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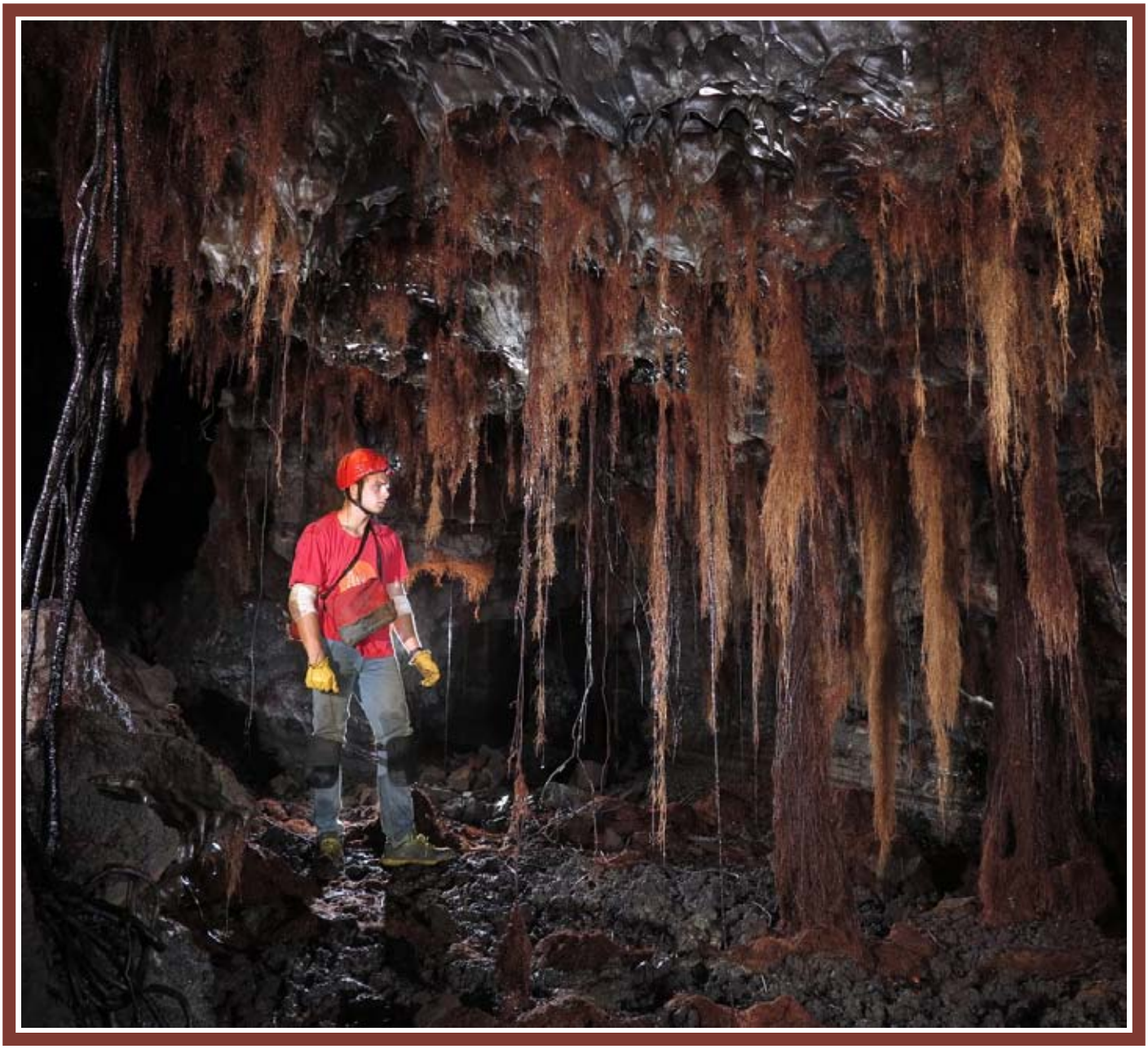

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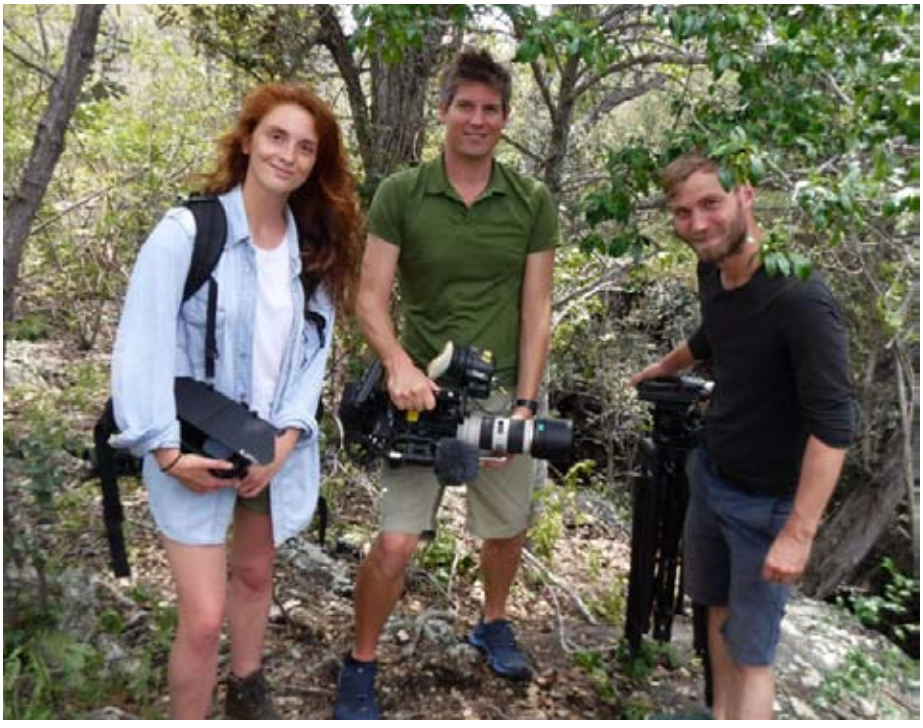
DOCUMENTARY FILM RECORDS CAVE LIFE IN A LAVA TUBE

by Annie Bosted

Kilauea's recent eruption is widely considered to be a disaster in human terms, but a natural occurrence in nature. How do eruptions affect the animal world? Which critters survive eruptions, and which ones do not? How do frogs, or goats or insects fare? How can humans benefit? Those questions, and others, will be posed in an upcoming TV documentary by "True to Nature", a UK film company. The program will focus on four aspects of life around volcanoes.

In Ecuador, a country famed for its multitude of rare frogs, the company filmed a segment about the Quito Rocket frog. Researchers are trying to save the last of the species before the volcano erupts. The frog lives in only one valley that is fed from meltwater off the top of Mt. Cotopaxi, so if the volcano were to erupt violently, lava or ash would obliterate the frog's last known refuge.

A second segment was made at the world's most active lava lakes on Vanuatu's Mt. Marum, where they filmed silver-suited scientists running experiments close to violently bubbling lava.



The film crew that flew half way around the world to document cave-adapted bugs in Ocean View. On the left is Amy Thompson the film's researcher. Mark Sharman, the cameraman, is in the middle and Alex Ranken, the producer, is on the right. Photo by Ann Bosted

On the slopes of Mt. Aetna in Sicily a crew documented goats that posses an uncanny ability to sense an imminent eruption. When goat herders there reported that the animals acted "strangely" before volcanic eruptions, researchers fitted the goats with GPS tracking devices. The herders were right. Some hours before a large eruption, the animals suddenly fled down slope and hid in the bushes.

In a lava tube in Ka'u, the British cinematographers added a fourth segment when they shot the first macro footage of cave-adapted underground life in August.

On hand to help the film makers and also explain the

unique world of the tiny critters were four caver scientists.

Dr. Megan Porter, Associate Professor in the Department of Biology at the University of Hawai'i at Mānoa, Honolulu and a long-time caver, who has studied cave life for over 25 years, was interviewed at length on camera.

Dr. Annette Summers Engel, a Professor of aqueous geochemistry the University of Tennessee, has also made numerous trips to the Big Island, and is now accomplished at finding insects that could be filmed.

Assisting them were Scott Engel, a geologist from Tennessee, and Alan Hudson, an evolutionary biologist from the UK, now living in Honolulu, and recently married to Megan.

To date, the biologists have made five field trips to the lava tubes of the Big Island. Their project began as a bio-inventory and has since evolved to a study of the evolution and ecology of the lava tubes of Ka'u. For the movie, the biologists were able to select a cave that would be easily accessible, and have a rich selection of lava tube life. Working in a lava tube in the Kipuka Kanohina system, they expertly found insects smaller than a pea, and others smaller than a grain of rice for the film crew to document.

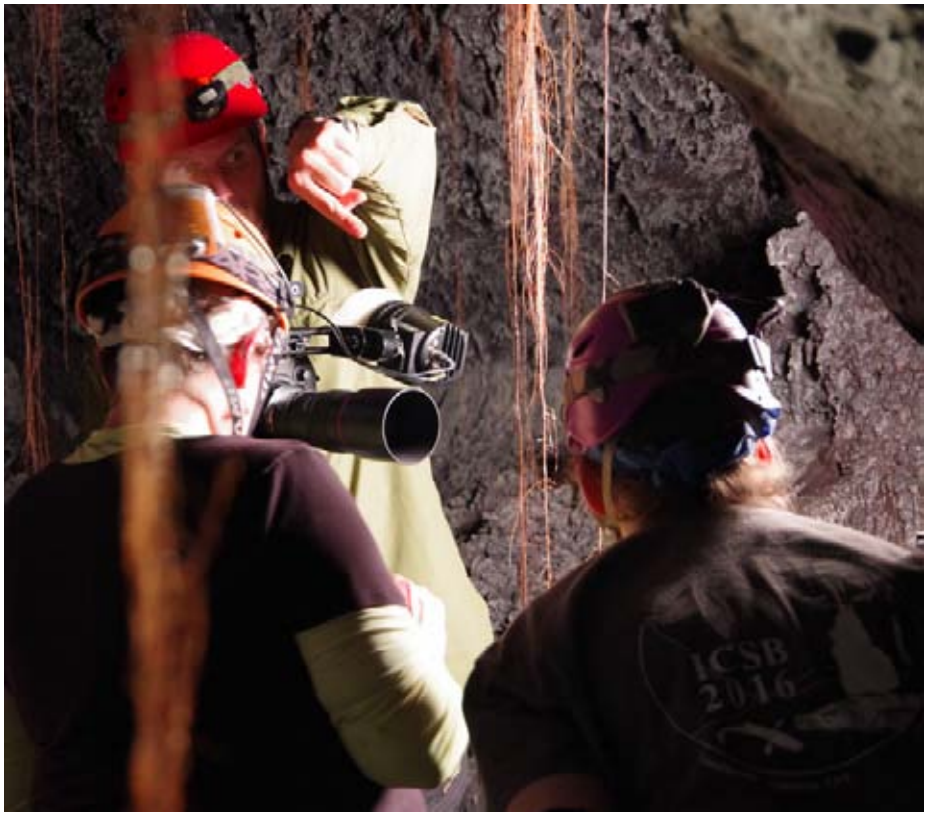
Megan and Annette explained in an interview how they were able to find the proverbial needle in a haystack and how the film crew was able to record the elusive subjects.

A curtain of 'Ohi'a tree roots in a lava tube is back lit by British documentary film makers. Cameraman Mark Sharman (left) and producer Alex Ranken confer on the shot that will reveal details of the cave adapted insects that call these roots home. Photo by Scott Engel

“We found that the best method was to firstly choose an area that is usually wet and also has tree roots,” Annette explained. “We then gently blow puffs of air onto a small area and watch carefully to see if anything moves. We can’t spot them unless they are moving. They are just too tiny”.

Once a minute subject had been spotted, the cameraman had to quickly set up his tripod and camera to have his lens in exactly the right place.

“They were able to get the camera incredibly close without alarming the animals. They filmed the bugs just walking naturally around the rocks or on the tree roots, which was very satisfying for us to see”, explained Annette.



Biologists in the foreground, Annette Summers Engel (left) and Megan Porter (right) help cameraman Mark Sharman (back) direct a powerful movie camera towards a cave-adapted insect nestling on an ‘Ohi’a root growing in an Ocean View lava tube. The eyeless creature may not have been aware of their presence. Photo by Scott Engel

“So often film makers capture an insect and then try to photograph it in a studio where the photographers can control the environment. This is not natural for the animal, so it will not behave naturally. It will act afraid, and behave defensively. But since this shoot was in a cave, the animals moved beautifully.

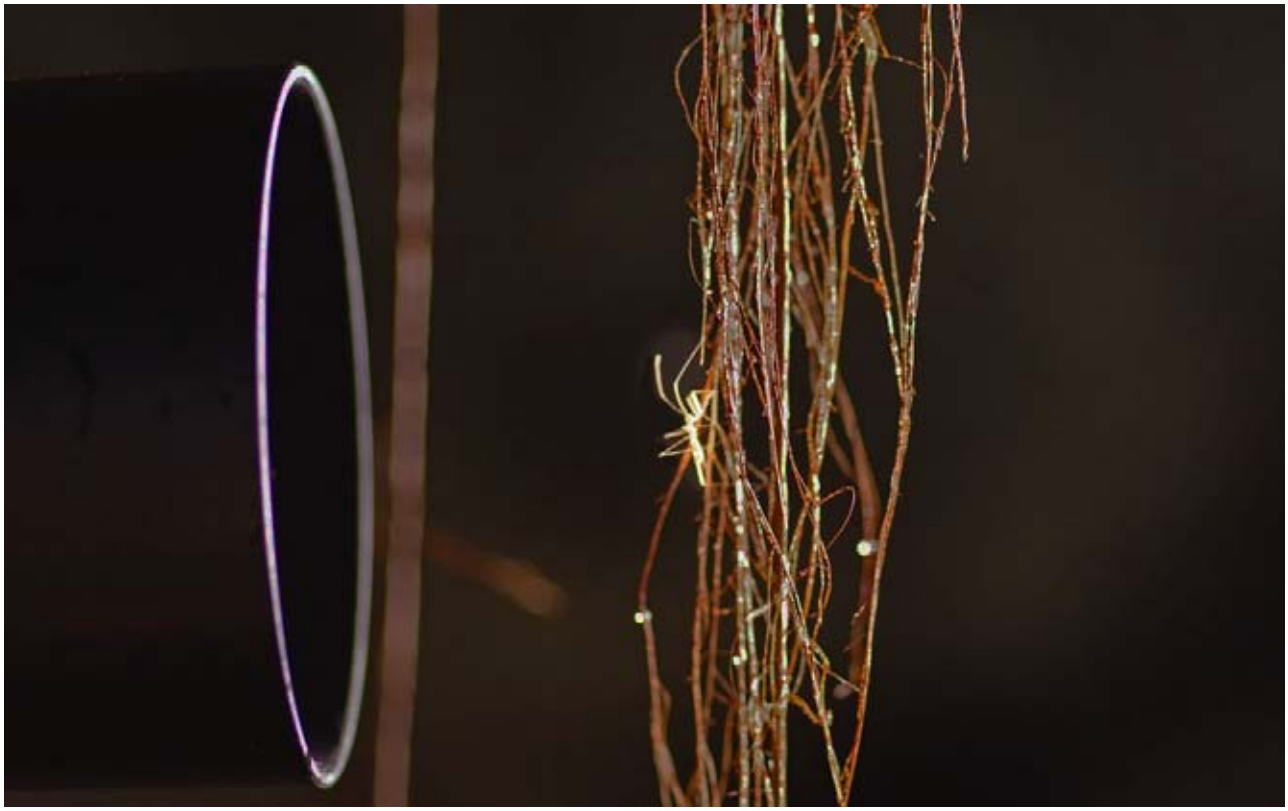
“The film makers got a fantastic close-up of a thread-legged bug walking up and down a tree root. It was amazing. I don’t think that has been filmed before.

“They also filmed a juvenile planthopper moving around a root, and a cave treader crossing over a rock. They wiggled their antennae and looked so perfectly natural. It was wonderfully authentic and also very satisfying for us to be a part of this new level of realism”.

Megan and Annette also talked authoritatively about their subterranean research and findings, and explained why the “True to Nature” film crew flew half way around the world to document the cave bugs of Ka’u.

“This documentary will be about life around volcanoes”, explained Megan. “Volcanoes create lava tubes and these habitats are a sanctuary for animals that are able to colonize and adapt to living their lives in darkness.

“Lava tubes are also a sanctuary in that they are free of predators, such as birds or bats, that prey



A tiny thread-legged Bug can be barely discerned in the tangle of fine 'Ohi'a roots in front of the movie camera. But in the film-makers' powerful super-macro lens, every detail of its spindly body will be documented as it walks around the root looking for a place to feed. This "bug" and other tiny eyeless insects living in lava tubes will be the featured stars of a TV program documenting life around volcanoes. Photo by Scott Engel

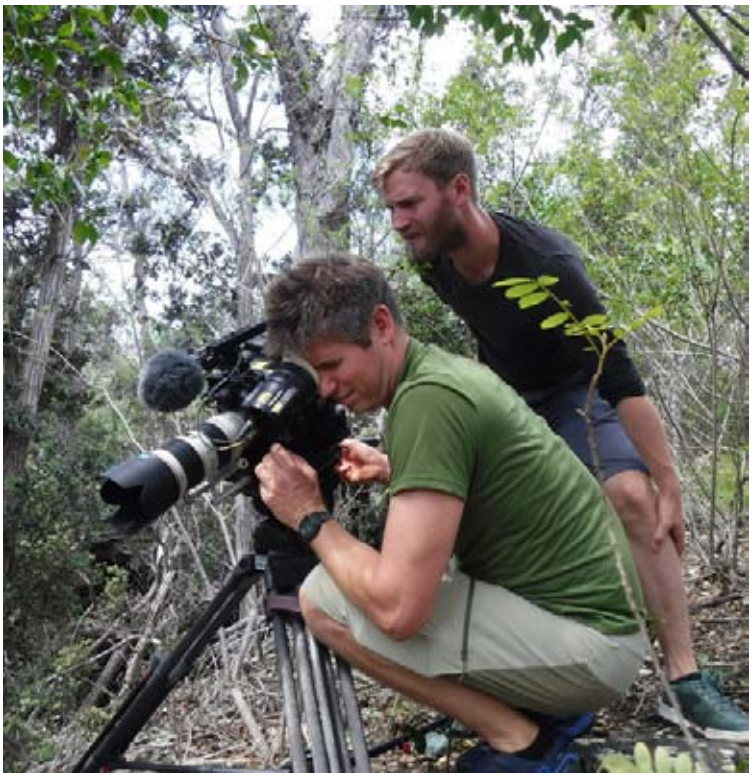
on insects. Lava tubes have fairly constant temperatures, and are uniformly moist, unlike the outside where insects must endure rain, drought, heat, and cold".

"Food is an issue for them", explained Annette, "without sunlight, very little grows in lava tubes, so cave-adapted animals must rely on 'Ohi'a roots and microbial mats growing on the rocks for nutrition.

"The problem is that while these are rich in carbon, they are poor in nitrogen. This is because volcanic soil is poor in nitrogen. Plants on the surface can pull nitrogen out of the air, and animals feeding on grass, leaves or stalks can then ingest it. But the animals that never leave the cave and can only access the roots of the trees clearly don't have access to that source. Without nitrogen, animals can't make amino acids or proteins. Without those, animals can't grow or function. Yet the insects we have found in the lava tubes all over the island of Hawai'i are clearly thriving.

"We know that sap-sucking insects, such as aphids that live outdoors, and planthoppers that live underground, have bacteria living in pouches in their bodies. These pouches of bacteria function like accessory organs for sap-suckers living above ground, by generating amino acids.

"We would like to know how the cave-adapted sap-suckers live. They may have more specialized bacteria living inside them", suggested Annette.



British cameraman, Mark Sharman, films the lava tube entrance in the 'Ohi'a forest in Ocean View, while producer Alex Ranken checks out the shot in the camera's video screen. Photo by Ann Bosted

"How do they get the bacteria - is it inherited, or is it from the environment? How many different types of bacteria live inside them, and how do the bacteria living in cave adapted planthoppers differ from the bacteria of those on the surface" she queried.

"We know planthoppers have adapted to the cave environment, but have their bacteria adapted? The bacteria living in planthoppers are not found in caves, meaning they are not part of the bacteria mats or "slimes" that microbiologists like Diana Northup are studying", added Annette.

Asked about other cave adaptations, Megan reeled off a long list of more easily observable characteristics, such as longer legs, a lack of pigment, no eyes or reduced vision.

"Since these animals live in complete darkness all their lives, they don't need visual senses, but do require better non-visual senses - so their hairs are more sensitive and their antennae are longer. They can easily create and detect vibrations. As far as we can tell, cave adapted planthoppers don't use chemical cues.

"Planthoppers living in lava tubes in different parts of the island have different "songs", whereby the communicate with each other, and likely attract mates that way", added Megan.

"In fact it was their 'songs' that made cave adapted planthoppers interesting to mainstream researchers," she explained, alluding to a 2006 paper that investigated the various songs of the insects in tropical areas around the world.

Asked to explain the differences among the various populations of planthoppers on our island, Megan replied that it was obvious that the populations developed very quickly.

"The island of Hawai'i is less than a million years old, yet we have seven genetically distinct populations. Normally it would take millions of years for this kind of development.

"We cannot say with certainty that they are different species without further study. They all look alike, but our detailed studies make it clear that the populations are genetically very different.

"Some species may be older than other species, depending on whether they have been able to move out of lava tubes that become inundated by fresh flows and into the newer lava tubes. It

would take a lot of work to try to figure that out. But its likely that a species is older than the tube or the flow which it is currently inhabiting, especially considering that some of the tubes are very young".

Asked about populations of cave adapted insects, Megan explained "Lava tubes confine a population and exert a tremendous selective pressure on populations. They can't easily move from one lava tube system to another, so generally, they must either adapt to that particular cave system or perish.

"Once adapted to the caves of a certain area, the planthoppers of that area rapidly evolve into a population."

Planthoppers on ohia tree root. Photo by Peter Bosted.

"Lava tube biology is like an untapped well. A lot remains to be learned about life from these lava tubes. We have only scratched the surface. The deeper we go and the more we learn, the more we find we still have to discover about life.

"It's fascinating", she concluded wistfully.

Editor's note: A version of this story appeared on pages 11 and 12 of the October 2018 Ka'u Calendar.