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Alien molluscs in British and Irish hothouses*

Thomas Walker

38 Redlands Road, Reading, Berkshire RG1 5HD, UK
Correspondence: *T. Walker (tom@tmwalker.co.uk)*

Abstract. Hothouse alien mollusc species, defined as those with breeding populations only able to live in heated environments, are under-recorded in Britain and Ireland. A project extending over 10 years visited 56 heated glasshouses and identified 15 such species, while another two are known to be present in British hothouses. One species, *Liardetia samoensis*, is new to the British list. Another 12 species which have previously been recorded as hothouse aliens are no longer extant in Britain or Ireland. Consideration is given to whether these aliens could lie in the open in our climate, and the consequences if they were able to do so. An Appendix lists all records of hothouse alien molluscs found in literature and on databases and will be a useful tool for future research.

Key words. Greenhouses, introductions, non-marine shells, adventitious shells

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Introduction

Many alien non-marine mollusc species have been accidentally introduced through trade and horticulture. In colder climates, artificially heated buildings, especially hothouses (heated glasshouses for growing plants), provide habitats that allow non-native species from warmer regions to survive. While populations of some species are non-breeding, or adventive, and therefore short-lived, others become established indoors with breeding populations. Such alien species can be spread to similar habitats in multiple cities, regions, or countries, presumably through the movement of plants or soil. Such species are known as hothouse aliens or greenhouse aliens (Kerney & Cameron 1979; Naggs *et al.* 2014; Rowson *et al.* 2021) and does not include those alien species which have become established in the open.

The Conchological Society of Great Britain and Ireland (CS) has long been known for its recording of non-marine species. Records in the CS database go back to 1670, and several thousand observations are added each year. However, only a very small proportion of the 350,000 entries currently in the database are of species limited to hothouse environments. Reporting of hothouse aliens molluscs is frequent in continental Europe, especially when species new to European greenhouses are identified, although this seems to be limited to relatively few countries: Austria (Leiss & Reischütz 1996; Leiss *et al.* 2008; Reischütz *et al.* 2018; Horsák *et al.* 2020; Schileyko 2020), Czech and Slovak Republics (Horsák *et al.* 2004; Beran & Glöer 2006; Juřičková 2006; Šteffek 2007; Horsák *et al.* 2013; Čiliak *et al.* 2016; Čejka *et al.* 2020; Beran 2022), France (Čejka *et al.* 2007; Audibert & Paillet 2014; Lemaire & Gerriet 2014), Germany (Albrecht & Meng 1997), Italy (Evangelista *et al.* 2013; Manganelli *et al.* 2023; Manganelli *et al.* 2024), the Netherlands (Meeuse & Hubert 1949; de Winter *et al.* 2009; Da Sois 2015/16; Neckheim & Inden 2019), Poland (Alexandrowicz 1993; Kaszuba & Stworzewicz 2008), Spain (Quiñonero-Salgado *et al.* 2014), and Sweden (von Proschwitz 2003, 2017; Richling & von Proschwitz 2021).

In some cases, hothouse aliens have later been widely recorded living outdoors in Britain and Ireland, for example *Ambigolimax valentianus* (A. Férussac, 1821) and *Ambigolimax parvipenis* (Hutchinson, Reise & Schlitt, 2022). It is therefore essential to record the initial hothouse observations to determine the extent to which this is an introduction pathway for alien mollusc species. Similarly, it is best to list occurrences presumed to be adventitious, rather than to ignore them on this basis. Several occurrences reported in

* This paper is based on the Presidential Address given to the Conchological Society on 20 April 2024.

the published literature are not in recording databases, and vice versa.

This paper deals with all non-marine mollusc species in Britain or Ireland found only (or predominantly) in hothouses, in which they form established (naturally reproducing) populations. It does not include species deliberately cultivated or kept in captivity (e.g. in laboratories, zoos, or home aquaria), species known only from certainly adventive individuals, or those intercepted in transit. Nor does it include the many other alien molluscs already known to be well-established outdoors in Britain or Ireland, but which also tolerate hothouse environments. Inevitably, however, there are a small number of species which are difficult to assign to a category on current evidence. In some cases, this could change in future as records accumulate.

The first recorded British hothouse alien was *Opeas hannense* (Rang, 1831), which was discovered by John Miller in Bristol in 1817. Miller observed the shells of this species in the pineapple beds of Carraway and Company's nursery and, thinking it a new species, named it *Helix Goodallii* (J.S. Miller 1822) (Fig. 1). This name was later found to be a junior homonym for *Helix goodallii*, which is now known as *Azeca goodalli* (A. Férussac, 1821). Miller found multiple specimens of different ages, so it was clearly a breeding population, and not a short-lived adventive, supported by the comments of Thomas Drummond, who perhaps first observed the species (Fleming 1828: 266):

> The *Helix Goodallii* was first pointed out to me in 1816, when I was in the habit of feeding them, and when I wanted a supply, I merely placed a flat board upon the surface of the tan, and left two or three small worms beneath it (dead ones of course), and I never saw it fail of being covered with them in a few days.

In addition to the above, there are sporadic reports of hothouse aliens in Britain and Ireland dating back to the 19th century (Turton 1826, 1831; Brindley 1906; Sturgess Dodd & Woodward 1906; Swanton 1906; Ellis 1926; Kennard & Woodward 1926), but systematic recording only commenced in the early 20th century with the publication of surveys of the fauna of Kew Gardens in London (Sich 1907; Verdcourt 1949; Airy Shaw 1973; Verdcourt 1993a, 1995, 2009). Other botanical gardens have reported their hothouse fauna, but only sporadically.

The first comprehensive listing of hothouse aliens in Britain and Ireland, in 1951 (Conchological Society Non-marine Recorders 1951), listed 20 species with their location but gave no information concerning dates of observation or recorder. The subject was then largely ignored until *A Field Guide to the Land Snails of Britain and North-west Europe* (Kerney & Cameron 1979) was published. It gave details of nine hothouse alien species (including *Ambigolimax valentianus*, now widespread in the open). Naggs *et al.* (2014) illustrated 11 terrestrial species but provided no details of locations. Alien freshwater species were included by Rowson *et al.* (2021).

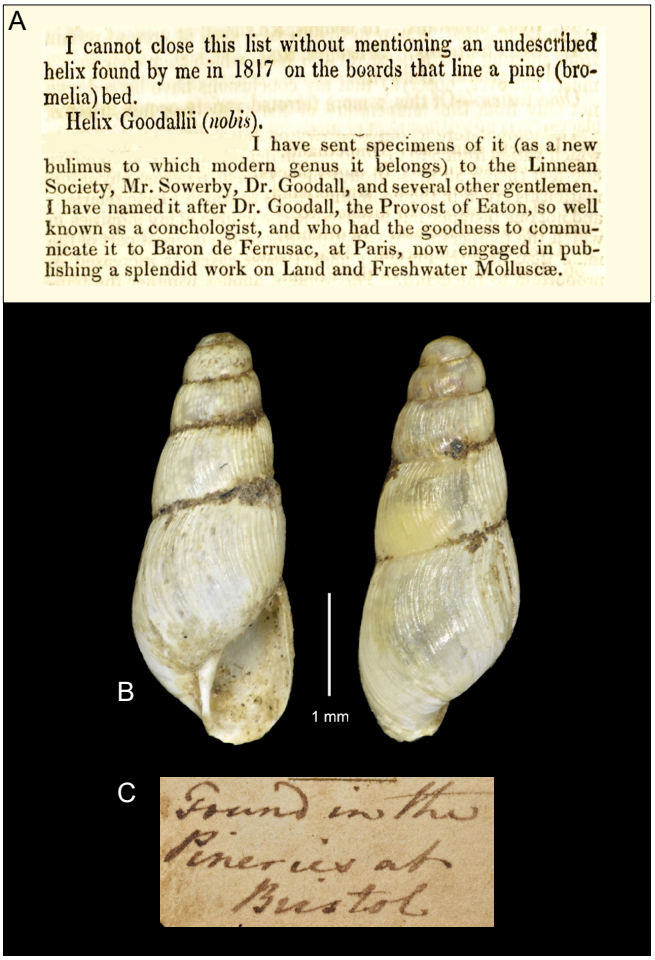


Figure 1. The first species found as a hothouse alien in Britain, *Opeas hannense*. **A**, as *Helix Goodallii* (Miller 1822: 381). **B**, possible syntype of *O. Goodallii*, now in the William Lyons collection in Tenby Museum, Pembrokeshire, Wales. **C**, label of the same. B and C reproduced from Mollusca Types in Britain and Ireland 2024, https://gbmolluscatypes.ac.uk/specimens/5471/Helix-goodallii, © Tenby Museum & Art Gallery, licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

These publications almost entirely concerned those species known from only a few botanical gardens, principally those at Kew in London, Cambridge, Glasgow, Edinburgh, and Glasnevin in Dublin, although there are more records on the Conchological Society database. There has been no

comprehensive study of alien hothouse molluscs that may be found in numerous other botanical gardens, as well as other locations which have hothouses, such as zoos, butterfly farms, and public parks—the majority of these have never had their mollusc assemblages studied.

Materials and Methods

The project

The project arose in 2014 following a visit to the botanic gardens in Oxford and investigation of two alien freshwater snails in the heated Lily House that were clearly not on the list of British molluscs. So began a search of other hothouses to determine what species may be present. This project was driven by my curiosity, as well as the need to document the species present and inform each location what species they held, to update the CS database, and to consider the implications of these species' survival in the open, especially in the light of our changing climate. I also reviewed the literature and databases to gather all records of hothouse alien molluscs in Britain and Ireland.

Fieldwork

Over 10 years, I visited 56 locations in Britain and Ireland which contained hothouses open to the public (Fig. 2). These included 28 botanical gardens, eight zoos, seven but-

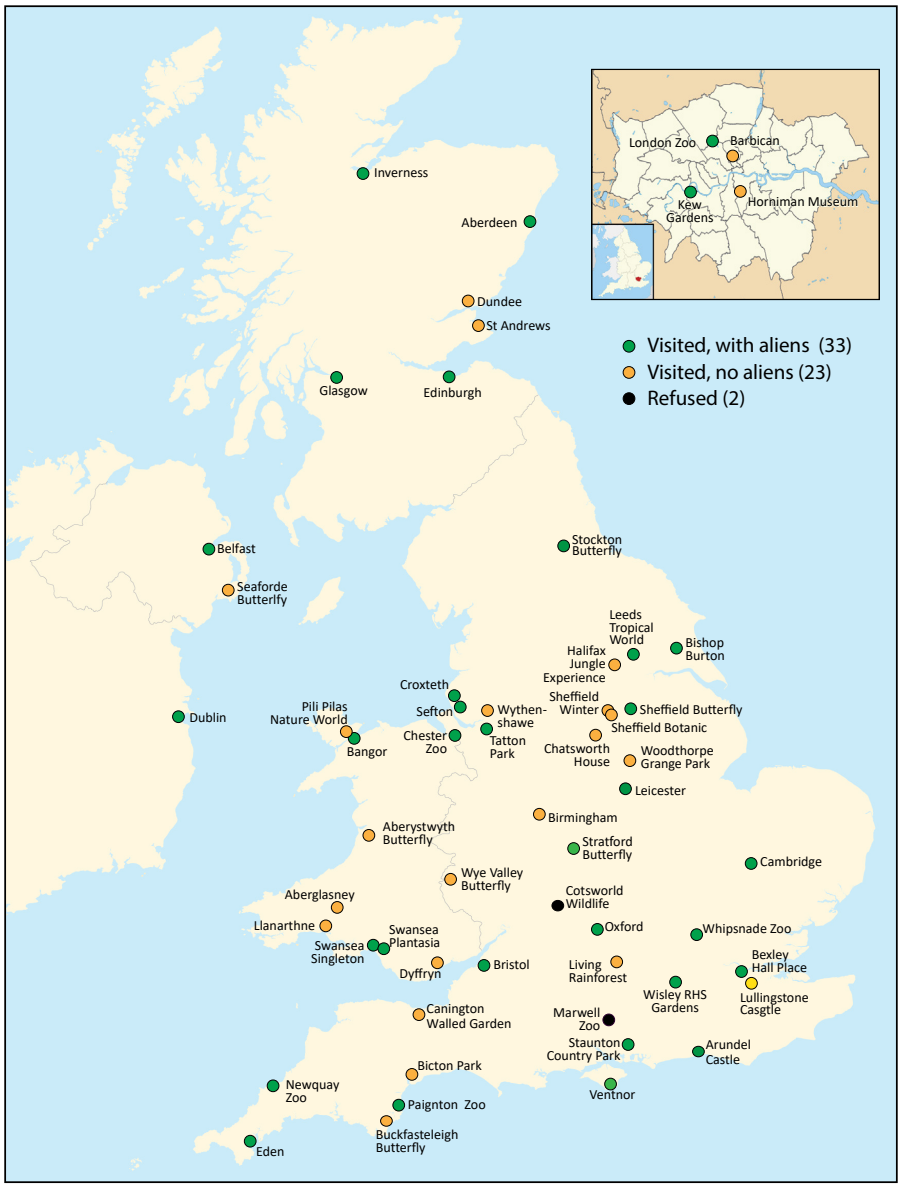


Figure 2. Hothouse locations visited, with presence or absence of hothouse alien mollusc species indicated.

terfly farms or houses, nine public parks, and five miscellaneous locations such as stately homes and castles. Permission to study the molluscs was obtained for almost all visits. Curators were made aware that some specimens would need to be collected for identification under the microscope or for COI gene sequencing. Two locations (Cotswold Country Park and Marwell Zoo) declined permission on the basis that they would not allow any biota to be removed from their sites. A single visit was made to most sites, although additional trips were made to Wisley RHS Gardens (4 visits), Kew Gardens (3 visits), Cambridge Botanic Gardens (3 visits), and Oxford Botanic Gardens (2 visits). This approach clearly has its drawbacks, as multiple visits would undoubtedly yield additional species. Additionally, most visits were by a single observer (myself), whereas multiple observers would likely have increased the detection rate.

I explored the publicly accessible hothouses at each location for molluscs and recorded the species found. At many sites I was permitted into areas closed to the public, for example, areas for the propagation or storage of flora. Representative specimens of most hothouse aliens were collected for identification, either microscopically or by barcoding using the COI gene. I took the opportunity to record non-hothouse alien molluscs observed at each location, 50 species being found. These are not included in this report, but the findings have been submitted to the CS database.

Internet searches identified many other glasshouses, but I visited only those glasshouses that were heated. There are undoubtedly other heated environments that I have not visited.

Literature and database searches

The *Journal of Conchology*, *The Conchologists' Newsletter*, and the *Proceedings of the Malacological Society* were searched for any report of alien hothouse species, as were the *Kew Bulletin* and its predecessor, the *Bulletin of Miscellaneous Information*. Books containing information of British non-marine molluscan fauna were examined for alien species. Internet searches for each species were made and revealed other information in various publications. There are likely additional reports of alien molluscs in local natural history society reports.

Database searches included the CS database, the National Biodiversity Network (NBN Trust 2025), and iRecord. The holdings of The Natural History Museum (NHM, London), the National Museum of Wales (NMW, Cardiff), and the National Museum of Scotland (NMS, Edinburgh), were interrogated. I visited the NHM and Adrian Sumner explored the holdings at the NMS, in both cases to find specimens which are not yet online.

The findings of these searches comprise Tables A1 and A2 in the Appendix.

Format of the list

Citations are included to the first British or Irish observation of each species. Full references to each later historical observation are given in the Appendix. Nomenclature follows MolluscaBase (MolluscaBase Eds 2024). The taxonomic order follows Anderson & Rowson (2020). 'First' and 'Subsequent' observations refer to Britain and Ireland only. Global distribution data has been obtained primarily from the Global Biodiversity Information Facility (GBIF; https://www.gbif.org).

All photographs are by the author unless otherwise stated.

Hothouse alien species extant in Britain and Ireland

Family Thiaridae

Melanoides tuberculata (O.F. Müller, 1774)

Figure 3

First observation. The first dated report in Britain was by J.W. Poulton, who exhibited it at a CS meeting in 1957 (Anonymous 1958).

Subsequent observations (Table A1). Kew Gardens, Liverpool Museum Aquarium and Glasgow Botanic Gardens. Six new locations: Bangor Treborth Gardens; Leeds Tropical World; Oxford Botanic Gardens; Staunton Country Park;

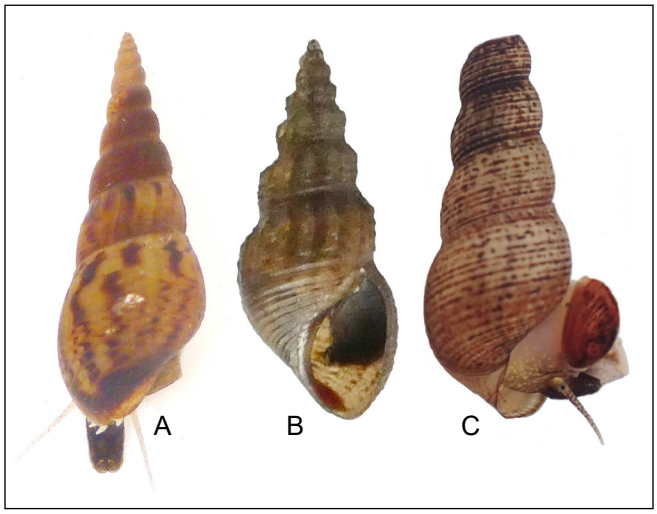


Figure 3. Variability of *Melanoides tuberculata*. **A**, smooth form (Oxford Botanic Gardens). **B**, nodose form (Staunton Country Park). **C**, truncated form (Glasgow Botanic Gardens).

Ventnor Botanic Gardens (dead shells only); Whipsnade Zoo.

Global distribution. Tropical Africa and south-east Asia.

Habitat. Typically found in shallow slow-running or standing waters.

Remarks. This is an extremely variable species (Fig. 3), reflected in the numerous synonyms (MolluscaBase Eds 2024).

It was abundant in most hothouses where it was found, and several hundred being present at Staunton Country Park in Hampshire.

There is a single report of *M. tuberculata* living in the open in Britain, in the warm industrial outflow channel draining into the River Tyne about 10 km upriver from Newcastle in Northumberland (Norris 2018). Whether this population will persist remains to be seen, but there is no concern that *M. tuberculata* could become established in the open elsewhere in Britain in the absence of artificially warmed water.

In some tropical countries *M. tuberculata* is an intermediate host of at least 11 human-infectious trematode parasites (e.g. Krailas *et al.* 2014; Tolley-Jordan *et al.* 2022; Metz *et al.* 2023), but these parasites are very unlikely to survive in temperate Britain or Ireland.

A COI mtDNA sequence was successfully obtained from a specimen from Glasgow Botanical Gardens with a 99% match to GenBank MT499036 for *M. tuberculata* (National Museum of Wales, specimen FW DNA 32) (B. Rowson pers. comm.).

Family Lymnaeidae

Radix rubiginosa (Michelin, 1831)

Figure 4A

First observation. Kew Gardens and Irish aquaria, undated (Anderson 2005). No early records in the CS database.

Subsequent observations (Table A1). Five new locations: Bristol Botanic Gardens; Glasgow Botanic Gardens; Oxford Botanic Gardens; Staunton Country Park; Whipsnade Zoo.

Global distribution. South-east Asia.

Habitat. Typically found in slow-moving water or poorly drained ponds.

Remarks. This species is very similar to the well-known, common *Ampullaceana balthica* (Linnaeus, 1758), but the animals differ in their pigmentation. *Radix rubiginosa* has dark speckling on the body (Fig. 4A); in *A. balthica* the speckling is very fine and pale (Fig. 4B).

COI gene sequencing was attempted (National Museum of Wales, specimen FW DNA 62) but was unsuccessful (B. Rowson pers. comm.).

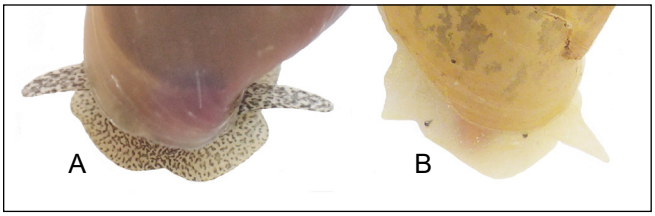


Figure 4. A, *Radix rubiginosa* showing dark speckles on its body. **B**, *Ampullaceana balthica* showing very fine, pale speckling.

Family Planorbidae

Planorbella cf. *duryi* (Wetherby, 1879)

Figure 5

First observation. Kew Gardens, London, 1948 (Verdcourt 1949).

Subsequent observations (Table A1). Glasgow and Inverness. Five new locations: Bristol Botanic Gardens; Oxford Botanic Gardens; Staunton Country Park; Ventnor Botanic Gardens; Whipsnade Zoo.

Global distribution. Native to Florida, USA (Wetherby 1879); now widespread in temperate zones of the Americas and Europe.

Habitat. Slow-moving streams, ditches, ponds, and wetlands.

Remarks. Identification of these hothouse-restricted planorbids is uncertain, but they are most likely *P. duryi*, although similar species may be present (Rowson *et al.* 2021).

It is a common aquarium species, available in a wide range of colours, from pink to blue, and it is inevitable that aquarists will "dump" unwanted snails. There appears to be no risk of this species becoming established in the open, although at Whipsnade Zoo, juveniles were observed in

Figure 5. A juvenile *Planorbella* cf. *duryi* from the outdoor holding tank at Whipsnade Zoo.

outdoor holding tanks (Fig. 5). This planorbid has not been found in the open in Britain or Ireland.

COI gene sequencing was attempted but was unsuccessful (National Museum of Wales, specimen FW DNA 75; B. Rowson pers. comm.).

Family Pleurodiscidae

***Pleurodiscus balmei* (Poitiez & Michaed, 1838)**

First observation. Glasnevin, Dublin (Stelfox 1911).

Subsequent observations (Table A1). Glasgow, Edinburgh, and Kew. Current study: Glasgow Orchid House (1 dead shell).

Global distribution. Mediterranean.

Habitat. Open and ruderal habitats.

Remarks. There is an open-air find in Canterbury, Kent, in 1979 (McMillan 1980). It is presumed to have been adventive.

Family Pristilomatidae

***Hawiia minuscula* (A. Binney, 1841)**
Figure 6

First observation. Orchid house, Nottingham, 1883 (Sturgess Dodd & Woodward 1906; Swanton 1906; Ellis 1926).

Subsequent observations (Table A1). Belfast, Cambridge, and Bangor. Current study: Aberdeen Winter Gardens; Bexley Hall Place (dead shells); Bishop Burton (dead shells); Sheffield Butterfly House; London Zoo; Wisley RHS Gardens.

Figure 6. *Hawaiia minuscula* in the David Welch Winter Gardens, Aberdeen.

Figure 7. *Oxychilus translucidus* from the Butterfly House at Whipsnade Zoo.

Global distribution. Widespread in North and Central America, with occurrences in Eastern Asia and Australia.

Habitat. generally found on bare ground.

Remarks. The small size (to 2.5 mm) of *H. minuscula* and similarity to juvenile *Vallonia* species in which the final whorl has not expanded possibly means that this species has gone largely unnoticed.

In the David Welch Winter Gardens in Aberdeen, *H. minuscula* was seen crawling over snail pellets and may not be susceptible to the chemicals within those pellets.

Family Oxychilidae

***Oxychilus translucidus* (Mortillet, 1853)**
Figure 7

First observation. Butterfly House, Whipsnade Zoo, Bedfordshire, 2017 (Guntrip & Rowson 2024).

Subsequent observations (Table A1). Not found at any other location, but still present at Whipsnade Zoo in 2022.

Global distribution. Known from a few European sites.

Habitat. Under shrubs and stones.

Family Gastrodontidae

***Zonitoides arboreus* (Say, 1817)**
Figures 8, 9

First observation. Glasnevin, Dublin, prior to 1911 (Stelfox 1911). The date of the first observation was not recorded.

Subsequent observations. Numerous locations in Britain (Table A1) but not recorded in Ireland after the initial report (Fig. 8).

Global distribution. Widespread in North and Central

Figure 8. Locations where *Zonitoides arboreus* was found; those in red are where the species has not previously been recorded.

America and Europe, with populations in the Far East and Australia.

Habitat. Humid woodland and similar habitats.

Remarks. By far the most frequently observed snail in the study, being present in over one third of all sites visited. Earlier reports were almost all from botanic gardens, but the current survey was able to add its presence at 14 new locations, which included botanic gardens, zoos, butterfly farms, parks, and castles. It is similar to our open-air *Zonitoides nitidus* (O.F. Müller, 1774), but has prominent radial ridges on the whorls, and the animal has a foot entirely white in its lower half (Fig. 9).

Figure 9. *Zonitoides arboreus* from Hall Place Gardens, Bexley, Kent.

This snail is a potential threat should its spread not be controlled. It is well known to be a major pest to orchids, feeding on their roots, especially those in greenhouses (e.g. Verdcourt 1979; Menis 1980; Hollingsworth & Sewake 2002). It is reassuring that no specimens of this species were found in the publicly closed areas of the Tropical Houses at Kew Gardens, and only dead shells on the Carnivorous Zone of the Prince of Wales Conservatory. It to be hoped that this species can be contained within glasshouses in Britain and Ireland, but its widespread distribution and the fact that it has been found in the open as far north as Polz in northern Germany (Jueg & von Proschwitz 2003) and in Sweden (Dvořák & Kupka 2007) suggests that open-air colonization could be possible in Britain and Ireland.

Family Euconulidae

Afropunctum seminium (Morelet, 1873)

First observation. Wet Tropics Zone, Kew Gardens, 1993 (Reynolds 1993; Verdcourt 1993b).

Subsequent observation (Table A1). Butterfly House, Whipsnade Zoo (D. Guntrip pers. comm.), but the identification is unconfirmed.

Global distribution. Central and southern Africa,

Habitat. Forest leaf litter.

Family Microcystidae

Liardetia samoensis (Mousson, 1865)

Figure 10A

First observation. Tropical Zone, Royal Horticultural Society Gardens, Wisley, 2014 (Walker *et al.* 2024).

Subsequent observations (Table A1). No other locations known, but additional specimens have been collected at Wisley up to 2024.

Global distribution. Pacific Ocean islands and Maldive Islands.

Habitat.

Remarks. This species has been regularly observed at the RHS, Wisley for over 10 years, confirming that there is an established breeding population. A full discussion of its

Figure 10. A, *Liardetia samoensis* found living on the concrete walls (**B**) of the upper part of the Tropical Zone at Wisley.

discovery and identification has already been published (Walker *et al.* 2024).

Family Chronidae

***Kaliella barrakporensis* (Reeve, 1852)**

First observation. Tropical Biome, Eden Project, 2010 (Preece & Naggs 2014).

Subsequent observations (Table A1). No other locations. A single dead shell was found in the Eden Project Tropical Biome during the present survey, but a confirmed report of live specimens in March 2024 (CS database) suggests that the species is surviving in the Eden Project.

Global distribution. Southern India, East and Southern Africa.

Habitat. Leaf litter.

Family Achatininidae

***Allopeas clavulinum* (Poitiez & Michaud, 1852)**
Figure 11

First observation. Commercial orchid houses in Nottingham, 1883 (Brindley 1904; Sturgess Dodd & Woodward 1906), but both publications refer to undated observations at Cambridge.

Subsequent observations (Table A1). Kew Gardens; Glasgow; Edinburgh Botanic Gardens. Five new locations this study: Chester Zoo, Newquay Zoo, Paignton Zoo, Eden Project, Swansea Plantasia.

Global distribution. Tropical East Asia, eastern Australia, Pacific Ocean Islands, south-eastern North and South America.

Figure 11. *Allopeas clavulinum* crawling over the ground in the Reptile House at Newquay Zoo.

Habitat. Leaf litter.

***Allopeas gracile* (Hutton, 1824)**

First observation. Cambridge, 2011 (Preece & White 2012).

Subsequent observations (Table A1). An iRecord report of the snail in Swindon in 2023 begs the question of an adventitious presence or misidentification.

Global distribution. Worldwide in the tropics.

Habitat. Leaf litter.

Remarks. If is uncertain if this species should remain on the British list, having only been found twice.

***Opeas hannense* (Rang, 1831)**
Figure 12

First observation. Bristol, 1817 (Miller 1822 as *Helix goodallii*).

Subsequent observations (Table A1). Numerous botanic gardens in Britain and Ireland. Present study: Eden Project (live); Swansea Plantasia (live); Edinburgh Royal Botanic Gardens (dead).

Figure 12. *Opeas hannense* in the main Tropical House at Swansea Plantasia.

Global distribution. Worldwide in tropical areas.

Habitat. Leaf litter.

Remarks. There are several presumed adventitious reports.

Subulina octona (Bruguière, 1789)

Figure 13A

First observation. Bristol, 1820 (CS database).

Subsequent observations (Table A1). In the propagating pits at Kew Gardens in 1884 (Brindey 1906), and since been reported from many sites in England and Ireland, although none from Scotland. In the current study: in the Eden Project (live and dead shells) and Swansea Plantasia (dead shells). **Global distribution.** Widespread in tropical areas worldwide.

Habitat. Leaf litter.

Remarks. The CS database includes several entries for "*Subulina* sp." some of which are from Scotland. There is often difficulty separating this species from *Striosubulina striatella* (Fig. 13), and it is probable that there is cross-identification of the some of the records for each species.

Striosubulina striatella (Rang, 1831)

Figures 13B, 14

First observation. Glasgow, 1906 (Anonymous 1907 as *Striatella octona*, but since redetermined Weddle (2020)).

Subsequent observations (Table A1). Kew Gardens, 1967. Six new locations in the current study: Cambridge Botanic Gardens (dead), Chester Zoo, Oxford Botanic Gardens, St Austell Eden Project, Staunton Country Park, Whipsnade Zoo.

Global distribution. West Africa, with some records from Madagascar.

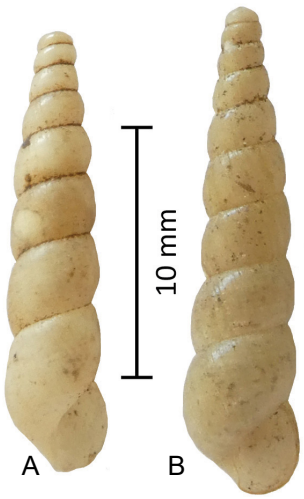


Figure 13. Dead specimens of (**A**) *Subulina octona* (Swansea Plantasia) and (**B**) *Striosubulina striatella* (Whispnade Zoo) demonstrating the difference in size of the two species.

Figure 14. *Striosubulina striatella* in the Palm House at Kew Gardens; an egg can be seen in the penultimate whorl.

Habitat. Damp leaf litter.

Remarks. COI mtDNA sequencing of a specimen from Glasgow Botanical Gardens was successful and showed with a 98% match to GenBank MF415358 for *S. striatella* (National Museum of Wales, specimen FW DNA 106; B. Rowson pers. comm.).

When present it is often in very large numbers. An approximately 1 L sample of leaf litter was taken from the Tropical Biome at the Eden Project, which had about 125 live specimens from very early juveniles (1–2 whorls) to fully grown adults, many of which contained eggs (Fig. 14). It has been reported as a pest, feeding on the roots of plants (Kerney & Cameron 1979).

Family Streptaxidae

Gulella io Verdcourt, 1974

Figure 15

First observation. This species is special in the British faunal list as the first description of it was in 1969 following its discovery two years earlier by John Armitage and Adrian Norris at Kew Gardens in Aroid House 1 (Verdcourt 1969), which was later demolished. The hothouse species was similar to one found by Matthew Connolly in 1931 in Edinburgh, which at the time was considered to be *Gulella devia* Connolly, 1931, a species he had observed in Uganda. Verdcourt examined those specimens and determined that they were, in fact, the same as those from Kew. After examining specimens from hothouses in Bratislava, the former Czechoslovakia, Verdcourt (1974) named it as a new species.

Subsequent observations (Table A1). Wisley RHS Gardens; Tropical Bird House at London Zoo; Cambridge Botanic Gardens.

Global distribution. Now known to have originated from

Figure 15. *Gulella io* very much alive in the Palm House at Kew Gardens in October 2023.

Liberia in West Africa (Oke & Alohan 2006). It is otherwise only known from European hothouses.

Habitat. Leaf litter.

Remarks. This snail was not found at any of the previously recorded locations other than a single specimen in the Palm House of Kew Gardens (Fig. 15). It seems that this beautiful snail may be on the brink of extinction in Britain, but it is hoped that appropriate conservation at Kew may allow it to recover.

***Tomostele musaecola* (Morelet, 1860)**
Figure 16

First observation. Glasgow Botanic Gardens, 2013 (Naggs 2014).

Subsequent observations (Table A1). Glasgow, 2016; Whipsnade Zoo, 2017 (P. Topley & M. Telfer pers. comm.). Current study study: Whipsnade, 2022 (alive).

Figure 16. *Tomostele musaecola* in the Butterfly House of Whipsnade Zoo.

Global distribution. Scattered distribution in the Caribbean, in Central Africa, and on the Pacific islands.

Habitat. Leaf litter.

Remarks. The finding of several live specimens in 2022 at Whipsnade provides evidence of breeding population (Fig. 16).

Species now probably no longer present in Britain and Ireland

Several species of non-marine alien molluscs have been reported in the British or Irish literature for which no recent records have been documented. All records are included in Table A2. Identifications of some species may have been mistaken, while for others there is little evidence of breeding populations, and some records likely represent finds of adventitious introductions. Only brief notes on each of these species are given below.

Family Lymnaeidae

***Galba cubensis* (L. Pfeiffer, 1839)**

Observations. Glasnevin Gardens, Dublin, before 1949 (Table A2).

Remarks. It is possible that this was a misidentification for the similar native *Galba truncatula* (O.F. Müller, 1774), a common open-air species in Britain and Ireland.

***Galba rustica* (I. Lea, 1841)**

Observations. Glasnevin Gardens, Dublin, before 1949 (Table A2).

Remarks. It is possible that this was also a misidentification for the similar *Galba truncatula*.

***Pseudosuccinea columella* (Say, 1817)**
Figure 17

Observations. Edinburgh Royal Botanic Gardens, 1935 and 1948 (Table A2).

Remarks. The 13-year period between collections made in Edinburgh implies that there was an established population. There are no recent records, but *P. columella* is established in many glasshouses on the Continent.

***Racesina luteola* (Lamarck, 1822)**

Observations. Kew Gardens, 1975 (Table A2).

Remarks. There have been no subsequent reports of this

Figure 17. *Pseudosuccinea columella* in the National Museum of Edinburgh (NMS Z.159.21.422) (photo: Adrian Sumner).

species from Kew or elsewhere. Perhaps the species was misidentified for *Radix rubiginosa* or adventitious.

Family Planorbidae

***Glyptophysa novahollandica* (Bowditch, 1822)**

Observations. Swansea (presumably Singleton Gardens) (Table A2).

Remarks. *Physastra dispar* (G.B. Sowerby II, 1873) presumably now refers to *G. novahollandica*. This is an extremely variable species which was likely to have been misidentified, or was adventitious.

***Gyraulus chinensis* (Dunker, 1848)**

Observations. Liverpool Museum Aquarium, 1975 and 1997; Northern Ireland, undated (Table A2). Anderson (2005: 632) stated that is it "common in tropical aquaria", but no supporting evidence was provided, and there are no records on the CS database.

Remarks. It is possible that this species is no longer extant in Britain and Ireland.

***Helicorbis* ? *umbilicalis* (W.H. Benson, 1836)**

Observations. Kew, 1943 (Table A2).

Remarks. This identification of this record was uncertain. It is perhaps a misidentification for *Gyraulus chinensis*, or was adventitious.

Family Physidae

***Stenophysa marmorata* (Guilding, 1828)**

Observations. Kew Gardens, 1967 (Table A2).

Remarks. Had Kew received a new batch of plants which were distributed to each House and its presence short lived, or was it misidentified for *Physella acuta* (Draparnaud, 1805), which is now common in Kew hothouses (pers. obs.)?

Family Limacidae

***Ambigolimax waterstoni* Hutchinson, Reise & Schlitt, 2022**

Observations. Edinburgh and Glasgow Botanic Gardens, both 1930 (Table A2).

Remarks. This species was first recognized by Waterston (1934) referred to as "*Limax* sp." Hutchinson *et al.* (2022) examined Waterston's specimens preserved in the National Museum of Scotland and confirmed that these were a previously undescribed species. It has not been recorded since the 1930s in Britain or Ireland but has been found elsewhere (Elba, Algeria, South Africa, Australia, New Zealand, and Washington DC).

Family Helicodiscidae

***Helicodiscus parallelus* (Say, 1821)**

Observations. Several reports from locations in Britain and Ireland: early 20th century in Ireland up to 1988 in Glasgow. Three reports from Cambridge between 1920 and 1986.

Remarks. The sporadic dating and lack of evidence of breeding populations suggest that all these observations are adventitious.

Family Chondridinae

***Solatopupa similis* (Bruguière, 1792)**

Observations. Lancashire, 1878 and 1889 in the open; later said to have been found in a few hothouses and nurseries (Table A2).

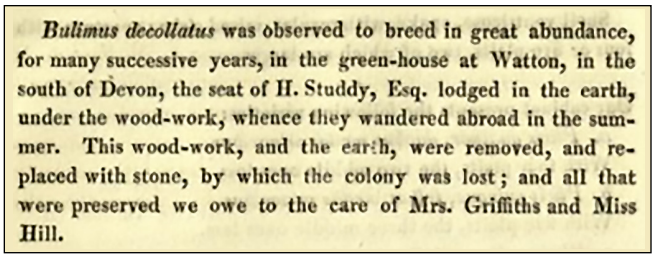
Remarks. Neither Swanton (1906) nor Ellis (1926) gave any specific locations or dates, and it is presumed that their information is probably incorrect and anecdotal.

Family Achatinidae

***Beckianum beckianum* (L. Pfeiffer, 1846)**

Observations. Rowntree's Tropical House, York, 1925 (Table A2).

Remarks. This species was likely to be adventitious, or perhaps a misidentification for *Allopeas clavulinum* or *A. gracile*.



Bulimus decollatus was observed to breed in great abundance, for many successive years, in the green-house at Watton, in the south of Devon, the seat of H. Studdy, Esq. lodged in the earth, under the wood-work, whence they wandered abroad in the summer. This wood-work, and the earth, were removed, and replaced with stone, by which the colony was lost; and all that were preserved we owe to the care of Mrs. Griffiths and Miss Hill.

Figure 18. The original report of *Rumina decollata* in Devonshire (Turton 1826: 565).

Rumina decollata (Linnaeus, 1758)

Observations. Watton, Devonshire, 1826 (Fig. 18) and 1920s (Table A2). Turton (1831: 77) later wrote that gardeners at Watton regarded the species as native, as "No foreign earth was ever known to have been admitted to the house", and that the greenhouse was removed, and the colony died out.

Remarks. There have been no later reports of this species in Britain, apart from an adventive observation in 2005 (Seddon & Pickard 2005). It is a large-shelled species (to 40mm in long) and is unlikely to have been overlooked in hothouses over the last 200 years. Its inclusion by Naggs *et al.* (2021) in their identification guide to British land snails does not appear justified, and this species should probably be deleted from the current British list.

Discussion

The subject of hothouse alien molluscs in Britain and Ireland has been largely overlooked in recent years. The last full listing of hothouse aliens was in 1951 (Conchological Society Non-marine Recorders 1951), although land snails have been illustrated more recently (Naggs *et al.* 2014, 2021), and freshwater alien species were described by Rowson *et al.* (2021).

Many of these alien species are native to tropical or semi-tropical countries, where the climate allows them to survive in the open throughout the year. The colder climate in northern Europe results in most of these species being restricted to glasshouses that are heated in winter, although in parts of Europe where winters tend to be warmer some species have managed to spread into the open and maintain breeding populations (Hausdorf 2023). However, it is very unlikely that they could survive in the open in the cooler British and Irish climate.

Species that are native to cooler, temperate climates present a greater risk of establishing open-air populations in Britain and Ireland. Mediterranean species such as *Pleurodiscus balmei*, *Solatopupa similis*, or *Rumina decollata*, and North American species such as *Zonitoides arboreus*, *Hawaiia minuscula*, and *Helicodiscus parallelus*, which have native populations as far north as 50°N or higher (Hausdorf 2023), could be become established in the open in Britain and Ireland in the future. Some of these molluscs are no longer extant in British or Irish hothouses and establishing open-air populations would necessitate reintroduction.

There are two slug species that demonstrate well that hothouse species can become established in the open. *Ambigolimax parvipenis* (Bourguignat, 1861) (until recently called *A. nyctelius*) is native to south-eastern Europe and was first observed in a hothouse in the Edinburgh Royal Botanic Gardens in 1934 by Andrew Waterston (CS database; Hutchinson *et al.* 2022), while *Ambigolimax valentianus* (A. Férussac, 1821), native to the Iberian Peninsula, was first seen in the Singleton Gardens in Swansea in 1936 (Quick 1949). For many years these two species remained confined to heated glasshouses, but in 1981 *A. valentianus* was recorded in the open at Portmarnok, Co. Dublin (Kerney 1982), and in 1987 *A. parvipenis* was found in the open in Pakefield, Sussex (Killeen 1987). Both species are now widespread in Britain and less so in Ireland (Fig. 19). These "escapees" do not appear to pose any serious threat to vegetation and have been classified as a minor or occasional pest (Rowson *et al.* 2014). Why they have been able to move outdoors into the colder winter climate after around 50 years of confinement to hothouses is open to speculation, but perhaps there was some minor genetic modification that allowed this.

To date, there have been only sporadic reports of other hothouse aliens being found in Britain or Ireland in the open (see species descriptions above and Table A1), and it is probable that most of these observations are adventitious. However, climate change may mean that in some areas of the country winters will become warmer, allowing some species to tolerate winter out of doors in some microclimates. It is unknown whether any would pose any economic or environmental threats, but there seems little reason for concern, except perhaps for *Zonitoides arboreus*, a known pest of orchids.

Many non-native species, both flora and fauna, arrive unintentionally in Britain and Ireland with imported goods, mostly on plant material or with human or animal food (e.g. Cavadino 2022). The majority are intercepted at the site of import or eradicated during quarantine, but some survive this process. Eggs of molluscs are especially a problem, as they may elude visual inspection and survive hidden and viable during a quarantine period. Plants that carry unintended visitors make their way to garden centres and from

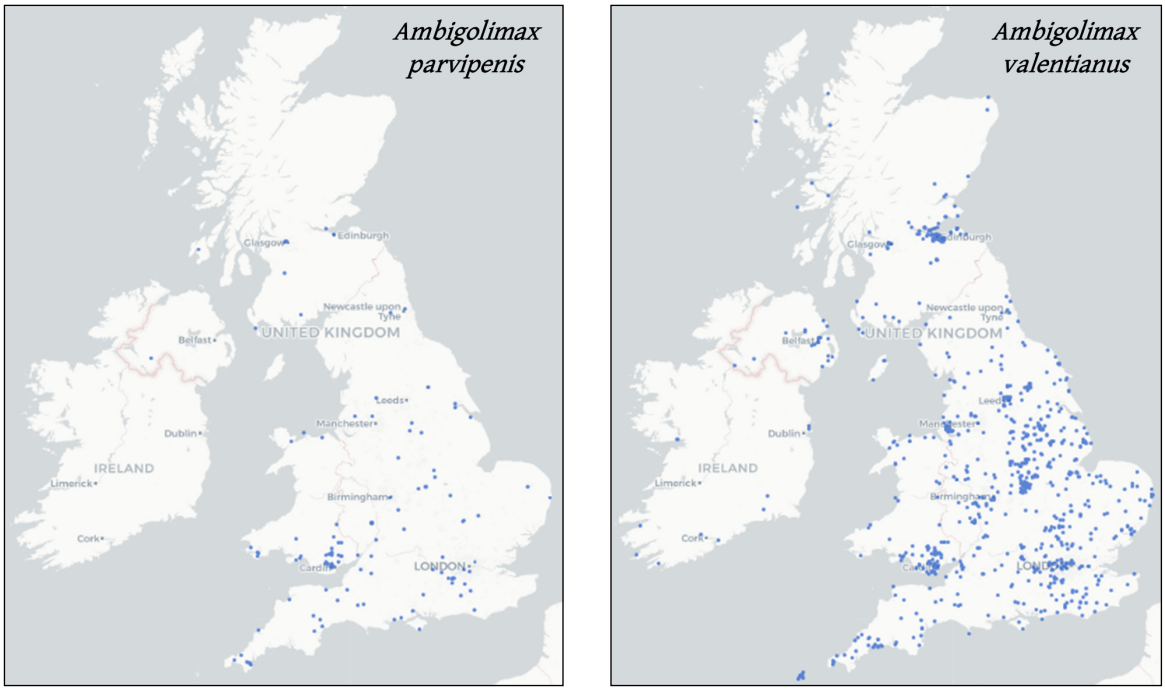


Figure 19. The distributions of *Ambigolimax parvipenis* and *A. valentianus* in 2023 (National Biodiversity Network). (Species maps from NBN Trust 2025; reproduced under Conchological Society Creative Commons BY license).

there into the home gardens, while others go directly to botanical gardens. Subsequent movements of plants, soil, and garden debris, from one location to another further the spread of alien molluscs.

About 20 alien mollusc species not yet known in Britain or Ireland have been recorded in European glasshouses in the last 25 years, and it clear that there is potential for these to arrive in Britain or Ireland. It is also likely that more species remain undetected, both here and in mainland Europe. They may already be established in some locations, but either were not detected during this project or at locations not visited. It is of interest that no alien bivalves have been reported in European glasshouses.

Conclusions

Recording of hothouse alien mollusc in Britain and Ireland has traditionally been limited to Botanic Gardens, with very little investigation of other establishments that have heated glasshouses, such as Zoos and Butterfly Houses. This study has demonstrated that alien species are present in many previously unrecorded sites. It is likely that more exist that have not yet been found, since the study mainly involved a single observer with single visits to hothouses. While the great majority of these aliens are probably of no biological concern, it is important that their presence in Britain and Ireland is documented.

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Appendix

Table A1. British and Irish hothouse alien molluscs in literature and databases. Adventive (both likely or definite) and open-air records are included. This includes records from garden centres or other locations when it is very unlikely that breeding populations are established. Abbreviations: CS = Conchological Society; NBN = National Biodiversity Network; NHMUK = Natural History Museum, London; NMS = National Museum of Scotland, Edinburgh; NMW = National Museum and Galleries of Wales, Cardiff. New sites found in this study are in bold type.

Family	Species	Site	Date	Recorder	Source of record or specimen
Thiaridae	*Melanoides tuberculata*	Dorking [possibly adventive]	Undated	Presented by G. Wilson	NHMUK 20000240
		Kew Gardens, London: Greenhouse 15	1957.vii.01	J.W. Poulton	Anonymous 1958
		Kew Gardens, London: House 10 Amazonica House 15 Waterlily	1967.ix.05	Bernard Verdcourt	Airy Shaw 1973
		Liverpool Museum Aquarium	1975	Nora McMillan	McMillan 1998
		Liverpool Museum Aquarium	1997	Marie Tracey	McMillan 1998
		Farr's Garden Centre, Caddington, Bedfordshire [likely adventive]	1986.i.08	Dave Guntrip	CS database
		Glasgow Botanic Gardens	2013.ii.12	Adrian Sumner	Naggs 2014
		Kew Gardens, London: POW Conservatory 1 Tropical Rainforest	2014.x.10	Tom Walker	This study
		Oxford Botanic Gardens: Lily House	2014.vii.19	Tom Walker	This study
		Glasgow Botanic Gardens: Orchid House, Lily House	2016.v.04	Tom Walker, Peter Dance	Weddle 2020
		Tributary of River Tyne, Northumberland [open-air, in warm industrial outflow waters]	2017.viii.04	Russell Barber	CS database
		Bangor, Treborth Gardens: Tropical House	2017.ix.27	Tom Walker	This study
		Leeds Tropical World: aquarium tanks	2018.ix.06	Tom Walker	This study
		Whipsnade Zoo, Bedfordshire: aquarium tanks	2022.vii.15	Tom Walker, Dave Guntrip, Peter Topley	This study
		Ventnor Botanic Gardens, Isle of Wight: Tropical House	2022.ix.21	Tom Waker	This study
		Isle of Wight [adventive]	2023.ix.02	Daniel King	iRecord [shell only; ident. confirmed]
Lymnaeidae	*Radix rubiginosa*	Kew Gardens, London: Victoria House	Undated	—	Anderson 2005
		Ireland: "aquaria"	Undated	—	Anderson 2005
		Kew Gardens, London: POW Conservatory 1 Tropical Rainforest Waterlily House	2014.x.10	Tom Walker	This study
		Oxford Botanic Gardens: Lily House	2014.vii.19	Tom Walker	This study
		Bristol Botanic Gardens: Tropical Zone 17	2014.x.16	Tom Walker	This study
		Staunton Country Park, Hampshire: Lily Pond House	2015.i.28	Tom Walker	This study
		Glasgow Botanic Gardens: Lily House	2016.v.04	Tom Walker, Peter Dance	This study
		Kew Gardens, London	2017.vii.10	Richard Comont	CS database
		Baslow, Derbyshire: Aquarium	2022.i.11	Peter Tattersall	CS database
		Whipsnade Zoo: Aquarium	2022.vii.14	Dave Guntrip, Peter Topley, Tom Walker	This study
		Kew Gardens, London: Tropical Glasshouse 5 Temperate Carnivorous Tropical Glasshouse 9 Warm Woody	2023.x.27	Tom Walker	This study
Planorbidae	*Planorbella* cf. *duryi*	Kew Gardens, London: Tropical Pits	1948.x	Bernard Verdcourtt	Verdcourt 1949 as *Helisoma duryi*, NHMUK 20250059/62
		Kew Gardens, London Oxford Botanic Gardens London Zoo	Undated	—	CS Census1951 as *Helisoma duryi*
		Kew Gardens, London: House 10 Amazonica House 15 Waterlily House 17A & B	1967.ix	John Armitage, Adrian Norris, Bernard Verdcourt	Airy Shaw 1973 as *Helisoma duryi*, NHMUK 20250060/61
		Kew Gardens, London: POW Conservatory Zone 1	1993.iii.06	CS field meeting	Verdcourt 1995, as undet. Planorbidae

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Planorbidae	*Planorbella* cf. *duryi*	"Common in tropical aquaria"	Undated	—	Anderson 2005
		Glasgow Botanic Gardens: Tropical Pond	2013.ii.12	Adrian Sumner	CS database
		Inverness Botanic Gardens	2013.v.26	Adrian Sumner	Pers. comm. as *Planorbella* sp.
		Oxford Botanic Gardens: Lily House	2014.vii.19	Tom Walker	This study
		Kew Gardens, London: POW Conservatory 1 Tropical Rainforest Waterlily House	2014.x.10	Tom Walker	This study
		Bristol Botanic Gardens: Tropical Zone 17	2014.x.16	Tom Walker	This study
		Wisley RHS Gardens: Tropical Zone	2014.xii.18	Tom Walker	This study
		Staunton Country Park, Hampshire: Lily Pond House	2015.i.28	Tom Walker	This study
		Glasgow Botanic Gardens: Lily House	2016.v.04	Tom Walker, Peter Dance	This study
		Whipsnade Zoo, Bedfordshire: Aquarian tanks	2022.vii.15	Dave Guntrip, Peter Topley, Tom Walker	This study
		Ventnor Botanic Gardens, Isle of Wight: Tropical House	2022.ix.21	Tom Walker	This study
		Kew Gardens, London: Tropical Glasshouse 3 Aquatic Tropical Glasshouse 9 Warm Woody	2023.x.20	Tom Walker	This study
Pleurodiscidae	*Pleurodiscus balmei*	Dublin Glasnevin	1910	Arthur Stelfox	Stelfox 1911–12 as *Patulastra flavida*
		Glasgow Botanic Gardens	Undated	—	Ellis 1926 as *Patulastra flavida*
		Dublin Glasnevin	Undated	—	Ellis 1926 as *Patulastra flavida*
		Glasgow Botanic Gardens: Orchid House	1968.vi.11	Beryl Rands	CS database
		Kew Gardens, London: Temperate Fern House 3 Range House	1975	Adrian Rundle	NHMUK 20050058
		Glasgow Botanic Gardens	1978.vi.15	Adrian Rundle	CS database
		Bekesbourne, Canterbury, Kent [open-air, likely adventive]	1979.ii.13	Nora McMillan	McMillan 1980
		Glasgow Botanic Gardens: Orchid House Filmy Fern House	1998.iii.12	Adrian Rundle	Hancock 1999
		Kew Gardens, London: Palm House	1993.iii.06	CS field meeting	Reynolds 1993; Verdcourt 1995
		Glasgow Botanic Gardens: Orchid House	1994.viii.16	Geoffrey Hancock	Hancock 1999
		Glasgow Botanic Gardens: Orchid & Cycad House	2013.ii.12	Adrian Sumner	Naggs 2014
		Edinburgh Botanic Gardens	2013.vi.22	Adrian Sumner	Pers. comm. as cf. *P. balmei*
		Glasgow Botanic Gardens: Orchid House [shell only]	2016.v.04	Tom Walker, Peter Dance	This study
Pristilomatidae	*Hawaiia minuscula*	The Grange, Cotham, Bluebell Hill, Nottingham = Mr Thacker's Orchid House	1883	—	Sturgess Dodd & Woodward 1906; Swanton 1906; Ellis 1926; all as *Zonitoides minusculus*
		Nottingham hothouse, property of R. Sturges Dodd	1903	Bernard Woodward	Anonymous 1903
		Belfast	Undated	—	Stelfox 1911–12 as *Zonitoides minusculus*
		Cambridge Botanic Gardens	1920	Hugh Watson	Watson 1929 as *Pseudovitrea minuscula*
		Ulster	Undated	—	Stelfox & Welch 1980
		Cambridge Botanic Gardens	1986.ix.06	Dave Guntrip	CS database
		Cambridge Botanic Gardens	2011.vii.23	Richard Preece, Tom White	Preece & White 2012 as *Zonitoides minusculus*
		Bangor, Treborth Gardens	2013.ix.04	Ben Rowson	Norris 2014
		Wisley RHS Gardens: Tropical Zone	2014.xii.18	Tom Walker	This study
		Aberdeen, David Welch Winter Gardens: Tropical House	2016.v.04	Tom Walker	This study
		Belfast Botanic Gardens: Palm House, Nursery	2017.ix.19	Tom Walker	This study
		Aston Butterfly House, Sheffield: Butterfly House	2019.iii.11	Tom Walker	This study
		Wisley RHS Gardens	2019.v.07	CS field meeting	CS database
		Hall Place Gardens, Bexley, Kent: Butterfly House	2022.vi.30	Tom Walker	This study
		Dyffryn Gardens, Glamorgan: Hothouse	2013.ii.17	Chris Owen, L. Olds	CS database

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Pristilomatidae	*Hawaiia minuscula*	**Bishop Burton Botanic Gardens, East Yorkshire: Potting Room**	2023.ix.25	Tom Walker	This study
		London Zoo: Tropical Birds House	2023.ix.04	Tom Walker	This study
		Inverness Botanic Gardens	2024.xii.14	Finley Hutchinson	iRecord [ident. confirmed]
Oxychilidae	*Oxychilus translucidus*	Whipsnade Zoo, Bedfordshire: Butterfly House	2017	Dave Guntrip	Guntrip & Rowson 2024
		Whipsnade Zoo, Bedfordshire: Butterfly House	2022.vii.15	Tom Walker, Dave Guntrip, Peter Topley	This study
Gastrodontidae	*Zonitoides arboreus*	Dublin Glasnevin	Undated	—	Stelfox 1911–12 as *Zonitoides* sp.
		Dublin Glasnevin Belfast: Crawford's nursery [likely adventive]	Undated	—	Ellis 1926
		Cambridge Botanic Gardens	Undated	Hugh Watson	Watson 1929
		Oxford Botanic Gardens	1932.vi	Presented by G.D.H. Carpenter	NHMUK 1931.6.4.11-15
		Kew Gardens, London: Fern House	1946.iv.16	A.D.J. Meuse	Meeuse 1948
		Whatcroft Hall, Northwich [glasshouses now gone]	1948.xii.19	W.M. Stirling	Verdcourt 1949; NHMUK 20200307
		Wisley RHS Gardens: orchid plot	1962	—	NBN database
		Kew Gardens, London	1967.i.29	Adrian Norris, John Armitage	Airy Shaw 1973
		Kew Gardens, London: House 1 Aroid	1967.ix.01	Bernard Verdcourtt	Airy Shaw 1973
		Kew Gardens, London: T-range hothouses	1975	Richard Preece	CS database
		Liverpool: Ness Gardens [glasshouses now gone]	1975.v.12	Chris Paul	CS database
		Crew's Hill, Enfield: garden centre [likely adventive]	1978.vi.12	Adrian Rundle	CS database
		Stockwood Bank, Luton [Corporation greenhouses; now gone]	1982.iii.09	Beryl Rands	CS database
		Reading [adventive]	1984.i	M. Hughes	CS database
		Leicester: Rotherby City Park Nurseries [glasshouses now gone]	1985.ix.14	Michael Kerney, Adrian Rundle	CS database
		Leicester: Belgrave Hall [some glasshouses still present)	1985.ix.14	Michael Kerney, Adrian Rundle	CS database
		Leicester University Botanic Garden, Beaumont Hall, Oadby	1985.ix.14	Michael Kerney, Adrian Rundle	CS database
		Leicester: Burley greenhouse [some glasshouses still present]	1986.x.25	Adrian Rundle	Nicholls 2015
		Edinburgh Botanic Gardens	1987.i.10	—	NMS Z.2020.31.71
		Glasgow Botanic Gardens: No. 4 Cool House	1988.iii.11	Beryl Rands	CS database
		Kew Gardens, London: POW Conservatory	1993.iii.06	CS field meeting	Reynolds 1993; Verdcourt 1995
		St Andrews Botanic Gardens	1987.i.10	Gordon Corbet	NMS Z.2020.3.171
		Warwick Road, Carlisle [adventive]	2008.iv.22	Peter Dance	CS database
		Cambridge Botanic Gardens	2011.vii.23	Richard Preece, Tom White	Preece & White 2012
		Edinburgh Botanic Gardens: Hot Tropics House Orchid & Cycad House	2012.vi.22	Adrian Sumner	CS database
		Cambridge Botanic Gardens: Tropical Rainforest House	2014.vi.13	Tom Walker	This study
		Kew Gardens, London: POW Conservatory 8 Carnivorous	2015.vii.09	Tom Walker	This study
		Staunton Country Park, Hampshire: Main Glasshouse	2015.i.28	Tom Walker	This study
		Swansea, Plantasia: Tropical House	2015.ix.09	Tom Walker	This study [shell only]
		Aberdeen, David Welch Winter Gardens: Tropical House	2016.v.05	Tom Walker	This study
		Edinburgh Royal Botanic Gardens: Lowland Wet Tropics House 10	2016.v.07	Tom Walker	This study
		Paignton Zoo, Devon: Crocodile Swamp	2017.vi.17	Tom Walker	This study [shell only]
		Inverness Botanic Gardens: Tropical House	2016.x.19	Tom Walker	This study
		Pearson Park, Hull: Conservatory	2017.iii.12	James Harding-Morris	CS database
		Belfast Botanic Gardens: Palm House, Nursery	2017.ix.19	Tom Walker	This study

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Gastrodontidae	*Zonitoides arboreus*	Dublin, Glasnevin Botanic Gardens: Curvilinear House Palm House	2917.ix.25	Tom Walker	This study
		Bangor, Treborth Botanic Gardens: Orchid House Tropical House	2017.ix.27	Tom Walker	This study
		Swansea, Singleton Gardens: Nursery House	2017.x.04	Tom Walker	This study [shell only]
		Thrieve, Dumfries, Botanic Gardens: glasshouses and hothouse	2017.x.05	Terry Crawford, Adrian Norris	CS database
		Watford [likely adventive]	2018.viii.09	Katie Tomkins	CS database
		Tatton Park, Knutsford, Cheshire: Orchid House	2018.viii.17	Tom Walker	This study
		Croxteth Park, Liverpool: Polytunnel	2018.viii.18	Tom Walker	This study
		Sefton Park, Liverpool: Palm House	2018.viii.18	Tom Walker	This study [shell only]
		Stockton Butterfly World, Co. Durham: Butterfly House	2018.ix.06	Tom Walker	This study
		Wisley RHS Gardens: Tropical Zone	2019.iv.27	Peter Topley	CS database
		University Botanic Gardens, Leicester: Tropical House	2019.x.02	Tom Walker	This study [shell only]
		Hotwells, Bristol [likely aventive]	2020.v.12	Matt Law	CS database
		Hall Place Gardens, Bexley, Kent: Butterfly House	202206.30	Tom Walker	This study
		Stratford-on-Avon Butterfly Farm, Warwickshire: Butterfly House	2022.ix.14	Tom Walker	This study
		Dyffryn Gardens, Glamorgan: Hothouse	2023.iii.17	Chris Owen	CS database
		Arundel Castle, Sussex: Tropical House	2023.v.31	Tom Walker	This study
		Kew Gardens, London: Tropical Glasshouse 4 Tropical Propagation	2023.x.20	Tom Walker	This study
		Inverness Botanic Gardens	2024.xii.14	Finley Hutchinson	iRecord [ident. confirmed]
Euconulidae	*Afropunctum semineum*	Kew Gardens, London: POW Conservatory: Wet Tropics Zone	1993.iii.06	Dave Guntrip	Reynolds 1993; Verdcourt 1993, 1995
		Whipsnade Zoo: Butterfly House	2017.v.05	Dave Guntrip	Pers. comm.
Microcystidae	*Liardetia samoensis*	**Wisley RHS Gardens: Tropical Zone**	2014.xii.18	Tom Walker	This study
		Wisley RHS Gardens: Tropical Zone	2022.x.01	Tom Walker	Walker *et al.* 2024
Chronidae	*Kaliella barrakporensis*	Eden Project, St Austell, Cornwall: Tropical Biome	2010.03	Richard Preece, Fred Naggs	Preece & Naggs 2014
		Eden Project, St Austell, Cornwall: Rainforest Biome	2014.iii.04	Finley Hutchinson	iRecord [ident. confirmed]
Achatinidae	*Allopeas clavulunim*	Mr Thacker's Orchid House, Blue Bell Hill, Nottingham	1883	—	Brindley 1904 as *Opeas urichi*; Sturgess Dodd & Woodward 1906 as *O. clavulinus*
		Cambridge Botanic Gardens	Undated	—	Brindley 1904 as *Opeas urichi*; Sturgess Dodd & Woodward 1906 as *O. clavulinus*
		Nottingham: a few hothouses	Undated	—	Swanton 1906, as *Opeas urichi, O. clavulinus*
		Kew Gardens, London	1915	John R. le B. Tomlin	Anonymous 1915; Ellis 1926 as *Leptinaria urichi*
		Kew Gardens, London; Doncaster [likely adventive]	1928.v.11	John R. le B. Tomlin	Anonymous 1928 as *Opeas urichi*
		Singleton Gardens, Swansea: Greenhouse	1928	H.E. Quick	NMW Z.2013.030 as *Opeas clavulinum*
		Singleton Gardens, Swansea: Greenhouse	1929.viii	H.E. Quick	NMW Z.2013.030 as *Opeas clavulinum*
		Cambridge Botanic Gardens	Undated	Hugh Watson	Watson 1929
		Edinburgh Botanic Gardens	1931.iii.3	A. Watson	NHMUK 20250064 as *Opeas clavulinum*
		Kew Gardens, London: Fern House	1946.iv.16	—	Meeuse 1948 as *Opeas clavulinum*
		Belfast Botanic Gardens	1948.ix	—	Meeuse & Hubert 1949 as *Opeas mauritianum*

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Achatinidae	*Allopeas clavulunim*	Kew Gardens, London Cambridge Botanic Garden Nottingham Edinburgh Botanic Gardens Belfast Botanic Gardens	Undated	—	CS Census 1951 as *L. clavulinus* [Kew, Cambridge, Nottingham, Edinburgh], *L. mauritianus* [Belfast]
		Kew Gardens, London: Houses 17A, 17B	1967.ix	Bernard Verdcourtt	Airy Shaw 1973 as *Opeas pumillum*
		Kew Gardens, London: T-ranges	1975	—	NHMUK 20250057
		Kew Gardens, London: POW Conservatory: Palm House	1992.vi.03	Bernard Verdcourtt	Reynolds 1993; Verdcourt 1995
		Kew Gardens, London: POW Conservatory: Palm House	1993.iii.06	CS field meeting	Reynolds 1993; Verdcourt 1995
		Edinburgh Botanic Gardens: Temperate House	1998.iii.18	Gordon Corbet	NMS Z.2020.31.62
		Kew Gardens, London: Palm House POW Conservatory 1 Tropical Rainforest POW Conservatory 5 Tropical Ferns POW Conservatory 8 Carnivorous	2014.x.10	Tom Walker	This study
		Eden Project, St Austell, Cornwall: Rainforest Biome	2014.xi.04	Tom Walker	This study
		Glasgow Botanic Gardens: Orchid House	2016.v.04	Tom Walker	This study
		Edinburgh Royal Botanic Gardens: Nursery, Lowland Wet Tropics House 10	2016.v.07	Tom Walker	This study
		Paington Zoo, Devon: **Reptile House, Crocodile Swamp**	2017.vi.17	Tom Walker	This study
		London Zoo: Tropical mantilla frog exhibit, Bugs building	2017.iv	—	NHMUK 20170147
		Newquay Zoo, Cornwall: **Tropical House, Octagonal frog exhibit**	2017.viii.03	Tom Walker	This study
		Chester Zoo: Butterfly House, Monsoon Forest	2018.viii.16	Tom Walker	This study
		London Zoo: Tiny Bugs House	2023.ix.04	Tom Walker	This study
		Kew Gardens, London: Tropical Glasshouse 8 Aracacae Tropical Glasshouse 9 Warm Woody Tropical Glasshouse 12 Tropical Ferns	2023.x.20	Tom Walker	This study
Achatinidae	*Allopeas gracile*	Headington Hill Gardens, Oxford [likely adventive]	1917.ix.26	L. Dawes	NHMUK as *Opeas goodallii*
		Cambridge Botanic Gardens	2011.vii.23	Richard Preeece, Tom White	Preece & White 2012
		Polaris House, Swindon [likely adventive]	2023.vi.28	Jo Holborn	iRecord [ident. unconfirmed]
Achatinidae	*Opeas hannense*	Bristol: on boards lining a pineapple bed	1817	John Miller	Miller 1822 as *Opeas goodalii*
		Bristol	1817	—	NHMUK 1974143
		Singleton Gardens, Swansea: greenhouse	1834.i.08	HE Quick	NMW Z.2013.030 as *Opeas goodalli*
		Scarborough, Yorkshire [likely adventive]	1848.vii.02	purchased from Damon	NHMUK 1849.2.2.228.230 as *Bulimus goodalli*
		Cardiff	1882	—	NHMUK 20250079
		Cheltenham: Orchid House	1886.ix	J Edwards	NHMUK 20250078
		Kew Gardens, London: propagating pits	1888	Harold Brindley	Brindley 1906 as *Stenogyra godallii*
		Kew Gardens, London: Palm House	1898	Harold Brindley	Brindley 1906 as *Stenogyra godallii*
		Bristol, Durham [probably Bristol Botanic Gardens]	1898.viii.20	purchased fro Rev Dr Norman	NHMUK 1898.5.20.8447/83
		Cambridge Botanic Gardens	Undated	—	Brindley 1904
		"In many parts of England"	Undated	—	Swanton 1906 as *Opeas goodalli*
		Cambridge Botanic Gardens	Undated	Hugh Watson	Watson 1929
		Kew Gardens, London: Fern House	Undated	—	Meeuse 1948
		Chillwell, Nottinghamshire: on roots of *Eucharis* bulbs [likely adventive]	Undated	Mr Pearson	Sturgess Dodd & Woodward 1906 as *Stenogyra goodallii*

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Achatinidae	*Opeas hannense*	Preston, Lancashire [likely adventive]	Undated	John R. le B. Tomlin	NHMUK 20350067
		Higher Broughton, Manchester [likely adventive]	Undated	—	NHMUK 20250081
		Manningham Park, Bradford greenhouses	1910	Fred Rhodes	CS database
		Belfast Botanic Gardens; Dublin, Glasnevin	Undated	—	Stelfox 1911–12 as *Opeas pumilum*
		Cardiff [likely adventive]	1916	F.W. Wotton	CS database
		Headington Hill, Oxford [some glasshouses at Headington House at the time; likely adventive]	1917.vii.26	L. Dawes	CS database
		Belfast Botanic Gardens Dublin, Glasnevin "Hertfordshire to Cumberland"	Undated	—	Ellis 1926
		Edinburgh Botanic Gardens	1931.vii.02	A. Rodger Waterston	NHMUK 20250066
		Edinburgh Botanic Gardens	1940	D.K. Kavan	CS database
		Kew Gardens, London	1949	Bernard Verdcourtt	NHMUK 20250055
		Kew Gardens, London: House 17A	1967.ii.29	John Armitage, Adrian Norris	Airy Shaw 1973 as *Opeas pumilum*
		Edinburgh Botanic Gardens	1987.v.30	Beryl Rands	CS database
		Dublin, Glasnevin	2001.vii.12	Roy Anderson	NHMUK 20140709
		Edinburgh Botanic Gardens: Hot Tropics House Moist Hothouse	2013.vi.22	Adrian Sumner	CS database
		London Zoo: Tropical Bird House	2014.iii.12	Peter Topley	CS database
		Swansea, Plantasia: **Tropical House** **Bird House**	2015.viii.09	Tom Walker	This study
		Edinburgh Royal Botanic Gardens: Lowland Wet Tropics House 10	2016.v.07	Tom Walker	This study
		Pearson Park, Hull: Conservatory	2017.iii.12	James Harding-Morris	CS database
		Kew Gardens, London	2022.ix.08	Hauke Koch	CS database
		Kew Gardens, London: Tropical Glasshouse 1 Temperate Paradise Tropical Glasshouse 9 Warm Woody Tropical Glasshouse 12 Tropical Ferns	2023.x.20	Tom Walker	This study
Achatinidae	*Subulina octona*	Bristol	1820	Hugh Watson	CS database
		Kew Gardens, London: propagating pits	1884	—	Brindley 1906; Meeuse 1948
		Manchester	1885	H.R. Hardy	NHMUK 20250071
		Kew Gardens, London: propagating pits	1888.iii	—	Brindley 1906; Meeuse 1948
		Fernihurst, Baildon, Bradford [extensive glasshouses, now gone]	1889	E. Self	CS database
		Heaton, Bradford [extensive glasshouses, now gone]	1897	Fred Rhodes	CS database
		Kew Gardens, London: Tropical Fern House	1905	J.W. Horsley	Horsley 1905
		near Manchester and other localities	Undated	J.R. Hardy	Swanton 1906
		Belfast Botanic Gardens Dublin, Glasnevin Castlewellan	Undated	—	Stelfox 1911–12
		Higher Broughton, Manchester [likely adventive]	Undated	—	NHMUK 20250057
		Kew Gardens; London Manchester [location?] Glasgow Botanic Gardens Belfast Botanic Gardens Dublin, Glasnevin Castlewellan "Elsewhere"	Undated	—	Ellis 1926
Achatinidae	*Subulina octona*	Kew Gardens, London	1948	Bernard Verdcourtt	CS database
		Kew Gardens, London: greenhouse	1950.iv	J Sawker	NMW Z.2013.030
		"various localities"	Undated	—	___ 1951
		Wisley RHS Gardens: Stove House	1960.x	—	NBN database

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Achatinidae	*Subulina octona*	Cambridge Botanic Gardens	1961	Chris Paul	CS database
		Wisley RHS Gardens: Stove House	1980.x.10	—	NBN database
		Eden Project, St Austell, Cornwall	2020.iii.01	Richard Preece, Fred Naggs	Naggs 2014
		Cambridge Botanic Gardens	2022.vii.23	Richard Preece, Tom White	Preece & White 2012
		Eden Project, St Austell, Cornwall: Rainforest Biome	2014.xi.04	Tom Walker	This study
		Eden Project, St Austell, Cornwall: Humid Biome	2015.iv.08	Richard Comont	CS database
		Swansea, Plantasia: Tropical House	2015.viii.09	Tom Walker	This study [shell only]
		Whipsnade Zoo, Bedfordshire	2018.vii.02	Whipsnade Zoo staff	CS database
		Kew Gardens, London: Palm House	2022.iv.02	"wychelm"	CS database
		Eden Project, St Austell, Cornwall: Rainforest Biome	2014.iii.14	Finlay Hutchinson	iRecord [ident. confirmed]
		Durdham Down Nursery, Bristol [likely adventive]	Undated	P.P. Cambridge	NMW Z.1992.023
Achatinidae	*Striosubulina striatella*	Glasgow Botanic Gardens	1906	Alexander Frew	Anonymous 1907 as *Subulina octona*; Weddle 2020
		Glasgow Botanic Gardens: Nepenthus House	1926	—	NHMUK 20250074 as *Subulina striatella*
		Kew Gardens, London: Waterlily House and others	1960.ix	J.F. Peake	NHMUK 2025-075 as *Subulina striatella*
		Kew Gardens, London: Palm House	1995.x	A.E. Ellis	NHMUK 2025-0065 as *Subulina striatella*
		Kew Gardens, London: Houses 9 and 10	1967.i.29	Adrian Norris, John Armitage	Airy Shaw 1973 as *Subulina striatella*
		Kew Gardens, London: Houses 1, 10, 15, 17A and 17B	1967.ix	Bernard Verdcourtt	Airy Shaw 1973, NHMUK 20250073 as *Subulina striatella*
		Glasgow Botanic Gardens: Ewing Range	1988.iii.12	A. Rodger Waterston	Hancock 1999, NHMUK 20250063 as *Subulina striatella*
		Kew Gardens, London: hothouses	1990	Ed Bishop	NNWM Z.2013.030 as *Subulina striatella*
		Cambridge Botanic Gardens: hothouses	1990	R.G.B. Williams	NNWM Z.2013.030 as *Subulina striatella*
		Glasgow Botanic Gardens: Ewing Range	1996.xii.18	E.G. Hancock	Hancock 1999 as *Subulina striatella*
		Kew Gardens, London: POW Conservatory: Palm House	1993.iii.06	CS field meeting	Reynolds 1993; Verdcourt 1995, as *Subulina striatella*
		Kew Gardens, London: Palm House	2005.x.01	Ben Rowson	CS database
		Glasgow Botanic Gardens: Moist Hot House Tropical Fern House	2013.iii.12	Adrian Sumner	Naggs 2014
		Kew Gardens, London: POW Conservatory 1 Tropical Rainforest 4 Tropical Ferns 5 Temperate Ferns	2014.x.10	Tom Walker	This study
		Eden Project, St Austell, Cornwall: Rainforest Biome	2014.xi.04	Tom Walker	This study
		Cambridge Botanic Gardens: Tropical Rainforest House	2014.vi.13	Tom Walker	This study
		Oxford Botanic Gardens: Lily House	2014.x.01	Tom Walker	This study
		Staunton Country Park, Hampshire: **Lily Pond House** **Main Glasshouse**	2015.i.28	Tom Walker	This study
		Glasgow Botanic Gardens	2015.vi.12	Adrian Sumner	CS database
		Glasgow Botanic Gardens: Orchid House Palm House Begonia House	2016.v.04	Tom Walker, Peter Dance	This study
		Chester Zoo: Butterfly House, Monsoon Forest	2018.viii.16	Tom Walker	This study

Table A1. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Achatinidae	*Striosubulina striatella*	Glasgow Botanic Gardens	2019.ii.05	Richard Weddle	CS database
		Whipsnade Zoo, Bedfordshire: Butterfly House	2022.vii.15	Dave Guntrip, Peter Topley, Tom Walker	This study
		Kew Gardens, London Palm House Tropical Glasshouse 9 Warm Woody Tropical Glasshouse 12 Tropical Ferns	2023.x.20	Tom Walker	This study
Achatinidae	*Subulina* sp.	Bristol Botanic Gardens: Nepanthus House	1820	—	CS database
		Glasgow Botanic Gardens	1931	A Rodger Waterston	CS database
		Glasgow Botanic Gardens: Orchid House	1968.iii.11	Beryl Rands	CS database
		Cambridge Botanic Gardens	1970	Chris Paul	CS database
		Kew Gardens, London: Aroid House	1975	Adrian Rundle	CS database
		London Zoo: Tropical Bird House	1978.iv.20	Adrian Rundle	CS database
		Cambridge Botanic Cardens	1978.vi.03	Adrian Rundle	CS database
		Kew Gardens, London	1978	Adrian Rundle	CS database
		Avery Hill Park, Elton, London [likely adventive]	1980	—	CS database
		Stockwood Bank, Luton [possibly adventive]	1982.iii.23	Beryl Rands, Dave Guntrip	CS database
		Cambridge Botanic Gardens: Stove House	1986.ix.06	Beryl Rands, Dave Guntrip	CS database
		Kew Gardens, London: POW Conservatory: Palm House,	1993.iii.06	Rosemary Hill	CS database
		Edinburgh Botanic Gardens	2013.vi.22	Adrian Sumner	CS database
		Glasgow Botanic Gardens	Undated	—	NBN database
Streptaxidae	*Gulella io*	Edinburgh Botanic Gardens	1931	A. Rodger Waterston	Connolly 1931 as *Gulella devia*
		Wisley RHS Gardens	1956.vi	Robert Scase	CS database
		Kew Gardens, London: House 1 Aroid	1967.i.29	John Armitage, Adrian Norris	Verdcourt 1969, 1974; Airy Shaw 1973
		Wisley RHS Gardens: hothouse [now gone]	1976	Robert Scase	Kerney 1976
		London Zoo: Tropical Bird House	1978.iv.30	Adrian Rundle	CS database
		Cambridge Botanic Gardens	1978.vi.03	Adrian Rundle	CS database
		Kew Gardens, London	1978	Adrian Rundle	CS database
		Cambridge Botanic Gardens	1986.ix.06	Dave Guntrip	CS database
		Cambridge Botanic Gardens: Tropical Fern House	2011.vii.23	Richard Preece, Tom White	Preece & White 2012
		Kew Gardens, London: Palm House	2023.x.20	Tom Walker	This study
Streptaxidae	*Tomostele musaecola*	Glasgow Botanic Gardens: Moist Tropics House	2013.ii.12	Adrian Sumner	Naggs 2014 as *Streptostele musaecola*
		Glasgow Botanic Gardens [shell only]: Palm House Begonia House	2016.v.04	Tom Walker, Peter Dance	This study
		Glasgow: Begonia House Palm Houses	Undated	Adrian Sumner	Weddle 2020 as *S. musaecola*
		Whipsnade Zoo: Butterfly House	2017.ii	Peter Topley, Mark Telfer	Pers. comm.
		Whipsnade Zoo: Butterfly House	2022.vii.15	Tom Walker, Dave Guntrip, Peter Topley	This study

Table A2. British and Irish hothouse alien molluscs in literature and databases but which are now probably extinct in Britain and Ireland. Adventive (both likely or definite) and open-air records are included. This includes records from garden centres or other locations when it is very unlikely that breeding populations are established. Abbreviations: CS = Conchological Society, NBN = National Biodiversity Network, NHMUK = Natural History Museum, London; NMS = National Museum of Scotland, Edinburgh; NMW = National Museum and Galleries of Wales, Cardiff.

Family	Species	Site	Date	Recorder	Source of record or specimen
Lymnaeidae	*Galba cubensis*	Dublin, Glasnevin	Undated	Arthur Stelfox	Meeuse & Hubert 1949 [probably *Lymnaea truncatula*]
		Dublin, Glasnevin	1949	—	CS Census 1951 as *Lymnaea* (*Galba*) *cubensis* [probably *Galba truncatula*]
	Galba rustica	Cambridge Botanic Gardens	Undated	Hugh Watson	CS Census 1951 as *Lymnaea* (*Galba*) *humilis rustica* (probably *Galba truncatula*)
	Pseudosuccinea columella	Edinburgh Botanic Gardens: Aroid House	1935.v.15	A. Rodger Waterston	Meeuse & Hubert 1949 as *Pseudosuccinea*; CS Census 1951 as *Lymnaea* (*Pseudosuccinea*) *columella*; Rowson 2023
		Edinburgh Botanic Gardens	1948	A. Meeuse, B. Hubert	Meeuse & Hubert 1949; CS Census 1951; Rowson 2023
	Racesina luteola	Kew Gardens, London: greenhouses	1975.iv.03	—	Verdcourt 1995 as *Lymnaea luteola* [could be *Radix rubiginosa*]
Physidae	*Stenophysa marmorata*	Kew Gardens, London: House 17B	1967.i	John Armitage, Adrian Norris	Airy Shaw 1973 as *Physa marmorata* [could be *Physella acuta*]
		Kew Gardens, London: House 10 Amazonica House 15 Waterlily	1967.ix	Bernard Verdcourt	Airy Shaw 1973 as *Physa marmorata* [could be *Physella acuta*]
Planorbidae	*Glyptophysa novahollandica*	Swansea (presumably Singleton Gardens)	1951	—	CS Census 1951 as *Physastra dispar*
	Gyraulus chinensis	Liverpool Museum Aquarium	1975	Shaun Barrett	McMillan 1998
		Liverpool Museum Aquarium	1997	Marie Tracey	McMillan 1998
		Tyrone & Antrim, N. Ireland	Undated	—	https://maps.biodiversityireland.ie/Map/Terrestrial/Species/123869
		"Common in tropical aquaria"	Undated	—	Anderson 2005
	Helicorbis umbilicalis	Kew Gardens, London: House 15 Waterlily	1943.ix.15	Fred Taylor	Airy Shaw 1973 as *Helicorbis* ? *umbilicalis*
Limacidae	*Ambigolimax waterstoni*	Edinburgh Botanic Gardens Glasgow Botanic Gardens	1934	A. Rodger Waterston	Waterston 1934 NMS Z.2022.2
Helicodiscidae	*Helicodiscus parallelus*	Higher Broughton, Manchester: Ainsworth's greenhouse	Undated	J.R. Hardy	As *Helicodiscus lineatus*, NMW 1955.158
		Cork: University College	Undated	R.A. Phillips	Stelfox 1911–12 as *Helicodiscus lineatus*
		Dublin, Glasnevin Castlewellan, Ireland	Undated	—	Stelfox 1911–12 as *Helicodiscus lineatus*
		"Various parts of the country"	Undated	—	Ellis 1926
		Cambridge Botanic Gardens	Undated	Hugh Watson	Watson 1929
		Hillsborough, Ireland [likely adventive]	Undated	—	CS Census 1951
		Cambridge Botanic Gardens: Succulent House	1986.ix.06	Dave Guntrip	CS database
		Glasgow Botanic Gardens: Filmy Fern House	1988.iii.12	Adrian Norris	CS database
Euconulidae	*Solatopupa similis*	Lancashire [open ground only]	1878 1879	—	Wigglesworth 1889 as *Pupa cinerea*; Kennard & Woodward 1926 as *Chondrina* (*Solatopupa*) *similis*
		"A few hothouses and nurseries"	Undated	—	Swanton 1906 as *Jaminia quinquedentata*
Achatinidae	*Beckianum beckianum*	York: Rowntree's Tropical House, in banana roots	1925	Wilfred Jackson	Anonymous 1925 as *Opeas* (*Synopeas*) *beckianum* [possibly *Allopeas clavulinum* or *A. gracile*]

Table A2. Continued.

Family	Species	Site	Date	Recorder	Source of record or specimen
Achatinidae	*Rumina decollata*	Watton, Stoke Gabriel, Devon: glass-house	Pre-1826	—	Turton 1826; Turton 1831
		Kew Gardens, London	Undated	—	CS database
		Caerphilly Garden Centre, Gwent [adventitious]	2005.iii	Mary Seddon, Matthew Pritchard	Seddon & Pickard 2005; Anderson 2005 both as *Rumina* cf. *decollata*; Anderson & Rowson 2020