragmentation, and/or degradation of habitat – the leadership of the Rolling Plains Quail Research Ranch essentially said, *Enough.*

The last straw was the discovery, when the Texas quail season opened October 30, that the plentiful coveys seen and heard over the course of the summer had simply vanished. The habitat appeared ideal; the rainfall that's so strongly correlated to quail abundance in that part of the world had come on cue; and ranch hands reported flushing birds by the score. Optimism was running high among the quail hunters of the Rolling Plains, the 24 million-acre swatch of mesquite-dotted grassland in West Texas and Oklahoma that's perhaps the last place in North America where bobwhites thrive on a landscape-wide scale *without* intensive management.

But between Labor Day and the quail opener a couple months later, something happened – something bordering on the catastrophic. The birds were just *gone*. Rick Snipes, whose ranch in Stonewall County is a showplace (and who happens to be the president of the Board of Directors of the RPQRR), figures he lost 80 to 90 percent of his quail during that period. Where he'd expected to move 20 to 30 coveys in a morning's hunting, he was lucky to move three or four – and believe me when I tell you that if Rick's pointers can't find birds, they're not there to be found.

Sadly, Rick's experience wasn't unusual. What started as a trickle of dismal reports swelled into a flood as sportsmen throughout the region saw their high hopes comprehensively dashed. To many, it was yet another nail in the coffin, irrefutable evidence that the quail decline, this intractable phenomenon that's been grinding its way westward through the heart of the bobwhite's historic range, had finally reached the Rolling Plains. The time-honored formula – rainfall plus cover equals quail – had cracked, and no one could put a finger on why.

"My rule of thumb," says Dr. Dale Rollins, the esteemed quail biologist (in Texas he's known as "Dr. Quail") who serves as the RPQRR's executive director, "has always been that when you get enough rain to grow a good dryland cotton crop, you get a good crop of quail as well. In 2010, though, that didn't happen.



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The eyeworm has been found infecting Northern bobwhite quail. It is a parasitic nematode *or essentially a "hookworm" that attaches to quail eye tissue, particularly in the back of the eye where it attaches and feeds on blood. In this picture of the eyeworm head part, essential features are demonstrated that facilitate blood-feeding capability.*

"Most of us," he adds, "were predicting going into the season that on a scale of one-to-ten it'd be a seven or eight. Instead, it was a one or two."

Rollins, who's seen this kind of puzzling disappearance before, not only in bobs but also in blue quail, calls them "idiopathic" events. A term borrowed from the world of medicine, *idiopathic* essentially means an affliction or abnormality of unknown cause. (Bob Wehle, for example, died of idiopathic pulmonary fibrosis. For no reason the doctors could identify, his lungs quit working.) The really troubling and alarming thing with respect to quail was that these idiopathic events seemed to be occurring more frequently – becoming the norm rather than remaining the exception.

One thing was for damn sure: It wasn't the habitat.

Established in 2007 and located on a 4,700-acre property about 50 miles northwest of Abilene, the Rolling Plains Quail Research Ranch is a "living laboratory" for quail research and the demonstration of

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best management practices. Its stated mission: "To preserve Texas's wild quail hunting heritage for this and future generations." Or, as Rollins likes to put it, "to defend the high ground," by which he means stemming the tide of the quail decline before it breaches the ramparts of the Rolling Plains – and one day perhaps even reversing that tide and restoring quail populations in East Texas and beyond.

And while one of the hopes of Rollins, Snipes, and everyone associated with the RPQRR was that they could get ahead of the curve and prevent the kind of crisis-event experienced in 2010 from occurring, in a broader sense this cut to the heart of the Ranch's charge: to identify the causes of the quail decline, *whatever they might be*, and to develop a coherent, science-based strategy for responding to them.

It was with this in mind that, in January 2011, the RPQRR announced the implementation of Operation Idiopathic Decline (OID), a multi-year, multi-million dollar research project aimed at coming up with some definitive answers.

Specifically, the goal of OID is to determine if disease, parasites, toxins in the environment, or some combination thereof are depressing quail populations and possibly triggering these idiopathic events. It seems like one of those fundamental questions that should have been addressed eons ago, and that's precisely the problem: It's been 80 years since anyone seriously studied it.

"When Herbert Stoddard published *The Bobwhite Quail* in 1931," notes Rick Snipes, "he devoted nearly a hundred pages to a discussion of the diseases and parasites known to affect the bird. Eighty years later, there'd been virtually no significant attempt to update Stoddard's research in this area until we started this project."

In the back of everyone's mind was the work Dr. Peter Hudson of Penn State had done on perhaps the only other gamebird that inspires the kind of passion and devotion the bobwhite does: the iconic red grouse of Scotland. Hoping to pinpoint the cause of the grouse's cyclical population fluctuations, which in low years could drop to levels that left gamekeepers no choice but to close their moors to shooting, Hudson identified an intestinal parasite that weakened the birds and rendered them especially susceptible to predation.

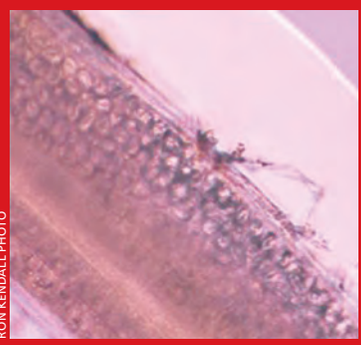
But Hudson didn't simply identify the problem. He designed a solution, too. By spreading grit treated with an anthelmintic (a de-wormer), Hudson and his cooperators were able to eliminate the worst of the cyclical lows and keep the grouse population from crashing every few years. Whether something analogous could be discovered and applied to the bobwhite quail of the Rolling Plains was an open question; but at the very least, Hudson's work provided a model for potential success – and a glimmer of hope.

With Rollins providing overall direction and coordination, an all-star team of research scientists was recruited from Texas A&M, Texas Tech, and other institutions, a team with multi-disciplinary expertise in such fields as toxicology, virology, and parasi-

tology. The inception of OID marked a philosophical sea change: For the first time, respected scientists with unimpeachable academic credentials acknowledged, on the record, that something other than habitat conditions may be affecting bobwhite populations.

The search for what that something might be kicked off in the late summer of 2011, when field workers began live-trapping quail not only on the RPQRR itself but on 31 additional properties, 21 in Texas and 10 in Oklahoma. These birds were subsequently euthanized and their tissues, organs, and blood analyzed in excruciating detail; ditto for birds (or the heads of birds) contributed by hunters. The team was searching for the "smoking gun," the telltale clue that might shed some clarifying light on the mystery of idiopathic decline. They looked for viruses, bacteria, toxic compounds, parasites, anything that could conceivably compromise the bird's health or impair its reproductive capacity.

In this cross section of the female eyeworm, you can see the densely packed eggs ready for dispersion in the environment. The female eyeworm feeds on blood as an energy source to maximize egg production in an infected Northern bobwhite quail. The quail then disperses the eggs in their feces, which are then consumed by the intermediate host.



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Over three years, 2,500 quail, and $3.5 million later (the funding, by the way, has all been in the form of donations from sportsmen), what have they found? Well, among other things, they've discovered that some quail harbor antibiotic-resistant bacteria. They've also found trace amounts of DDE, a "breakdown" product of DDT – which, as most of us know, was banned in the United States over 40 years ago. (Whoever labeled DDT a "persistent toxic compound" clearly knew what he or she was talking about.)

But while these findings are interesting from an academic perspective, says Rollins, "They're not smoking guns."

The researchers found one thing, though, that really made their antennae vibrate. A surprising number of quail were found to harbor a parasitic eyeworm, *Oxyspirura petrowi.* This parasite wasn't unknown – A.S. Jackson, a legendary figure in Texas quail circles, first documented it over 50 years ago – but it had never been studied in any detail. Or, for that matter, implicated as anything other than a nuisance to affected birds.

But here's the kicker: At the same time that the eyeworm was beginning to attract the OID team's attention, they began receiving reports of quail *flying into things.* Barns. Fences. Cars. Houses.

"I've been around quail all my life," asserts Dr. Ron Kendall, who heads up the Wildlife Toxicology Laboratory at Texas Tech's Institute of Environmental and Human Health, "and healthy quail don't fly into houses."

The notion that something might be impairing the vision of quail prompted Kendall and his colleagues to take a closer look at the eyeworm – and what they found blew their minds. It had always been assumed that the eyeworm was an external parasite, but in point of fact the worms that attach to the bird's eyelid (which are visible as pale, threadlike filaments) are just outliers. Their real home is in the *back* of the eye – where no one had bothered to look before.

Kendall explains, "These parasitic nematodes attach to the tissues in the rear of the eye – including the lachrymal duct, which is adjacent to the optic nerve – where they use a lancing appendage to pierce the tissues and feed on blood. This results in inflammation, swelling, and edema, which can impinge on the optic nerve and impair the vision of the affected bird. This may explain the reports of quail flying into things – and if you've ever watched a quail being chased by a Cooper's hawk, you know how crucial vision is to their survival in the wild."

Large masses of eyeworms were also found in the nasal sinuses of some quail, almost certainly impairing their ability to breathe – to say nothing of the generally debilitating effects on *any* bird that harbors a heavy parasite load. One quail was found to harbor more than 80 worms! These aren't microscopic critters, either; easily visible to the naked eye, they're about as long as a penny is wide. If they were scaled up to human dimensions, they'd be three inches long and the diameter of a toothpick. Imagine *that* living in the back of your eye.

Eyeworms are not small by any means. This picture depicts multiple sizes of eyeworms at various stages of maturity. If these eyeworms were compared volumetrically with infection in a human, they would be comparable in size to a toothpick.

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The female eyeworm may produce more than 1,000 eggs a day, Kendall adds, and egg-production is a high-energy process that requires a lot fuel, i.e., blood. In this case, quail blood.

"It's a cumulative process," Kendall notes. "Once a quail's infected, the eyeworms continue to accumulate, and in time they'll kill the bird. It's the same as a dog with hookworms: If you don't treat for them, the dog will eventually die.

"In reality, though, few if any wild quail will ever have the luxury of rolling over and dying from eyeworms. Quail face a complex matrix of challenges to their survival every day, and a bird that's even five-to-ten percent 'off' is a prime target for predation. The bottom line is that a quail infected with eyeworms is going to be killed by something else before the eyeworms kill it."

The eyeworm eggs pass with the quail's feces, waiting to be ingested by one of several crickets, grasshoppers, and cockroaches – biologists call this family of insects *arthropods* – that serve as the parasite's intermediate host. The eggs hatch inside the host, where they remain in larval form until a quail eats the bug. Once they get inside a quail, they respond with frightening speed, migrating toward the eye tissues literally in a matter of minutes and attaching in a matter of hours.

And, as Kendall also found, once they get their hooks into a *population* of quail, the rate of infection can rise at a rate he characterizes as "phenomenal." On one study area in the Rolling Plains, a sampling of quail collected in June 2013, showed a small percentage of birds infected with immature eyeworms. A sampling taken just a few weeks later, however, showed an astonishing 90 percent of the quail harboring adult worms!

"That was a game-changer," says Kendall. "We realized we were witnessing an 'epizootic event' – a pandemic, basically. Seeing that this very sophisticated parasite is capable of such explosive outbreaks really got our attention."

Is this the smoking gun? While Kendall won't go that far – yet – he acknowledges that the "weight of evidence" points increasingly to the eyeworm as a significant limiting factor on bobwhite populations in the Rolling Plains. Rick Snipes, on the other hand – who has no academic reputation to protect – has seen and heard everything he needs to.

"I have no doubt whatsoever," he states, "*none*, that an eyeworm outbreak was responsible for the disappearance of quail from my ranch in 2010."

The challenge ahead, says Kendall, is to identify the "weakest link" in the eyeworm's life cycle and devise a strategy for attacking it there. "We're basically dealing with a hookworm here," he says. "And whether you're talking cattle, horses, dogs, or quail, if they're infested with worms you need to de-worm 'em. We're committed, passionately so, to figuring this thing out and coming up with a solution."

They've taken a number of promising steps in this direction, including developing an anthelmintic that, at least under laboratory conditions, is highly effective at eliminating eyeworms. And while Kendall doesn't want to get too specific at this point, they're essentially taking a page from Dr. Hudson's book and evaluating a methodology for delivering this compound to a population of wild quail. The difference is that instead of using treated grit, they're using treated milo, proffered at feeding stations that are equipped with call birds to attract their brethren to the site.

Eventually, quail from the "treated" area will be compared to quail from a nearby non-treated area to determine the efficacy of this delivery system. They've consulted with Hudson on this approach, and he feels they're on the right track… but there's a long, long way to go.

There are questions that remain to be answered, too. The eyeworm isn't host-specific – that is, it doesn't affect quail exclusively – but its incidence in quail appears to be dramatically higher than in other birds. Turkeys, for example, feed heavily on the same arthropods quail do, but in studies of turkeys and quail collected from the same properties, the turkeys show vastly lower rates of eyeworm infection. Why? Finding the answer could yield valuable information, information that, in turn, researchers might be able to use to develop new tools and strategies for combating the parasite in quail.

"We're not going to eradicate the eyeworm," emphasizes Rick Snipes. "Our goal is to *control* it. If we can do that, we think we can eliminate these abrupt, non-weather-related declines in the quail population. Again, it's similar to what Dr. Hudson was able to accomplish with red grouse in Scotland."

Adds Snipes, "In this part of the country, quail numbers are always going to fluctuate depending on the amount of rainfall. Our hope is that we can prevent the kind of devastating eyeworm outbreak that could cause the population to decline even when the weather's favorable, which is what I'm convinced happened in 2010. I'm very optimistic about our chances, and I also believe that our ability to treat birds for eyeworm will improve by leaps and bounds in the near future. I tell people that right now we're still in the 'bag phone' stage, but that in just a few years we'll be in the 'iPhone' stage."

Has the smoking gun been found? Maybe, maybe not. But judging from the "weight of the evidence," it seems clear that a gun with a red-hot barrel has been.

Where Do We Go From Here?

Park Cities Quail of Dallas has committed to fund the next, most important segment of the eyeworm research, the three-year population study comparing quail populations in treated versus untreated areas. This will be the definitive study of the efficacy of the treatment. PCQ has been a stalwart supporter of the Research Foundation and Operation Idiopathic Decline.

To stay abreast of developments in Operation Idiopathic Decline, visit *www.quailresearch.org*. While you're there, be sure to sign up for the monthly e-Quail Newsletter from Dr. Dale Rollins.