Ripple Marks

The Story Behind the Story

BY CHERYL LYN DYBAS

Global Warming Comes to Tanzania's Highlands: Malaria, Infectious Disease of the Lowlands, Heads for the Hills

Mosquitoes, once unheard of on the 8,000-foot-high rim of Tanzania's Ngorongoro Crater, have landed.

"With them comes pestilence," said Teete, a member of a Maasai tribe that lives in the round, mud-hut-lined village of Seneto. "The mosquitoes make us sick with malaria."

Seneto is perched on Ngorongoro Crater's edge, where, said Teete, "we never had malaria until the past few years. Now we're like everyone else in Tanzania: worried about the disease."

Enter global warming.

Mosquitoes infected with the malaria parasite (*Plasmodium falciparum*) have come to the highlands with a vengeance.

The mosquitoes were lured in not by the scent of human blood, but by warmer and warmer temperatures moving up-slope from the lowlands, allowing the insects to thrive at the crater's peak. "We used to need coverings at night it was so cold up here," said Teete. "Now they hang on our walls, seldom used."

Ngorongoro Crater is the world's largest volcanic caldera. It formed when a giant volcano exploded and collapsed two to three million years ago. The original volcano was 19,000 feet high.

Today, Ngorongoro's precipice separates dry Serengeti grasslands on the crater's flanks from greener forest and swamp in its wildlife-filled caldera.

Zebras and lions are common throughout Ngorongoro, but mosquitoes were once found in only one place there: the Lerai Forest on the crater's floor. Lerai Forest is made up of stands of yellow-barked acacia trees. The trees form thicket-like woodlands in low, wet areas. Yellow-barked acacias are known as "fever trees": early pioneers thought the acacias were responsible for the fevers of malaria.

When the rains come to northeastern Tanzania—the "short rains" in November and December, and "long rains" from March through May—they are manna from heaven for female mosquitoes, which need water in which to lay their eggs.

"The ecology of malaria is closely associated with the availability of water; the larval stage of the mosquitoes develops only in water bodies," according to a World Health Organization report on water-related diseases. "In drier areas, outbreaks of malaria can be predicted with reasonable accuracy by mapping rainfall."

In Tanzania, mosquitoes have moved to higher elevations like the Maasai village of Seneto (left) and town of Karatu (right).
Photos courtesy of Ilya Raskin, Rutgers University

In Tanzania, that statement covers a lot of ground, especially during the rainy season and the weeks afterward, when standing water is left behind in everything from tire rims to cooking utensils, from potholes to ponds.

Water is a fundamental piece of the malaria puzzle, according to medicinal chemist Kelly Chibale of the University of Cape Town in South Africa. "Today, more than three billion people live under the threat of malaria," said Chibale, who is working to develop new anti-malaria drugs through natural products research on native African plants and other means.

In the 1950s and 1960s, he said, "there was a massive drive to try to get rid of malaria worldwide following the successful eradication of the disease in the United States."

But the ongoing battle against malaria was far from over. "The ban of DDT [which killed mosquitoes] and the concurrent emergence of resistance to the drug chloroquine led to the collapse of that early campaign," said Chibale.

Now, more than 300 million cases of malaria occur annually, with 40% of the world's population at risk of contracting the disease. The malaria parasite multiplies in red blood cells, causing anemia and eventual death if untreated. "Malaria kills more than one million people each year," Chibale said, "most of whom are children under the age of five."

Due to the high mortality rates of malaria victims, the disease is thought to have had the greatest selective pressure on the human genome of any factor in recent history.

A major challenge to stopping it is the malaria parasite's ability to develop drug resistance. "As history has already shown," said Chibale, "development of anti-malarial agents aimed at a single parasite target or specialized process has failed to stem the tide of drug resistance."

That challenge is further complicated by the effects of climate change, land-use change, and population growth.

"There's an increase in malaria cases during the rainy season, with more disease then," said Dutch physician Adrian Groen, who has lived in Tanzania since 1974 and practiced medicine at clinics across the country. "And now malaria is on the march toward higher-elevation parts of Tanzania, something that's not well-known to the average Tanzanian, or even to many doctors here."

One physician who has seen the results of malaria's spread first-hand is Frank Artress, director of the African Foundation for Medicine and Education in Karatu, Tanzania.

Miles south of the Ngorongoro Crater rim, and at almost half the elevation, lies the district of Karatu. "Karatu's elevation [5,000 feet] was considered above the limit for mosquitoes and malaria," said Artress. "But not any longer." Artress has treated victim after victim of the disease in Karatu.

"When I arrived in 2006, I was told that there were no mosquitoes and no malaria here. So I didn't put up any mosquito nets—and proceeded to get completely chewed up [by mosquitoes]. For the past two years, Karatu has had mosquitoes buzzing around in droves, and malaria coming to town with them."

At two local orphanages, Artress has helped numerous children with malaria. "Because of the historic lack of mosquitoes," Artress said, "very few people sleep under mosquito nets, compounding an already complex situation."

A better understanding of the larger-scale factors responsible for the spread of malaria is urgently needed, Artress believes. "Climate is changing, and water plays an important role. The ultimate effects, while global, are also very individual, right down to the children who die of malaria every minute."

From Seneto to Karatu and beyond, the effects of climate and environmental change on malaria are far more than a statistic.

"And the results are up close," said Artress, "and very personal. All it takes is one mosquito bite."

Karatu children have a high malaria risk.
Photos courtesy of Ilya Raskin, Rutgers University

It's the Full Moon. Better Not Go Fishing.

A full moon rises over Hawaii's Mo'omomi Bay. Not a good time to go fishing, at least if you are out to catch aholehole (Hawaiian flagtail, *Kuhlia sandvicensis*), said Kelson Poepoe, conservation biologist and founder of Hui Malama o Mo'omomi (Hawaiian for "group to protect Mo'omomi Bay").

Mo'omomi Bay is on Molokai's northeast coast, near the community of Ho'olehua. There, many residents still live by subsistence, finding much of their food by fishing. Although overfishing has depleted many of the piscine populations in Hawaiian waters, those in Mo'omomi Bay are flourishing, with more fish than almost anywhere else.

The community credits an unusual calendar designed by Poepoe, a moon phase wheel that tells people when not to fish—instead of when the fish are jumping.

Based on the ancient practices of native Hawaiians, the calendar is linked to phases of the moon, rather than to tides alone.

It is traditional for Hawaiians to consult nature so that fishing is practiced at times and in places that cause minimum disruption of natural biological and ecological processes, according to Poepoe.

The Ho'olehua Hawaiian Homestead, as Poepoe's village is formally called, is working to get the moon calendar accepted beyond Mo'omomi Bay. "This is a great example of how shared knowledge, beliefs, and community values can be channeled to promote good fishing behavior," write Poepoe, Paul Bartram of the Pacific American Foundation in Honolulu, and Alan Friedlander of The Oceanic Institute in Waimanalo, in the proceedings of a recent conference called *Putting Fishers' Knowledge to Work*.

The tenets of traditional Hawaiian marine resource use include Lokahi ("harmony"), in which time spent fishing fosters intimacy and harmony with the ocean; Malama ("taking care of living things"), a holistic view of relationships among living things; Laulima ("many hands"), whereby the intensity of fishing activities is determined by kinship obligations, reciprocity and communal exchange of labor and foods; Ha'aha'a ("humility"), a recognition of Hawaiians as part of the living world, not superior to it; and Imi Ike ("to seek knowledge"), training to see changes in the condition of marine resources.

A good Hawaiian fisher, said Bartram, "is always watching the ocean, monitoring it for cues that signal what can be fished, and where and when, in a manner compatible with the rhythms of the species."

Natural events that affect fish populations are monitored by the Ho'olehua community, the most important of which is the phase of the moon. "The moon was as essential in scheduling the activities of ancient Hawaiians as clocks are to modern man," said Bartram. "The moon calendar is a modern-day predictive tool based on awareness of ocean cycles and their relationship to fishing success."

By observing fish spawning behavior, the members of Hui Malama o Mo'omomi have designed the moon calendar to identify the spawning periods of major food fish species.

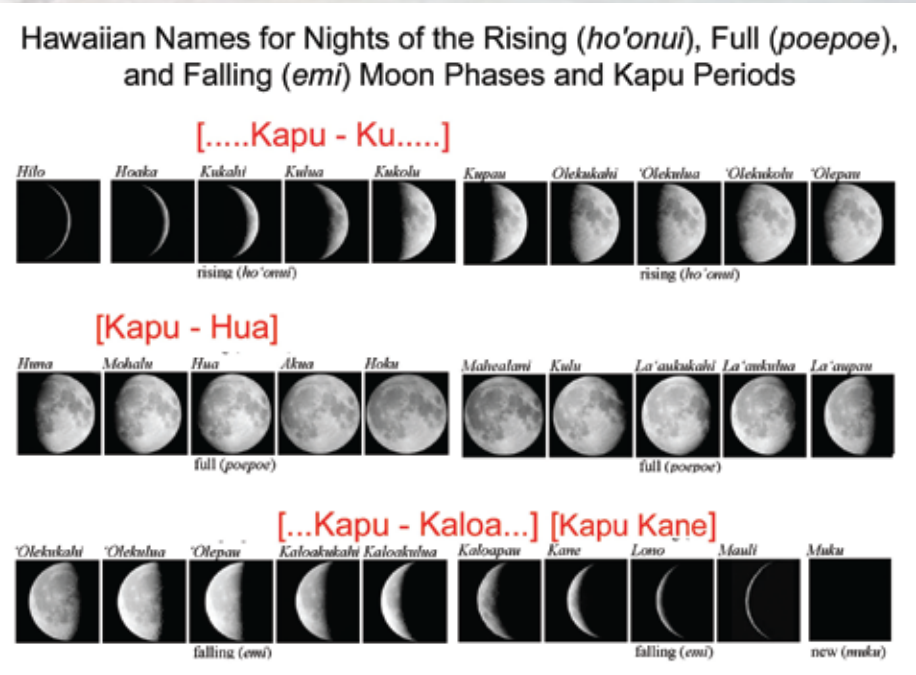
The calendar emphasizes natural processes that repeat on seasonal, monthly, and daily cycles. It highlights two general seasons, ka'u or dry and ho'oilo or wet, and three phases of the moon—'ho'onui, nights of enlarging (waxing) moon; poepoe, nights of the full moon; and emi, nights of the diminishing (waning) moon.

By consulting the calendar, fishers know when certain species are likely to reproduce. During spawning season, those fish are not caught, allowing their numbers to remain high.

How does the community enforce the guidelines set forth by the moon calendar?

"We watch out for each other," said Poepoe. "We set rules, everyone knows them, and we can tell if our neighbors are doing something wrong."

What gives them away? The bright light of a full moon shining across the waters of Mo'omomi Bay.



Courtesy of Kelson Poepoe

Brittle Stars Take Over Seamount off New Zealand: Tens of Millions Discovered, Arms Raised, in Swirling Current

At an underwater summit higher than the world's tallest building, brittle stars have executed a take-over that could show Wall Street a thing or two.

On Macquarie Ridge off New Zealand, tens of millions of brittle stars live tip-to-tip, completely obscuring the undersea mountain they call home. Corals and sponges usually dominate seamount peaks, filtering food that arrives with passing currents. But, not on this seamount. Here, brittle stars and more brittle stars cover the 100-square-kilometer seamount. The seamount's base is 850 meters deep, but its top is relatively shallow, 90 meters beneath the ocean's surface.

Brittlestar City is the only known aggregation of brittle stars atop a seamount. Brittle stars, or ophiuroids, crawl across the seafloor using flexible arms for locomotion. Also called serpent stars, brittle stars have five slender, whip-like arms that may reach up to 60 centimeters long. Some 1,500 species of brittle stars are alive today, mostly in the sea's depths.

Scientists affiliated with the Census of Marine Life, a global effort to catalog Earth's marine biodiversity, discovered Brittlestar City in April during a month-long expedition to survey the sea-floor off New Zealand. "We were astounded to see such a huge assemblage of brittle stars," said ecologist Ashley Rowden of New Zealand's National Institute of Water and Atmospheric Research (NIWA). "The implications for the uniqueness of seamounts are far-reaching."

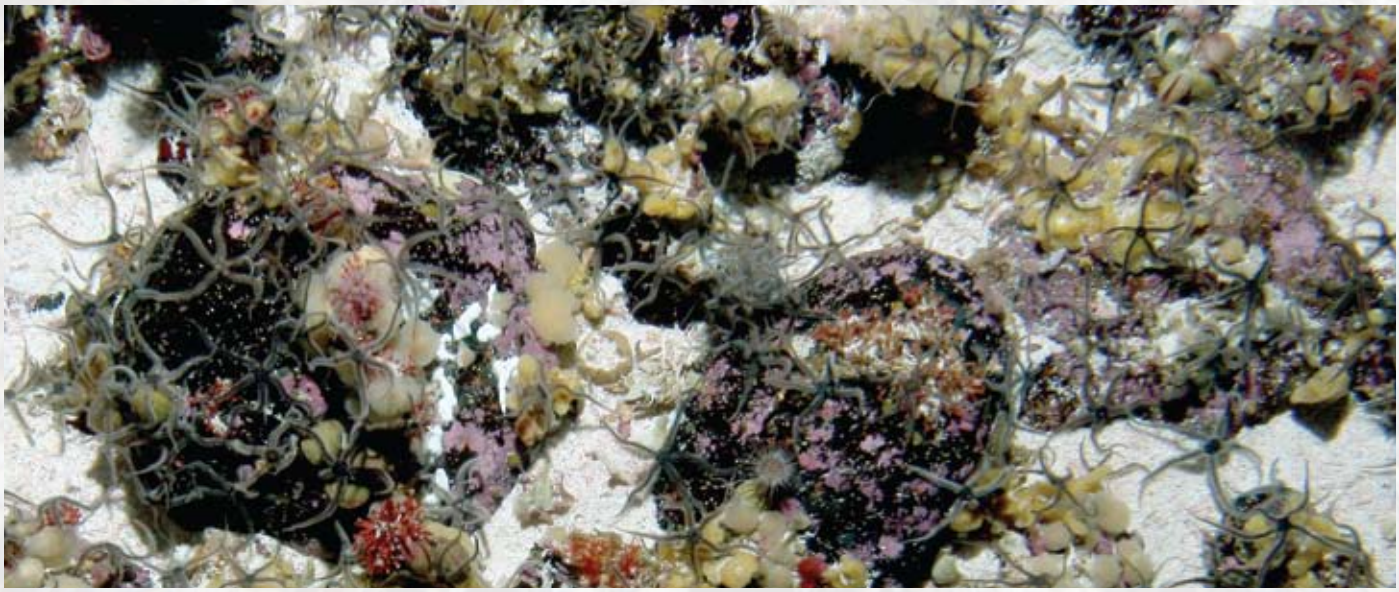
The brittle stars' success is a result of a circumpolar current flowing over and around the Macquarie Ridge seamount chain at a fast clip, four kilometers per hour. It allows the inhabitants of this marine metropolis to capture food simply by raising their arms, and sweeps away fish and other would-be predators.

Macquarie Ridge stretches 1,400 kilometers from New Zealand to just above the Antarctic Circle. The ridge is one of the few places where the Antarctic Circumpolar Current is detoured in its clockwise loop around the globe's southernmost latitudes. The current plays a vital part in the global oceanic ecosystem, merging with and mixing the waters of the Atlantic, Indian, and Pacific Oceans.

"The Antarctic Circumpolar Current is 110 to 150 times larger than all the water flowing in all the rivers of the world," said Mike Williams, a scientist at NIWA. "Understanding the current will shed light on how much water flows into the Pacific instead of going around Antarctica. That knowledge is important for predicting changes in the current and their impact on global climate."

For now, brownish-black brittle stars live arm-tip to arm-tip on the sand and cobble substrate of their Macquarie Ridge peak. Orange-red brittle stars cover the seamount's flanks.

Earth's oceans contain some 100,000 seamounts rising at least one kilometer from the seafloor. Fewer than 200 have been sampled, leading biologists to ask: if Brittlestar City exists, what else might be out there?



Dense aggregation of brittle stars on sand and rock seabed. Also sponges, brachiopods, anemones, and calcareous algae. *Credit: NIWA ©2008*

CHERYL LYN DYBAS (cldybas@nasw.org) is a marine scientist and policy analyst by training. She also writes on a freelance basis about the seas for *The Washington Post*, *BioScience*, *National Wildlife*, *Wildlife Conservation*, and many other publications.