# 12.4 Understanding the Ecology and Impact of Parasitoids of the Whitefly (*Bemisia tabaci* Complex: Aleyrodidae) in Cassava Landscapes of East Africa

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Over the last 20 years there has been an increase in outbreaks of the whitefly pest complex, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), in cassava production landscapes in East Africa. This species complex transmits plant viruses that have caused widespread damage to cassava, a staple food in many households. In addition to plant disease symptoms, *Bemisia tabaci* populations, when they reach very high numbers, cause damage from direct feeding and excreting sugar-rich exudate; this encourages sooty mold on the leaf surface, reduces photosynthesis and causes further yield losses. Whilst significant effort has gone into developing virus-resistant cultivars, less attention has been paid to the management of natural enemies of *B. tabaci* that may provide biocontrol services. Furthermore, the role that naturally occurring parasitoids play in preventing or dampening outbreaks is unclear (Fig. 12.4.1).

A comprehensive picture of the common parasitoid species that cause significant mortality to *B. tabaci* species found on cassava is not available. This is partly due to recent (and ongoing) molecular clarification of the phylogeny of the *B. tabaci* species complex (De Barro *et al.,* 2011) and unexplored parasitoid species diversity in East Africa. A list of the parasitoids attacking the *Bemisia* genus in Sub-Saharan Africa included eight or more species, with *Eretmocerus mundus* Mercet (Hymenoptera: Aphelinidae) and *Encarsia sophia* Girault (Hymenoptera: Aphelinidae) and Dodd being the most often recorded (Legg *et al.*, 2003). More recent surveys of *B. tabaci* parasitoids in cassava in Tanzania found 10 species of parasitoids (Guastella *et al.*, 2015). Given that there are likely to be more parasitoid species present than currently recognized, we urgently need to use both morphological and molecular techniques to identify the parasitoid species diversity in this region and to determine the most numerically common species in order to focus future research on harnessing their naturally occurring biocontrol services.

Hoelmer (1995) summarized several papers that suggested that parasitoids may be insufficient to control *B. tabaci* without other control methods. Similarly, in cotton systems in America, predation was found to be the key factor determining intergenerational variation in mortality. Parasitism was considered the factor contributing least to marginal mortality of immature *B. tabaci* on cotton (other factors such as dislodgement were greater) (Naranjo and Ellsworth, 2009). However, in other systems parasitoids do play an important role. *Eretmocerus hayati* was introduced into Australia and in combination with the careful use of pesticides has improved the level of control of *B. tabaci* Middle East-Asia Minor 1 (MEAM1, formerly called the B biotype) in vegetable systems (Villanueva-Jimenez *et al.*, 2012). Furthermore, there are management strategies that could be used to increase the abundance or activity of parasitoids that have not yet been explored for East African cassava production landscapes.

**Fig. 12.4.1.** Parasitized nymphs of *Bemisia tabaci* on the underside of a cassava leaf, which have a black colouration. Two non-parasitized *B. tabaci* adults can also be seen in the process of emerging. (Photo credit: CSIRO).

A small amount of research has been completed to quantify the impact of parasitoids on *B. tabaci* on cassava. In Uganda, *Eretmocerus mundus* and *Encarsia sophia* were responsible for 34% parasitism of fourth instar nymphs (Legg, 1995). Percent parasitism was recorded as <20%, and on three occasions <50%. However, there was a negative relationship between parasitism rate and nymph numbers indicating that these parasitoids may not respond in a density dependent manner (Otim *et al.*, 2006). Life history studies conducted under field conditions showed that parasitism caused the highest mortality to fourth instar nymphs, but dislodgement was the key mortality factor for eggs (Asiimwe *et al.*, 2007). Survey data from four regions in Uganda showed that parasitism rate on field-collected nymphs was 40-58% (Otim *et al.*, 2005).

There has been little research to understand how different cassava cultivars might influence the activities of natural enemies of *B. tabaci*. Across East Africa there is a large diversity of local cultivars, including those that have been bred to possess a range of tolerance or resistance to viruses. However, a comprehensive understanding of how the traits of each cultivar impacts higher trophic levels is unknown. Otim *et al.* (2008)

conducted some research to look for cultivar effects on parasitoids, using a comparison between a glabrous and hirsute cultivar. Leaf hairiness in one cultivar caused some changes in parasitoid behaviour, but did not reduce parasitism.

Given the long growing season of cassava and the low level of pesticide use by East African smallholder farmers, the use of parasitoids in combination with other approaches to control *B. tabaci* in cassava is worth exploring further. We conducted a broad survey of the spatial patterns of activity of parasitoids from cassava growing regions in Uganda, Tanzania and Malawi. We discuss the information needed to assess impact in terms of potential for biocontrol of *B. tabaci*. Developing biocontrol options for farmers involving both predators and parasitoids will be important elements of future management strategies that address the *B. tabaci* problem in East Africa.

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