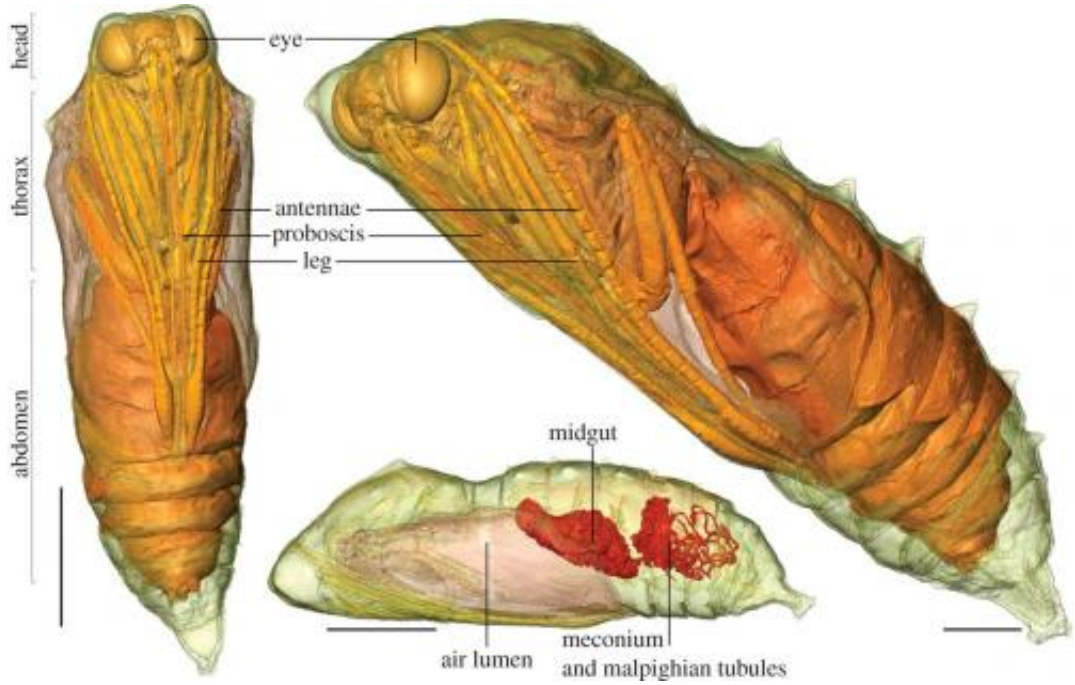
Researchers use CT scanners to watch living pupae develop into butterflies inside chrysalis

May 16 2013, by Bob Yirka



The pharate adult at 16 days development, showing aspects of the internal anatomy (air lumen and gut structures), and the external anatomy such as limbs, mouthparts and the cuticle. Scale bars, 5 mm. Credit: *J. R. Soc. Interface*, doi: 10.1098/rsif.2013.0304

(Phys.org) —Two British research teams have begun using micro-CT scanners to watch butterfly pupae develop into butterflies while still alive inside their chrysalis shells. The first team did so as a means of studying the initial stages of insect metamorphosis, focusing specifically on

trachea development. Their work, done as part of a BBC documentary has not yet been published. The second team has taken things much further. In their paper published in *Journal of the Royal Society Interface*, they describe how they created several time-lapse videos of pupae as they changed into painted lady butterflies.

The first team, working with the BBC, scanned blue morpho pupae several times over a single week looking to learn more about how the network of breathing tubes was changed over time as caterpillars move to the pupae stage. The second team focused on the metamorphosis of pupae into painted lady butterflies.

Butterflies are naturally more tolerant of radiation then humans and most other animals, which led the research teams to wonder if they could survive repeated CT scans. The researchers report that most of the pupae did survive despite undergoing near daily scans for the entire transformation period.

The second team, made up of members from the University of Manchester and the Natural Museum in London created several videos that show every stage of pupae development as they slowly change into butterflies—all over a period of 16 days. To generate 3D views, chrysalis's were glued to drinking straws and twirled during scanning. The researchers acknowledge that the videos don't offer much in the way of new information about the process—researchers have been cutting open chrysalis's for years to see what was going on inside. But they do offer for the first time, a real life view of what goes on during a process that has filled people with wonder for thousands of years.

Interestingly, the videos show that the breathing system for the insects doesn't change much from beginning to end—unlike the gut which shrinks dramatically. They also show that the changes that go on are part of a deconstruction and reconstruction process rather than a massive

breakdown of everything into small bits which then reform as new parts.

Because the technique was so successful with butterflies, it's likely that it will be applied to other insects as well. One idea is to use the technique on bees to see if pesticides might be negatively impacting their development process.

More information: Metamorphosis revealed: time-lapse three-dimensional imaging inside a living chrysalis, *J. R. Soc. Interface* 6 July 2013 vol. 10 no. 84 20130304. Published 15 May 2013 doi: 10.1098/rsif.2013.0304

Abstract
Studies of model insects have greatly increased our understanding of animal development. Yet, they are limited in scope to this small pool of model species: a small number of representatives for a hyperdiverse group with highly varied developmental processes. One factor behind this narrow scope is the challenging nature of traditional methods of study, such as histology and dissection, which can preclude quantitative analysis and do not allow the development of a single individual to be followed. Here, we use high-resolution X-ray computed tomography (CT) to overcome these issues, and three-dimensionally image numerous lepidopteran pupae throughout their development. The resulting models are presented in the electronic supplementary material, as are figures and videos, documenting a single individual throughout development. They provide new insight and details of lepidopteran metamorphosis, and allow the measurement of tracheal and gut volume. Furthermore, this study demonstrates early and rapid development of the tracheae, which become visible in scans just 12 h after pupation. This suggests that there is less remodelling of the tracheal system than previously expected, and is methodologically important because the tracheal system is an often-understudied character system in development. In the future, this form of time-lapse CT-scanning could allow faster and more detailed

developmental studies on a wider range of taxa than is presently possible.