

Guinea Worm in a Frog

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Today, I'm talking with Dr. Mark Eberhard about frogs and Guinea worm. Dr. Eberhard is a retired CDC parasitologist and is currently back at CDC as a guest researcher. Welcome, Dr. Eberhard.

[Mark Eberhard] Good morning, and thank you for having this podcast.

[Sarah Gregory] First off, would you please explain what Guinea worm is?

[Mark Eberhard] Sure. Guinea worm, or *Dracunculus medinensis*, is a nematode, or roundworm, parasitic in people. The male and female worms are very different in size, the male being only a centimeter in length and rarely, if ever, seen, but the female is nearly a meter long when she emerges through the skin of an infected person. The infection is transmitted to people by way of contaminated drinking water containing copepods, which are small aquatic zooplankton that have ingested Guinea worm larvae. Of historical interest, Guinea worm likely represents the Fiery Serpent of biblical times.

[Sarah Gregory] And how does this affect people?

[Mark Eberhard] The female worm takes approximately one year to develop in the human host, during which time it mates, grows from a very small larva to the adult worm, which is basically a large sack full of first stage larvae. The mature female worm migrates to the surface of the skin over any part of the body, but most commonly the extremities, where it produces a painful blister that ruptures when it comes in contact with water. The female worm herself then ruptures and releases hundreds of thousands of larvae into the water, which is needed to continue the life cycle. The open sores produced when the worm emerges can often become secondarily infected as a result of poor sanitation and hygiene, leading to prolonged healing and other sequelae resulting in loss of ability to work, attend school, or conduct other normal daily activities.

[Sarah Gregory] Where it is normally found?

[Mark Eberhard] The disease was once endemic in 21 countries across much of Africa, north of the equator, the Middle East, and India and Pakistan. Now, there are only three remaining endemic countries: Chad, Ethiopia, and South Sudan. When the eradication campaign began there were over three million cases per year, but last year there were only 25 human cases. It was, and still is, typically found where people remain extremely poor and forced to use unsafe water for drinking. Once the larvae are released into a water source, they need to be ingested by copepods, in which necessary development of the parasite occurs. The small larvae go through three stages in the copepod, and develop to the infective stage in 10 to 14 days. When these infected copepods are ingested by a person, the larvae are released into the stomach and migrate out of the digestive system into the body cavity, and on into subcutaneous tissues where they complete their development in 10 to 14 months.

[Sarah Gregory] But you found it in a frog. Why were you even looking for it in frogs? And where was this?

[Mark Eberhard] Starting in 2011, the epidemiology of the disease in Chad was noted to be very peculiar, suggesting that typical waterborne transmission is not the primary means of transmission. Our knowledge of other species of parasite whose infective larvae survive, without maturing, in animals which are called paratenic, or transport, hosts led us to surmise that some aquatic animal in Chad was likely involved in transmission, despite there never being any previous suggestion of such occurrence in Chad or any other formerly endemic countries. Our primary focus was on small fish and tadpoles, both of which are known to be large consumers of copepods. Preliminary studies in the laboratory with colleagues at the University of Georgia suggest that most fish are not susceptible hosts, but that nearly all types of tadpoles tested are susceptible. Now, we have to step back and say that we don't think that tadpoles are eaten by people, but from studies done years ago with a related parasite in raccoons in North America, we knew that Guinea worm larvae in infected tadpoles migrated into the adult frog tissues as tadpoles metamorphosed into frogs. It is also known that adult frogs often eat tadpoles, which would lead to infection of the frog. People eat frogs and we surmise that is how most people in Chad are becoming infected. So, we have made several trips to Chad specifically to look for infection in frogs. During one such trip this past June, we were very fortunate to find a frog infected with a Guinea worm larva, which upon molecular testing proved to be *Dracunculus medinensis*. Although only a single finding, it did confirm that infection does occur in wild-caught frogs, and supports the laboratory experiments that demonstrated frogs are good paratenic hosts for Guinea worm.

[Sarah Gregory] Okay. So, how would people actually get Guinea worms from frogs?

[Mark Eberhard] People would acquire infection from eating undercooked or poorly cooked frogs.

[Sarah Gregory] So, a completely cooked frog is okay to eat?

[Mark Eberhard] Correct.

[Sarah Gregory] I know that there has been hope of a Guinea worm eradication in the near future. How does finding it in a frog impact that quest?

[Mark Eberhard] Well, it's not a show stopper but it certainly is a game changer. It is quite possible that the finding of a paratenic host in the life cycle will slow the progress towards the eradication goal. The addition of a paratenic host to the life cycle has several ramifications. First, it has the potential to lengthen the time that infective larvae exist in the environment and are available to infect humans. The infective larvae are much longer lived in the frog than they are in copepods, simply because frogs live for much longer times than do copepods, which have a rather short life span. Secondly, paratenic hosts have the ability to circumvent safe water – that is, even if people are using safe water, or filtering their water to remove copepods, they can still be exposed to infection via eating frogs. Lastly, although good interventions are in place to provide safe water by way of bore wells, treating water sources with an insecticide to kill

copepods, or using cloth filters to remove copepods, there are at present few interventions in place directed at frogs.

[Sarah Gregory] What does this newly found frog host mean to public health?

[Mark Eberhard] In addition to potentially slowing eradication progress, it also has necessitated renewed research at this late stage to learn more about this ancient disease, one that we thought we knew sufficiently well. The Russian parasitologist, Fedchenko, described the life cycle of *Dracunculus medinensis* in 1871, and here we are nearly 150 years later adding a totally new mode of transmission. Ironically, for scientists such as myself, this has been an incredibly exciting and challenging time to uncover such a twist to the life cycle of Guinea worm. On the other hand, with appropriate research, we have not only solved the mystery of the peculiar epidemiology of Guinea worm in Chad, but we've also provided insight into the way forward to reach our goal of eradication. Certainly one public health message for all control, elimination, and eradication programs is to not stop doing directed research and to be prepared for the unexpected.

[Sarah Gregory] Are there precautions people should take to avoid getting Guinea worm in this new way?

[Mark Eberhard] Yes, the most straightforward precaution is for people to cook their food thoroughly. This is a health message that the program is implementing in Chad with some success. However, behavior change is a very difficult undertaking, and one that not only takes time and requires the proper health messages be framed correctly to reach all segments of the population, especially remote groups who are subsistence living on the edges and wary of any new ideas or messages.

[Sarah Gregory] Thank you, Dr. Eberhard, for talking with me today. Listeners can read the entire November 2016 article, Guinea Worm Infection in a Wild-Caught Frog, Chad, online at cdc.gov/eid.

I'm Sarah Gregory for Emerging Infectious Diseases.

[Announcer] For the most accurate health information, visit cdc.gov or call 1-800-CDC-INFO.