

# FIRST INCURSION IN EUROPE OF BAMBOO WHITE SCALE *KUWANASPIS HOWARDI* (HEMIPTERA: DIASPIDIDAE), WITH A REVIEW OF *KUWANASPIS* SPECIES DETECTED IN BRITAIN

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## ABSTRACT

*Kuwanaspis howardi* (Cooley) (Hemiptera: Diaspididae) is a scale insect native to East Asia that feeds on bamboo. A large infestation of *K. howardi* was found in January 2015 at the Royal Horticultural Society's Garden, Wisley, Surrey, on mature *Fargesia nitida* (Chinese Fountain Bamboo) plants that were planted in 1988. *Kuwanaspis howardi* has previously been intercepted by the Plant Health and Seeds Inspectorate on *Phyllostachys vivax* plants imported from China at a nursery in Hampshire, in April 2002. These are the first findings of this scale insect in Britain and Europe. The biology, geographical distribution and potential economic importance of *K. howardi* are discussed. In addition, the status of four other non-native *Kuwanaspis* species recorded in Britain is reviewed; one species, *K. pseudoleucaspis* (Kuwana) has established widely on ornamental bamboo outdoors and on indoor plantings in England since at least the 1960s. *Fargesia* is recorded as a new host genus for *K. howardi* and *Drepanostachyrum* and *Himalayacalamus* as new host genera for *K. pseudoleucaspis*.

## INTRODUCTION

On the 25th January 2015 several stems of a single large Chinese Fountain Bamboo (*Fargesia nitida* (Mitford), Poaceae: Bambusoideae) plant growing outdoors at the Royal Horticultural Society's Garden (RHS), Wisley, Surrey, England (GU23 6QB) were found by W. McCutcheon (RHS Horticulturalist) to be encrusted with an extensive population of scale insects (Plate 6, Fig. 1). The plant had been *in situ* since June 1988 and appeared to be healthy despite the scale infestation. Samples of infested stems were submitted to The Food and Environment Research Agency (now Fera Science Limited), where the scale was identified as *Kuwanaspis howardi* (Cooley) (Hemiptera: Diaspididae). This scale insect is native to East Asia where it is recorded as a pest of bamboo (Wang, Varma & Xu, 1998). It is commonly known as 'Bamboo White Scale' (Miller & Davidson, 1990) or 'Woolly Bamboo Scale' (Gogua, 1975). This appears to be the first known incursion (FAO, 2009) of this scale insect in Europe as it was not recorded in a recent review of the scale insects on bamboo in the Western-Palaeartic region by Ülgentürk, Porcelli & Pellizzari (2014) or in the comprehensive review of non-native scale insects established in Europe by Pellizzari & Germain (2010). It is not recorded from Europe by ScaleNet, an online catalogue of the scale insects of the world (García Morales *et al.*, 2016), nor on EUROPHYT (2015). In addition, scale insect specialists were contacted in France, the Netherlands and Italy (details provided in the acknowledgments) who confirmed that they had no unpublished records of *K. howardi*. A small number of adult female *K. howardi* had been previously intercepted by the Plant Health and Seeds Inspectorate (PHSI) (now part of the Animal and Plant Health Agency (APHA)) at a commercial nursery in

Hampshire on Chinese timber bamboo *Phyllostachys vivax* McClure (Poaceae) plants imported from China, in April 2002. This finding was not considered an 'incursion' as there was no evidence of breeding. No statutory action was taken to control the scale as it was considered to pose a negligible economic and environmental risk in Britain (see Discussion).

The purpose of this communication is to report the first findings of *K. howardi* in Europe and to review its geographical distribution, biology and economic importance. In addition, the status of four other non-native *Kuwanaspis* species in Britain is reviewed.

Slide mounted specimens of *K. howardi* are deposited at Fera.

### ***Kuwanaspis howardi* (Cooley) – Bamboo White Scale (Plate 6, Figs 1–4)**

Synonymy: *Chionaspis howardi* Cooley 1898; *Duplacionaspis howardi* (Cooley); *Kuwanaspis howardi* (Cooley); *K. phyllostachydis* Borchsenius & Hadzibejli 1950; *K. howarai* (Cooley), misspelling of species epithet; *K. howadi* (Cooley), misspelling of species epithet.

#### DETECTION AND IDENTIFICATION

The following description of the adult female and nymphs is based on observations made of specimens found in Britain. Adult female cover white, elongate, pyriform, oyster-shell or mussel-shell shaped, slightly convex, 1.0–1.5 mm long; exuviae (shed skins) apical, yellow or tan (Plate 6, Fig. 2). The scales remain attached to the host long after they have died and the older scale covers become discoloured as they are contaminated with debris and fungi. Adult female body is elongate, yellow or orange (Plate 6, Fig. 3); eggs and first instars (crawlers) are bright yellow (Plate 6, Fig. 4). The scale is found primarily at the base of the stems, particularly at the nodes. Many of the female scales had a single hymenopteran parasitoid emergence hole in the dorsal surface, although no live parasitoids were observed and therefore the species could not be determined. Male scales were not observed in the samples submitted to the laboratory, which may be because male scales often form separate colonies. During the summer these male colonies can appear 'woolly' or 'fluffy' with abundant, dorsal, loose, wax strands (Bustshik, 1958). Male covers are smaller than the female covers, and are elongate, white, with two median longitudinal ridge; exuviae skin marginal and yellow.

In life, *K. howardi* is indistinguishable from *K. pseudoleucaspis* (Kuwana), a species that is widely established outdoors in the UK, occasionally found on bamboo plants grown indoors, and intercepted on imported bamboo plants (see details below). Authoritative identification of the two species can only be achieved by microscopic examination of slide-mounted teneral adult females.

*Kuwanaspis howardi* was originally described by Cooley from specimens taken at quarantine in Washington D.C., USA, on imported bamboo (Cooley, 1898). A detailed morphological description and illustration of *K. howardi* adult female is provided by Balachowsky (1954), and the immature stages are described by Howell & Tippins (1973). A detailed illustrated glossary of morphological terms for the Diaspididae is available in Miller & Davidson (2005). There are currently 20 species assigned to the genus *Kuwanaspis* and keys for the identification of adult female *Kuwanaspis* species are provided by Ferris (1942), Balachowsky (1954), Chou (1982), Hu (1982), and Suh & Hodges (2007). There is no published key for the British

Diaspididae but the three named species may be separated using the following couplets:

1. With less than 10 perivulvar pores on each side of the body (scale cover very long and slender, about 2.5 mm long, sides straight, parallel, sometimes curved, usually found on foliage) . . . . . *Kuwanaspis hikosani* (Kuwana)
- With more than 20 perivulvar pores on each side of body (scale cover shorter and broader, about 1.5 mm long, usually found on stems) . . . . . 2
2. Venter of abdominal segment 1 with transverse row of small-sized macroducts . . . . . *Kuwanaspis howardi* (Cooley)
- Venter of abdominal segment 1 with macroducts restricted to marginal areas and not forming a transverse row. . . . . *Kuwanaspis pseudoleucaspis* (Kuwana)

#### HOST RANGE AND BIOLOGY

*Kuwanaspis howardi* is oligophagous on bamboo, feeding on plants assigned to five genera. The nomenclature of bamboo plants has changed significantly in recent decades and here it follows The Plant List (2015). Poaceae: *Arundinaria* sp.; *Bambusa multiplex* (Lour.) Raeusch. ex Schult.; *Bambusa* sp.; *Fargesia nitida* (Mitford) Keng f. ex T.P.Yi (recorded here for the first time); *Phyllostachys aurea* Rivière & C.Rivière; *P. bambusoides* Siebold & Zucc.; *P. dulcis* McClure; *P. edulis* (Carrière) J.Houz.; *P. nigra* (Lodd. ex Lindl.) Munro; *P. reticulata simonsonii* (Krasn.) Ginkul (unresolved name); *P. violascens* Rivière & C. Rivière; *P. viridiglaucescens* (Carrière) Rivière & C.Rivière; and *Phyllostachys* sp. (García Morales *et al.*, 2016).

In the Caucasus and Crimea *K. howardi* has two generations per year and overwinters as second instar nymphs. In the first half of May females lay about 32–60 eggs over 20–50 days. Eggs hatch in 12–14 days with larvae emerging at the end of May (Borchsenius & Hadzebejli, 1950). Bustshik (1958) observed a mass flight of adult males in mid-July. *Kuwanaspis howardi* also has two generations each year in China (Zhejiang Province) but overwinters as the fertilized adult female (Gang & Liu, 2000). The first nymphal instars, or crawlers, are the primary dispersal stage and move to new areas of the plant, or are dispersed by wind or animal contact. Mortality due to abiotic factors is high in this stage. Dispersal of sessile adults and eggs occurs through human transport of infested plant material.

The population found at Wisley in January 2015 consisted of eggs, first and second-instar nymphs, and adult females. There were egg-laying females and first instars actively crawling over the bamboo. No males were observed. The biology of the scale in Britain remains unclear and requires further investigation. Three natural enemies have been recorded attacking *K. howardi*: a parasitoid wasp *Encarsia citrina* (Crawford) (Hymenoptera: Aphelinidae), Heather Ladybird *Chilocorus bipustulatus* (L.) (Coleoptera: Coccinellidae) and predatory mite *Androlaelaps casalis* (Berlese) (Mesostigmata: Laelapidae) (García Morales *et al.*, 2016).

#### GEOGRAPHICAL DISTRIBUTION

*Kuwanaspis howardi* is native to East Asia and has been spread to the Caucasus region, Middle East, North America and to the Bonin Islands in the Pacific (Nakahara, 1982; Danzig & Pellizzari, 1998; Tao, 1999; Watson, 2002).

**Orient:** China; Korea. **Palaeartic:** Azerbaijan; China; Georgia; Iran; Japan; Russia; and Ukraine. **Nearctic:** USA. **Oceania:** Bonin Islands.

### ECONOMIC IMPORTANCE

*Kuwanaspis howardi* is recorded as a serious pest of bamboo in China (Wang, Varma & Xu, 1998) and Georgia (Gogua, 1975), and is included in a list of diaspid pests by Miller & Davidson (1990). Large populations may reduce host vigour, cause chlorosis and lower the value of individual ornamental plants. The culms of the bamboo turn white as they become encrusted with scales giving the plants an unsightly appearance. However, it is of no economic importance in Florida (Dekle, 1977) and a large population of the scale found at one site in the UK had no noticeable impact on the host plant.

### ***Kuwanaspis* recorded in Britain**

There are no *Kuwanaspis* species native to Britain or Europe. Five species of *Kuwanaspis* have been found in Britain on growing plants, but only three of these have been identified to species. Two morphologically distinct species (referred to as A and B) could not be keyed out satisfactorily and require further research. Two species have been found breeding in Britain: *K. pseudoleucaspis* is fairly widespread; *K. howardi* is currently only known from a single location.

### ***Kuwanaspis hikosani* Kuwana – Armoured Thread Scale**

*Kuwanaspis hikosani* was originally described from specimens collected from *Phyllostachys bambusoides* in Japan. It is native to Asia and has been recorded from China, Japan, Korea, and has been introduced to the U.S.A. There is an old record of this species being found in Turkey (Bodenheimer, 1953). It is oligophagous on bamboo (Poaceae) and is recorded feeding on: *Arundinaria simonii* (Carr.) Riv.; *Bambusa* sp.; *Phyllostachys bambusoides*; *P. edulis*; *P. nigra* (Lodd. ex Lindl.) Munro; and *Sasa* sp..

It has been found on two occasions in England: Hampshire, commercial nursery, on *Phyllostachys vivax* imported from China, 17.iv.2002, leg. Robin Whittaker of the PHSI (together with *K. howardi*); Surrey, commercial nursery, on *Phyllostachys aureosulcata* McClure (new host) imported from China, 3.v.2006, leg. Justine Walker of the PHSI.

### ***Kuwanaspis howardi* (Cooley) – Bamboo White Scale**

The first known incursion and interception in Europe are reported above.

### ***Kuwanaspis pseudoleucaspis* (Kuwana) – Bamboo Diaspid**

*Kuwanaspis pseudoleucaspis* was described from specimens collected from *Bambusa* sp. in Japan (Kuwana, 1902, under the junior homonym *Leucaspis bambusae*). It occurs in Europe, Asia, Central Asia, North America, Bermuda, Hawaii, and New Zealand. In Europe and the Mediterranean region it has been recorded from Algeria, Croatia, France, Germany, Italy, Morocco, Poland, Portugal, Russia, Slovenia, Sweden, Turkey, Ukraine, and the United Kingdom. This species was apparently the first exotic bamboo scale introduced into Europe (Ülgentürk, Porcelli & Pellizzari, 2014) and has become widely established since at least 1900 (Pellizzari & Germain, 2010). It was first collected in Britain from *Arundinaria* growing outdoors at the Royal Botanic Gardens, Kew, Surrey, in 1961, although it was already well

established and no import connection was recorded (Boratynski & Williams, 1964). Fera have recent records of *K. pseudoleucaspis* found in botanical collections in Surrey and Devon, and under glass in South Yorkshire. It has also been intercepted on many occasions at nurseries in England on bamboo plants imported from China, USA and Italy. It is oligophagous on Poaceae, feeding on plants assigned to 10 genera: *Arundinaria*; *Bambusa*; *Cynodon*; *Fargesia*; *Paspalum*; *Phyllostachys*; *Pleioblastus*; *Sasa*; *Semi-arundinaria*; and *Sinobambusa*. In addition it has been recorded by Fera in the UK on *Drepanostachyrum* and *Himalayacalamus*. It is a serious pest of bamboo in China (Wang, Varma & Xu, 1998), but in Europe even high infestations do not apparently affect the vigour of the host plant (Ülgentürk, Porcelli & Pellizzari, 2014).

#### ***Kuwanaspis* sp. A**

Intercepted on one occasion in England: Lancashire, a public garden in a college, on *Fargesia luhuiensis* Hsueh & T.P.Yi imported from China, 21.ii.2007, leg. Keith Warwick of the PHSI.

#### ***Kuwanaspis* sp. B**

Intercepted on one occasion in England: Hampshire, Southampton Container Port, on *P. aureosulcata* imported from China, 13.iii.2015, leg. Andrew Gaunt of the PHSI. The scale covers were exceptionally long and narrow.

### DISCUSSION

This is the first published record of *K. howardi* being found in Britain and Europe, and the pathway of introduction is unknown. The plants may have been infested with *K. howardi* since 1988 when they were originally planted at Wisley, as they are easily overlooked, being highly cryptic and hidden at the base of the culms. It appears to have a negligible impact on ornamental bamboo, and can easily be confused with *K. pseudoleucaspis* which is already widespread in Europe. The heavily infested bamboo plants at the RHS Garden have been removed, not because of the presence of the scale insect but as part of normal garden maintenance. However, it is possible that other bamboo plants at the gardens and in the vicinity are infested at low levels.

*Kuwanaspis pseudoleucaspis* has been established outdoors in southern Britain since the 1960s but has not been recorded damaging plants, and it is considered here that *K. howardi* will have a similar negligible economic and environmental impact in Britain.

Three exotic scale insects (*Balanococcus kwoni* Pellizzari & Danzig, *Chaetococcus bambusae* (Maskell) and *Trionymus bambusae* (Green)) have been found breeding on bamboo in Britain since the 1990s (Malumphy, 2015) and there are many other exotic species found on bamboo in Europe (Ülgentürk, Porcelli, & Pellizzari, 2014). There is therefore a continual risk of further introductions of unregulated exotic scale insects due to international trade in bamboo plants.

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## SHORT COMMUNICATION

**Lundy Ciidae (Coleoptera: Tenebrionoidea), July 2014.** – This note confirms the presence of *Octotemnus glabriculus* (Gyllenhal) and *Cis bilamellatus* Wood on Lundy and adds *Cis vestitus* Mellié to the island's list. It reports the apparent use of *Stereum rugosum* (Pers.) Fr. as a breeding host by *C. vestitus*.

The Ciidae is a family of obligately fungivorous beetles that typically live and breed in the fruiting bodies of wood-rotting basidiomycetes with a poroid or smooth hymenial surface (Orledge & Reynolds, 2005). There are 21 native and one introduced ciid species on the British list (Orledge & Booth, 2006, 2012; see also Orledge, 2009, for nomenclatural comments). Only two of these – the native *Octotemnus glabriculus* (Gyllenhal) and the Australasian *Cis bilamellatus* Wood – have been reported from Lundy (Orledge, 2012).

My visual search for ciid hosts during the BENHS recording meeting on Lundy, 5–8 July 2014, resulted in records for three ciid species exploiting basidiomycete fruiting bodies growing on dead wood in Millcombe Valley. Specimens of each ciid species were retained to confirm identification, and voucher specimens have been deposited in the BENHS collections.

Two live males of *O. glabriculus* were found in *Trametes versicolor* (L.) Pilát on a dead fallen tree trunk at SS139441. A substantial number of small old basidiomycete fruiting bodies on a dead standing *Pinus* trunk at the same location yielded ciids subsequently determined as *C. vestitus* Mellié (four adults) and *C. bilamellatus* (four adults). At SS140439 a small sample of *Stereum rugosum* (Pers.) Fr. fruiting bodies growing on a dead *Quercus* branch was collected in the hope that subsequent examination might reveal specimens of the *Cis festivus* (Panzer)/*Cis vestitus* species pair. Eighteen days later two ciid larvae, but no adults, were noticed in this sample. Sixty days after collection an unexpectedly high total of 21 *C. vestitus* adults, including one teneral, were extracted, together with three ciid larvae and two ciid pupae.

*Cis vestitus* is here added to the Lundy ciid list, with the limited available evidence suggesting that Millcombe Valley currently supports a good population of this species. It is noteworthy that on mainland Britain *S. rugosum* generally yields specimens of *C. festivus* rather than *C. vestitus*. The latter is typically found by beating, or is recorded exploiting *Stereum hirsutum* (Willd.) Gray. Both ciids have been recorded throughout England, Wales and Scotland, with by far the greater number of records being for *C. festivus* (Orledge & Smith, in prep.).

In common with the larvae of the other members of the ‘*Stereum* ciid host-use group’ (Orledge & Reynolds, 2005), those of *C. vestitus* develop in a relatively restricted range of fungi. For *C. vestitus* only three fungus species – *Stereum gausapatum* (Fr.) Fr., *Stereum hirsutum* and *Peniophora quercina* (Pers.) Cooke – appear to have been recorded as breeding hosts (Koch, 1989; Reibnitz, 1999; Holter, Milewski & Reibnitz, 1999; Orledge & Smith unpublished). The possibility that one or two adult ciids might have been overlooked at the ‘18 day’ examination of the Lundy *S. rugosum* sample must be acknowledged. However, their apparent absence then, and the subsequent extraction of 21 adult *C. vestitus*, implies that *C. vestitus* eggs and/or larvae were present at the time of collection and that this ciid is using *S. rugosum* as a breeding host on Lundy. Certainly, the presence of a teneral adult sixty days after collection demonstrates the ability of *C. vestitus* to develop in this fungus.– GLENDA M. ORLEDGE, Department of Biology and Biochemistry, University of Bath, Claverton Down, Bath BA2 7AY.

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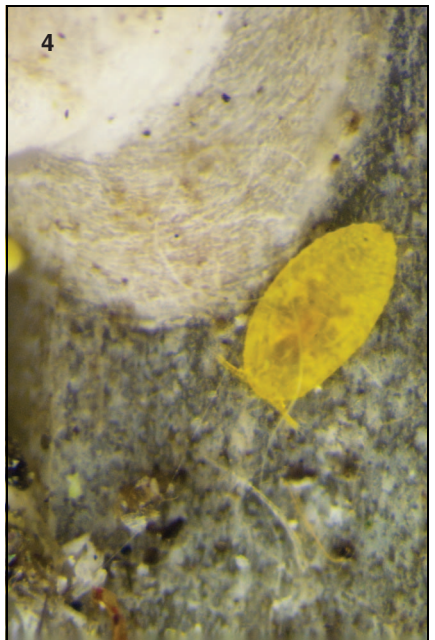


PLATE 6. Fig. 1. Bamboo culm encrusted with *Kuwanaspis howardi*. © Crown copyright. Fig. 2. *Kuwanaspis howardi* adult female scale cover. © Crown copyright. Fig. 3. *Kuwanaspis howardi* adult female body with scale cover removed. © Crown copyright. Fig. 4. *Kuwanaspis howardi* first instar or crawler. © Crown copyright.