ARTICLE SEVEN

NATIVE BEE HIVES
VIEWED IN SPECTACULAR 3D!

by Dr Anne Dollin
Australian Native Bee Research Centre
December 2005

Aussie Bee Online
Article 7
December 2005

MARK Greco of the University of Western Sydney - Hawkesbury has developed an amazing new way of looking inside the nests of native bees, using 'X-ray computerised tomography' or CT scans!

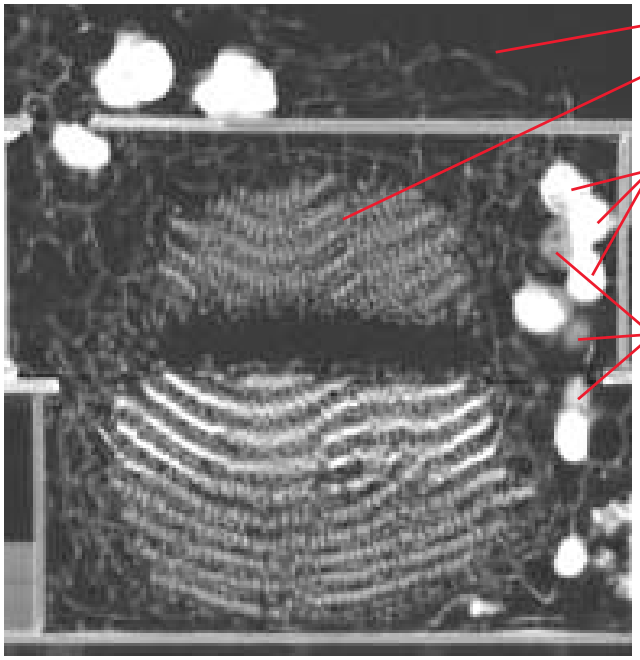
Our stingless social native bees are secretive creatures! They enclose their brood chamber inside an 'involucrum' sheath made up of multiple layers of cerumen (a mixture of wax and resin). If you break open a nest frequently you will damage this vital involucrum sheath and bees may drown in honey spilt into the hive. Curious beekeepers sometimes fit glass observation panels to their stingless bee hives but stingless bees quickly smear an opaque layer of resin over these panels.

Our solitary native bees are also secretive. Many species hide their tiny brood cells at the ends of narrow burrows in the soil. Breaking open a solitary bee nest to observe it usually destroys the nest. So it is normally very difficult to observe and monitor the progress of native bee nests.

Mark Greco displays one of his three dimensional CT scans of a Trigona stingless bee hive. Photograph by Sally Tsoutas, courtesy of University of Western Sydney - Hawkesbury.

An Innovative Solution

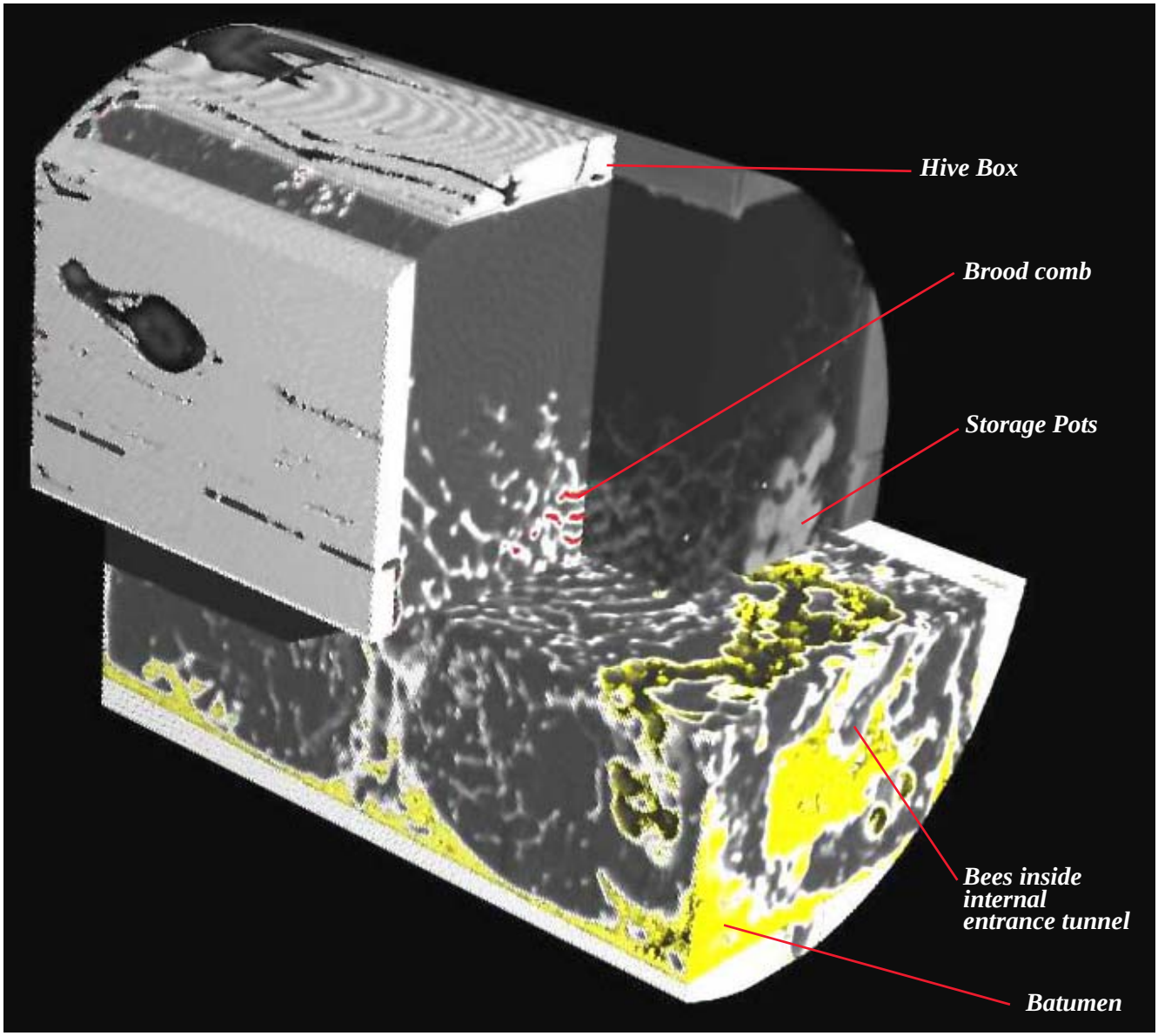
Mark Greco has found a remarkable solution! Prior to beginning his PhD studies at the University of Western Sydney, Mark had 25 years of experience as a diagnostic radiographer. CT scans have been used for decades to image the organs of patients for medical diagnosis. Mark decided to try using CT scans to image the structures inside a hive of *Trigona carbonaria* stingless bees. Macarthur Diagnostic Imaging kindly donated time on their CT scanner for this project.



Aussie Bee Online

Article 7
December 2005

Left: A two dimensional CT scan of a Trigona carbonaria hive with a honey super box, showing a detailed side view of the multilayer brood comb surrounded by a number of honey pots and pollen pots. Below: A three dimensional CT image of another Trigona carbonaria hive. Sections of the hive image have been cut out using computer software to reveal the brood comb (larval cells coloured in red), storage pots and the hive's supporting batumen layers (coloured in yellow).



Mark did two scans of the stingless bee hive at right angles to one another. The CT computer then combined the scans into dramatic three-dimensional images of the inside of the hive.

The scans accurately reveal the bees' intricate spiral brood comb. The layers of larval cells in the brood can be distinguished from the layers of cocoons. Clusters of pollen and honey pots can be seen around the brood. The honey pots can be distinguished from the pollen pots because the honey pots look brighter in the CT scan image. The CT computer can also calculate accurate figures for the volume of the brood and the volume of the honey and pollen pots.

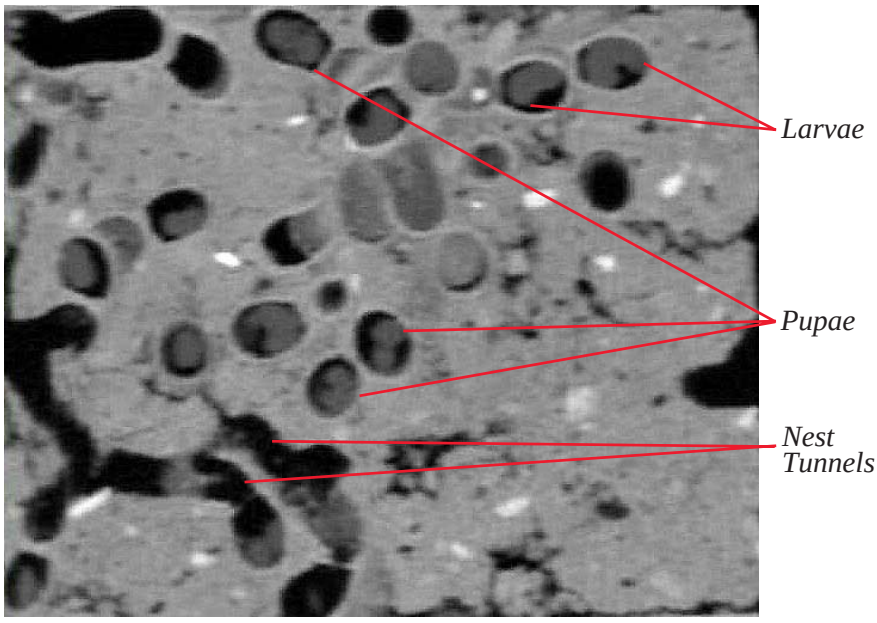
Best of all, this detailed information about the inside of the hive can be obtained without harming the bees at all. Scientists have determined the minimum radiation dose that has a biological effect in insects. Mark says that the radiation dose needed to do one of his scans is 3,800 times lower than this minimum dose!

Monitoring Hive Health

Mark's new technique allows scientists for the first time to take an accurate look inside a hive of stingless native bees without opening the hive up. A growing brood comb and increasing food stores are signs of a healthy hive. So this technique allows scientists to monitor the progress of a stingless bee hive at regular intervals during an experiment without disturbing the bees.

'The queen lays all her eggs in the brood chamber', says Mark, 'and if the brood chamber is shrinking, then the queen is laying fewer eggs. If food resources and environmental factors are adequate, then a shrinking brood chamber can indicate that there are health problems within the colony. A growing brood chamber indicates that the queen is laying plenty of eggs and colony health is strong.'

Mark has been using his CT scans to monitor the progress of stingless bee hives in a greenhouse experiment. Mark is studying the potential of stingless bees as pollinators of greenhouse capsicums. European honeybees suffer when confined inside a greenhouse but Mark has found that the greenhouse environment had no ill effect on the health of his stingless bee hives. The progress of Mark's greenhouse study will be reported in a future *Aussie Bee Online* article.



Above: A two dimensional CT scan of a blue banded bee nest block, viewed from the top. Short lengths of nest tunnels can be seen as well as brood cells containing developing larvae and pupae.

Scanning Solitary Bees Too

The nests of blue banded bees can also be studied with Mark's CT scanning technique. Blue banded bees dig nest burrows in clay soils and mud bricks. It is impossible to examine a blue banded bee's nest tunnels or brood cells without badly damaging the nest.

Mark scanned 13 of Melissa Bell's mud bricks containing blue banded bee nests (see *Aussie Bee Online* Article 2). The twisting tunnels and urn shaped brood cells of these solitary blue banded bees can be clearly traced in Mark's scans and developing larvae and pupae as well as fly parasites and invasive fungi can be seen inside many cells.

With Mark Greco's technique, the interior of native bee nests can at last be seen in spectacular 3D without harming the bees. Many applications are sure to be found for Mark's valuable new technique in research projects on native bees throughout the world.

This article is based in part on an interview by Suzie Vlaming, University of Western Sydney.

Further Reading

M Greco, R Spooner-Hart and P Holford (2005), A new technique for monitoring *Trigona carbonaria* nest contents, brood and activity using X-ray computerized tomography. *Journal of Apicultural Research* 44(3): 97–100.

Booklets in the *Native Bees of Australia* Series:

- Nests of Australian Stingless Bees
- Behaviour of Australian Stingless Bees

These booklets are available from the *Aussie Bee* website:
http://www.aussiebee.com.au

or contact the Australian Native Bee Research Centre,
PO Box 74, North Richmond NSW 2754;
Fax: (02) 4576 1196

Below: A three dimensional CT image of a blue banded bee nest block with part of the image cut away using computer software to reveal the internal structure of the block. Tunnels have been coloured in blue, brood cells in yellow and the mud brick material in beige.