An Internal Environment Comparison between a B.S. National Wood Hive and a ZEST Hive environment

A Honey bee colony has a deep and abiding interest in adjusting and maintaining a healthy hive environment based on Temperature, Humidity, Ventilation, Evaporation and Condensation and to do so continuously.

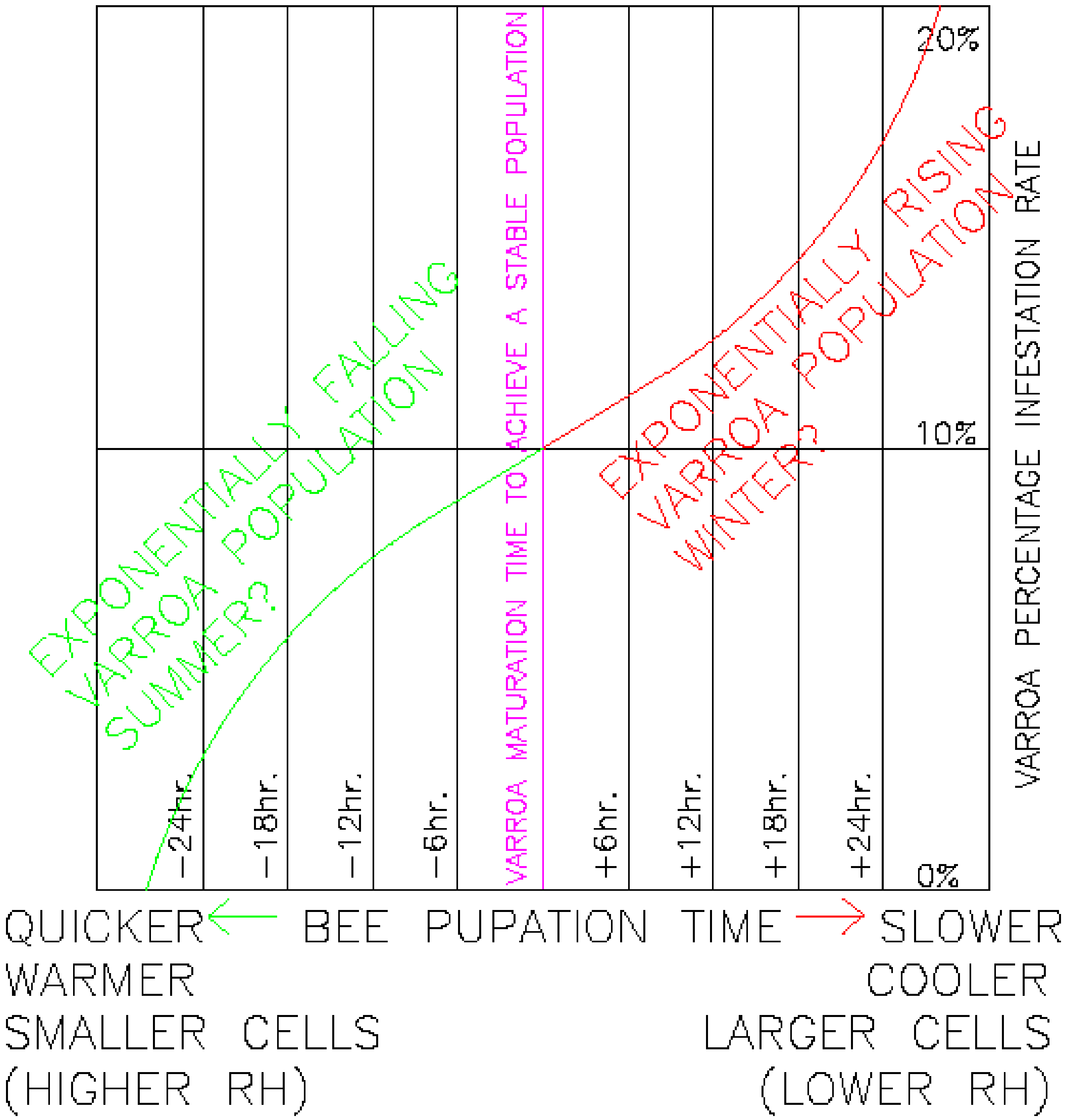
Prior to the Victorian invention of wood hives the straw skep had served honeybees needs as a biological system well enough. It provided them with an insulated gently ventilated and moisture free environment. It was too small and induced swarming, but this was seen as no bad thing at the time. The Victorian industrial revolution based on fossil fuel and machine technology took over in beekeeping. The resultant hives were larger, made of wood and were no longer so environmentally friendly to honeybees, being cold and damp. Looking on the bright side, the size of the external envelope could be varied by man to the benefit of the bees and himself.

It was not until the early 20th Century that any serious thought was given to whether the bee’s most fundamental environmental needs were being met in traditional hives. The 43 page text “Constructive Beekeeping” written by Ed. H. Clark in 1918 was written with the bees in mind and for the increase in honey that such an approach brings. It was passed over by both scientists and bee keepers, because it was concerned with design (as the ZEST hive is) and not just science. This once in a century opportunity was missed, but is now revisited and updated for the 21st. century with the ZEST hive design.

Bee hives are a manmade artificial habitation for an ancient biological system that previously made its home in either a cave or hollow tree. These were the best available, but less than ideal in environmental control terms, being voids that were too large, too small, not of ideal shape, wet and lined with fragile material. They did have the merits of being insulated and/or with a high thermal mass. Both of these qualities are made available in a ZEST hive, but the hive volume can be varied to suit the bee colonies changing size and environmental requirements. Purpose made ZEST hives when deployed by man can actually do better than nature when housing honeybees. We have a symbiotic relationship of mutual advantage.

Once designed, built and with bees installed it became apparent that apart from the intended consequences of better bee health regarding nosema and acarine, an unintended consequence of the ZEST hive design is that it is also varroa free. Our best theory for why this is so is expressed in the ZEST Varroa extinction/Survival diagram.

THE ZEST VARROA EXTINCTION/SURVIVAL DIAGRAM

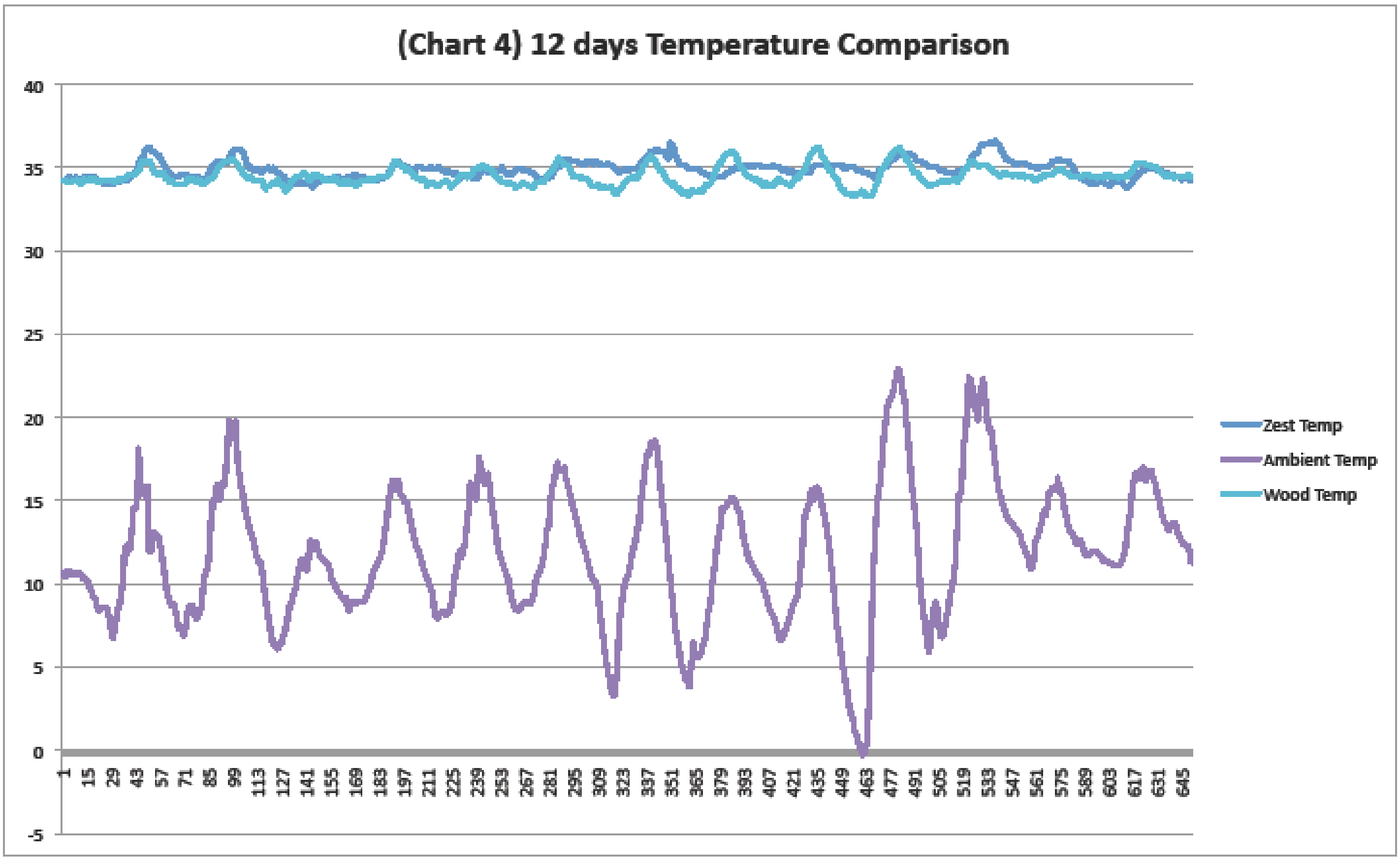


Above 37 deg. the pupa die.
35 deg. 10–11 days as pupa.(summer?) 96–98% surviving
31 deg. 14–15 days as pupa.(winter?) 89–100% surviving.
Below 29 deg. the pupa die.
Therefore winter is varroa breeding heaven due to more pupation time for varroa to mature.
Google:– "Synaptic organisation in the adult bee brain is influenced by brood temperature control during pupal development" and view table 1.

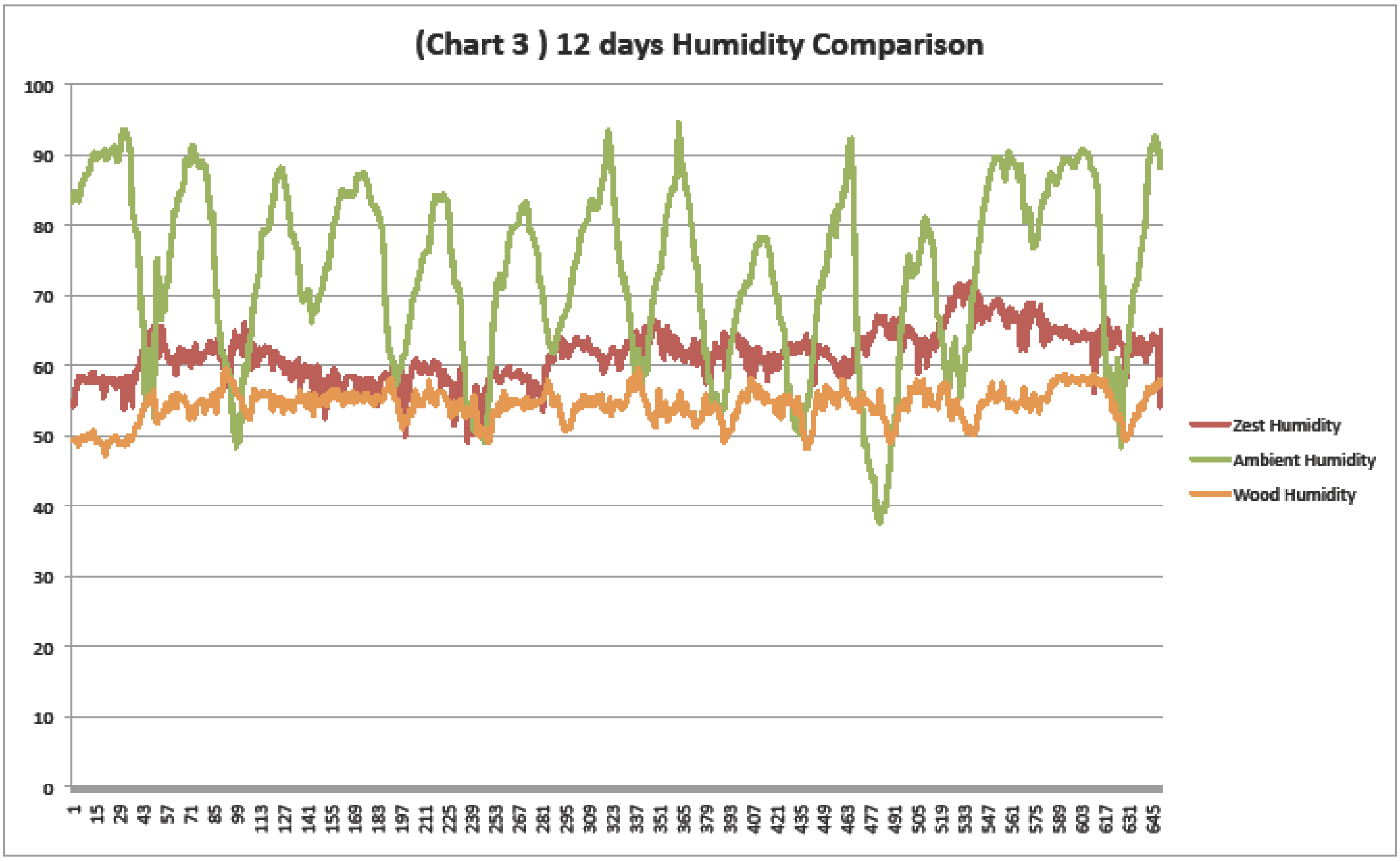
<u>Comparative Hive Environmental Data by Dave Durrant (Spring 2017)</u>

The data logger results here compare the traditional B.S. wood hive environment with a ZEST one. Both can be seen against ambient for temperature and humidity.

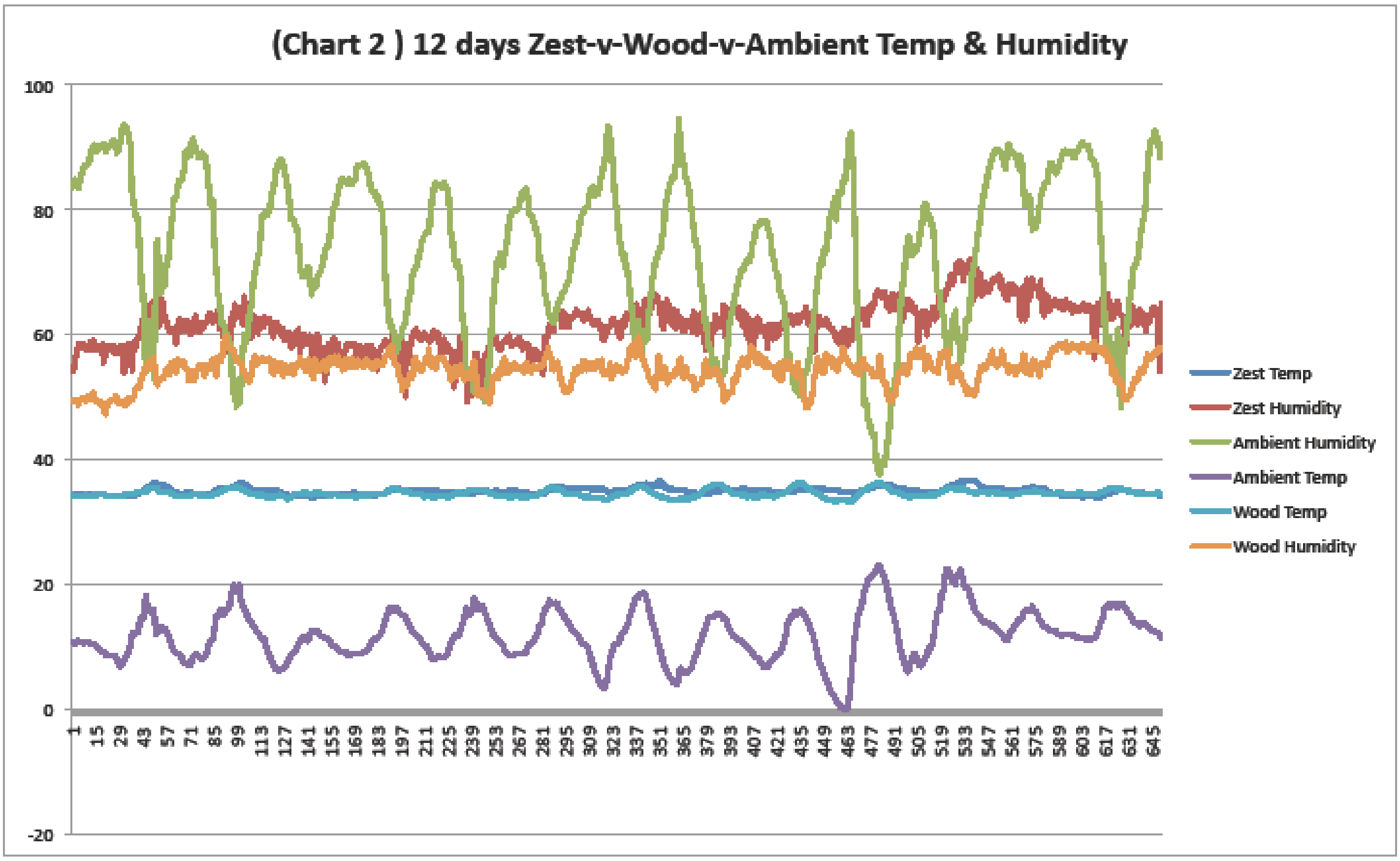
We leave it to others to test the difference in environmental control for other types of hive. We predict with confidence that none will compare favourably in efficacy with the ZEST hive whose merits will be seen to prevail.



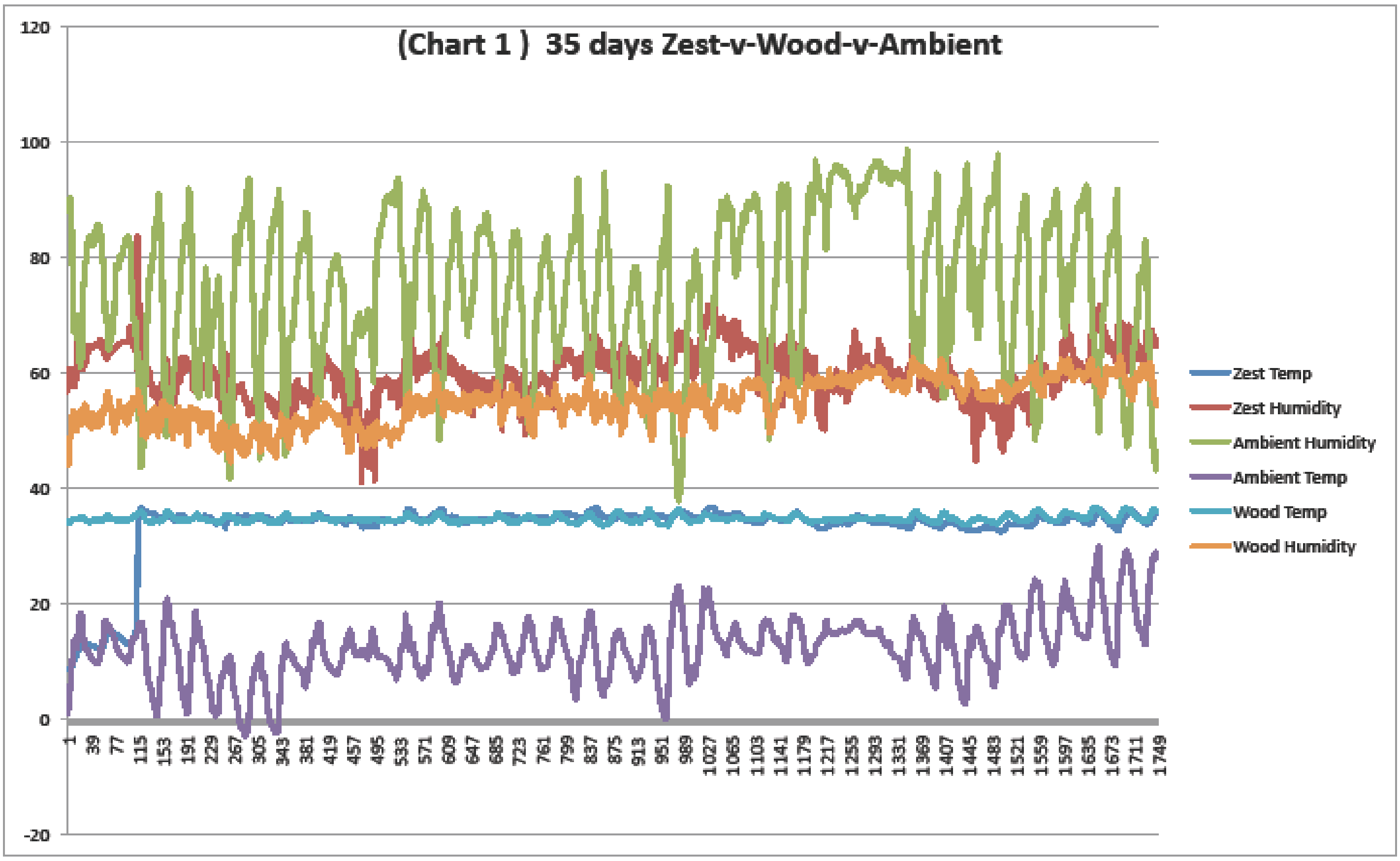
Temperature/Ambient. Wood B.S. wood versus ZEST.



Humidity/Ambient. Wood B.S. versus ZEST.



Temperature/Humidity/Ambient. Wood B.S. versus ZEST.



35 day overview

Observations on the data

* The ZEST internal environmental conditions are moderated and slower to follow the ambient.
A consistently varying colony environment is worse for the bees than any consistent one. The peaks and troughs are shallower in a ZEST. The likely cause is the thermal mass and insulation of the external envelope acting as in a tree or cave.

* The internal air temperature in both the wood and the ZEST hive is similar, rising slightly during the day and falling at night. The wood hive rises and falls more showing a lower ability for the wood hive to be controlled and at a greater cost of stores. Temperature is clearly important to the bees, but the ZEST must assist the bees with the insulation and thermal capacity of the external envelope. Trickle top cross ventilation rather than a stack effect found in a traditional wood hive must also help the bees in their ambition to run at 35deg.c.

* The humidity in the ZEST hive is significantly higher than in the wood hive.
If air is cooled the humidity naturally rises and if warmed it falls. The bees in the wood hive are unable to control the humidity to any great extent. The humidity in the ZEST however is not only higher, but rises when the temperature rises instead of falling as the ambient and the wood hive does. This may be counter intuitive, but infers that the bees in the ZEST are able to control not only the temperature, but the humidity as well. High humidity is implicated in varroa's demise. The varroa mite's tiny spiracle breathing tubes may become blocked in a high humidity environment or by some other mechanism.

* The ZEST is less likely to have in inner surface condensation unlike in a thin walled hive upon which it forms. Condensation is water and kills bees. Humidity is water vapour which bees need to prevent desiccation of the brood.
* The ZEST hive, with its thermal insulation and mass in its external envelope is capable of maintaining a bee friendly environment with less use of stores. A traditional B.S.National wood hive needs 15kgs. of stores to survive the winter. From 01/11/2016 until 28/02/2017 less than 4kgs. was used by one ZEST colony.

Discussion of the data

E.H. Clark in Constructive beekeeping said that:-
"In order to process nectar to honey the bees must employ condensation as well as evaporation and ventilation". The question remains “How” and with what result.

As with termites and other social insects, honey bees have a need to moderate the brood nest environment within critical limits for the benefit of the brood. They control temperature, humidity, evaporation, condensation and ventilation in order to sustain around 35 Degrees centigrade and a high relative humidity without condensation in the brood nest. The differences between hive designs are expressed in the vital signs of temperature, relative humidity, absolute humidity, ventilation and dew point between the two hive environments and can only be a result of the hive external envelopes. You are invited to inspect the differences between the hives and of the ambient and to consider which hive best assists the bees in achieving a consistent environment of around 35 Deg. Centigrade and high relative humidity with as little effort as possible allowing the bees to do **more with less**.
Honeybees warm the hive by vibrating their wing muscles after they have been detached from the wings, burning honey and warming the colony by radiation and air flow through the spiracles in the thorax. The trachea exchange oxygen for carbon dioxide and water which is vented to the outside. The relative humidity should fall as the temperature (and dew point temperature) rises. The warmer air can hold more water and the % humidity should therefore fall, but it does not in the ZEST. It rises and falls as the temperature does. This is counter intuitive, and infers that a water condensate cycle is in place in the ZEST resulting in the temperature rising and falling as a result of water “state” management, rather than directly.
Alternatively and in addition, the bees may deploy their crops as a reverse osmosis device to pass water in the nectar through their crop walls into their spiracles, vented into the hive and circulated to the outside or naturally as the foraging bees return home with their nectar.

Evaporating cooling cycle.
It is known that bees collect water and vaporise it into the colony to cool it. Evaporation absorbs the latent heat within the hive when the water changes its state to vapour. When the hive needs cooling in the summer bees collect water and return it to the hive. It is then vaporised by fanning it into the hive deploying an evaporation cooling cycle. This cools the air, withdrawing heat from it when the water changes its "state" from water to vapour storing it as latent heat which is then vented away.

Condensation warming cycle.
It is unknown if the bees have this ability which would allow the bees to release the latent heat from water vapour when it changes its state from a gas to a liquid, being water. It is likely that they can, being a useful skill to have developed over 30 million years of evolution. The bee’s propolize the inner surface of the ZEST hive walls and ceiling. This may be so that it acts as a condensation surface, releasing its latent heat.