Large Hive Beetle: A potential new pest of honeybees in Kenya

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Abstract: Substantial decline in the abundance and diversity of pollinators have been reported worldwide. Loss of pollinators has serious consequences for both biodiversity and crop productivity. Pollinators are essential or beneficial for the production of many crop species and also important for reproduction of more than 65% of the world's wild plants. The drivers implicated in honeybee colony losses in Europe and North America have been reported in Kenya, including pathogens, parasites and pesticides. The recent declines in honeybee populations and demand for sustainable pollination to ensure food security have resulted in increased awareness of the need to protect honeybee populations especially in Africa. In many areas of the world where it is managed, the honeybee (*Apis mellifera*) has been plagued by diseases, pests and parasites. The presence of Large Hive Beetle (LHB) in Kenya honeybee colonies has raised concern as affecting honeybee colony performance and productivity. On-going research is aimed at determining their seasonal occurrence; effect on colony performance (comb, brood, pollen and nectar area and colony weights); colony productivity and effectiveness of low-tech control strategies such as reduction of hive entrance sizes. This will be the first report of heavy large hive beetle infestation in *Apis mellifera scutellata* in Chawia Taita Hills, Kenya and the potential to affect colony productivity through interaction with other factors such as pathogens, pesticides, varroa mites and nutritional stress.

Key words: Honeybee, performance, colony, Large hive beetle

Background: Pollinators are essential contributors to global nutrition and food security. An estimated three quarter of major global food crops benefit from pollination (Klein *et al.,* 2007). Fruits, vegetables and nuts, which provide key vitamins, minerals, fats and other micro-nutrients are particularly dependent on pollination (Eilers *et al*.,2011), and thus pollinators form a crucial line of defense against micro-nutrients deficiencies in developing countries. Furthermore, the productivity of many high value crops grown in coffee, and cashew nuts is strongly tied to pollination services (Gallai *et al.,* 2009). Indeed, the amount of animal pollinated crops grown globally has increased significantly in the last fifty years (Roubbik and Harder, 2009), making both developed and developing world countries increasingly depend on pollinator populations for food security and production of economically important crops.

Through pollination of cultivated and wild flowering crops, honeybee *Apis mellifera* L., provide essential ecosystem services (Kremlin *et al.,*2007) that ensure sustained food production, ecosystem stability and opportunities for income generation and habitat conservation for rural poor communities through sale of bee products such as honey, propolis and wax (Sande *et al.,*2009; Raina *et al.,* 2011). The value of pollination of food production is estimated at €153 Billion globally and €11.9 Billion in Africa (Gallai *et al.,* 2009). These values are based on the services rendered by managed honeybee colonies (responsible for 80-85% of pollination in commercial farm plots), and as a result underestimates the real value of honeybees (Allsopp *et al.,* 2008).

Valuation of honeybee pollination to crop yields reveal: $US 238.9 Billion worldwide (Gallai *et al.,* 2009). Earlier valuation had revealed $US 312 Million in the United Kingdom, 1998, $US 0.78 Billion in Canada, in 1998, $US 14.6 Billion in USA, in the year 2000 and $US 2.4 Billion in Australia. Globally, pollination services amount to £212 Billion, corresponding to 9.5% of the total value of the world agriculture production for human consumption in 2005 (Gallai *et al.,* 2009). Table: (Economic impact of insect pollination of the world agricultural production) Honeybees, *Apis mellifera,* are one of the most important pollinators worldwide, contributing to $14,6 Billion in pollination services to the US in 2000 (Morse and Caldrone, 2000) and $ 3.2 Billion to the South African economy in 1998 (Allsopp, 2004). However, honeybee population has been in decline in North America and Europe over the last 30 years, with beekeepers routinely losing 30% of their managed colonies every winter during the last seven years (vanEngelsdorp and Meixner, 2010).

Recently honeybee populations have been reported to be on decline in most parts of the world (Granberg *et al.,* 2013; Ellis *et al.,* 2010; Potts *et al.,* 2010). The decline has been characterized by sudden loss of worker bees from colonies without sign of dead or diseased bees, despite presence of abundant breeding cells, pollen and honey (Le Conte *et al.,* 2010). The decline has been attributed to interaction of multiple factors (Anderson and East, 2008), including both environmental and human induced (Moritz *et al.,* 2010). Among the factors are pests and diseases, poor nutrition, hive management and incidental pesticides exposure (Vanbergen, 2013; Potts *et al.,* 2010; Johnson *et al.,* 2009).

The known bee parasites and bee diseases include Varroa mites (*Varroa spp),* Tropilaelaps mite (*Tropilaelaps spp),* tracheal mite (*Acarapi woodi)*, and bee louse (*Braula spp). Aspergillus spp,* American foulbrood (*Bacillus larvae*), European foulbrood (*Melissoccocus plutonius*) and protozoan *Nosema spp.* Bee mites play a major role in the spread of bee pathogens exacerbated by human movement of bees for pollination and trade (Sammataro *et al.,* 2000). A number of viruses have been associated with varroa mites (*V. destructor*) at varying degrees. The mite weakens bee's immune system triggering viral multiplication leading to death (Le Conte *et al*., 2010; Rosenkranz *et al*., 2010). Varroa mites have also been shown to transmit bee bacteria through feeding bites.

Although presumed free of sudden honeybee losses, pests and diseases associated with Colony Collapse Disorder (CCD) have been reported on the African continent over the last decade (Hussein, 2000; Frazier *et al.,*2010; Kijobe *et al.,* 2010; Strauss *et al.,* 2013), suggesting that a closer examination of possible existence of CCD in Africa is warranted. Despite claims of a decline in honeybee populations on the continent (Neumann &Carreck, 2010; Kluser *et al.,* 2011), these changes appear inconspicuous compared to those in Europe and North America (Neumann & Carreck, 2010). This scenario has been attributed to greater resilience of Africa honeybee towards pests and diseases compared to their European counterparts (Tarpy,2003) and paucity of information through insufficient surveys (Dietemann *et al.,*2009). The observation of colony decimation and death due to Varroa mites and diseases on the Island of Madagascar (OIE, 2010; Rasolofoarivao *et al.,* 2013) points to the probable existence of isolated and undocumented cases of CCD on the continent. More so, the presence of Varroa has been confirmed in many countries in

Africa (Dietemann *et al.,* 2009; Frazier *et al.,* 2010; Rasolofoarivao *et al.,* 2013), clearly suggests that the health status of the continent's main pollination resources is under threat and therefore urgent and extensive health surveys are needed. Furthermore, a recent study on presence of the large hive beetle (LHB) found in various parts of Kenya and their damage on honeybee combs under laboratory observations indicated the need for further study on its long term effect in the performance and productivity of honeybee colonies in the country.

In East Africa, honeybees provide critical pollination services, nutrition and income for small holder farmers and rural families. There is considerable genetic diversity in *Apis mellifera* populations in this region: indeed, five distinct *Apis mellifera* subspecies, each adapted to a specific ecological niche, have been identified in Kenya and in the surrounding region (Meixner *et al.,* 2011; Whitfield *et al.,* 2006). These bee populations are unmanaged: typically beekeepers set out empty receptacles (traditionally, hollowed-out logs) and bee's swarms will occupy them as they migrate into the area (Crane E, 1999; Mbae R. M, 1999). In western Kenya, pollinators provide $US 3.2 Million in ecosystems services to eight crops (beans, cowpeas, butternuts, sunflower, monkey nut, tomatoes, capsicum and passion fruits (Mbae, 1999). Furthermore, the honey collected from these colonies serve as an important source of nutrition and income for families.

Table: Economic impacts of insect pollination of the world agricultural production used directly for human food and listed by the main categories ranked by their rate of vulnerability to pollinator loss.

Crop category	Average value of a production unit	Total production Economic Value(EV)	Insect pollination Economic value(IPE)	Rate of Vulnerability (IPEV/EV)
	€ per MT	10^9€	10^9€	%
Stimulant crops	1225	19	7.0	39.0
Nuts	1269	13	4.2	31.0
Fruits	452	219	50.6	23.1
Edible oil crops	385	240	39.0	16.3
Vegetables	468	418	50.9	12.2
Pulse	515	24	1.0	4.3
Spices	1003	7	0.2	2.7
Cereals	139	312	0.0	0.0
Sugar crops	177	268	0.0	0.0
Roots & tubers	137	98	0.0	0.0
All categories		1618	152.8	9.5

Source: Gallai *et al.,* 2009.

Large hive beetle: Surveys in Kenya have established the main arthropod pests associated with honey bees to be small hive beetles, *Aethina tumida* (Coleoptera: Nitidulidae); *Oplostomus haroldi* and *Oplostomus fuligineus* (Coleoptera: Scarabaeidae) and the ecto-parasitic mite, *Varroa destructor* (Frazier *et al*. 2010; Torto *et al*. 2010). The occurrence, genetic diversity and damage caused by scarab beetles under laboratory conditions in Kenya have been reported (Ayuka *et al*. 2012). Two large hive beetle species, *O. haroldi* and *O. fuligineus* have been found in specific non-overlapping areas; *O. fuligineus* occurred mainly in the semi-arid eastern areas while *O. haroldi* occurred predominantly within the coastal and highland areas of Kenya (Torto *et al*. 2010; Ayuka *et al*. 2012). Large hive beetle feeding resulted in a characteristic damage pattern consisting of either small (1 – 3 cells) and large (> 5 cells) clusters of damaged cells. Small cells damage was derived from feeding on a fourth or fifth instar larva or pupa across neighbouring cells, while large clusters resulted from either burrowing into single cell containing second or third instar larva or capped pupal cell. Large hive beetles consumed more brood compared to honey and pollen (Ayuka *et al.* 2012). More recently, December 2017,

beekeepers have reported an unexpected surge in the number of large hive beetles in honey bee colonies in Taita Hills, a range of coastal highlands in Kenya.
A follow up rapid survey established that colonies where harboring high numbers of large hive beetles. We sampled four apiary sites in Chawia Forest, Taita Hills (GPS coordinates 3.48° S 38.35° E, 0328′38″ S38°21′351° E, Elev.1347 m.a.s.l) and randomly inspected one colony in each apiary site. Large hive beetles numbers were 460; 112; 65 and 72 in each of the colonies inspected in the four apiaries respectively. The two beekeepers owning the apiaries reported to have lost 48 colonies due to absconding presumably caused by the high numbers of beetles. A Sugar roll test established that the colonies did not have detectable varroa mite infestations (zero count).

Beekeepers are managing the beetles by physically removing the beetles during periodical colony inspections and crashing the beetles to death. Collected beetle specimens were confirmed to be *O. haroldi* and *O. fuligineus* by comparing with specimens at the International Center for Insect Physiology and Ecology (Icipe) museum.

On-going research is aimed at determining their seasonal occurrence; effect on colony performance (comb, brood, pollen and nectar area and colony weights); colony productivity and effectiveness of low-tech control strategies such as reduction of hive entrance sizes.

We provide the first report of heavy large hive beetle infestation in *A. m. scutelatta* in Taita Hills, Kenya. Of importance is the potential to affect colony productivity through interaction with other factors such as varroa mites, pesticides, pathogens and nutritional stress.

Figure 1. Honeybee comb (*A. scutellata colony)* with open and capped brood heavily infested with *O. haroldi* and *O. fuligineus* in Chawia, Taita Hills.

Figure 2. Pattern of damage for *Oplostomus species* showing frame section of capped cells destroyed by infestation of the beetle. The Large Hive Beetles feed on the brood leaving comb partly damaged.

Figure 3. Adult large hive beetle (*Oplostomus fuligineus)* forcing its way to the modified beehive entrance. (Photo: B. Wambua 2018).

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