

FIRST INCURSION OF CHINESE MUSSEL SCALE *LEPIDOSAPHES CHINENSIS* (HEMIPTERA: DIASPIDIDAE) IN EUROPE, WITH A REVIEW OF *LEPIDOSAPHES* SPECIES FOUND IN BRITAIN

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ABSTRACT

In November 2011, a large infestation of *Lepidosaphes chinensis* Chamberlin (Hemiptera: Diaspididae) was found on a *Yucca elephantipes* plant grown in a conservatory near Northwich, Cheshire, England. Small numbers of scales were also present on *Beaucarnea recurvata*, *Euphorbia elegans* and *Sansevieria trifasciata* 'Laurentii'. This is the first incursion of this scale insect in Europe. It has previously been intercepted in the Netherlands on *Dracaena sanderiana* imported from China (2005–2006) and origin unknown (2008). The biology, geographical distribution and economic importance of *L. chinensis* are discussed. In addition, the status of the fourteen *Lepidosaphes* species that have been recorded in Britain is reviewed. One species, *L. ulmi* (L.), is native; two non-native species (*L. chinensis* and *L. pinnaeformis* (Bouché)) are currently found breeding on indoor plantings in Britain; the other eleven non-native species are not currently known to be established in Britain. The following *Lepidosaphes* species are recorded here from these countries for the first time: *L. beckii* (Newman) from Bangladesh; *L. gloverii* (Packard) from Bangladesh, Kenya and Uruguay; *L. pinnaeformis* (Bouché) from Madagascar; *L. rubrovittata* Cockerell from Jamaica; and *L. tapleyi* Williams from Ghana and Pakistan.

INTRODUCTION

A single giant yucca *Yucca elephantipes* Regel ex Trel. (Asparagaceae) plant grown in a conservatory heated all year round to 30°C in a private property, near Northwich, Cheshire, England, was found to be infested with scale insects in November 2011. A sample was submitted to The Royal Horticultural Society (RHS) and forwarded to The Food and Environment Research Agency (Fera), where the scales were identified as *Lepidosaphes chinensis* Chamberlin (Hemiptera: Diaspididae), commonly known as the 'Chinese lepidosaphes scale' in the USA (McKenzie, 1956; Gill, 1997). The common name 'Chinese mussel scale' is proposed here for use in Britain, as the female scale cover resembles a mussel, 'mussel scale' is already widely used for the native *Lepidosaphes ulmi* (L.), and the name lepidosaphes is not familiar to non-specialists. The sample leaves were infested with more than 100, mostly live, scales. All developmental stages were present with the exception of adult males, although mature male pupae were present and adult males were likely to have emerged in the near future. The scales had not caused significant damage but had caused small chlorotic spots and black streaks on the foliage. Further enquiries found that small numbers of Chinese mussel scale were also present at the same location on pony tail palm *Beaucarnea recurvata* Lem. (Asparagaceae), mother-in-law's tongue *Sansevieria trifasciata* Prain. 'Laurentii' (Asparagaceae), and *Euphorbia elegans* Spreng. (Euphorbiaceae). All of the infested plants had originally been imported from the Netherlands two or three years before, but this is not confirmed as the origin of the scale infestation, due to the lapse in time.

Lepidosaphes chinensis has been intercepted in the Netherlands, Aalsmeer, on lucky bamboo *Dracaena sanderiana* Sander ex Mast. (Asparagaceae) imported from China, 20.iv.2005, Mijdrecht, 27.xii.2006 and De Kwakel, origin unspecified, 3.i.2008. *Lepidosaphes ?chinensis* (specimens were in poor condition) was also intercepted in the Netherlands, Aalsmeer, on lucky bamboo imported from China, 7.viii.2007, but there is no evidence that it has established (Maurice Jansen, pers comm., 2012). The purpose of this communication is to report the first known incursion (an isolated population of a pest recently detected in an area, not known to be established, but expected to survive for the immediate future (FAO, 2009)) of *L. chinensis* in Britain (and Europe) and to review its geographical distribution, biology and economic importance. In addition, the status of the 14 *Lepidosaphes* species recorded in Britain is reviewed.

Slide mounted specimens of *L. chinensis* are deposited at Fera.

DETECTION AND IDENTIFICATION

The following description of *L. chinensis* is based on observations of the British samples. All developmental stages occur on the stems and foliage (upper and lower surfaces) of the host plant (Plate 5, Figs 1–6). The scales often congregate in groups along the leaf margin and at stem nodes (Plate 5, Fig. 1). The adult female scale covers (Plate 5, Figs 2 & 3) are up to 3.0 mm in length, moderately broad, slightly convex, and pale to orange brown with a dark orange terminal exuviae. Adult female bodies are white with the margin of the pygidium yellow to orange. Male scale covers are much smaller and narrower than the female covers, up to 1.5 mm in length, elongate oval, slightly convex, and pale brown with a dark orange terminal exuviae. Male prepupae and pupae are pale lilac, with their eyes deep purple. First instars (crawlers) of both sexes are white and their covers are also white (Plate 5, Fig. 5). Second instar scale covers are brown with a dark orange terminal exuviae (Plate 5, Fig. 6).

Lepidosaphes chinensis was originally described by Chamberlin (1925) from specimens collected from *Magnolia* sp., in Canton, Guangdong, China, in 1925 by the Italian entomologist F. Silvestri. A detailed morphological description and illustration of an adult female is given by Ferris (1938). Keys to the identification of adult female *Lepidosaphes* (including *L. chinensis*) are provided by Ferris (1938) and Gill (1997).

There are currently 163 species assigned to the genus *Lepidosaphes* (Miller, Denno & Gimpel, 2011) and there are no comprehensive keys to all species. Borchsenius (1962, 1963) divided *Lepidosaphes* into ten smaller genera, but this classification is not recognised by most recent workers (Watson, 2002; Miller, Denno & Gimpel, 2011).

Slide-mounted adult female *L. chinensis* (Fig. 1) may be most easily confused in Britain with *L. ulmi* (L.) and in continental Europe with *L. beckii* (Newman). They may be distinguished from *L. ulmi* by the presence of the following combination of characters: prepygidial abdominal segments I–V with small, but distinct, bosses (sclerotised spots) on dorsum (Fig. 1), slightly in from lateral margin on each side; well-developed blunt marginal spurs (Fig. 1); mesal margin of the median pygidial lobes usually notched twice (the latter character is less reliable than the previous two). In *L. beckii* the bosses on the prepygidial abdominal segments are usually absent or, if present, they are indistinct and only three are present on each side. In addition the marginal spurs are small and distinctly pointed (spine-like), and the mesal margin of median pygidial lobes are notched once. *Lepidosaphes chinensis* may

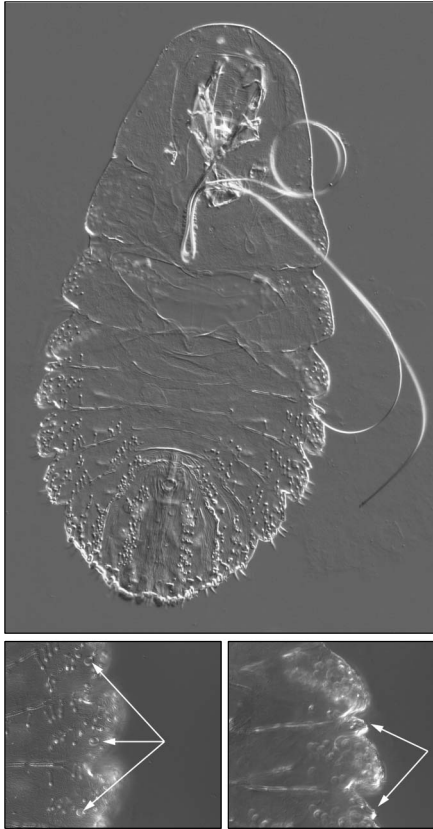


Fig. 1. *Lepidosaphes chinensis* slide mounted female; arrows on the lower left indicate the abdominal bosses; arrows on the lower right indicate the well-developed blunt marginal spurs
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be distinguished from *L. beckii* by the presence of marginal spurs, and by the presence of bosses on segments I–V, while in *L. beckii* these bosses are present only on segments I, II and IV.

HOST RANGE AND BIOLOGY

Lepidosaphes chinensis is polyphagous, feeding on the following plant families and species: Asparagaceae, *Beaucarnea recurvata* (recorded here), *Dracaena* sp., (recorded here), *Liriope* sp., *Sansevieria trifasciata* ‘Laurentii’ (recorded here), *Yucca elephantipes* (recorded here); Elaeagnaceae, *Elaeagnus umbellata* Thunb.; Euphorbiaceae, *Euphorbia elegans* (recorded here); Lamiaceae, *Caryopteris incana* (Thunb. ex Houtt.) Miq.; Magnoliaceae, *Magnolia* sp.; Orchidaceae, *Cymbidium aloifolium* (L.) Sw., *C. sinense* (Jacks.) Willd., *Cymbidium* sp., *Schomburgkia* sp.; Pandanaceae, *Pandanus* sp.; Papilionaceae, *Indigofera tinctoria* L. (Chamberlin,

1925; Takahashi, 1936; Ferris, 1938; Hunt, 1939; Nakahara, 1982; Tang, 1986; Tao, 1999; Martin & Lau, 2011).

The biology of the scale does not appear to have been studied in detail. The following observations are based on the sample of *L. chinensis* from England. It is sexually reproductive and each female lays between 32 and 38 eggs. All life stages (except adult males, although male pupae were present) were observed in November which suggests that it may have overlapping generations and be multivoltine if environmental conditions are favourable. There were approximately two male scale covers for every female scale, although the sex ratio varied considerably on different leaves.

GEOGRAPHICAL DISTRIBUTION

Lepidosaphes chinensis is native to East Asia and occurs widely in China (Chamberlin, 1925; Takahashi, 1936; Tang, 1986; Tao, 1999), including Hong Kong (Martin & Lau, 2011). It is also recorded from the Philippines (Hunt, 1939), Singapore (Nakahara, 1982), and Taiwan (Takahashi, 1936). Transient populations have occurred in California (USA) on orchids (Ferris, 1938) but it has been eradicated (Gill, 1997). It has been intercepted in the Netherlands on *Dracaena* plants imported from China (Maurice Jansen, pers comm., 2012), but is not known to have established. The first incursion of *L. chinensis* on plants growing indoors in Europe is recorded here.

ECONOMIC IMPORTANCE

There are no published records of *L. chinensis* causing economic damage; however, large populations may cause reduced host vigour and lower the value of ornamental plants. It was observed to cause minor chlorosis and necrotic streaks on the foliage of the giant yucca in Britain.

LEPIDOSAPHES RECORDED IN BRITAIN

Fourteen species of *Lepidosaphes* have been recorded in Britain. One species is native, *L. ulmi*; two non-native species are established (at least temporarily) on protected plantings, *L. chinensis* and *Lepidosaphes pinnaeformis* (Bouché). The other eleven non-native species are not currently established in Britain.

The majority of the samples recorded here were collected by the Plant Health and Seeds Inspectorate (PHSI) during inspections of imported plant material for regulated pests.

Synonyms are only given below if they have been used in literature pertaining to scale insects in Britain. Complete synonymies are provided by Miller, Denno & Gimpel (2011).

Lepidosaphes beckii (Newman) – citrus mussel scale or purple scale

Synonym: *Mytilaspis flavescens* Targioni-Tozzetti

Lepidosaphes beckii is one of the most commonly imported scale insect species in Britain and often listed, incorrectly, as established in Britain (Danzig & Pellizzari, 1998). It is usually found on citrus (Rutaceae) fruit and has been imported into Britain since at least the nineteenth century (Douglas, 1886; Newman, 1869). It occasionally occurs in enormous numbers (hundreds of scales per fruit), particularly on produce imported for processing (usually juicing). It was frequently misidentified in Britain as *L. ulmi* up until the 1980s (e.g., Seymour, 1978). It has been recorded on

Rutaceae: calamondin (*Citrofortunella microcarpa* (Bunge) Wijnands), key lime (*Citrus aurantiifolia* (Christm.) Swingle), Seville orange (*C. aurantium* L.), pomelo (*C. maxima* (Burm.) Merr.), kaffir lime (*C. hystrix* DC.), lemon (*C. limon* (L.) Burm.f.), king mandarin (*C. nobilis* Lour.), grapefruit (*C. × paradisi* Macfad.), mandarin (*C. reticulata* Blanco), orange (*C. sinensis* (L.) Osbeck), ugli fruit (*C. × tangelo* J. W. Ingram & H. E. Moore), and *Citrus* spp. It has been found on plant material imported from Argentina, Bahamas, Bangladesh, Belize, Brazil, Cuba, Cyprus, Dominican Republic, Egypt, France, Ghana, Greece, Guyana, Honduras, Israel, Italy, Kenya, Jamaica, Lebanon, Malaysia, Mexico, Peru, St. Vincent and the Grenadines, South Africa, Spain, Sri Lanka, Swaziland, Syria, Taiwan, Thailand, Turkey, United States of America (USA), Uruguay, and Venezuela (Fera, unpublished records).

Bangladesh is a new country record for *L. beckii* (country of origin confirmed on the phytosanitary certificates) (CABI, 1982; Watson, 2002; Miller, Denno & Gimpel, 2011). The collection details are as follows: England, London, Heathrow Airport, on *Citrus* sp. imported from Bangladesh, 3.xi.2005, 14.xii.2005, 17.i.2006, 12.ix.2006, 31.viii.2008, 10.iii.2009, repeated interceptions during v–ix.2011 (PHSI).

Lepidosaphes chinensis Chamberlin – Chinese mussel scale

The first incursion is reported here.

Lepidosaphes conchiformis (Gmelin) – fig or red oystershell scale

Synonym: *Lepidosaphes minima* (Newstead)

Transient incursions of this species have occurred on figs (*Ficus carica* L., Moraceae) grown indoors and in well sheltered situations outdoors on several occasions (Newstead, 1901; Green, 1915, 1916). It was found at RHS Garden Wisley in 1916, xi.1920, vi.1921 and vii.1924; in Tenterden, Kent x.1938 (Malumphy & Badmin, 2012); and Greater London, Enfield, 1955–56. It is no longer known to occur in Britain.

Lepidosaphes cupressi Borchsenius

Transient incursion at a commercial plant nursery in Worplesdon, Surrey on Chinese juniper (*Juniperus chinensis* L., Cupressaceae) imported from Hong Kong, iii.1975 (Bowman, 1976).

Lepidosaphes flava (Signoret) – De Stefan scale

Transient incursion at The Eden Project, Cornwall, on olive (*Olea europaea* L., Oleaceae) grown indoors, October 1999.

Lepidosaphes gloverii (Packard) – Glover's scale

Lepidosaphes gloverii is very common on imported *Citrus* fruit (together with *L. beckii*), and is often listed incorrectly as established in Britain (Danzig & Pellizzari, 1998). It has been found on *C. aurantiifolia*, bergamot (*C. bergamia* Risso & Poit.), *C. hystrix*, *C. maxima*, *C. limon*, *C. × paradisi*, *C. reticulata*, *C. sinensis*, *C. × tangelo*, *C. sp.* and *× Citrofortunella microcarpa*. It has been found on plant material imported from Argentina, Bangladesh, Belize, Brazil, Cuba, Dominican Republic, Egypt, Ghana, Honduras, India, Indonesia, Israel, Italy, Jamaica, Kenya, Malaysia, Mexico, Pakistan, Philippines, South Africa, Spain, Thailand and the USA (Fera, unpublished records).

Bangladesh, Ghana and Uruguay are new country records for *L. gloverii* (country of origin confirmed on the phytosanitary certificates) (CABI, 1962; Miller, Denno &

Gimpel, 2011; Watson, 2002) and the collection details are as follows: England, Essex, Port of Tilbury, on *C. sinensis* imported from Uruguay, 31.iii.1998 (PHSI); Kent, Thamesport, on *C. sinensis* imported from Ghana, 12.ix.2011 (PHSI); London, Heathrow Airport, on *Citrus* sp. imported from Bangladesh, 3.xi.2005, 14.xii.2005, 11.iii.2007, 10.iii.2009 (PHSI).

Lepidosaphes laterochitinos Green

It was originally described by Green (1925) from specimens collected from *Coelogyne* sp. (Orchidaceae) at the RHS Garden, Wisley, and consequently has often been incorrectly recorded as occurring in Britain. Transient incursions have been found at nurseries in Kent, on *Codiaeum* sp. (Euphorbiaceae) imported from Sri Lanka, March, 2009 (Malumphy & Badmin, 2012); and in Wales, Gwynedd, on ivy tree (*Schefflera heptaphylla* (L.) Fordin Araliaceae) imported from Taiwan, July, 2003 (Fera, unpublished records).

Lepidosaphes pini (Maskell) – Oriental pine scale

Transient incursion at a nursery on a bonsai Japanese white pine (*Pinus parviflora* var. *pentaphylla* (Mayr) A. Henry, Pinaceae) imported from Japan, June 1986 (Fera, unpublished record).

Lepidosaphes pinnaeformis (Bouché) – cymbidium scale

Synonym: *Lepidosaphes machili* (Maskell)

Established on *Cymbidium*, *Dendrobium* and other orchids (Orchidaceae) grown indoors. It is most commonly found in public botanic gardens, for example, at The Royal Botanic Gardens (RBG), Kew, Surrey, during 2000 and 2011, and may have been present in Britain for at least a century (Fernald, 1903). Other records include Birkenshaw, West Yorkshire, on *Cymbidium* sp., iv.1920 (Green 1921, 1925; Malumphy, 2009); Orchard House Havant, Hampshire, on *Cymbidium*, i.1930; Wisley, Surrey xii.1953; Horsham, West Sussex, xii.1953; and Berkhamsted, Hertfordshire, xii.1940.

It is also occasionally intercepted on imported orchids, for example, at the RBG Kew, on *Aeranthe* sp. (Orchidaceae) imported from Madagascar, ii.1995 (PHSI) (Fera, unpublished record). *Lepidosaphes pinnaeformis* is recorded here for the first time from Madagascar (country of origin confirmed on the phytosanitary certificate) (Mamet, 1959; Miller, Denno & Gimpel, 2011; Watson, 2002).

Lepidosaphes piperis (Green)

Transient incursion at a nursery in Somerset on black pepper *Piper nigrum* L. (Piperaceae) imported from India, xii.1998 (Fera, unpublished record).

Lepidosaphes rubrovittata Cockerell – guava scale

Transient incursion on guava (*Psidium guajava* L., Myrtaceae) plant imported from Jamaica, v.2003, for the RHS Chelsea Flower Show (Fera, unpublished record). It is recorded here for the first time from Jamaica (country of origin confirmed on the phytosanitary certificate) (Miller, Denno & Gimpel, 2011).

Lepidosaphes tapleyi Williams – guava long scale

This species has been commonly intercepted on mango (*Mangifera indica* L., Anacardiaceae) fruit imported from Pakistan since 1993, and on guava foliage and fruit imported from India since 2005. It has also been found on several occasions since 1993 on mango fruit imported from Gambia; on mangoes from Ghana, 1996

and 2010; on *Cordia dichotoma* G. Forst. (Boraginaceae) fruit from Kenya, xi.2006; and on sweet potato (*Ipomoea batatas* (L.) Poir., Convolvulaceae) foliage from Gambia, v.2005 (Reid & Malumphy, 2006). An incursion of *Lepidosaphes tapleyi* has occurred at the RBG Kew, on a *Caralluma* sp. (Asclepiadaceae) plant imported from Egypt, vii.1998 (Fera, unpublished records).

Lepidosaphes tapleyi Williams is recorded here for the first time from Ghana and Pakistan (country of origin confirmed on the phytosanitary certificates) (Miller, Denno & Gimpel, 2011; Watson, 2002), and collection details are as follows: England, Heathrow Airport, on mango from Ghana, 6.xi.1996, 13.x.2010 (PHSI); West Sussex, Gatwick Airport, on mango fruit from Pakistan, 28.vi.1998, 7.ix.1999 (PHSI).

Lepidosaphes tokionis (Kuwana) – croton scale

Several transient incursions of *L. tokionis* have occurred in England. It has been found in Greater London, on croton cuttings (*Codiaeum variegatum* (L.) Rumph. ex A. Juss., Euphorbiaceae) imported from Singapore, vi.2011; West Sussex, on croton from Sri Lanka, iii.1971; Cheshire, Birkenhead, on a tropical shrub imported from Grenada, v.1975 (Bowman, 1976); Greater Manchester and West Midlands, on croton from Singapore, xi.1980 (Seymour & Kilby, 1980); Lincolnshire on croton of unknown origin, i.1999, and from Sri Lanka, iv.2003. A scale suspected to be *L. tokionis* has also been found at the RBG, Kew, on *Celastrus* sp. (Celastraceae) from China, xi.1985 (Seymour, Davis & Roberts, 1986).

Lepidosaphes ulmi (L.) – mussel scale

Lepidosaphes ulmi is common throughout Britain and broadly polyphagous on woody hosts, especially Rosaceae (Malumphy, 2009). Populations are often larger, and therefore more noticeable, in urban gardens. It is an occasional pest of Buxaceae: box (*Buxus* spp.). Rhamnaceae: ceanothus (*Ceanothus* sp.). Cornaceae: common dogwood (*Cornus sanguinea* L.). Rosaceae: rock cotoneaster (*Cotoneaster horizontalis* Decne.); hawthorn (*Crataegus* spp.); apple (*Malus domestica* Borkh.); pear (*Pyrus communis* L.); cherry (*Prunus avium* (L.) L.); rose (*Rosa* spp.), and many other plants. It is also occasionally intercepted on imported plant material, for example: apple from Iran, 1985 (Seymour, Davis & Roberts, 1986); pear from Italy, 1976 (Seymour, 1978); and bay laurel (*Laurus nobilis*) from Belgium, 1976 (Seymour, 1978).

Lepidosaphes yanagicola Kuwana – yanagicola oystershell scale

Transient incursion at a nursery in Wiltshire, on 24 willow *Salix* sp. (Salicaceae) cuttings imported from Japan, 6.ii.1986.

Lepidosaphes spp.

There is a very large number of other interceptions records (too many to be listed in this paper) of *Lepidosaphes* species undetermined found in association with imported plant material, which are likely to represent species not listed above.

DISCUSSION

This is the first published incursion of *L. chinensis* in Britain (and Europe). The biology of this species is largely unknown but it is polyphagous, feeding on plants belonging to at least eight families (with a preference for Asparagaceae and Orchidaceae), and appears to be multivoltine. It is primarily a tropical and sub-

tropical species that is unlikely to be able to naturalise (over-winter outdoors) in Britain, but could establish on indoor plantings (for example, on *Dracaena* spp., orchids, mother-in-law's tongue, and yucca). It could easily be overlooked, as it resembles other *Lepidosaphes* species that are already present in Britain and continental Europe. It is not, however, recorded as an economic pest in its native range (Asia), although it could be more damaging in new geographical areas where its natural enemies are absent.

Fourteen *Lepidosaphes* species have been detected in Britain: one species is native, two non-native species are currently known to be breeding in Britain, and eleven are non-established introductions. The free movement of plants within the Europe Union provides a pathway for the continual introduction into Britain of *L. beckii* and *L. gloverii* on ornamental citrus, and *L. conchiformis* on fig from the Mediterranean, where all three *Lepidosaphes* species are common. In June 2011, croton plants imported from Sri Lanka were found to have a moderate infestation of *L. tokionis*. It is possible that in the future, these and other non-native species of *Lepidosaphes* will be accidentally introduced into Britain, although the majority of non-native species will be restricted to indoor plantings and are unlikely to have a significant negative economic impact on UK agriculture, horticulture, forestry or biodiversity.

Any findings of suspected non-native plant pests should be reported to the local Fera PHSI office or to the PHSI HQ, York (Tel.: 01904 465625).

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PLATE 5. Fig. 1. *Lepidosaphes chinensis* colony on the stem of *Dracaena sandreriana* © Maurice Jansen. Fig. 2. *Lepidosaphes chinensis* mature adult female scale cover (bottom, cover length 3.0mm) and male scale cover (top, cover length 1.4mm) on *Yucca* © Fera. Fig. 3. *Lepidosaphes chinensis* female scale cover turned over to show the white eggs © Fera. Fig. 4. *Lepidosaphes chinensis* female scale cover turned over to show the white eggs © Fera. Fig. 5. *Lepidosaphes chinensis* first instar scale cover © Fera. Fig. 6. *Lepidosaphes chinensis* second instar scale cover © Fera.