Earth, wind and fire: the fruit bats of Montserrat have had to contend with most of nature's torments - Naturalist At Large

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It was July 1997, and a long night, which had followed a long day, was finally nearing its end. A volcano was grumbling, and rain had just begun ... again. My right boot was quickly filling with water and sinking deeper into cold mud, and a large, muscular pig-nosed fruit bat (Brachyphylla cavernarum) had latched its mouth firmly onto the flesh of my thumb. I had been careless taking the bat out of one of my mist-nets--a finely spun net--and the bat was impressing this fact on me.

For once, though, the truth didn't hurt. Typically a bite from this species would have left me trying to stifle a string of colorful expletives, but this animal didn't have a tooth left in its head. The rather soggy-looking, unfortunate animal was also just about entirely bald. Things were getting a bit surreal: a hairless, toothless bat was gumming my thumb as I stood on the flanks of an active volcano; large, glowing rocks were rolling down the slope in my general direction; and now the mud was beginning to swallow my other boot. I suddenly felt the need for a very cold beer.

The pathetic bat and I were in the British crown colony of Montserrat, a rugged, forty-square-mile tropical island in the northern Lesser Antilles, some 250 miles southeast of Puerto Rico. Although Columbus never bothered to land on the island, he named it, in 1493, after a Spanish monastery near Barcelona, famous for its wooden statue of the Virgin and child. The British colonized the island in 1632, and a succession of sugar cane, cotton, and lime plantations dominated the local economy.

Montserrat lies in the middle of the Atlantic Ocean's "hurricane belt" a highway of sorts for the storms heading north from the Tropics. At least thirty hurricanes have battered Montserrat in the past 360 years; twelve have been severe, and Hurricane Hugo, in 1989, was the most destructive in recent history. Montserrat also lies near the convergence of the North American and Caribbean tectonic plates, so if the hurricanes don't get you, the earthquakes and volcanic eruptions might. Major temblors hit the island in three periods: 1898-1900, 1933-36, and 1966-67. Seismic activity in the Soufriere Hills volcano, beginning in 1992, resulted in an explosive eruption in July 1995, followed by a series of pyroclastic mudflows that destroyed and buried most of Plymouth, the island's capital, by 1998. Subsequent eruptions have reduced much of the southern half of the island to a wasteland. (Although the volcano's activity has decreased for the moment, it is too soon to tell whether the current cycle of eruptions is at an end.)

It is hard to convey the scope of the human tragedy the recent eruptions have visited on this small island community. Casualty reports vary widely, but officially, at least twenty-one Montserratians were

killed. Between 1997 and 1998, thousands were forced to emigrate, to neighboring islands, Canada, England, or the United States. Many families were separated, and a vibrant and unique culture was temporarily put on hold until the volcano settled down and the islanders could begin to rebuild the island's infrastructure.

In the midst of all this suffering, it might seem crass to worry about wildlife. But even before the eruption, Montserrat--a small but lush island--had been getting a great deal of attention from biologists interested in island biogeography. Bat biologists had been at work there since 1978; I arrived in 1993. Since our studies began, my coworkers and I have compiled a reasonably complete natural history often bat species (six fruit bats, three insectivores, and one carnivore that specializes in capturing small fish with its hind feet), covering the good times as well as the periods marred by the overlapping effects of devastating natural disasters.

Hurricane Hugo was the first such disaster under our watch; it smashed directly into Montserrat, careened into Puerto Rico, and eventually hit the eastern seaboard of the U.S. For the fruit bats on the two islands, survival in the aftermath of the storm was a matter of size--the islands' size. On Puerto Rico, fruit bat populations could abandon hurricane-damaged forests and disperse across a larger landmass into unscathed areas. On Montserrat, Hugo was a crushing blow for tree-roosting and other highly specialized bat species; their numbers fell twentyfold. Many fruit bat populations suffered primarily because there was nowhere for them to go. Their roosts and food sources--much of the island's forests, really--had simply been blown out into the Caribbean.

Not all the island's bat populations crashed in Hugo's wake. A large colony of pig-nosed fruit bats roosts in a series of relatively hurricane-proof dares at the northern end of the island. The animal also enjoys a catholic menu of flowers, fruits, insects, leaves, nectar, and even immature legumes. Such omnivory proves to be a powerful survival strategy when disasters limit the availability of particular foods.

I fully expected to spend many years monitoring the post-Hugo recovery of Montserrat's bat populations, with a special focus on the cave-dwelling colony of pig-nosed fruit bats. The 1995 eruption of the Soufriere Hills volcano, however, dramatically redirected my research program.

Hurricanes and volcanic activity differ fundamentally in both their immediate and long-term effects on ecosystems. The tremendous wind speeds of hurricanes typically strip foliage and most of the trees' fruit crop. Large hurricanes such as Hugo also strip bark from large trees and knock smaller trees over, destroying roost sites for tree-roosting species of bats.

Volcanoes are another matter. Explosive eruptions result in pyroclastic flows--landslides of superheated gas, rock, and clouds of volcanic ash that typically move faster than fifty miles an hour and reach temperatures of between 200 and 700 degrees Celsius. They incinerate, suffocate, or bury everything in their paths. Unconsolidated deposits of ash may eventually mix with water to become massive, quick-moving mudflows, called lahars, that can fill in small valleys. Lahars have buried entire

towns and villages on Montserrat. Together, the pyroclastic flows and the lahars have devastated the southern half of the island, burying many river drainages under tens of feet of sterile volcanic ash. On many parts of the island, ash smothered all vegetation; the weight of the ashfall stripped limbs from trees and toppled smaller plants, such as banana and heliconia. The destruction turned several of my old sample sites--once deep, lush valleys, replete with streams, pools, luxuriant vegetation, and huge trees--into nightmarish visions of the surface of the moon.

For example, large mudflows and a number of small pyroclastic flows from the Soufriere Hills volcano partially destroyed the Belham River and obliterated a quirky thirteen-hole golf course that had meandered across the river's bottomlands. Although the episode was clearly a setback for the Montserratian golfing community, the flows were catastrophic to a unique ecosystem that was also the island's only known habitat for the fishing bat (Noctilio leporinus).

Fishing bats are large, yellow-orange, and rather pungent creatures that can hawk large flying insects or snag small ocean fish from the surf. But they much prefer to take minnows from the surface of freshwater streams and ponds--exactly what the course of the Belham River afforded. The fishing bats had survived Hugo as well as two years of volcanic eruptions. But with the loss of the river, they have not been seen on Montserrat since mid-1997.

The pervasive destruction of foraging and roosting habitat across the southern portion of Montserrat forced the fruit bats (as well as the people) remaining on the island to relocate to its northern half. Predictably, the initial competition within the bat colony for limited food and shelter there was intense.

The survival struggles of Montserrat's large population of pig-nosed fruit bats became a lesson in the effects of overcrowding. Before 1995 the colony would alternate between a roost on the flanks of the Soufriere Hills volcano and another in one of the caves at the northern end of the island. For several weeks at a time, each location served as the regional shelter; from there the entire colony would fan out to mob the fruiting trees in the vicinity. (Archaeological evidence suggests that Amerindian populations as long ago as A.D. 200 took culinary advantage of this predictable clustering of large fruit bats.) But by 1996 the eruption had destroyed the southern roost, leaving only the northern cave as a home for the colony.

Since that time the fruit-bat population has rebounded and stabilized, but not without complications. External parasites on the bats are significantly more numerous than anyone had ever previously recorded, either on Montserrat or on any of the nearby islands. I had interpreted the bats' alternation of roost sites as a means to better exploit regional food resources. In fact, though, it may have had more to do with escaping roosts that had become heavily contaminated by blood-sucking ectoparasites. Ever since the fruit bats have been forced to take permanent residence in one location, the walls of that northern cave have been literally crawling with parasitic insects and their larvae.

So what explains the bald, toothless bat that was clamped onto my thumb in 19977 Before the onset of volcanic activity two years earlier, less than 1 percent of the fruit bats examined by biologists on

Montserrat showed any sign of tooth wear or hair loss. The bats that did were elderly animals with other obvious signs of age: scarring, broken bones that had healed, arthritic joints. Yet between 1995 and 1999 the teeth of nearly half of the fruit bats we captured were worn at least halfway to the gum line, and a quarter of all the bats had lost 50 percent of their hair.

Excessive dental wear is caused by the fine, abrasive ash that blankets everything after a pyroclastic eruption. It is next to impossible for a fruit bat to avoid the grit, which adheres to the sticky fruit it eats as well as to the animal itself; even as a bat grooms itself, it gets a mouthful of the ash. For now, since the volcanic activity has at least temporarily decreased, we are finding progressively fewer bats with tooth wear. The ones that do have worn-out teeth are older animals, veterans of earlier exposures to ash. For our 2002 census it was easy to tell old bats from younger ones simply by offering them an exposed thumb.

What about the loss of fur? One might expect to find some kind of skin inflammation or skin infection associated with the loss, but not one of the hundreds of bald fruit bats we have examined has shown either. There are several other possibilities under active study: Perhaps in response to external parasites such as streblid batflies, the bats simply groom themselves until their hair falls out. Perhaps the hair loss is caused by mineral imbalances associated with the ingestion of ash. Or perhaps the bats, deprived of their preferred fruits by the pyroclastic flows, are reduced to eating foods they normally shun. The false tamarind (Leucaena leucocephala), for instance, contains noxious chemical compounds such as mimosine, which induces hair loss.

As forested land on Montserrat has been lost to the volcano, both the number of species and the number of animals on the island have declined. Ten bat species lived on Montserrat before Hurricane Hugo struck in 1989. By 2002 three species that either had persisted as marginal populations or were habitat specialists--the fishing bats, yellow-shouldered bats (Sturnira thomasi), and white-lined bats (Chiroderma improvisum)--had been locally extirpated.

That is not to say they might not return. Tropical storms and hurricanes regularly transport insects, birds, and bats from one island to another throughout the Caribbean. Once a storm drops flying animals such as bats on an island, they tend to stay put. They have no way of knowing what is out there, and a fruit bat that ventures out over the empty sea runs a big risk, given what seem to be the species' limited navigational abilities over long distances.

Two bat species that lived briefly on Montserrat in small transient populations--the yellow-shouldered bat and the white-lined bat--had previously been known only from Guadeloupe. It is likely that large storms will eventually return those and other species to Montserrat. Fishing bats are strong fliers, and could return to Montserrat on their own, probably from the neighboring islands of Antigua or Barbuda. Similar extirpations and reintroductions occur throughout the "hurricane belt" with some regularity, changes that are of great interest to those of us who study the biogeography of bats in the West Indies. We now have genetic data that also support this rare but consistent storm-blown reintroduction of new animals. The cycle suggests that the biogeography of the West Indies is far more

dynamic and changeable than ecologists had previously suspected.

Fruit bats are critical to the rejuvenation of the forests destroyed by Montserrat's volcano, primarily because they play such a crucial role in dispersing seeds and nutrients. Hence the dramatic loss of biodiversity within the bat population jeopardizes the forests' recovery. Our plan is to document the excursions of fruit bats into marginal areas, tracking the dispersal of seeds into heavily damaged regions and the beginnings of a recovery that will take many human lifetimes.

In spite of the "inconveniences" of being blown out to sea by hurricanes or endangered by pyroclastic flows, the fruit bats of Montserrat have soldiered on. Their tenacity has given me a unique opportunity to study how animal populations respond to a variety of natural disasters. And the news is finally taking a turn for the better. My 2002 census of Montserrat's fruit bats followed the wettest spring since 1995. Several varieties of fig trees were heavy with fruit for the first time since 1995. And we were able to capture nearly three and a half times more fruit bats last summer than we had during the peak of volcanic activity in 1997. The rain, the dramatic rejuvenation of Montserrat's remaining forested areas, and a great increase in fruit bat populations are all most welcome.

In fact the entire island--its resilient people, forests, and wildlife--seems well on its way to recovery from a very long volcanic nightmare. Who knows what the future will bring to the people and bats of Montserrat? Before I returned to the vast windblown expanses of South Dakota (where my alter ego is that of university professor), I treated myself to one last night in the small village of Cudjoehead. There I was immediately struck by a strong sense of deja vu: the beer was cold, the town throbbed with reggae music that pushed its way along the narrow streets, the warm tropical breeze that blew overhead was once again full of large fruit bats--the way Montserrat used to be.

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