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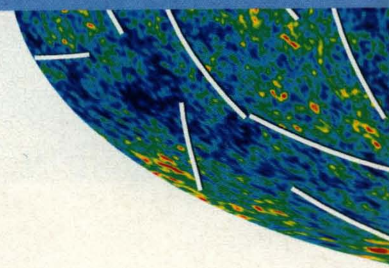

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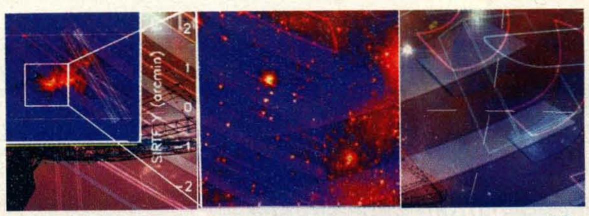

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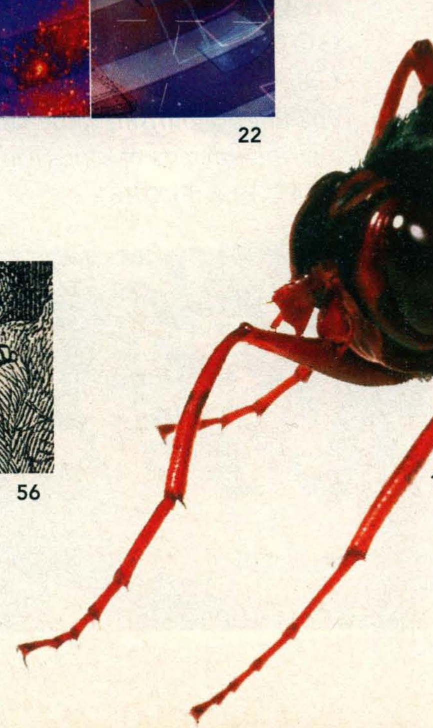

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Bushels of Bots

Africa's largest fly is getting a reprieve from extinction.

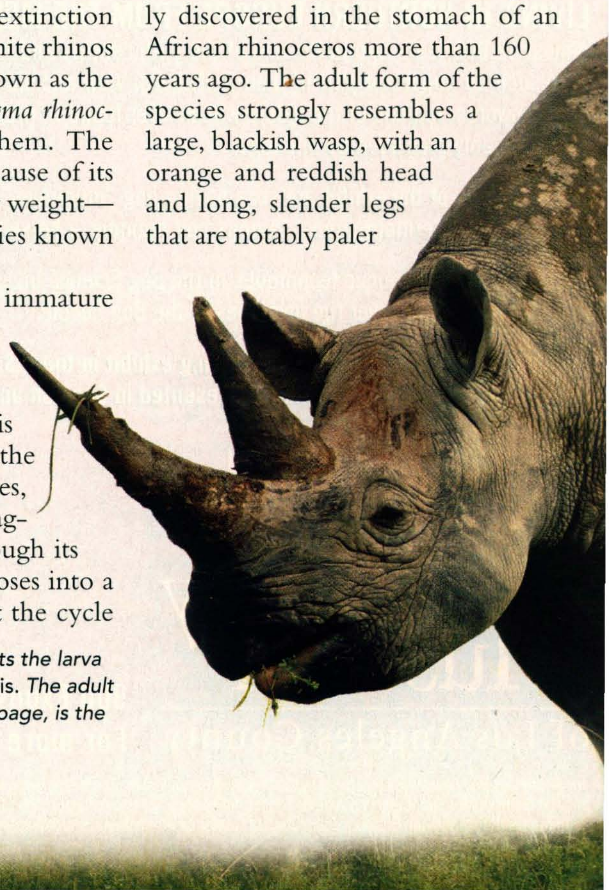
By David A. Barraclough

In the past 125 years all five of the world's rhinoceros species—the Indian, Javan, and Sumatran rhinos in Asia, and the black and white rhinos in Africa—nearly went extinct. And some of the African rhinos were quite literally taking a large fly with them on their slide toward extinction. Most people, even in scientific circles, had no idea the fly existed. They still don't. Certainly no one considered conservation programs for the fly while the rhinoceros populations were plummeting. Such a lack of concern about threats posed to insects and other invertebrates is not uncommon, but it is irresponsible. At least 95 percent of all animal species inhabiting the Earth are invertebrates, and so they constitute the bulk of animal diversity on the planet. Luckily for the endangered rhinoceros fly, conservationists were inadvertently drawn to its cause.

The plight of the big, charismatic rhinoceroses caught the world's attention in the 1990s; their populations had fallen drastically because of poaching, the illegal trade in their horns, and the destruction of their natural habitats. Today in Asia, only about 2,500 Indian, 300 Sumatran, and sixty Javan rhinos remain. Both African species, though, have benefited greatly from sustained and well-publicized conservation efforts. The white rhinoceros, the world's second-largest land mammal, has two subspecies, one of which lives in southern Africa and now numbers more than 11,000. After declining to as few as twenty individuals at the end of the nineteenth century, the southern white rhino has become one of Africa's biggest conservation success stories. (The other white rhino, a central African subspecies, numbered more than 2,000 in the 1960s, but only five or ten individuals are left, making it critically endangered.) Populations of the black rhinoceros fell by a staggering 96 percent between 1970 and 1992; the species is still endangered, but the population has risen to 3,500.

Rebounding from near extinction along with the black and white rhinos is a large fly, commonly known as the rhinoceros bot fly *(Gyrostigma rhinocerontis),* which parasitizes them. The fly has the distinction—because of its robust appearance and body weight—of being the largest fly species known in Africa.

Like other bot flies, the immature form of the insect is a spiny maggot, or bot, that burrows into its host and feeds off the host's tissues—in this case the gut of the black or the white rhino. After three stages, or instars, of growth, the maggot worms its way out through its host's anus and metamorphoses into a short-lived fly that can start the cycle over again by laying eggs on the hide of its host. Because *G. rhinocerontis* depends entirely on its hosts for survival, its numbers would have mirrored the rise and fall of rhinoceros populations in all parts of Africa. In some periods of the twentieth century, it must have been close to extinction.



Black rhinoceros (right) often hosts the larva of the fly Gyrostigma rhinocerontis. *The adult bot fly, shown actual size on this page, is the largest fly in Africa.*

About 24,000 known species of flies, in slightly more than a hundred different families, live in the Afrotropics, a region that includes sub-Saharan Africa, Madagascar, and associated islands in the Atlantic and Indian oceans. Beyond those species, a substantial number still await scientific description and classification. Estimates differ, but I would venture that at least 30,000 more African fly species remain unknown to science.

Even within that astonishing context, few entomologists would dispute the exceptional nature—both visually and biologically—of *G. rhinocerontis,* in the family Oestridae. The largest adult specimens grow as long as 1.6 inches, with wingspans as wide as 2.8 inches, making it one of Africa's most striking fly species.

The rhinoceros bot fly was originally discovered in the stomach of an African rhinoceros more than 160 years ago. The adult form of the species strongly resembles a large, blackish wasp, with an orange and reddish head and long, slender legs that are notably paler than the rest of the body. The elongated wings are brown to black and, when the fly is at rest, run along almost the entire length of the body [*see photograph on opposite page*]. Adult flies occur in parts of Africa where their rhinoceros hosts live. In recent years that has meant the grasslands and savannas of southern and East Africa, but historically the flies and their hosts extended, except for the Congo Basin, across most of sub-Saharan Africa. No matter the flies' range, even the most experienced collectors have had a tough time finding them.

Two other bot-fly species of the genus *Gyrostigma* are known, and both are exceptionally rare. One of them, *G. conjungens,* was discovered in its bot form in the belly of a Kenyan black rhinoceros in 1901, but it hasn't been collected, or even seen again, since 1961. The other rare species, *G. sumatrensis,* is known only from a single bot, which was in the late developmental stage of the larva known as the third instar. It was discovered in a captive Sumatran rhinoceros and described in 1884, but it, too, has not been seen again. No *Gyrostigma* bot flies have been found in the Indian or the Javan rhinos, but it is not unreasonable to expect that the intestinal parasites may eventually be discovered in all five rhinoceros species.

In 1847 the French naturalist and explorer Adulphe Delegorgue described large numbers of bots in the stomach of a black rhinoceros from northeastern South Africa. He published this vivid description of them in his *Voyage dans l'Afrique australe* ("Travels in Southern Africa"):

> The *Rhinoceros Africanus bicornis* could well claim the title of foster father of bots. The imagination boggles at the quantity contained in his stomach; they could be shoveled out in bushels. . . . I am much inclined to think that the viciousness and ill-humor which characterize the *Rhinoceros Africanus bicornis* are due simply to the presence of thousands of these parasites and can be compared with the irritability of a man infested with tapeworm. However, in spite of their numbers, which sometimes seem to exceed all natural limits, bots do not, as far as I know, cause the death of indigenous animals.

Delegorgue was the first of many to become intrigued with the biology of *G. rhinocerontis.* Brian R. Stuckenberg, an African fly specialist who is also a former director of South Africa's Natal Museum, maintained an interest in *Gyrostigma* biology throughout his fifty-year career, continuing South Africa's tradition as the hub of research on African bot flies. Stuckenberg took the first of what are still only a few good photographs of living bots [*see photograph at top of this page*]. He and other entomologists working today, including myself, rely heavily on the pioneering studies of another famous fly taxonomist, Fritz K.E. Zumpt, who was based in South Africa and published his major works during the 1950s and 1960s.

What about the fly's behavior? Observing the flies in the field has been difficult. Many of the South African specimens studied by Zumpt and others were not wild; rather, they were reared from mature bots collected from the stomachs of dead hosts. Finding mature bots hasn't been easy, and getting mature flies to lay eggs has been even harder. Only a few large museum collections have the luxury of owning an adult specimen of *G. rhinocerontis,* and amateur collectors lucky enough

Stomach wall of a rhinoceros has become pitted from the depredations of bot-fly larvae, which parasitically feed on the rhino tissue. The three larvae in the photograph, shown actual size, are nearly ready to leave the rhino gut, pupate, and emerge as adult flies.

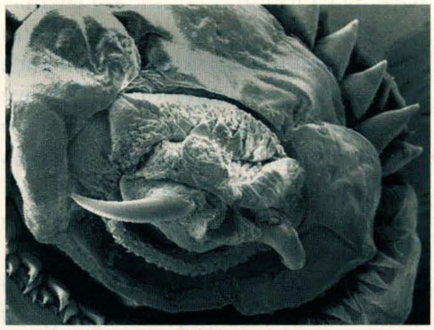
to have caught the elusive insect prize their specimen highly.

What makes the adult flies so hard to collect in the field? First, the airborne stage of their lives lasts only three to five days, severely limiting the collecting time. One reason the airborne stage is so short is that *Gyrostigma* flies have rudimentary, nonfunctional mouthparts; in fact, they probably don't feed at all during that stage. Even though they gorge themselves as larvae, stored energy goes quickly when you're flying but not eating. That could certainly account for their speedy demise.

A second reason the flies are hard to catch is that they probably do not fly extensively by day. The evidence is conflicting about when the adults are most active, and no one knows where they spend their time when they are neither flying nor laying eggs. Some observers have reported them flying near their rhinoceros hosts on hot, sunny days in northern KwaZulu-Natal, a province in eastern South Africa. But some entomologists think they are crepuscular, becoming active only at dawn or at dusk.

One explanation for the seeming contradiction may be that the two sexes keep to differing schedules. I believe that the female flies will prove to be most active during daylight hours, when they deposit their eggs on the hide of their hosts, and that the males are most active at dawn and dusk, when mating may take place. I have examined the specimens in the Natal Museum's collection—the largest fly collection in Africa—and all of our field-collected male flies were found at dusk, giving credence to the crepuscular theory. But there is no solid information available about where mating takes place—if there were, the flies might be captured or at least observed.

Finally, the flies are fairly safe from the traps of insect collectors and entomologists because even the most daring collector never gets very close to the formidable rhinoceroses for long! In my twenty years of collecting flies in the field, I have managed to catch only one adult *Gyrostigma.* I was on a reserve in northern KwaZulu-Natal early one summer evening, and a male rhino fly loudly buzzed up to a light that I had set up in hopes of catching just such a specimen. I knew rhinos were in the area, but I was still surprised and delighted by my good fortune. Flies have been attracted to light traps in other parts of South Africa, as well; they were captured in Kruger National Park soon after rhinoceroses were re-introduced there from KwaZulu-Natal.

Pink bot-fly larvae in an intermediate, or second instar, stage of growth, feed on the stomach wall of a white rhinoceros that has just died (left). The larvae attach themselves with mouth hooks and spines, both visible in the photomicrograph (right), magnified 20X.

The life cycle of the rhinoceros bot fly begins when female flies deposit oblong-shaped eggs in crevices in the host's hide, apparently near the rhino's horns or elsewhere on the head. Precisely what happens next is unknown; I think it likely that once the eggs hatch, after about six days, the young bots enter the rhino through its mouth or nostrils and eventually attach themselves to the lining of the rhino's stomach wall. They hook into it with spines and a pair of well-developed mouth hooks: sicklelike structures at the anterior end of the bot [*see photomicrograph below*]. There the bots feed on their hosts' blood and tissue.

As the bot continues to eat away at the rhino, it progresses through two more stages of development. At the second instar, it is 0.8 inch long, and has developed more prominent spines. At the third and final instar, it reaches its full adult length, but the most striking feature of the third instar is the development of large bands of spines. Each band comprises three to four rows of sharp spines. The spines help the bots attach to the rhino's stomach and burrow into it, a process that leaves large pits in the stomach wall. No scar tissue seems to result from the pits, though, so they are thought to be benign.

Unlike their adult forms, the bots of *Gyrostigma* have often been found in large numbers inside a rhinoceros's stomach. Only once, though, have I had the good fortune of examining them. Parts of a freshly dead rhino, from Pilanesberg National Park, in northern South Africa, were couriered to me in a parcel (I could not get to the site in time for dissection). I found quantities of first- and second-instar bots still attached to the stomach wall of the dead rhino—not "bushels" of them, as Delegorgue described, but certainly fifty or more.

The bots were clustered in groups. The first instars were colored dark pink and buried deep within the mucosal folds of the stomach lining. The second instars were larger, a paler shade of pink, and more conspicuous because only their front ends were embedded in the mucosal folds. It is possible that the bots develop rather slowly, perhaps because they are competing with so many other sister bots, and overstressing their hosts would not be at all to their advantage. But that hypothesis awaits further confirmation.

Unfortunately, "my" rhinoceros hosted no third-instar bots, so I wasn't able to rear adult flies. Mature third-instar bots are whitish to yellow with irregular dark brown spots—evidence of the internal changes they are making as they prepare to pupate. *G. rhinocerontis* then passes out through the host's anus. Zumpt's research showed that the black pupal cases do not occur in rhinoceros dung piles, which the males leave to advertise their presence and rank to other rhinos. So it is likely that the bots quickly burrow into the soil beneath the dung or pass out of the anus independently of defecation, burrowing somewhere away from the dung piles. After six weeks of pupating, the adult flies emerge.

Entomologists still have much to learn about these rare and amazing flies. By now, the basic biology of *G. rhinocerontis* has been extensively studied, but the nature of their interaction with Africa's rhinoceros species—the flies' exclusive hosts—still needs extensive probing. No one knows what effect the presence of hundreds of bots in the stomach has, if any, on the rhinoceros's temperament. Was Delegorgue right? Are rhinos more ornery because of their baggage of bots? Given the widespread, and continuing, concern about the conservation of both African rhinoceros species, that question, and related ones, will need to be answered. And answering them will prove useful in the understanding of at least two species, not just the more prominent one—whichever one that might be.

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