Two invasive whiteflies (Hemiptera: Aleyrodidae) to Tanzania

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Two invasive whiteflies (Hemiptera: Aleyrodidae), Aleurotrachelus trachoides Back and Aleurotrachelus atratus Hempel, are recorded for the first time in Tanzania. These species were found colonising sweet potato (Ipomoea batatas L.) in a screenhouse at Kibaha Research Station in the Coast Region of Tanzania and a palm (Areaceae) in Arusha, Tanzania, respectively.

The enormous increase in the volume, diversity and swiftness of movement of plant products throughout the world has led to a proliferation and dissemination of invasive species, particularly ones closely associated with plants, such as scale insects and whiteflies. Two Neotropical whitefly species, Aleurotrachelus trachoides Back and Aleurotrachelus atratus Hempel have been rapidly extending their range to other regions of the world (Borowiec et al. 2010; EPPO 2016). This is the first report of their occurrence in Tanzania.

Whiteflies (Hemiptera, Aleyrodidae) are represented by more than 1560 nominal species (Hodges & Evans 2005; Evans 2008). Some of these species are economically important pests that cause damage to crops directly through their feeding on phloem sap (Byrne & Bellows 1991; Bellotti & Arias 2001; Morales & Anderson 2001) which may result in greater than 50 % yield reduction in affected crops. In addition, whiteflies excrete honeydew, which leads to the proliferation of sooty mould fungi, discolouring and reducing the quality of food and fibre plants. However, certain species, especially those within the Bemisia tabaci complex, may cause enormous crop losses through the transmission of plant viruses (Gilbertson et al. 2015) and are perhaps the most economically important pests on a wide range of crops.

The genus Aleurotrachelus is worldwide in distribution and consists of approximately 71 nominal species; of these, 12 are known to occur in the Afrotropical Region (Evans 2008) although only two species have been reported in Tanzania: Aleurotrachelus marginatus (Newstead) reported on a forest tree by Newstead (1911) and Aleurotrachelus tuberculosis Singh reported on guava (Psidium guajava L.) in Tanzania in 2014 (Evans 2008; Guastella et al. 2014).

Back (1912) described the pepper whitefly, Aleurotrachelus trachoides Back (Hemiptera: Aleyrodidae), on Brazilian nightshade (Solanum seaforthianum Andr) in Cuba. Since then, it has spread through most of the Neotropical Region, many of the southern U.S. States, and more recently to the Afrotropical (Gambia, Mozambique, Nigeria), Malagasy (Réunion), Oriental (India), Austro-Oriental (Malaysia) and Pacific Islands (Fiji, French Polynesia, Guam, Hawaii, Kosrae, Micronesia, Tahiti) regions (Evans 2008; EPPO 2015; Oyelade & Ayansola 2015; Kumar et al. 2016). Although not known to vector any plant viruses, A. trachoides can cause economic damage as its population can increase rapidly, especially in areas where it is removed from its natural enemies. This species has been found on over 34 different plant families but is most common on solanaceous plants and Chamaedorea palms. It has potential to spread around the world through movement of infested plants as indicated by numerous interceptions of the species at US ports of entry (Evans 2008). No published records are known of its presence in the East African region; however, it was intercepted at a U.S. port of entry on Ipomoea batatas from the Democratic Republic of Congo on 17 March 2013.

In June of 2016, large colonies of A. trachoides...
were discovered on the leaves of sweet potatoes (*Ipomoea batatas* L.) grown in a screenhouse at Kibaha Research Station in the Coast Region of Tanzania; this represents the first record of its occurrence in Tanzania. Routine monitoring of insect pests on crops rarely occurs in Tanzania, so it is not possible to determine when the whitefly first arrived in the country. A recent study by Guastella *et al.* (2014) reported two new whitefly species, *Aleurotrachelus tuberculatus* Singh and *Aleuroclava psidi* Singh, in Tanzania, but it could not be determined when these species entered the country for the same reason.

Whiteflies were observed colonising sweet potato plants growing in a screenhouse at Kibaha Research Station, coastal Tanzania (6.77838°S 38.97263°E, 179 m a.s.l). A colony was established on sweet potato in the screenhouse at IITA-Tanzania in Dar es Salaam (Fig. 1A, B). The species was identified by one of us (G.A.E.) as *Aleurotrachelus trachoides*, an invasive whitefly to the region. A survey was conducted around the Kigamboni area in Dar es Salaam and within the Kibaha, Kisarawe and Mkuranga districts in the Coast Region of Tanzania to determine if *A. trachoides* was present in the environment (outside the screenhouse). Plants selected for sampling included some of the known or potential hosts of *A. trachoides* such as sweet potato, spinach, eggplant, okra and morning glory. These plants were found to be free of *A. trachoides* and any other whiteflies.

1. **Morphological identification of *A. trachoides***: Adult and immature (puparia) specimens of the whitefly were sent to G.A.E., who identified them as *Aleurotrachelus trachoides*. *Aleurotrachelus* is a very large genus (71 species) and can be difficult to identify to species because no comprehensive key to the species has been published. However, this species can be identified with a high degree of certainty based on a combination of distinct characters given in the identification key below and in Figs 2, 3 and 4.

*Aleurotrachelus atratus* (Hempel) was described by Hempel in 1922 after it was found occurring on coconut (*Cocos nucifera*) in Bahia, Brazil. Currently it is known to occur throughout the Neotropical Region (U.S.A.), Western Palearctic (Canary Islands), and Afrotropical (São Tome, St. Helena, Uganda), Malagasy (Comoros Islands, Seychelles) and Pacific islands (Guam, Hawaii, Samoa). It is often found on palms (Arecaceae) but has been found on a wide range of other hosts (Borowiec *et al.* (2010). One of us (G.A.E.) found it on a palm surrounding the freedom monument in Arusha, Tanzania, in February 2016. This is the first record of the species to have been collected in Tanzania; it was intercepted at a U.S. port of entry, 19 August 2014, on *Phoenix* sp. from Tanzania.

**Key to *Aleurotrachelus* species in Tanzania**

1. Lateral margin teeth with acute apices; body entirely black; ex. tree.  
2. Marginal area as dark as rest of body; marginal teeth separated, with converging subtruncate or rounded apices, each one with serrated margins; body elongate oval; lingula apex rounded, not bilobed; T3 very long, extending beyond

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**Fig. 1.** *Aleurotrachelus trachoides* adults and puparia on sweet potato leaf (A, B) and adult on pepper *Capsicum annuum* L. (C). Fig. 1C has been used with permission from Vivek Kumar.
A2; A8 long, much longer than vasiform orifice; caudal setae very long and set on tubercles; C1 apparently absent; clusters of round dots present on head near C1 and on lateral margin of abdominal segments; submarginal area with rows of flat, elongate granules of subequal size; anteromedial part of A1 granulose widespread mostly on palm . . . . atratus (Hempel)

Marginal area yellow, in sharp contrast to rest of dark body; marginal teeth parallel-sided with rounded apices and without small teeth on the sides of each tooth; body oval, not as narrow as atratus; lingula apex bilobed (forked); T3 short to medium in length, A8 and caudal setae short to medium about 2 as long as vasiform orifice or less; submarginal area with rows of flat, elongate granules of subequal size; anteromedial part of A1 granulose; widespread on many hosts . . . . . . . . trachoides (Back)

2. Molecular identification of A. trachoides: DNA was extracted separately from 10 individual whiteflies obtained from the culture established from whiteflies sampled from the sweet potato at Kibaha Research Station. Polymerase chain reaction (PCR) was carried out to amplify a ~575 bp portion of the mitochondrial DNA cytochrome oxidase I (mtCOI) gene using primers (TTACTGTTGGGATAGATGTGGA - F and AACCAGAAGAAAGACTCTAAA - R). The PCR product was directly sequenced at Macrogen, U.S.A. The sequences were edited and assembled using CLC Bio WorkBench 6.6 (Qiagen, U.S.A.). The phylogenetic tree was assembled using MEGA 6.06 using the maximum likelihood procedure on default settings and with 1000 bootstraps.

MtCOI sequences obtained were blasted
(BLASTn) on GenBank, and the closest matches found were for *Aleurocanthus woglumi* – JX281760 and *Aleurotrachellus camelliae* – AB536801. In both cases, however, the level of homology was less than 80 %, indicating that our sequences represented a different species. These two related sequences were used as outgroups in the construction of maximum likelihood phylogenetic tree (Fig. 5). There are two *Aleurotrachelus trachoides* sequences in the GenBank database (KF059957;
KM459443 (~500 bp mtCOI), but the failure of these to match with those from this study is probably because they are from a different part of the mtCOI gene. KF059957 was collected from sweet potato, while the host of KM459443 is not reported. The whiteflies from the current study were subsequently identified taxonomically by the junior author as *Aleurotrachelus trachoides*.

There is limited knowledge on diversity of whiteflies in Africa. Most of what is known is based on Cohnic’s work in West Africa (1968, 1969) and Bink-Moennen’s (1983) work in Chad. The only recent study is by Oyelade & Ayansola (2015) who reported 35 whitefly species collected from crops and ornamental plants in southwestern Nigeria. Most surveys have been restricted to food crops such as cassava (Legg et al. 2014). Recently, two whitefly species *Aleurotrachelus tuberculatus* Singh (Tanzania) and *Aleuroclava psidii* Singh (Tanzania and Egypt) were recorded for the first time in Africa (Abd-Rabou & Evans 2014; Guastella et al. 2014). Previously, the spiralling whitefly *Aleurodicus dispersus* Russell, a widespread, polyphagous whitefly species, was also collected on guava (Guastella et al. 2014). This species was introduced to Tanzania in 2003 from a putative Asian origin. This fact, coupled with the new introductions reported here, suggests that a pathway exists for

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**Fig. 4.** *Aleurotrachelus atratus* puparium. **A**, Habitus; **B**, lateral margin; **C**, vasiform orifice; **D**, puparia on palm.

**Fig. 5.** Maximum likelihood phylogeny of mtDNA COI sequences obtained from *Aleurotrachelus trachoides* sampled from sweet potato at Kibaha, Coast Region, Tanzania, including outgroup sequences (*) from GenBank for comparison.
the importation of exotic insects or noxious pest species from Asia to East Africa. (Guastella et al. 2014). Although it cannot be ascertained when A. trachoides entered Tanzania, its presence on sweet potato at Kibaha is recent, since researchers have been collecting whiteflies from that location for several years and had not previously encountered it. More surveys need to be carried out, especially on screenhouse crops, to determine if this was an isolated incidence or if this particular whitefly is present and widespread in Tanzania and at large in East Africa. The rapid population build up and damage caused to sweet potato due to feeding by this whitefly indicates it could be a potentially serious pest, especially on screenhouse crops.

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