New scale insect country records for Kenya (Hemiptera: Coccomorpha) from old samples in insect collections

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Abstract

Scale insects (*Hemiptera: Sternorrhyncha: Coccomorpha*) are some of the least understood insects, particularly in agriculture, even though they can cause high crop losses. Due to their small size and cryptic habits they are rarely noticed at the onset of an infestation. In Kenya, efforts have been initiated to understand these pests better. Scale insects from Kenya, found in samples between 13 and 107 years old, were studied in the insect collections of the Natural History Museum, London, U.K. and the Kenya Agriculture and Livestock Research Organisation, Nairobi, Kenya. The study identified 51 new country records of scale insects including one new continental record for Africa, *Ferrisia dasylirii* (Cockerell) (*Pseudococcidae*). Of the new records, 35 species (68.6%) are native to Africa and 16 (31.4%) have been introduced from elsewhere. Six of the 51 species (11.8%) are pests in Kenya today. Amongst the introduced species, at least one (*Aonidiella comperei* McKenzie) could cause plant quarantine issues in trade, and four (25.0%) are pests, more than four times the frequency of pests amongst the African species (5.7%). The remaining 45 species have been present in Kenya for at least 13 years and many have not been collected again since the original samples, suggesting that either they have not survived or they

are rare because they are under good natural control. Most of the introduced species listed (75.0%) have not caused economic problems in Kenya to date, so it is thought unlikely that they will do so in the future.

Key words: Scale insects, introduced species, native species

Introduction

Specimens in old insect collections provide evidence of the species that were established in a country or region at a specific date. Review of historic insect collections can reveal new country records and early distribution records of species that have never been recorded in the literature: for example, study of the Wirjati collection in Indonesia (containing material collected 1916-1960) revealed three new Indonesian country records of mealybug species (Sartiami *et al.*, 2016), and study of Takahashi slides from Malaysia (containing material collected 1943-1944) revealed the earliest known Malaysian records of two mealybug species (Sartiami *et al.*, 2017). Such baseline information provides clarification of which non-native species have been accidentally introduced in more recent times (Sartiami *et al.*, 2016, 2017).

As part of the Darwin Initiative-funded project 25-032: "Agriculture and biodiversity: addressing scale insect threats in Kenya", old scale insect slide mounts in two important insect collections were studied. The collection at the Kenya Agriculture and Livestock Research Organisation (KALRO) National Agricultural Research Laboratory (KALRO-NARL) at Kabete, Nairobi, Kenya contains samples mostly collected between 1920 and 1970. Giovani De Lotto worked at this laboratory between 1950 and 1963 (Ben-Dov & Russo, 1991) and greatly enlarged the scale insect slide collection; the 3,597 slides were re-curated and databased during this work. The collection at the Natural History Museum, London, U.K. (NHMUK) contains samples mostly collected between 1910 and 2000, including the type material of many species. Study of Kenyan material in these collections has revealed multiple

unpublished first country records for Kenya and one new continental record for Africa. Here we document these new records, and provide data on recent collections of some of the species as evidence that they are still present in the country.

Materials and methods

Old samples of scale insects on slide-mounts in the KALRO-NARL and NHMUK collections were studied using a Zeiss Axiophot compound light microscope with phase contrast illumination and magnifications of 25x-800x. Species identities were checked using the most recently published identification keys available (listed in Table 1), together with unpublished keys being developed by the first author (GW) as part of the Darwin Initiative project. Specimens were also compared to type material when it was available. To assess which of the species identified had never been recorded from Kenya in the literature, a list compiled from the old collections was compared with a list searched online from the ScaleNet database (García Morales *et al.*, 2016), which is based on the literature, particularly De Lotto's publications.

For each species, collection data are given for the historic samples first, followed by data from recently collected material where available. Species likely to have been introduced from outside continental Africa are marked with an asterisk (*****); those known to be native to Africa are marked with a dagger (**†**). New host-plant records are indicated by **[N]**. Collectors' names are provided where known. Recent samples from the present Darwin Initiative project are represented by slides that will be deposited in both the KALRO-NARL and NHMUK collections. Some recent material will be deposited also in the collections at the National Museums of Kenya, Nairobi, Kenya (NMK); University of Nairobi, Nairobi, Kenya (UoN); and Kenya Plant Health Inspectorate Service, Muguga, Kenya (KEPHIS).

Table 1. References used for identification of scale insect slide mounts from Kenya in the collections at KALRO and NHMUK. The references are in chronological order so that it is evident which is the most up-to-date.

Scale insect family	Identification aid resources
Aclerdidae	Howell & Williams (1976), **Ben-Dov (1977), Gill** (1993), Hodgson & Millar (2002), Miller et al. (2014)
Asterolecaniidae	Russell (1941), **Giliomee** & **Munting (1968),** Howell & Williams (1976), **Kosztarab** & **Kozár** (1988), Williams & Watson (1990), Gill (1993), Kosztarab (1996), **Stumpf & Lambdin (2001, 2006),** Giliomee & Kozár (2008), Miller et al. (2014)
Cerococcidae	Howell & Williams (1976), **Lambdin** & **Kosztarab** (1977), Williams & Watson (1990), Gill (1993), Kosztarab (1996), Miller et al. (2014), Hodgson & Williams (2016)
Coccidae	Hall (1925), **Laing** (1929), De Lotto (1954a, 1955, 1956a, 1956b, 1957a, 1957b, 1958a, 1958b, 1959a, 1960, 1961b, 1962, 1963, 1964b, 1965, 1966a, 1966b, 1966c, 1967b, 1969a, 1970, 1971, 1974a, 1975b, 1978, 1979), Hodgson (1967a, 1994), Howell & Williams (1976), Nakahara & Gill (1985), **Kosztarab** & **Kozár (**1988), Williams & Watson (1990), Gill (1988, 1993), **Kosztarab** (1996), Hodgson & Henderson (2000), Miller et al. (2014), Łagowska & Hodgson (2019)
Conchaspididae	Mamet (1954), Hodgson (1967b), Howell & Williams (1976), **Ben-Dov (1981),** Williams & Watson (1990), **Gill** (1993), Miller et al. (2014)
Dactylopiidae	**Karny** (1972), De Lotto (1974b), Howell & Williams (1976), Williams & Watson (1990), Gill (1993), Miller et al. (2014)
Diaspididae	Ferris (1937, 1938, 1941, 1942), Hall (1946), B**alachowsky** (1956, 1958), Mamet (1958), Williams (1963), Howell & Williams (1976), Tang (1986), **Kosztarab** & **Kozár** (1988), **Ben-Dov** (1988), Williams & Watson (1988a), Danzig (1993), **Gill** (1993, 1997), Kosztarab (1996), Watson (2002), **Miller** & **Davidson (2005),** Miller et al. (2014), Schneider et al. (2019)
Eriococcidae	Howell & Williams (1976), **Kosztarab** & **Kozár** (1988), Williams & Watson (1990), Gill (1993), Kosztarab (1996), **Kozár** et al. (2013), Miller et al. (2014)
Halimococcidae	Stickney (1934), Williams & Watson (1990), Miller et al. (2014)
Kermesidae	Howell & Williams (1976), **Bullington & Kosztarab (1985), Gill** (1993), Miller et al. (2014)
Kerriidae	Howell & Williams (1976), **Varshney (1984, 1990),** Williams & Watson (1990), Gill (1993), Kondo et al. (2011), Miller et al. (2014)

Kuwaniidae	Morrison (1928), De Lotto (1959b), **Gill** (1993), Hodgson & Foldi (2006), Miller et al. (2014)
Lecanodiaspididae	De Lotto (1955), Hodgson (1973), Howell & Williams (1976), Williams & Watson (1990), Gill (1993), Miller et al. (2014)

Table 1: Continued from previus page

Scale insect family	**Identification aid resources**
Margarodidae	Morrison (1928), de Klerk (1982a, 1982b, 1983), Foldi (2005a), Vahedi & Hodgson (2007)
Matsucoccidae	Boratynsky (1952a, 1952b), Gill (1993), Foldi (2005b), Miller et al. (2014)
Micrococcidae	Miller & Williams (1995), Miller et al. (2014)
Monophlebidae	Morrison (1928), De Lotto (1959b), Gill (1993), Kosztarab (1996), **Kosztarab** & **Kozár** (1988), **Unruh & Gullan (2008),** Foldi (2010), Miller et al. (2014)
Ortheziidae	Morrison (1925, 1952), Howell & Williams (1976), **Kosztarab** & **Kozár** (1988), Williams & Watson (1990), Gill (1993), Kosztarab (1996), **Kozár & Konczné Benedicty** (2000, 2001), **Kozár et al.** (2002), Miller & Koz**ár** (2002), **Kozár** (2004), Kondo et al. (2013), Miller et al. (2014)
Phoenicococcidae	Howell & Williams (1976), **Gill** (1993), Miller et al. (2014)
Pseudococcidae	James (1935), Ferris (1950, 1953), **De Lotto** (1954b, 1955, 1957c, 1958c, 1961a, 1964a, 1964c, 1967a, 1969a, 1969b, 1974c, 1975a), Ezzat & McConnell (1956), Williams (1958a, 1958b, 1961, 1970, 1986, 1996, 1998, 2001, 2004), Ezzat (1960, 1962), **Balachowsky & Matile-Ferrero** (1966), McKenzie (1967), **Matile-Ferrero** (1970), Howell & Williams (1976), **Cox** (1987, 1989), **Kosztarab** & **Kozár** (1988), Williams & Watson (1988b), Watson & Cox (1990), **Williams** & **Granara de Willink** (1992), Kosztarab (1996), Williams & Matile-Ferrero (1999, 2005), **Granara de Willink & Szumik (**2007), **Schneider** & **LaPolla (2011),** Miller & Giliomee (2011), Kaydan & Gullan (2012), Miller et al. (2014)
Putoidae	Gill (1993), Miller et al. (2014)
Rhizoecidae	Hambleton (1976), Kosztarab (1996), **Kozár & Konczné Benedicty** (2007), Miller et al. (2014)
Stictococcidae	Richard (1976), Williams et al. (2010), Miller et al. (2014)

Results

The scale insect species below were found in the KALRO-NARL, NHMUK and NMK collections. According to the ScaleNet database (García Morales *et al*., 2016) they have not been recorded from Kenya in the literature before.

Family Coccidae (13 species)

†A wax scale, *Ceroplastes ficus* Newstead: Kenya, Nairobi, National Museums of Kenya, Biodiversity Centre, on shrubs and trees, coll. G.W. Watson, 5.x.1996 (NHMUK).

†A wax scale, *Ceroplastes quadrilineatus* (Newstead): Kenya, Nairobi, on *Ficus* sp., coll. W.J. Hall, 26.iii.1949 (NHMUK).

†A wax scale, *Ceroplastes ?sinoiae* (Hall): Kenya, on *Coffea* sp., coll. H.C. James, [probably in the 1930s] (NHMUK).

†A soft scale, *Ceroplastodes zavattarii* Belio: Kenya: Yatta Plateau, Katangi, on ?Malvaceae, 6.viii.1977, coll. J.H. Martin (NHMUK); Malindi, on *Hoslundia opposita*[N], 20.v.1988, coll. J.H. Martin (NHMUK).

†A soft scale, *Coccus* sp. near ***cajani* (Newstead):** Kenya: Kiambu Co., Kikuyu, on *Acacia mearnsii*, v.1974 (NHMUK); Nairobi County, Waithaka, on *Cajanus* sp., coll. Alice, 19.vi.1977 (NHMUK).

†A soft scale, *Coccus milanjianus* Hodgson: Kenya, Kikuyu, on *Elaeodendron (=Cassine) buchananii*[N], v.1974 (NHMUK).

†A soft scale, *Inglisia theobromae* Newstead: Kenya: Limuru, on *Pelargonium*[N] sp., 16.i.1963, coll. G. De Lotto (NHMUK); Kikuyu, on *Acacia mearnsii*[N], v.1964 (NHMUK); Kikuyu, on *Abutilon* [N] sp., v. 1974 (NHMUK); Nairobi, N.A.L., on cotton, 4.vii.1977, coll. P. Nderi (NHMUK).

†A soft scale, *Lagosinia vayssierei* (Castel-Branco): Kenya, Kisumu, on *Grewia*[N] sp., 23.xi.1953 (NHMUK).

†A soft scale, *Pulvinaria merwei* Joubert: Kenya, Kiambu Co., Ruiru, on *Ipomoea batatas*, 20.viii.1957 (NHMUK).

***Cottony citrus scale, *Pulvinaria polygonata* (Cockerell):** Kenya: Mombasa, on *Mangifera indica*, 10.viii.1958 (NHMUK); Malindi, on *Mangifera indica*, 25.iii.1961, coll. J.F. Graham (NHMUK). **Recent:** Kilifi Co., Mtwapa, KALRO orchard, S 3º 56' 12", E 39º 44' 32", 10 m alt, on *Mangifera indica*, 10.vii.2019, coll. Extension officers (NHMUK, KALRO-NARL); Kwale Co., Lunga Lunga, S 4º 33', E 39º 52', 52 m alt., on *Citrus sinensis*, 28.viii.2019, Michael Githae (UoN). The species originated in southern Asia and is known to be a pest of citrus. In the coastal counties of Kenya it is a pest on citrus, causing serious honeydew and sooty mould fouling of leaves and fruits, impacting fruit quality.

***Urbicola soft scale, *Pulvinaria urbicola* (Cockerell):** Kenya: Kwale, on roots of *Capsicum* sp., 11.vi.1956 (NHMUK); Mombasa, on roots of *Solanum tuberosum*[N], 8.xi.1956 (NHMUK); Mombasa, on *Capsicum* sp., 10.vii.1957 (NHMUK). The species is of unknown origin but probably is not native to Africa; it is polyphagous and can cause significant defoliation of woody hosts. *Pulvinaria urbicola* has a history of damaging native forests on small islands in the Pacific Ocean, particularly if ants are present to attend it (Smith et al., 2004; Peck *et al*., 2014; Neumann *et al*., 2014, 2016).

***Iceplant scale, *Pulvinariella mesembryanthemi* (Vallot):** Kenya, Nairobi, on *Mesembryanthemum* sp., 6.ix.1951 (NHMUK). The insect is native to South Africa; in California in the absence of its natural enemies, it can kill large areas of highway ice plant (Aizoaceae: *Carpobrotus edulis* (L.) N.E. Br.) ground cover beside roads (Gill, 1993). No such damage has been recorded in Kenya in the literature but ice plant is not widely used in amenity plantings there, possibly because the scale makes them unsightly.

†Giant soft scale, *Pulvinarisca inopheron* (Laing): Kenya: Chogoria, on *Cajanus indicus*[N],

4.x.1937, coll. A.R.M. (NHMUK); Nairobi, on *Croton manostachys*, 16.ix.1951 (NHMUK); Nairobi, on *Chaetacme aristata*[N], 29.x.1953 (NHMUK); Nairobi, on *Salvia* sp., 7.vi.1954 (NHMUK). **Recent:** Kenya, Central Province, Muguga, on small farm, on *Caliandra carobensis*[N], 15.vii.2018, coll. G. Opondo (NHMUK, KALRO-NARL). In Kenya, this species forms very heavy infestations on *Calliandra* grown for animal fodder. Each adult female may be up to two cm long and produces a conspicuous large white ovisac.

Family Diaspididae (23species)

†**An armoured scale, *Africaspis communis* (Hall):** Kenya, Nairobi, on fig, 26.iii.1949, coll. W.J. Hall; Eldoma Ravine, on stems of shrub, 25.ii.1970, coll. E.S. Brown (NHMUK).

***False yellow scale, *Aonidiella comperei* McKenzie:** Kenya: Pemba Island, host not noted, coll. Anderson, pre-1962. **Recent:** Kilifi County, Mtwapa, KALRO orchard, S 3° 56' 12", E 39° 44' 32", 10 m alt., on *Citrus* sp. leaf undersides, coll. Extension Officers, 10.vii.2019, 2 samples; Mtwapa, S 3.93717°, E 39.7424, 169 m alt., on *Citrus sinensis*, coll. M.M. Githae, 12.xii.2019 and 13.xii.2019; Malindi, S 3.27643°, E 40.01251°, 139 m alt., on *C. sinensis*, coll. M.M. Githae, 12.x.2019; Malindi, S 3.27442°, E 40.04494°, 166 m alt., on *C. sinensis*, coll. M.M. Githae, 12.x.2019; Kwale County: Matunga, S 4.27996°, E 39.56794°, 68 m alt., on *C. sinensis*, coll. M.M. Githae, 25.viii.2019; Ukunda, S 4.28601°, E 39.5284°, 63 m alt., on *C. sinensis*, coll. M.M. Githae, 14.xii.2019; Njego, S 4.65341°, E 39.1998°, 53 m alt., on *C. sinensis*, coll. M.M. Githae, 16.xii.2019; Botela, S 4.5809°, E 39.10918°, 45 m alt., on *C. limon*, coll. M.M. Githae, 16.xii.2019. Worldwide, this species has been recorded on host-plants in 12 families including species of *Citrus*, *Annona* and other fruit trees, *Cocos nucifera*, *Carica*

papaya, Musa sp. and *Vitis vinifera* and may have a wider host range (Williams & Watson, 1988; Watson, 2002; García Morales *et al*., 2020). *Aonidiella comperei* secretes a circular, flat, yellow-brown scale cover that is often closely attached to the insect beneath. The anterior part of the adult female expands with maturity to become kidney-shaped, forming postero-lateral lobes that lie alongside the smaller abdomen, and becomes hard and brown (like *A. aurantiae* (Maskell)). Mounted on a microscope slide, the adult female *A. comperei* has the pygidial venter with one small group of perivulvar pores on either side of the vulva, and lacks prevulvar scleroses and apophyses (whereas *A. aurantiae* lacks perivulvar pores but has paired prevulvar scleroses and apophyses). *Aonidiella comperei* probably originated from tropical Asia, but has been spread to other continents through the movement of infested live plant material. Balachowsky (1958) recorded it previously from Tanzania and remarked that it has a preference for citrus. In Kenya it was found on citrus and may have the potential to become a citrus pest. Its presence on exported fruit could cause plant quarantine issues in trade.

***Aglaonema scale, *Aspidiotus ?excisus* Green:** Kenya, Siaya County, on *Lantana camara*, coll. Prof. Odihambo, 6.iv.1990. These specimens differ from typical *A. excisus* by having median lobes with basal scleroses. **Recent:** Mombasa Co., Likoni, S 4.0948°, E 39.64874°, 142 ft alt., on *Capsicum frutescens* leaf, coll. W. Kinuthia, J. Achieng, 20.ii.2020. CHECK for scleroses Aglaonema scale has been intercepted from Africa (Mozambique) at plant quarantine in South Korea (Suh, 2016). The species is considered to be a pest of ornamental plants (Davidson & Miller, 1990).

†Fried egg scale, *Aspidiotus ?ruandensis* Balachowsky: Kenya, Kericho County: Kericho,

on *Camellia sinensis*[N], 2.iii.1967; Nakuru, on *Camellia sinensis*, coll. G.W. Oloo, 30.x.1972; Kericho, on *Ca. sinensis*, coll. V. Sudoi, iv.1986; Kiambu County: Kiambu, on *Coffea arabica*[N], coll. J.W. Waikwe, 10.vii.1978; Kiambu, Makana Estate, on *Co. arabica*, coll. R.H. Markham, 18.iv.1983; Ruiru, on *Co. arabica* leaves, ?1991; Ruiru, Ruara Estate, on *Co. arabica*, coll. G.W. Watson, viii.1993; Ruiru, Ruara Estate, 1500 m asl,, on *Co. arabica*, coll. T.J. Crowe, 29.iv.1994; Kwale County: Diani forest, on *Diospyros squarosa*[N], 17.x.1983 (NHMUK). This is a native African species; there is some uncertainty about its identity because when *A. ruandensis* was described from Rwanda (Balachowsky, 1955), the scale cover was described as light grey-brown with a yellowish cast, and with dark exuviae; whereas specimens in Kenya have white scale covers with yellow exuviae. However, the morphology supports the material representing a single species with a variable number of submarginal prepygidial macroducts. Molecular analysis of material representing these two scale-cover colours would resolve whether there is more than one species involved. Fried egg scale may have been introduced to Kenya from further west; it has been present in the country since at least 1967. It occurs on shade trees in Kenyan beverage crop plantations; in dry conditions it spreads onto the foliage of coffee bushes, sometimes becoming a pest (T.J. Crowe, pers. comm. 1994). The sample data above and in García Morales et al. (2016) indicate that it is relatively polyphagous on tree foliage, including fruit trees.

Cactus scale, *Diaspis echinocacti (Bouché): Kenya, Nairobi, on *Diospyros abyssinica*[N], coll. G. De Lotto, 28.iii.1956 (KALRO-NARL).

†Mango scale, *Duplachionaspis natalensis* (Maskell): Kenya, Machakos, on *Panicum coloratum*[N], 9.v.1950 (KALRO-NARL).

†**An armoured scale, *Hemiberlesia mammillaris* (Lindinger):** Kenya, Magadi, on *Aloe* sp., 29.vii.1956 (KALRO-NARL).

† **An armoured scale, *Hulaspis dombeyae* (Hall):** Kenya, Kikuyu, on Dombeya goetzenii, v.1974 (NHMUK).

†**An armoured scale, *Lindingaspis musae* (Laing):** Kenya, Ruiru, on *Syzygium cordatum*[N], 31.x.1953 (KALRO-NARL).

†**An armoured scale, *Morganella conspicua* (Brain):** Kenya, Kajiado, on *Commiphora*[N] sp., 10.vi.1956 (KALRO-NARL).

†**An armoured scale, *Morganella spinigera* (Lindinger):** Kenya, Nairobi, on *Gelonium procerum*[N], 18.iv.1953 (KALRO-NARL).

†**Reed scale, *Odonaspis phragmitis* Hall:** Kenya, Ruiru, on roots of *Paspalum scrobiculatum*[N], 7.ii.1956 (KALRO-NARL).

Bermuda grass scale, *Odonaspis ruthae Kotinsky: Kenya, Nairobi, on roots of *Rhychelytrum repens*[N], coll. G. De Lotto, 20.iv.1954 (KALRO-NARL). This is the most polyphagous species in *Odonaspis*, and has been recorded damaging lawn grass in Egypt and Israel, and forage and turf grasses in the southern U.S.A. and Chile (Watson, 2002).

***Paragrass scale, *Odonaspis sacchariculis* (Zehntner)**: Kenya, on roots of lemon grass, coll. F.S. Notley, 28.v.1935; British East Africa, Kenya, on roots of lemon grass (*Andropogon* sp.), no date; Ramisi, on sugarcane, 8.xi.1971, coll. G.W. Oloo (NHMUK). The species can be a pest of sugarcane in India.

***Parlatoria date scale, *Parlatoria blanchardi* (Targioni Tozzetti):** Kenya, Turkana, on date palm, coll. Smead, 8.xi.1971 (NHMUK). The scale is not native to Africa but probably originated in the Middle East; it is a well-known pest of date palms. There are no recent records, probably due to lack of sampling in northern Kenya.

***Boxwood scale, *Pinnaspis buxi* (Bouché):** Kenya, Nairobi, Scott Agricultural Laboratory, on *Bauhinia purpurea*, 26.ii.1951

(NHMUK); Nairobi, on *Musa ensete*[N], 25.ix.1951 (KALRO-NARL).

†**An armoured scale, *Pseudaonidia baikeae* Newstead:** Kenya: Nairobi, on *Chaetachme aristata*[N], 24.vi.1951 (KALRO-NARL); Thika, on *Rawstonia usambaruensis*[N], 24.viii.1952 (KALRO-NARL).

†**An armoured scale, *Pseudotargionia glandulosa* (Newstead):** Kenya, Magadi, on *Acacia senegal*, coll. R.W. Le Pelley, 6.viii.1951 (NHMUK); Magadi, on *Acacia* sp., coll. G. De Lotto, 29.vii.1956 (KALRO-NARL).

†**An armoured scale, *Rolaspis polypora* Munting:** Kenya, Sultan Hamud, 19.viii.1956 (KALRO-NARL).

†**An armoured scale, *Rolaspis syrinx* Williams:** Kenya, Naivasha, on *Acokanthera schimperi*[N], 1.i.1953 (NHMUK).

***Lychee bark scale, *Rutherfordia major* (Cockerell):** Kenya, Nairobi, on *Ehretia sylvatica*[N], 4.xi.1951, coll. G. de Lotto (KALRO-NARL). **Recent:** Kenya, Nairobi, National Museums of Kenya, on unknown plant, 7.x.2019, coll. J. Achieng (NMK). Ebeling (1959) recorded this species as a pest of lychee (*Litchi chinensis*, Sapindaceae) in Florida. There is no record of it causing damage in Kenya.

†**An armoured scale, *Sclopetaspis ?malawica* Munting:** Kenya, Kikuyu, on 'Rwegethia' [=*Zehneria scabra*], v.1974 (NHMUK).

†**An armoured scale, *Umbaspis spatulata* (Hall):** Kenya, Nairobi, on *Tulia simplicifolia*[N], 10.iv.1953 (KALRO-NARL).

Family Eriococcidae (1 species)

†**A felt scale, *Acanthococcus ?etbaicus* (De Lotto):** Kenya, N 01º 07', E 35º 51', on *Acacia nilotica,* 1.i.1987 (NHMUK).

Family Kerriidae (1 species)

†**A lac insect, *Tachardina ?brachystegiae* (Hall):** Kenya, Buchuma N.W. of Mombasa, on twigs of *Acacia nilotica*, 16.v.1986 (NHMUK).

Family Lecanodiaspididae (1 species)

†A false pit scale, *Lecanodiaspis mimosae* (Maskell): Kenya, Naivasha, on *Acacia xanthaphloea*[N], 9.viii.1970, coll. H. Schmutterer (NHMUK).

Family Monophlebidae (2 species)

†Spiny monophlebid, *Aspidoproctus ?tricornis* (Newstead): Kenya, Marigat, Loruk, on *Acacia nilotica* ssp. *subalata*, 6.vi.1990, coll. J. Marohasy (NHMUK).

†A monophlebid, *Pseudaspidoproctus fulleri* (Cockerell): Kenya, Chiromo, on grass, 2.ii.1971, coll. H. Schmutterer (NHMUK).

Family Pseudococcidae (10 species)

†Acacia mealybug, *Acaciacoccus hockingi* Williams & Matile-Ferrero: Kenya, Lake Naivasha, lakeside, on whistling thorn *Acacia*, 27.v.1988, coll. J.H. Martin (NHMUK).

†A mealybug, Delottococcus phylicus (De Lotto): Kenya, Naromoru, on Asteraceae (=Compositae), 26.viii.1977, coll. J.H. Martin (NHMUK).

†Podocarpus mealybug, Eastia jouberti De Lotto: Kenya, Nyeri Province, on *Podocarpus ?gracilea*, 27.ix.1982 (NHMUK).

***A mealybug, Ferrisia dasylirii (Cockerell):** Kenya: Kiambu, on coffee, iv.1926, coll. T.W. Kirkpatrick (NHMUK); Central Province, Mitungu, 1,500 m alt., on *Tephrosia*[N] sp., viii.2007, coll. Dudutech 030907F (NHMUK). **New continental record.** The mealybug is of South American origin. It is polyphagous and was only identified recently because Kaydan & Gullan's (2012) revision of the genus provided an identification key. Like *F. virgata* (Cockerell), also present in Kenya, heavy infestations can cause honeydew and sooty mould fouling of foliage.

***A mealybug, *Ferrisia malvastra* (McDaniel):** Kenya, Namanga, on *Abutilon mauritiense*[N], 21.i.1961, coll. G. de Lotto (KALRO-NARL). The species is of

South American origin. Like the related species *F. virgata* (Cockerell), also present in Kenya, heavy infestations can cause honeydew and sooty mould fouling of foliage.

†**A mealybug, *Heliococcus* sp.** near ***osborni* Sanders:** Kenya, Mt Kenya, on grass, coll. H. Schmutterer, 14.ii.1971 (NHMUK).

***Hall's mealybug, *Planococcus halli* Ezzat & McConnell:** Kenya, Nanyuki, on *Pistacia*[N] sp., 30.ix.1977, coll. O. Barton (NHMUK). The origin of this polyphagous species is unknown; hosts include yams, groundnuts, cassava, pigeon pea, sugarcane, coffee and citrus. The mealybug is often intercepted at plant quarantine inspection in the U.S.A. on yam tubers from Nigeria (Cox, 1989).

***Passionvine mealybug, *Planococcus minor* (Maskell):** Kenya: Kikuyu, on *Jacaranda mimosifolia*[N], v.1974 (NHMUK); Malindi, Msabaha Ag. Res. Station, on potato in storage, 5.iii.1987, coll. B.L. Parker (NHMUK); Nairobi Arboretum, on buds of *Callistemon*[N] sp. with ants, 31.viii.1988, coll. J.H. Martin (NHMUK); Nairobi Arboretum, on *Clausena anisata*[N], 2.v.1988, coll. J.H. Martin (NHMUK). **Recent:** Kilifi Co., Mtwapa, KALRO orchard, S 3º 56' 11", E 39º 44' 28", 14 m alt, on *Psidium guajava*, 10.vii.2019, coll. Extension officers (NHMUK, KALRO-NARL). *Planococcus minor* is possibly of Pacific origin and is highly polyphagous, attacking many economically important plants; it is sometimes ant attended. The species is a fairly common pest on crops including citrus in the coastal counties of Kenya, where it occurs much more frequently than *P. citri* (Risso).

***Obscure mealybug, *Pseudococcus viburni* (Signoret):** NHMUK: Kiambu Co., on *Datura*[N] sp., coll. R.H. Le Pelley, 20.x.1929 (NHMUK). Of unknown origin, this species is highly polyphagous and there are many literature records of it being a pest on tree, field and glasshouse crops (García Morales

et al. 2016). No recent samples have been seen from Kenya.

†**Short-legged mealybug, *Vryburgia brevicruris* (McKenzie):** Kenya, on roots of *Bidens pilosa*[N], 5.iv.1930, coll. H.C. James (NHMUK).

Discussion

The 51 new country records of scale insect species for Kenya recorded above are based on samples between 13 and 107 years old. While 35 (68.6%) of these species are native to Africa, 16 (31.4%) have been introduced accidentally from outside the continent (Table 2). Most of the introduced species had been recorded previously from some other part of Africa but there is one new continental record: Ferrisia dasylirii (Pseudococcidae).

Table 2. A breakdown of taxonomic, geographic origin and economic data for the new Kenya species records found in old samples.

Families (in size order)	No. genera	No. spp.	No. spp. of African origin	No. spp. from outside Africa	Pests of African origin	Introduced pest species	No. species with pest potential
Diaspididae	18	23	15	8	1	2	3
Pseudococcidae	8	10	5	5	0	1	3
Coccidae	8	13	10	3	1	1	1
Monophlebidae	2	2	2	0	0	0	0
Eriococcidae	1	1	1	0	0	0	0
Lecanodiaspididae	1	1	1	0	0	0	0
Kerriidae	1	1	1	0	0	0	0
Totals	**39**	**51**	**35**	**16**	**2**	**4**	**7**

Six of the 51 species (11.8%) are pests in Kenya today (Tables 2 and 3). Amongst the 16 introduced species, at least one (*Aonidiella comperei*) could cause plant quarantine issues in plant produce trade, and four (25.0%) are pests (*Aonidiella comperei*, *Odonaspis ruthae*, *Planococcus minor* and *Pulvinaria polygonata*). *This is* more than four times more than the frequency of pests amongst the

African species (5.7%). Only two native African species recorded from Kenya for the first time are pests: *Pulvinarisca inopheron* (Coccidae) and *Aspidiotus ?ruandensis* (Diaspididae). *The difference in pest frequency between these two groups is* probably because the introduced species lack specialist natural enemies from their areas of origin. This may make them suitable for classical biological control, since many scale insects have host-specific parasitoids (Hymenoptera: Chacidoidea) in their native ranges.

Table 3. Newly recorded species in Kenya in this work, of economic importance or with pest potential: * = introduced, †=originating from Africa.

Family	Pest species	Potential pests
Coccidae	**Pulvinaria polygonata*	**Pulvinaria urbicola*
	†Pulvinarisca inopheron	
Diaspididae	**Aonidiella comperei*	**Odonaspis saccharicaulis*
	†Aspidiotus ?ruandensis	**Parlatoria blanchardi*
	**Odonaspis ruthae*	**Rutherfordia major*
Pseudococcidae	**Planococcus minor*	**Ferrisia dasylirii*

The remaining 45 non-pest species (12 (26.7%) of them introduced) have been present in Kenya for at least 13 years. Many have not been collected again since the original samples, suggesting that either they have not survived or they are rare because they are under good natural control.

Recommendations

In this small sample, introduced species were found to be almost three times more likely to become agricultural pests than native African species, probably due to the absence of specialist natural enemies from their areas of origin. Once identified, such introduced pests may be suitable for classical biological control using specialist natural enemies from their areas of origin. There is need for continued monitoring, awareness creation on the biology, spread and management of the pest in the surveyed counties.

Acknowledgements

The authors would like to thank the Director General, KALRO, Nairobi, Kenya, and Prof. Kenneth Norris, Head of Life Sciences, the Natural History Museum, London, U.K. for permission to study the collections at their institutions. The study was made possible by funding provided by the United Kingdom's Darwin Initiative scheme, project 25-032, supported by Department for Environment Food & Rural Affairs (Defra), Department for International Development (DFID) and the Foreign and Commonwealth Office (FCO).

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