Health of honey bees adversely impacted by selenium

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UC Riverside's Kristen Hladun is shown here looking for the honey bee queen on a hive frame. Credit: Trumble Lab, UC Riverside.

Traditionally, honey bee research has focused on environmental stressors such as pesticides, pathogens and diseases. Now a research team led by entomologists at the University of California, Riverside has published a study that focuses on an anthropogenic pollutant: selenium (Se).

The researchers found that the four main forms of Se in plants—selenate, selenite, methylselenocysteine and selenocystine—cause mortality and delays in development in the honey bee.

"Metal pollutants like selenium contaminate soil, water, can be accumulated in plants, and can even be atmospherically deposited on the hive itself," said Kristen Hladun, the lead author of the study and a postdoctoral entomologist. "Our study examined the toxic effects of selenium at multiple life stages of the honey bee in order to mimic the chronic exposure this insect may face when foraging in a contaminated area."

Study results appear in the Oct. 2013 issue of the journal *Environmental Toxicology and Chemistry*.

The honey bee is an important agricultural pollinator in the United States and throughout the world. In areas of Se contamination, honey bees may be at risk because of the biotransfer of the metal from Se-accumulating plants.

Se contamination is a global problem originating from naturally contaminated soils and a multitude of anthropogenic sources including mining and industrial activities such as petroleum refining and coal-power production, as well as where agricultural runoff is collected and can concentrate selenium from the surrounding soils.

Low Se concentrations are beneficial to many animals; in particular, it is a critical component of an antioxidant enzyme. Slightly higher concentrations, however, are toxic. Several insect species suffer toxic effects from feeding on Se-contaminated food.

In the case of the honey bee, Se enters the body through ingestion of

contaminated pollen and nectar. Organic forms of Se can alter protein conformation and cause developmental problems, and inorganic forms of Se can cause oxidative stress.

This is a 24-well plate containing honey bee larvae and pupae at various stages of development. Credit: Trumble Lab, UC Riverside.

"It is not clear how selenium damages the insect's internal organs, or if the bee has the ability to detoxify these compounds at all," Hladun said. "Further research is necessary to examine the cellular and physiological effects of selenium."

Hladun explained that honey bees may also be more susceptible than other insects due to a lack of detoxification enzymes that other insects still possess. Further, honey bees at the larval stage are more susceptible to selenium relative to other insect species.

"Mortality within the hive can reduce the number of workers and foragers overall," she said. "The forager's ability to tolerate high concentrations of selenium may act against the colony as a whole. Honey bees are social animals and their first line of defense against environmental stressors is the foraging bees themselves. High concentrations of Se will not kill foragers outright, so they can continue to collect contaminated pollen and nectar, which will be stored and distributed throughout the colony."

Besides areas surrounding coal-fired power plants, petroleum refineries, copper refineries, and mining activities, areas around industrial plants producing glass, pigments, inks, and lubricants, can all be anthropogenic sources of Se. In the United States, the well-established toxicity of Se to wildlife and humans has resulted in this element being regulated by the Toxic Substances Control Act and the Clean Water Act.

"Selenium occurs naturally in many places around the world, but it also is a byproduct of many industrial activities, and finding ways of recovering and recycling it is key to minimizing the damage to the environment," Hladun said. "Currently, researchers are exploring its use in solar energy technologies."

According to Hladun, knowing which contaminants are the most important to regulate is key to minimizing the exposure of honey bee hives to contaminants.

"Beekeepers can take steps to prevent bees from foraging during flowering periods of plants that have exceptional pollutant levels or to move hives away from contaminated areas," she said. "Also, better management of weedy plant species that are known to be Se-accumulators can prevent them from becoming a route of exposure."

Currently the researchers are conducting experiments feeding honey bee

colonies with Se-laden food. They will monitor the bees for changes in survival and behavior. In addition, they are exploring the effects of other metal pollutants (cadmium, copper, and lead in particular) that have been found in honey bee hives, especially the ones located near urban or industrial areas.

Provided by University of California - Riverside