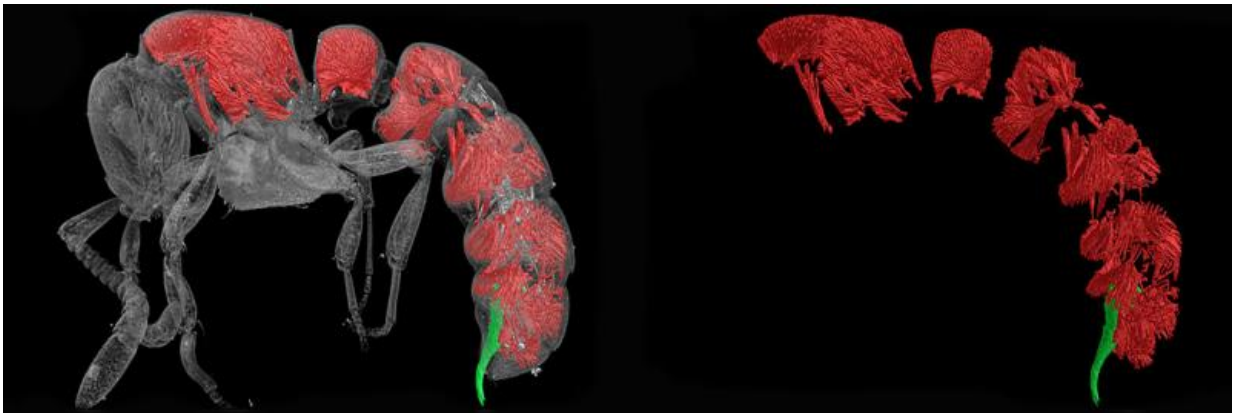
X-ray micro-CT enhanced revision of the ant genus Zasphinctus Wheeler

August 30 2017



Reconstruction of musculature inside the Zasphinctus sarowiwai ant. Credit: Okinawa Institute of Science and Technology

Biologists at the Okinawa Institute of Science and Technology Graduate University (OIST) have named three new, rare ant species in Africa after important figures in African biodiversity conservation—a former United States president, a writer-activist, and a world-renowned scientist. Using new scanning technology for documenting species, the OIST researchers compiled scans of the ants to create 3D avatars, giving them, and their namesakes, a measure of immortality.

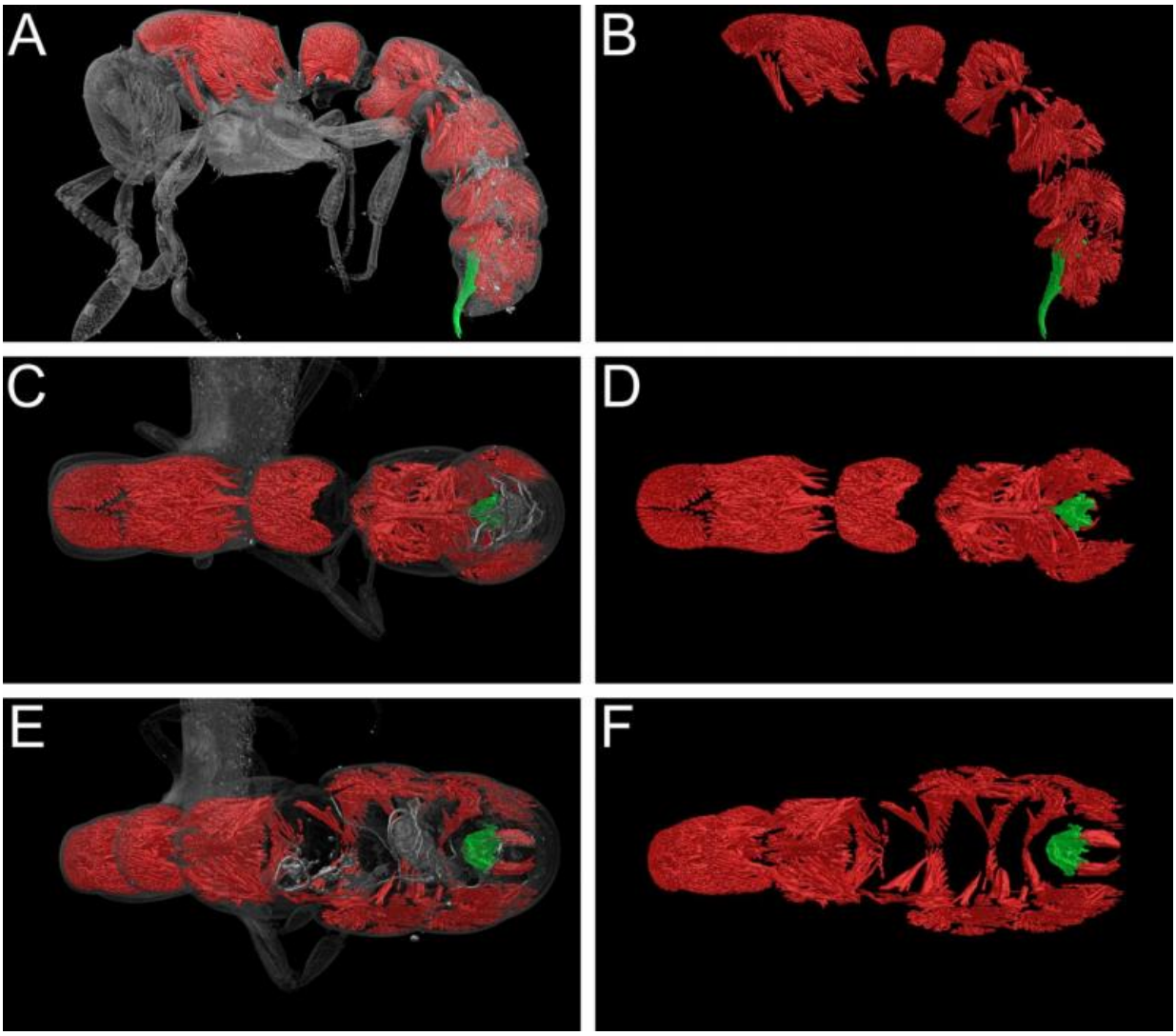
The first ant species, Zasphinctus obamai, was discovered in the Kakamega Forest National Park, Kenya, located near Mr. Barack

Obama's ancestral family village. The OIST researchers chose to honor Mr. Obama for his prodigious contributions to global biodiversity conservation. The second species, Zasphinctus sarowiwai, was named after Ken Saro-Wiwa, a Nigerian writer and environmental activist who, after campaigning against irresponsible oil development, was executed in 1995. The third, Zasphinctus wilsoni, was named after biologist Edward O. Wilson, who is famous for his contributions to sociobiology, ant biology, evolution, and biodiversity conservation. Through his foundation, Wilson has contributed to the resurgence of Gorongosa National Park in Mozambique, which is one of Africa's most successful wildlife restoration stories.

To create the 3D avatars, "we used X-ray microtomography, or micro-CT, which is comparable to when you go to the doctor and get a CT scan but at much higher resolution, to scan very small insects," explains Dr. Francisco Hita Garcia, first author on the study and a member of the Biodiversity and Biocomplexity Unit at OIST.

The OIST research team then compiled the scans into 3D reconstructions of the ants—identical to their originals down to the thinnest hair on the tiniest leg. The reconstructions hint at a future of virtual taxonomy with the potential to alleviate issues of time, money, and specimen damage, and realize new horizons of inquiry into hard-to-reach details, such as the thickness of an ant's exoskeleton.

The following link shows an interactive model of a whole-body 3D reconstruction of the Obama ant: Zasphinctus obamai. (sketchfab.com/models/dfe15a585 … 4be89cdeff7f9713091c.) It is an exact replica of a physical specimen that the OIST researchers collected during field work in the Kakamega Forest in Western Kenya and scanned using micro-CT.



Reconstruction of musculature inside the Zasphinctus sarowiwai ant. This image shows a 3D reconstruction of the arrangement of muscles inside the Zasphinctus sarowiwai ant, shown in red, and the stinger, showed in green. This ant species has many muscles in the abdomen, which suggests that its sting is quite powerful and functional for predation. Credit: Okinawa Institute of Science and Technology

There are plenty of advantages to creating these models. For example, since they are made using micro-CT technology, the original, physical

specimens are recreated on both the outside and inside. As such, if researchers wanted to study the way the inside of an ant's mouth is organized, they could simply virtually remove the outside parts that are in the way—something that cannot be done on a physical specimen without damaging it. In their study, the OIST researchers did precisely this.

In addition to reconstructing and examining the ants' mouthparts, the OIST researchers also visualized the muscles inside of the ants' bodies and measured the thickness of their skin, called the cuticle, all with the help of the virtually reconstructed 3D models.

"We saw things that nobody ever looked at," Dr. Hita Garcia explains, and through those new observations the research team was able to confirm details about the ants' lifestyles. Other species of Zasphinctus from outside Africa are known to be predators of other ants, and the mouthparts, musculature, and skin-thickness data from the OIST researchers' study all provide evidence that the African Zasphinctus ants are top predators as well. "Normally when you describe a new species, you don't know much about its biology," Dr. Hita Garcia explains, but with the 3D reconstructions researchers can discover details right away.

Another advantage of 3D models is that they can be easily accessed from anywhere. Especially for specimens that are rare, examining them requires a lot of time and money to coordinate—such as an expensive plane ticket to visit a museum in Nairobi. This is not the case with the 3D models. "If someone wants to see the Obama ant, they can download it, look at it, and 3D print it," Dr. Hita Garcia explains. All of the 3D material that the OIST researchers created can be found and freely accessed at the Dryad Digital Repository: datadryad.org/resource/doi:10.5061/dryad.4s3v1.

Yet despite advances in scanning capabilities, the world of virtual

taxonomy is not yet ready to be realized. For one, there are not enough research labs and institutes that provide access to micro-CT scanners. "We have millions of species on the planet, but we have 3D models for only a handful," Dr. Hita Garcia explains. The technology is ready, the scientific community just needs the means and incentive to apply it, as well as to embrace it.

Until that future arrives, however, the OIST researchers can focus on using the unique names of the three new ants for altruistic purposes. "Since these ants are from very threatened habitats in Africa, we wanted to pick names that draw attention to the environment, and not just the ants," Dr. Hita Garcia explains. The rainforests in equatorial Africa, as well as the savannah in Mozambique, needs to be protected before the habitats and animals living within them are destroyed.

More information: Francisco Hita Garcia et al. Next-generation morphological character discovery and evaluation: an X-ray micro-CT enhanced revision of the ant genus Zasphinctus Wheeler (Hymenoptera, Formicidae, Dorylinae) in the Afrotropics, *ZooKeys* (2017). DOI: 10.3897/zookeys.693.13012

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Provided by Okinawa Institute of Science and Technology