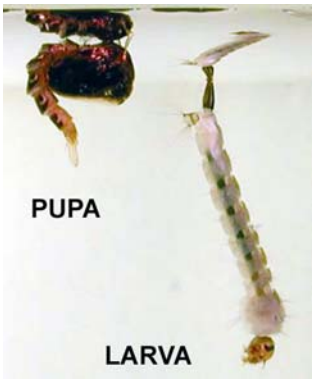
32. Mosquitoes, Filariasis & Dengue Fever

Mosquitoes may play a role in the grand scheme of things, but I'm not really keen on the idea that they want to suck my blood. Worse still, they can infect us with two diseases in American Samoa -- more about that shortly.



At least 12 species of mosquitoes (*namu*) occur in American Samoa. Most are common across the western South Pacific region, but some are endemic to the Samoan islands (*Aedes upolensis, Coquillettidia samoaensis, Ochlerotatus samoanus, Oc. tutuilae*) and a few are newly introduced.

Their life cycle involves several stages, one is the irritating adult mosquito, but their juveniles live in water. To reproduce, the adult female needs to obtain a blood meal (from you) to develop her eggs. She then lays her eggs in quiet puddles of water where they hatch and grow. The larvae breath air, so they generally hang around at the water surface but will wiggle quite actively when disturbed. After a week or two, the larvae pupate (a resting stage) and then emerge as flying adults. Females may live for 2-3 weeks and lay several clutches of eggs (each requires a blood meal). Only the female mosquito searches for a blood meal; the males (the ones with fuzzy antennae) feed on plant nectar. Also, not all the mosquitoes are after you personally -- some species seek out birds as their preferred blood meal.

The female mosquito finds you by following signals given off by your body such as body heat, odors and carbon dioxide. Light and movement also help her zero-in on you. She then sinks her long and thin mouth parts into your skin and sucks out a drop of blood, engorging so much that she can barely fly away. During the biting process, she secretes saliva into the cut to prevent the blood from coagulating. Your body's reaction to this saliva is what causes the bite to itch and swell.

Mosquitoes can carry two diseases in American Samoa: filariasis and dengue. Both can cause serious problems. These diseases are spread by specific mosquito species: dengue (principally *Aedes polynesiensis* and *Ae. aegypti)* and filariasis (mainly *Aedes polynesiensis,* and *Oc. samoanus*).

Filariasis, also known as elephantiasis (*tutupa, mumu*), is caused by parasitic nematode worms called filariae. When an infected mosquito bites you, these minute worms crawl from the mosquito's mouthparts onto your body and into the cut. This is not a particularly efficient way to enter your body, so the number of them transmitted from a single mosquito bite is probably limited. Multiple mosquito bites by infected *A. polynesiensis* may be needed before a person develops the full-blown disease. The worms lodge in a person's lymphatic system where they can live for 4-6 years and produce millions of minute larvae (microfilariae). These larvae circulate in your blood and are sucked up by other mosquitoes that bite you and thus can be spread to other people. In severe cases, filariasis can cause a very large swelling of arms, legs or genitals.

The number of people infected in American Samoa is considerable. In two surveys, people in several villages here were examined for filariasis and 17% (in 1999) and 13% (in 2002) were found to be currently or recently infected. But not all these people have swollen limbs. In general, about half of the people who are infected show no symptoms of the disease, but they may develop them as they get older. Our local Public Health Department together with the Center for Disease Control has joined a worldwide program to reduce filariasis by giving every person on island a medication that kills the

microfilariae circulating in your blood, thus preventing their further spread by mosquitoes. The cycle of infection can be broken if the number of people carrying this disease is significantly reduced.

Dengue fever is also transmitted by mosquitoes. Dengue is a viral disease that is rapidly expanding in tropical and subtropical areas of the world. It's not native to American Samoa but is periodically brought here by travelers from other infected areas. It then gets spread around primarily by the daytime-biting *Aedes polynesiensis* and *Ae. aegypti* mosquitoes. This virus is present in the mosquito's saliva, so it is injected directly into you when an infected mosquito bites you. Symptoms range from mild fevers to severe and potentially life-threatening illness. No vaccine is available yet.

A key point to emphasize here is that filariasis and dengue cannot be spread directly from person to person. An intermediate host, the mosquito, is required to transmit the disease.

Three other mosquito-borne diseases are worth mentioning. The most serious one, malaria, does not occur in American Samoa. It is found in the western region of the South Pacific, but the particular species of mosquito that transmits malaria (the *Anopheles* mosquito) does not occur this far east. A different type of malaria does occur here, but it infects only birds (avian malaria). The birds don't seem to be greatly affected by it however, perhaps because they've adapted to it over a long period of time. Similarly, there is a mosquito-borne parasitic nematode on island that affects dogs (heartworm).

Will tourists to American Samoa pick up these diseases? Not too likely. First, dengue is usually not present here, only when an infected traveler brings the disease here. Second, filariasis probably requires multiple bites by specific mosquito species, and probably only a small percent of this species actually carries the disease at any given time.

Scientists predict that we may see an increase in such diseases due to global warming and climate change. Although exact mechanisms are not known, many pathogens are sensitive to temperature; for example, growth, reproduction, and biting rates of insects all increase with higher temperatures. Global warming appears to be triggering a number of disease epidemics worldwide, involving a diversity of pathogens (viruses, bacteria, fungi, parasites) and a wide range of hosts (humans, corals, oysters, terrestrial plants, birds).

There are several basic measures that can be taken to reduce mosquito-borne diseases:

1. Find their breeding sites. Mosquitoes require water to complete their life cycle, so removing pockets of standing water around your house will help reduce their numbers. Survey your yard and eliminate areas where water can collect, such as discarded tires, buckets, coconut shells, saimin bowls, aluminum cans, cemetery urns, clogged roof gutters, etc. Drill holes in the bottom of large containers so that the water does not accumulate in them, or cover large objects like rain barrels with screening.
2. Avoid getting bitten. When the mosquitoes are out, wear long-sleeved shirts and long-pants. Use repellants and insecticides safely. Repair window screens on your house, and if needed, sleep under mosquito net tents while resting during the day and night.
3. Take filariasis medicine. Remember, you can be infected with the filariasis worm and not have symptoms. The filariasis medicine is free, so take it every year to break the cycle. If the health workers miss coming to your house each year, go to the hospital and ask for the medicine.
4. Be thankful for the swiftlets (pe'ape'a). They eat mosquitoes (and other flying insects).

P.Craig, NPS

33. Fungi: the vital decomposers

What do leaf spots, beer, itchy feet, rotting trees, fresh bread, mold, and pizza have in common? Fungus! Different kinds of fungi (the pleural of fungus is fungi) can cause diseases in plants and humans, make alcohol and raise bread. Certain fungi (mushrooms) are cooked and eaten.

Fungi are sometimes used by Samoans to make fermented drinks, such as *pulouaitu* (ghost hat). This drink is made from mushrooms growing out of cattle dung that are boiled, strained, and drunk to cause an alcohol-like feeling. *Alafa* is an interesting forest mushroom (*Mycena* sp.?) that glows in the dark and has actually been used to illuminate or mark trails at night. Children also create a strange effect by sticking *alafa* on their faces. Several other unrelated organisms also produce this bioluminescence, or biological light, by metabolizing a chemical in their bodies called luciferin. Different organisms produce different colors of light: green for jellyfish, greenish-yellow for fireflies, red for railroad worms, and greenish-blue for glow worms and mushrooms. Scientists continue to study this light-producing process, which is extremely efficient (almost 90%).

People used to think fungi were a kind of plant and placed them in the plant kingdom. But fungi are so different from any other organism, they were given their own kingdom. Most fungi (except yeasts and a few others) are made up of many cells arranged in long strands called hyphae. All the hyphae together make up the mycelium, or body of the fungus. As the hyphae grow through their food, a plant for example, they release enzymes. These enzymes dissolve the plant cell walls and the fungus mycelium absorbs the nutrients from the plant.

We are usually aware of fungi only when they damage something. That's because they live inside the things they are eating. Sometimes we see their white mycelium in rotted wood, but most often we don't see them until they form "fruiting bodies". These fruiting bodies make thousands and thousands of spores that grow into new fungi wherever they land. Sometimes these spores are brightly colored, like the blue, green, or white mold on old food, or the black mold in the bathroom shower. Other times we find mushrooms, another kind of fruiting body, growing on the ground or from trees. Fruiting bodies are an indication that the insides of the trees are being eaten. These fungi may be thin and delicate, tough and rubbery, or hard as wood. The "ear fungus" (*Auricularia*) is brownish-purple, and thin like an ear, while the "tooth fungus" (*Flavodon*) is bright chartreuse with short tooth-like pores on which the spores are formed.

Most wood decay fungi are called conks, or shelf fungi. One of the most common "wood rotters" in American Samoa is the artist's conk (*Ganoderma australe*). This fungus grows out from the tree in the shaped of a fan. It has a light brown top that is sometimes dusty with spores from the conks above

it, and a whitish-gray lower surface. The gray surface looks smooth but is actually made up of thousands of very small pores, inside of which the spores are formed. If this pore surface is lightly scratched, a brown line remains, and for centuries people have left messages or drawn pictures on them, hence their name, “artist’s conk”.

Some fungi threaten our food supply. The black leaf streak disease of bananas (*lausu lui*, or black Sigatoka) is caused by a fungus (*Mycosphaerella fijiensis*) that you can only see through a microscope. It damages the banana leaves, making the fruit small and of poor quality. Farmers have to use special chemicals to control this disease, which cost them time and money. The taro leaf blight disease (*lega*) that killed most of the Samoan taro in 1993-1994 was caused by a water mold (*Phytophthora colocasiae*). We used to call water molds ‘fungi’, but scientific tests show they are more closely related to certain red algae. They have spores that swim and their mycelium is made of very different ingredients. Water molds are no longer in the kingdom Fungi, but have been placed in one of the new kingdoms, either Protoctista or Chromista.

Banana black leaf streak disease (*lausu lui*)

Taro leaf blight (*lega*)

The colorful lichens that grow on trees and rocks are actually fungi and algae living together. This type of relationship is called mutualism, where both organisms benefit from the relationship. In severe climates, the fungus protects the alga from damaging ultraviolet light and supplies water and dissolved minerals. The alga makes food for both organisms through photosynthesis. In other instances, this symbiosis could be considered parasitism. In American Samoa, many algae living on leaves or tree bark receive enough moisture and shade to exist without the help of a fungus. In fact, the fungus may actually damage or kill the algae.

Fungi fill a very important role in nature by breaking down dead organisms into their basic elements so those elements can be used again to build new organisms. This nutrient recycling is especially important in the tropics where organisms are born and die at a very fast rate. If it weren't for fungi, bacteria, and other small organisms that eat dead plants, dead trees and bushes would soon bury us.

WARNING! Many fungi are poisonous. Eating them can cause sickness or even death. Don’t eat any mushrooms unless you are certain they are safe.

Fred Brooks, ASCC Land Grant

34. Pest invaders are here

The history of life on islands is a story of invasions. Ever since the high islands of American Samoa rose out of the sea as barren piles of volcanic rock, living things have been making the long and dangerous journey across the Pacific to reach this new land. Until a few thousand years ago, every plant, insect, and bird that lived on our islands was the descendant of a lucky adventurer that had crossed hundreds or thousands of miles of open ocean to establish a new colony here.

The first Samoans were also such lucky adventurers, making the perilous voyage here in their journeying canoes. But their arrival marked the beginning of a new way for plants and animals to reach our islands -- being carried here, either by accident or on purpose, by people. Ever since then, the environment of American Samoa has changed tremendously.

Some of these changes may have benefited some wildlife species. For example, the introduction several important food plants such as breadfruit and bananas provide a year-round source of food for some birds and fruit bats, rather than seasonally like some native plants that are eaten by wildlife. Other changes brought by the Polynesians were harmful to the environment -- for example, the introduction of rats (*isumu*). And since the arrival of Europeans and Americans, the rate of introduction of new plants and animals to American Samoa has increased tremendously. The results have often been disastrous.

Some plants brought by the Polynesians "escaped" to spread widely through the natural forest such as *ifi* and *nonu* trees. More recently, about 250 alien plant species (many of them weeds) have also become established in American Samoa and some of these threaten our native forest. One that is familiar to everyone is the "mile-a-minute" vine, or *fuesaina* (*Mikania micrantha*). This was introduced by accident, sometime before 1924. It is now a major pest in plantations and forests, and has spread tremendously following tropical cyclones in the early 1990s. The vine needs sunlight for its very fast growth, and so doesn't do well inside the shade of the mature forest. The cyclones, however, opened up the forests to sunlight by knocking down many trees and breaking off the tops of thousands more. Vines like these can form layers several feet thick that can choke the seedlings of native trees and slow the recovery of our forests from the damage of the cyclones.

Another well-known pest to agriculture is the giant African snail (*sisi aferika, Achatina fulica*). This was reportedly introduced to the Pacific when the governor of Tahiti imported them to satisfy the hunger of his mistress for escargot, or edible snails. Bad, bad idea -- not only were the snails not edible, but they quickly spread throughout Polynesia, and became a major pest of taro and other crops.

Unfortunately, the story does not end there. In the hopes to control the giant snails, a predatory snail (*Euglandina rosea*) native to Florida was deliberately introduced here in 1980. The idea was that this new snail -- the one with the long pinkish shell -- would kill off all the giant snails. Instead, it has driven the native land snails of the Pacific islands to the edge of extinction. Most of the native snails of Tahiti are now extinct, and the Samoan snails, which used to

be collected by the thousands to make *ula*, are almost gone. Meanwhile, the giant snail continues to thrive despite the new predator.


Bulbul

Another example is of an invasion that is still under way -- by introduced birds. The first bird introduced to American Samoa was, of course, the chicken (*moa*). Although these occasionally nest in the forests, they are not truly established as wild birds here, and are no threat to our native birdlife. However, we do have three introduced bird species on Tutuila. One of these is the *manu palagi*, or Red-vented Bulbul, the black bird with the crest that is common in nearly every village. This species became established here in the 1950's. The other two species both arrived in the 1980's and there seems to be no name for them in Samoan. These are the Common Myna and the Jungle Myna. They look almost the same -- both are blackish brown, with big white patches in the wings and tail when they fly. They are now abundant from Pago Pago to Leone and are spreading to the eastern and western ends of the island. None of these three introduced birds has made it to Manu'a, which is still home to only our native Samoan birds.


Myna

What's wrong with having new kinds of birds to live in our villages and gardens? In some parts of the world, including Hawaii, both bulbuls and mynas are serious pests on fruit crops such as guava. Second, they may spread the seeds of pest plants, like mile-a-minute vine and “Koster's curse” weed (*Clidemia hirta*), that native birds do not eat as readily. Third, they may drive out native birds, like the *iao* or Wattled Honeyeater. Although we don't know for sure that this is happening, there seem to be more *iao* around villages in Manu'a than on Tutuila where the introduced birds are common. Finally, the introduced birds may spread diseases that will attack our native birds. This has happened in Hawaii. In fact, on the main islands of Hawaii, the native birds have been almost completely exterminated. Every bird you seen in the lowlands of Hawaii is an introduced species; the native birds hang on only in isolated mountain forests. We don't want our Samoan birds to share this sad fate.


Clidemia

The lesson to learn from these examples is that we must be very, very careful when thinking about introducing a new plant or animal to Samoa. Even species that seem beneficial, like the predatory snail, can have bad and unforeseen effects. And once a new species is established, it is almost impossible to get rid of. Wisely, the Territory has established strict laws against bringing in exotic animals and any plant that may become a noxious weed. Flowering plants, like Honolulu rose (*Clerodendrum chinese*), may look pretty in a garden but turn into major pests when they run wild.

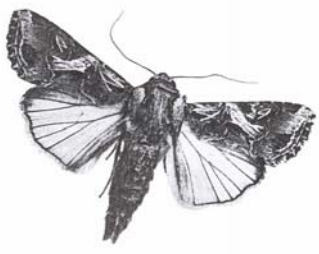
American Samoa's forests and wildlife are unique to all the world, having developed here over hundreds of thousands of years in isolation. We must take care to preserve and protect this special heritage by staying alert to keep unwelcome invaders from our shores.

Pepper Trail
DMWR

35. Common pests and diseases of local agricultural plants

Gazing up at the beautiful mountains on our islands, we see hillsides of lush green tropical foliage -- a picture of botanical health. That's true for the most part, but if we look closer, we notice that some plants can get sick and die, or they can be injured when insects, animals, strong winds or landslides damage their leaves, stems or roots. Sometimes insect pests or diseases spread fast, injuring or killing many plants over a large area. Then we take notice, particularly if we were growing those plants to eat. Here are five common plant pests and diseases that can cause serious damage to local agricultural plants.

Taro leaf blight disease (*lega, laumu*). Many people became acutely aware of this plant disease in 1993-94 when it destroyed most of the Samoan taro crop. The disease is caused by a fungus (*Phythophthora colocasiae*) that has been in Fiji for many years, but we don't know how it came to American Samoa. Perhaps it arrived here on taro tops (*tiapula*) from another island, or its fungal spores blew in on the winds of Cyclone Val in 1991. Taro leaf blight is most severe when the weather is cool and wet. Rain splashes spores of the fungus into the air, which are then blown by wind from plant to plant. The expanding brown spots made by this fungus cause leaves to die faster than normal, so the plant must use its energy to make more leaves instead of storing the energy in the taro corm (*i'o ole talo*) that we want to eat. Farmers are now growing taro varieties from Micronesia that are more resistant to the fungus. The Palau taro, for example, still gets the disease, but less severely, so the leaves live longer and corms are of normal size.



Armyworms (*anufe-ailatalo*). These insects are more appropriately called cluster caterpillars, because they are not worms at all. They are the juvenile stage of a thick-bodied grayish-brown moth (*Spodoptera litura*) that flies about at night. It is a serious pest for many crops and may occur throughout the year. The caterpillars are often found on taro leaves in small numbers and if found soon enough, they can be picked off by hand before they eat too much of the leaves. Sometimes there are so many that they can't be removed fast enough. As with taro leaf blight, this has a major impact on the plant, because energy is taken from the corm (*i'o ole talo*) to replace damaged leaves, so the harvest is reduced. The female moth lays 200 to 300 eggs in a cluster during the night. After the eggs hatch, the young larvae feed together, eating larger and larger holes in the leaves as they grow, until only the thick ribs of the taro leaf remain. The mature larva falls to the ground, forms a pupa which is the resting stage when the caterpillar changes shape and grows wings, and afterwards emerges as an adult moth that flies off to lay more eggs. The complete life cycle, eggs to adult, takes only about 30 days. In American Samoa there are several friendly insects, mainly small wasps, that attack and kill armyworms. But if the armyworms are too numerous, the wasps cannot control them and considerable damage to the plant may result. Unfortunately, spraying the armyworms with pesticides also kills the helpful wasps.

Banana bunchy top virus (*laufeti'iti'i-vaelusi*). This is one of the most serious diseases of bananas. The virus can be so devastating that some regions of the world affected by it, like parts of Hawaii, are no longer able to produce bananas commercially. For unknown reasons, places like American Samoa are less severely affected. It may have something to do with the small insect, an aphid (*afiti*), that carries

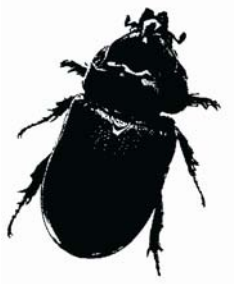
the disease from plant to plant. Perhaps these aphids are less effective virus carriers or they are not very abundant here. Banana plants infected with the virus produce small, narrow leaves with yellow, tattered edges bunched together, thus the name "bunchy top". When one plant becomes infected, the virus spreads to the rest of the plants growing from the same "root" mat. Infected plants stop producing bananas and become shorter and shorter until the plant finally dies. During this time, any aphid feeding on an infected plant can carry the virus to an uninfected banana plant. Another way the disease is spread is by removing suckers from an infected root mat and planting them elsewhere. There is some concern in American Samoa that the disease could begin to spread more widely, but there is a safe way to control bunchy top with a small application of a common herbicide [contact Land Grant for details].

Burrowing nematode (*nematota*). This pest attacks the roots of banana plants. Nematodes are small, worm-like residents of soil and water. Most of them feed on dead plants and other tiny organisms, but some attack the roots of living plants. The burrowing nematode (*Radopholus similis*) enters young banana roots and eats the insides. When large numbers of nematodes feed on a plant, the roots are so damaged that the plant can fall over. This is one reason why banana plants topple over during strong winds or rain, or when they bear a heavy bunch of fruit. Damaged banana plants usually produce fewer and smaller fruits than healthy plants. Banana varieties grown in American Samoa have no resistance to this pest. The best way to control the nematodes is to remove their source of food (the banana root mat) for one year or flood the land, making it unsuitable for the nematode.

Rhinoceros beetle (*manuainiu*). These giant beetles cause a distinctive diamond-shaped pattern cut out of coconut leaves (fronds). The adult beetle burrows into the tops of coconut trees, then down toward their center. As it burrows, it cuts through the new, unopened leaves, so when the leaves open later, large wedges of the leaves are missing. If the midrib is cut, the leaf may break on windy days. While this may weaken some leaves and make them look unsightly, we don't know if the damage is serious enough to reduce the number of coconuts produced by the tree.

The adult beetle (*Oryctes rhinoceros*) is amazingly large -- almost two inches long -- black and shiny, with a horn on its head, like a rhinoceros. Although it's hard to visualize, the horn apparently helps them feed by stabilizing the beetle while it moves its jaws up and down, scraping a hole in the tree. The beetles do not eat the wood but live on sap from the damaged plant cells. The female lays one egg on the ground, usually in dead coconut trees, logs, piles of compost or debris. The young larvae are white with a brown head. They grow almost four inches long before they pupate and become adult beetles.

Larva



Rhinoceros beetle

Fred Brooks
ASCC Land Grant