Worker bees, sealed brood, bee bread and vitellogenin as parameters for colony vitality.

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The vitality of an individual honey bee depends on several factors e.g. the age related physiological condition, stress factors like diseases and parasites and quantity and quality of the protein feed. The honey bee colony is a super organism with trophallaxis and feed- back mechanisms to maintain the vitality of the colony. Therefore the vitality of the colony must be established on colony level. This raises the questions what matrix should be used and what is a representative sample of a colony. Bees from the flight entrance do not represent the colony as older forager bees are over represented. In case in-hive bees are sampled, knowledge of the age distribution is important. On all brood frames in summer, the age distribution is about 25% 1 week bees, 25% 2 week bees, 25% 3 week bees and 25% 4 + 5 week bees. On storage frames the older bees are overrepresented.
Parameters to describe the colony to assess the (differences in) vitality can be (not complete) hemolymph protein (vitellogenin, HSP, immune related proteins), number of worker bees. Cells sealed brood, cells bee bread, food gland development, fat body protein etc.
In our studies we used hemolymph protein / vitellogenin, number of worker bees, number of sealed brood cells as parameters in vitality studies. Vitellogenin is the main storage protein, essential to synthesize larval feed and regulation of the immune system. In individual hemolymph vitellogenin titres correlate strongly with levels of total hemolymph protein. The same goes for representative colony samples. A pooled sample of the hemolymph of 25 bees appears to be representative for the colony to assess the total hemolymph protein and vitellogenin. For other hemolymph parameters like carbon hydrates and immune related proteins this may be different.
The number of bees is an obvious parameter. The parameter “number of sealed brood cells” is chosen instead of “number of brood cells: eggs, larvae, pupae” because the number of eggs and larvae are affected by normal mortality and cannibalism.
Hemolymph protein, vitellogenin, number of bees and number of sealed brood cells are related to each other via feed-back systems. However external factors like Varroa, pollen diversity affect / disrupt the feed-back mechanisms, affecting the colony vitality. E.g. feeding bee bread results in more hemolymph protein a vitellogenin than feeding just sugar. Bees, being parasitized in the pupal phase by Varroa synthesize less vitellogenin than bees that have not been parasitized in the pupal phase.
In our studies it is demonstrated that the number of bees and the fraction vitellogenin is positive related in September; the more bees, the more vitellogenin. The demonstrated negative impact of Varroa on the synthesis of vitellogenin in individual bees can also be demonstrated on colony level, demonstrated it is an over-all negative effect of Varroa on colony vitality. Pollen diversity and pollen quantity have a positive effect on colony vitellogenin.
The combination of the parameters is needed to describe the colony’s vitality. The combination of the parameters, determined in a 2010 study show that in a pollen rich and poor environment, in September the bees respectively stop breeding and don’t,

consequently having a mean high and low fraction of hemolymph vitellogenin (0.45 and 0.33). This raises the question: do colonies in the pollen poor environment keep on breeding because of the low vitellogenin fraction which does not reach the “winter population’ level of vitellogenin or are other factors involved? In general is it possible that, because of Varroa or environmental factors, vitellogenin cannot reach a certain level in September, the colony will keep on breeding and will not turn into a real winter colony?