BEE NEWS & VIEWS

The Mississippi Beekeepers Association Newsletter

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January-February 2014

Beginners Workshop in Jackson, MS

By Jeff Harris

The Central Mississippi Beekeepers Association (CMBA) and the Mississippi Beekeepers Association (MBA) will jointly conduct a beginning beekeepers workshop at the Agricultural & Forestry Museum on March 15, 2014. The event will practically run all day (8 AM – 4 PM).

The morning session will consist mostly of Power Point presentations. Topics will include basic beekeeping equipment, basic bee biology, nutrition, and diseases and pests. Lunch will be provided on site. The afternoon session will be spent outside examining bee colonies. Topics will include how to light a smoker, personal protective equipment, examining bee hives, and extracting honey. The short course will end with a Q&A wrap-up session at the end.

We are asking folks to pre-register for the course so that we can get a good estimate of number of participants to prepare lunch. The cost is $10 now and $20 at the door. You can obtain the preregistration form from me (JHarris@ext.msstate.edu), and completed forms should be sent to Justin Hamilton, 1020 W Thompson Lane, Edwards, MS 39066. Justin's phone number is 601-218-8711 for those who have questions about the event.

Beekeeping Camp Becomes a Reality!

By John Guyton

I am excited to announce a new camp in our outreach programming! Dr. Jeff Harris and I have been discussing a beekeeping camp since we joined the department, and the time has arrived. We are very interested in getting more youth involved in beekeeping. I started as an undergraduate student and kept bees for almost two decades, only quitting when I finished my doctorate and moved to Kentucky to accept a faculty position at Murray State. And yes, that is a picture of me collecting a swarm—that almost got away!

We will operate this as an intergenerational camp, and youth campers will be required to be accompanied by a parent or guardian. We will only accept 12 camper teams, or 24 people. Youth need to be 12 years of age to attend, unless they have been participating in our Bug and Plant Camp.

The announcement of the camp to Mississippi and Louisiana beekeeper associations has already generated a lot of interest! Camp will be the week of June 8 (the week before Bug and Plant Camp). At the end of camp participants will be ready to setup their own hives. We will take them through the entire process from purchasing bees and equipment to processing honey and wax. They will know what to watch for to insure the health of their bees and produce a crop of honey. We will also find mentors to assist them, as close to where they live as possible, as they get started. As usual, we will respond to campers' emails or calls. The cost of camp is $375 per person, or $750 for a team of two. Please email or call me if you would like a registration form (Dr. John Guyton; email JGuyton@entomology.msstate.edu; phone 662-325-3482.

MBA Honey to MS Government Officials

By Jeff Harris

About a decade ago, Mr. D. L. Wesley and Mr. Milton Henderson (and others) started an MBA tradition of visiting and giving honey bears to all members of the State Senate, House of Representatives, the Governor and the Agriculture Commissioner. This simple gesture serves to remind them of our industry and its importance to agriculture.

Several MBA members, including Mr. D. L. Wesley, repeated the gesture on Thursday, February 20, 2014. Members of both legislative bodies acknowledged the honey bears and thanked MBA for giving them a good taste of Mississippi. Unfortunately, the Governor had to cancel his meeting with the group. Mrs. Cindy Hyde-Smith made up for his absence with a warm and friendly conversation outside her office.

It is not often that bills affecting beekeeping appears before the legislative bodies, but it does not hurt to keep MS beekeeping fresh in the minds of those that represent us. One shortcoming of this last trip was that the number of MBA participants was relatively low. Perhaps only 8-10 members actually participated. Mr. D. L. Wesley says that a larger group of people impresses the legislators more. So, next year we should make a greater effort to get MBA members from all over the state to make the visit to Jackson.

Female Caste Determination: Another Piece of the Puzzle

By Audrey Sheridan

Those of you who follow honey bee research may already be aware of some of the holes in our knowledge of honey bee caste determination. I'm not talking about drone vs. worker—that's quite well sorted out; queen vs. worker, on the other hand, is much more complicated. Consider this: from about 48 hours to 88 hours after hatching, the reproductive future of a female honey bee larva is determined. At any point during that window of time she can switch from being a worker to queen and back to worker, but once the window is shut her fate is sealed. She will thereafter be a worker or a queen, depending on what the nurse bees have been feeding her during that 2-day interval. The fact that larval diet determines the female caste is no new information, but just recently scientists have discovered two important components of larval jelly that regulate worker vs. queen fate: one in the worker jelly and one in royal jelly.

According to Guo *et al.* (2013), female larvae are preprogrammed to become queens, and workers result from the activity of tiny segments of RNA, called "microRNAs", which are provided in great quantities in the worker larval jelly and small quantities in royal jelly. These microRNA's suppress the expression of queen traits and possibly 'turn on' worker traits, though the latter assumption has not yet been thoroughly investigated. There are many types of microRNAs in honey bee larval jelly, and the phenotypic (physical) effects of at least one have already been determined (Guo *et al.* 2013). MicroRNAs, along with other types of small RNAs, and the way in which these molecules regulate gene expression comprise a novel field of molecular biology called, *epigenetics*. But before we delve any further into that topic, let us review the basic steps of gene expression.

> *Every cell in a female honey bee larva contains a nucleus, and each nucleus houses the "blueprints" for that bee, otherwise known as DNA. Genes are segments of DNA that code for specific traits, like eye color, wing length and ovary development. In order for genes to be expressed, the information from those genes first has to be transported to the cytoplasm of the cell, which is the space outside the nucleus. DNA cannot leave the nucleus, so a copy of the gene is made within the nucleus and is carried out to the cytoplasm. The*

process of copying genes from DNA is called transcription, and the final copy itself is called mRNA. In the cytoplasm, mRNA is decoded by ribosomes during translation, and specific proteins are formed from the mRNA's instructions. These proteins are responsible for expressing the traits encoded by genes to change the size, shape and function of a cell.

Now, turn your attention back to microRNAs. These small molecules are naturally present in all plants and animals, and they can be transferred from one organism to another by ingestion (e.g. from nurse to larva in larval jelly). They are made from pieces of RNA that are left over from the process of mRNA formation in the cell nucleus. Their function is to seek out mRNA in the cytoplasm and *block the translation of mRNA into proteins*. They accomplish this by teaming up with a protein complex and binding to a specific gene site (codon) of mRNA. When a ribosome proceeds to read the mRNA from one end to the other, it hits this roadblock and stops. The mRNA at this point may be degraded and all of the gene information beyond the roadblock is lost. We call this mechanism *gene suppression* or *gene silencing* (Fig.).

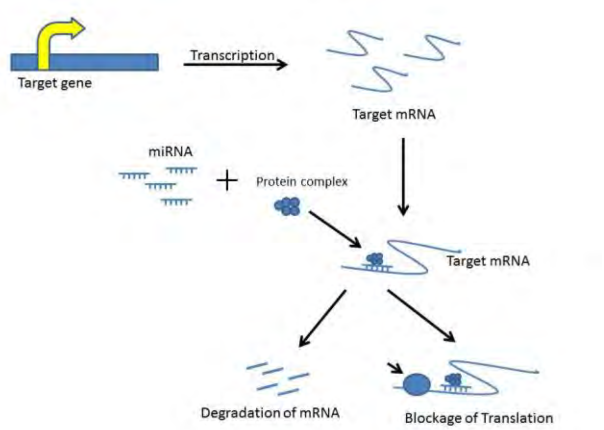

Figure - MicroRNA disruption of mRNA translation

In the case of honey bees, microRNAs are produced by the nurse bees and fed selectively to larvae that have been chosen for a worker fate. Several types of microRNA's are present in worker jelly, and one of these, miR-184, resulted in several worker-like morphological characteristics when fed to queen larvae: birth weight, body length, proboscis length, wing length, wing width and wing area (Guo *et al.* 2013). This was a surprise, for physical characteristics are not typically regulated by only one type of microRNA. Exactly *how* the microRNAs are produced remains a mystery, but it is generally held that they are produced in the hypopharyngeal glands of the nurse. We still do not know how nurse bees can switch between production of worker and royal jelly.

The other factor contributing to female caste determination is a protein found in royal jelly, appropriately called 'royalactin' (Kamakura 2011). This protein, when isolated and fed to young honey bee larvae, caused both physical and physiological changes in the direction of the queen: shorter development time, greater adult mass, enlarged ovaries, and an increase in juvenile hormone and vitellogenin (egg protein). Royalactin had a similar effect on female fruit flies, which indicates it has a general purpose of enhancing female reproductive traits. Kamakura (2011) also showed that when royalactin was deactivated in royal jelly, larvae that were at the queen-worker intermediate stage developed into small adults with reduced ovaries, even when they had received royal and not worker jelly.

The ability of female honey bee larvae to become either worker or queen adults is a phenomenon that scientists call *phenotypic plasticity*. The technical definition is, "a variation in physical characteristics between genetically identical individuals (e.g. worker and queen)", and it is not limited to bees—or even to eusocial insects—but can be observed in aphids, dung beetles and migratory locusts (Weiner and Toth, 2012). There are so many environmental factors influencing phenotypic plasticity in insects that it is often difficult to nail down even seemingly simple mechanisms, like worker/queen caste determination. We now have two more pieces of the puzzle: microRNAs and royalactin, and the whole picture is becoming clearer.

Acknowledgements
Figure by Hana Mujahid

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Suspicious Virus Makes Rare Cross-Kingdom Leap From Plants to Honey Bees

By Jennifer Frazer

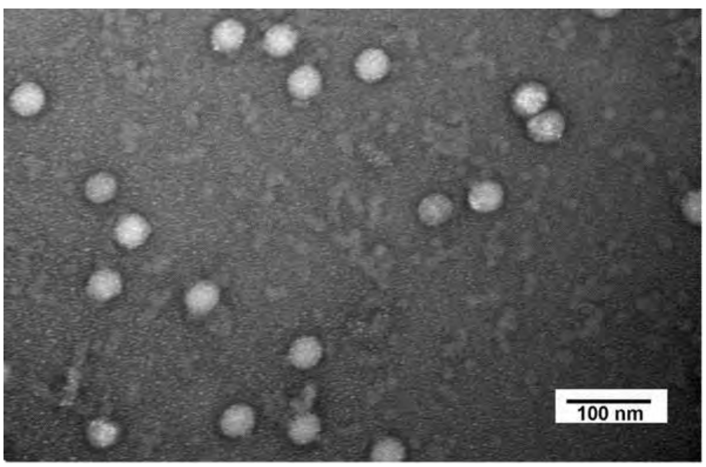

Figure - Tobacco ringspot virus extracted from honey bees. Adapted from Fig. 2 from Li *et al.*, 2014.

When HIV jumped from chimpanzees to humans sometime in the early 1900s, it crossed a gulf spanning several million years of evolution. But tobacco ringspot virus (TRSV), scientists announced last week, has made a jump that defies credulity. It has crossed a yawning chasm ~1.6 *billion* years wide.

And this is likely bad news for its new host, the honey bee, matchmaker of crops and bringer of honey. These are two services for which humans are both eternally indebted, and, in the case of the former, possibly unable to live without. Bees pollinate the majority of our fruit and nut crops and many vegetables — some 90 all told — without which humanity would be nutritionally impoverished.

Yet shortages are a possibility we are confronting, as bee populations in America have declined in recent years for reasons that seem to be both diverse and elusive. Colony collapse disorder, as it is called, was first reported in 2006 and has spread globally. Many viruses, parasites, and pesticides have been implicated, but no smoking gun has emerged.

As scientists were studying the possible role of pollen in spreading known bee viruses, a team of scientists from the United States and China began screening bees and pollen for viruses of all sorts. To their surprise, as they reported Jan. 21 in the journal *mBio,* they discovered a common plant virus — tobacco ringspot virus — had seemingly infested honeybees. Was it merely a transient visitor? Or had it made itself at home in a place inconceivably different from its usual digs?

Their first clue was the virus's genome. Tobacco ringspot virus is an RNA virus. Though DNA acts as a stable repository of instructions for building proteins, RNA is how that information is transmitted to the part of the cell that manufactures them. It is transient by nature and recycled after a short time. As a result, RNA polymerase, the enzyme that makes RNA by copying DNA, is not as careful as DNA polymerase, the enzyme that replicates it. It lacks a key proofreading mechanism that DNA polymerase has (3′->5′ proofreading), and as a result, is more likely to make mistakes called mutations.

In humans, that is not a problem, because the life of an individual strand of RNA is brief and any mistakes end with its destruction. But for RNA viruses, their hereditary information *is* RNA, and the extremely high RNA virus mutation rate is a powerful engine of evolution. It generates the diversity on which natural selection can act.

Mistakes can lead quickly to deformed or mal-functioning virions (no big deal for viruses) or to new host conquests (big deal for viruses) alike. RNA viruses have generated many celebrities; HIV is an RNA virus, as are SARS and influenza. RNA viruses are the most likely source of host-jumping viruses or an infection that suddenly acquires greater virulence, the authors of the study said.

Still, a leap between kingdoms is not an everyday event. Most plant viruses do rely on plant-eating insects to swap hosts. But very few of them actually infect those insects. One exception is the Rhabdoviridae, the family of viruses that includes rabies. Some viruses in that family have long been known to infect both plant and animal hosts.

In spite of its name, tobacco ringspot virus infects many plants besides tobacco from more than 35 families, including tomato, cucumber, beans, and many woody plants. This is a virus that *loves* plants, although they assuredly don't love it back. It can stunt or kill the plant, possibly discoloring the leaves in a characteristic ringspot pattern in the process.

Figure - Symptoms of tobacco ringspot virus on burley tobacco, *Nicotiana tabacum*. Tobacco ringspot infects many plants besides tobacco, most seriously soybean. R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org. CC by 3.0, via IPM Images.

Tobacco ringspot virus is spread between plants in any number of ways — the virus is not picky. It can be transmitted directly to the next generation by infected seed. Or it can be passed from one plant to another by a dagger nematode, a tiny soil worm with a piercing stylus for sucking plant juices. Any number of other plant-sucking or leaf-eating insects can do the job, too: aphids, thrips, grasshoppers, or tobacco flea beetles, perhaps. Or honeybees. The bees can spread the virus to a new plant via infected pollen.

Which brings us back to the mysterious matter of the plant virus that appeared in a bee, how it might have gotten there, and what it might be doing? Bees handle pollen in some fairly intimate ways. Their bodies are electrically charged so that pollen sticks, but they also carry baskets on their hind legs into which they stuff gobs of the stuff. Then, back at the hive, they mix the pollen into "bee bread", by combining it with honey and their own glandular secretions, which they may later eat. In short, bees wallow in pollen like hogs in slop, ensuring that any enterprising pollen-borne viruses have both means and motive to make a host leap. Whether the virus had established long-term residency in its new host was unknown, though.

The scientists sampled tissue from throughout the bees' bodies to see if was concentrated in their gut and salivary glands, where it would be most expected if it was just passing through. They found something very different. The virus did not appear to replicate at all in their guts or salivary glands, and very few virus particles were found there. Instead, the virus had spread throughout bees' bodies and replicated particularly well in their wings, nerves, antennae, trachea, and blood (technically, hemolymph). Ominously, it seemed to especially favor nervous tissue. Far from being a polite and unobtrusive guest, it looked like the virus had picked the front door lock, raided the fridge and keg, and called to start the cable TV.

But the news for bees got worse. When the scientists looked inside the mites *Varroa destructor*, which have been implicated in colony collapse disorder and make a living as a nasty tick-like parasite of bees (if ticks were the size of dinner plates), their guts were full of tobacco ringspot virus. As with ticks, *Varroa* mites sap their hosts' energy and are known to spread disease. But unlike the bees, the mites' tobacco ringspot infections were limited to their gut, vastly decreasing the possibility of a silver lining in which the virus preyed on bee parasites as well as bees.

To see what the viruses themselves might reveal about what had happened, the scientists compared tobacco ringspot genes from plants, bees, and mites. The viruses in bees and mites were closely related, implying the mites picked up the virus from the bees, and that they both came by their virus via a common ancestor — a single ill-starred encounter between a particular bee and a particular grain of pollen, perhaps. Moreover, bee pollen stashed in the hive — that “bee bread” stuff mentioned earlier — was contaminated with the same strain.

But the presence of virus alone throughout bee bodies doesn’t reveal whether the virus is causing harm. So the scientists sampled six strong and four weak hives of bees over the course of a year in order to see whether tobacco ringspot might be having any deleterious effects on its new mobile home. They looked for that virus and a variety of other viruses implicated in colony collapse disorder — among them, Deformed Wing Bee Virus (DWV), Black Queen Cell Virus (BQCV), and Israel Acute Paralysis Virus (IAPV). Indeed, higher concentrations of tobacco ringspot and these other viruses seemed to presage colony collapse.

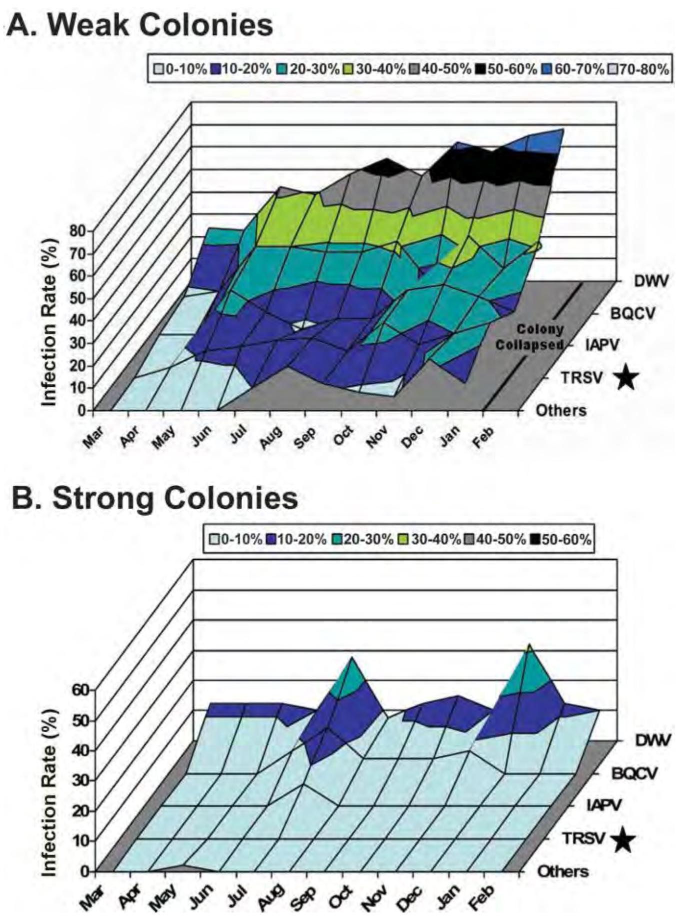

Figure – High virus levels associated with weak and collapsing colonies (from Li *et al.*, 2014).

Many other unknowns remain. The team doesn’t know if the virus can persist in bees without frequent re-introduction from pollen. They also don’t know if the bees can give the virus back to uninfected plants. And of course, whether these suspicious viruses are jointly the cause of collapse, a symptom of some other underlying malady (weakened bees may be more prone to viral infection), or both, remains difficult to say. The story of colony collapse disorder remains unfinished.

It’s worth reflecting on why this particular viral invasion is so remarkable. A virus wishing to conquer any new host — much less one separated from the established host by more than a billion years of evolution — must overcome several substantial obstacles. It must encounter the new host. Its coat proteins must evolve such that they permit it to gain entry to hosts’ cells, although a change to one or a few protein subunits called amino acids may be enough to get the job done. Then, the virus’s genome must evolve to let it evade its new host’s immune system and hijack its cellular replication machinery. Finally, the virus must find a way to spread from one new host to another. It’s a tall order, and that tobacco ringspot appears to have accomplished it all seems extraordinary.

According to the authors of this study, this is the first evidence that honeybees can be infected by plant-virus contaminated pollen, but it might not have been the first or last. About 5% of plant viruses are pollen-borne. The genetic material of most? RNA.

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Originally printed in Scientific American, Blogs, January 31, 2014

Honey Bees Threatened by Pesticide Cocktails during Pollination Service

By Jeff Harris

The honey bee is the most important managed agricultural pollinator throughout growing regions of the world. Many crops (e.g. almonds) totally depend on managed honey bee colonies for pollination to produce food, while other commodities (blueberries, citrus, cranberries, cherries, melons, etc.) yield more and better fruit after pollination by honey bees. In 2000 it was estimated that approximately one third ($14.5 billion) of all agricultural production ($47.1 billion) in the United States could be tied to pollination by honey bees.

Honey bee health has become a primary focus of researchers in response to several episodes in which commercial colonies were lost in unusually high numbers in the U.S. and Canada. Although not fully understood, high bee mortality in some years stemmed from multiple factors that include the parasitic mite *Varroa destructor* Anderson & Trueman, viruses vectored to bees by *Varroa*, residues of agrochemicals in hives, and poor nutrition. *Varroa* and the viruses it vectors are viewed as the primary killers of bees worldwide, and indirectly, the acaricides used to control *Varroa* become an additional threat as they become chemical residues in combs. Additionally, honey bee health is significantly impacted by interactions of some agrochemical residues in combs with acaricides used by beekeepers to control *Varroa.*

The possible effects of agrochemicals on bee physiology are important to beekeepers in Mississippi, a state with agriculture as a primary economic driver. By the very nature of their foraging behavior, honey bees collect agro-chemicals when gathering pollen and nectar from flowers or extra-floral nectaries of plants. These agrochemicals include fungicides, herbicides or insecticides that are applied directly to flowers, or they may include systemic insecticides that move throughout plant tissue into the nectar and/or pollen. The average number of agrochemicals found in pollen loads of returning forager bees that were sampled from sentinel colonies in a Cooperative Area Project (CAP) was 7.1.

Typically, agrochemicals are lipophilic and tend to accumulate in the beeswax of combs over time. A major route for introducing chemicals into hives involves beekeeper applications of insecticides to control *Varroa* mites. Recent investigations indicated that >160 agrochemicals could be found in combs that were sampled from various regions of the U.S., and the most frequently encountered chemicals, and those with the highest concentrations in combs, were applied by beekeepers to control parasitic mites.

The occurrence of agrochemical residues in comb has been documented, but the long term consequences of chemical residues on colony health remain largely unknown. The previously mentioned CAP study could not associate bee kills to higher levels of residues in hives, and only a weak association could be found between residues and queen supercedure rates. The relationship between queen supercedure and chemical residues deserves further investigation because of recent beekeeper complaints of increasing supercedure rates in commercially produced queens. Perhaps there is a greater effect of residues during metamorphic development of queens than when adult queens are exposed to residues when laying eggs.

Although there are few reports directly relating chemicals in comb to bee health, a recent study showed that the lifespan of worker honey bees was reduced by 4 days after exposure to chemical residues in the combs where they were raised and experienced metamorphic development. Although 4 days seems relatively short, such a reduction in lifespan could have a profound effect on task allocation within a colony. Young workers may precociously forage in response to loss of the older foragers sooner than normal which could create a ripple effect in the age demography of the workers and cause adverse changes in normal colony functions.

The research into the effects of pesticides is complicated by the fact that foragers are actually returning to the hive with pollen loads laced with more than one type of chemical: insecticides, herbicides and fungicides. In one study, it was found that the combination of certain types of insecticides or specific insecticides with common fungicides led to an increased susceptibility of honey bees to *Nosema* spp. The authors found that dwindling colonies often had these agro-chemical cocktails in field-collected pollen while bees were being used for managed pollination on various crops (almonds, apples, blueberries, cranberries, cucumber, watermelon and pumpkin). The major conclusion was that the contaminated pollen had reduced the immune response in bees, which made them more susceptible to *Nosema* infection. The significance of the study is that field relevant levels of agro-chemical mixtures in pollen were associated with dwindling and collapsing colonies.

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Buy or Sell

Beekeeping Workshop: Basic beekeeping presented by the Baldwin County Beekeepers Association; PZK Civic Hall, 17833 HWY 104, Robertsdale, AL. Pre-registration fee is $40 per person or $45 per family ($5 extra for registration at the door); for more information, contact Roger by phone (251-233-0168) or email (BemisRoger@hotmail.com).

Queen Rearing Workshop: How to raise queens, mark & clip queens, and how to make splits. 9 AM – 4PM, Saturday, March 29, 2014 at the Foley Library, AL. $75 registration fee; for more information, contact Roger by phone (251-233-0168) or email (BemisRoger@hotmail.com).

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