Hedychium gardnerianum Sheph. ex Ker Gawl. from its discovery to its invasive status: a review

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Abstract

Hedychium gardnerianum Sheph. ex Ker Gawl. is one of the 100 world's worst invasive alien species and the research target in areas as diverse as biological control, natural fibres uses, taxonomy or the biological activity of its compounds. This review aimed to clarify the taxonomic status and the native range of H. gardnerianum and bring accuracy to the history of its introduction and escape from cultivation through the analysis of the increasing number of accessible digitalized dry specimens and grey literature. The analysis of the available information allowed to conclude that: (a) Hedychium gardnerianum is a validly published name, the authority of the name is Sheph. ex Ker Gawl., the species holotype is the illustration published along with the species name, and the Natural History Museum BM000574691 specimen collected in 1815 is the first dried specimen of H. gardnerianum; (b) This species is native to the Central and Eastern Nepal, Bhutan, Northeast India and North Myanmar; (c) The species was cultivated at Cambridge Botanical Garden since 1818 and the first known herbarium specimen collected in Europe dates back to 1821; (d) Kathmandu (Nepal) and Khasi Hills (India) specimens are considered two varieties of the same species and the BM000574691 specimen is the lectotype of H. gardnerianum var. speciosum; (e) Specimens, references, and/or pictures support that H. gardnerianum escaped from cultivation at Galicia (Spain), Azores archipelago, Madeira, Tenerife, Cuba, Jamaica, Martinique, Trinidad, Ascension, Mexico, Honduras, Brazil, South Africa, Swaziland, Zimbabwe, Réunion, Mauritius, Australia, New Zealand, Fiji, Hawaii, and Vietnam; and (f) H. gardnerianum is a serious pest in Azores, Madeira, Jamaica, Réunion, New Zealand and Hawaii and continues to expand its distribution area in South and Central America, Australia and Southern Africa. This review presents linear raw information compiled with precision, allowing the world databases updating their data but also gives the most detailed information possible to each country/region identifying new regions of concern and updating the invasiveness status in each region.

Keywords: Hedychium gardnerianum, Nomenclature, Types, History of introduction, Distribution, Invasion severity

Introduction

Hedychium gardnerianum Sheph. ex Ker Gawl. (IPNI 2021) is a perennial herb with large branching surface rhizomes producing stems 1–2 m tall; the bright green, long ovate-elliptic (25–45 cm × 10–15 cm) and subsessile leaves are alternately arranged with sheaths clasping the stems; the plant produces terminal cylindrical spikes (25–40 cm long) above the foliage, holding scented bright yellow flowers with a single large bright red stamen, and later orange fleshy capsules with small shiny red seeds included in a crimson aril (CABI 2021a) (Fig. 2). This ornamental species is one of the '100 of the World’s Worst Invasive Alien Species’ (GISD 2021) with high environmental and economic costs for several countries; nevertheless, the plants and seeds are still marketed worldwide without any
adventerence or recommendations about the conditions that potentiate its escape from cultivation.

At the end of the twentieth century research on this plant was focused on its physical, chemical, and biological control (CABI 2021a; GISD 2021); in the twenty-first century the research is focused on the effectiveness of in-field *H. gardnerianum* control actions (e.g. Chauchard and Lavergne 2009; Minden et al. 2010a), remote sensing technologies for mapping this invasive species (Asner and Vitousek 2005), modelling its potential distribution (e.g. Baret et al. 2006; Gallardo et al. 2015); investigating the biological activity of its compounds (Medeiros et al. 2003; Rosa et al. 2010; Arruda et al. 2012; Tavares et al. 2020), and its use in cattle feeding (Nunes et al. 2014) or biomaterials production (Eleutério et al. 2017, 2018, 2020).

Current worldwide research on invasive species make use of important biological databases as CABI (2021a), POWO (2021), GISD (2021) or PIER (2021) and great economical and human efforts are put nowadays in the construction of those databases which need to be constantly updated and revised to become sources of reference and avoid lapsus spread in literature. Also, in the last decades we gain access to an increasing number of digitalized documents on databases as Biodiversity Heritage Library (2021), the Internet Archive (2021) or digitalized specimens (e.g. Natural History Museum 2021; AVH 2021). In fact internet has profoundly changed how we produce, use and collect research and information with grey literature (data that is either unpublished or has been published in non-commercial form) playing an increasingly important role (Laurence et al. 2015; UNE 2021). Although finding, accessing and evaluating this material can be a difficult and time-consuming task, the importance of grey literature on research has been recognized (Haddaway and Bayliss 2015).

The analysis of the currently available information about this important invasive species unveiled some inconsistencies regarding the authority of the scientific name and its synonymy, its native range and the regions where the species escaped from cultivation. Therefore, this review aims to clarify the taxonomic status and the native range of *H. gardnerianum* and bring accuracy to the history of its introduction and escape from cultivation. This review presents linear raw information compiled with precision allowing the world databases to update their data and gives the most detailed information possible to each country/region emphasizing the lack of knowledge to fulfill, identifying new regions of concern and updating the invasiveness status in each region.

The scientific discovery of *Hedychium gardnerianum*  
**Wallich’s *Hedychium speciosum* from the Khasi Hills (India)**  
In 1820, Nathaniel Wallich, the Calcutta Botanical Garden Director, publishes in *Flora Indica* the description of two new species of *Hedychium: H. villosum* and *H. speciosum*; however, no drawing or specimen number is indicated for each species (Carey 1820). When referring to *H. villosum* he states: ‘A native of the mountains North-East of Bengal, from whence our indefatigable collector of plants, Mr Matthew Robert Smith, sent specimens to me in 1815’ (Carey, 1820, p 12). In the next description regarding *H. speciosum* he states: ‘A native of the same country [mountains of North-East of Bengal] with the preceding [*H. villosum*], and like all the species flowering in the rainy season’ (Carey, 1820, p 13). Although it is not explicit to *H. speciosum*, we assume that this first specimen was also collected and sent by Matthew Robert Smith in 1815; in fact, at the UK Natural History Museum (2021) botanical collections, the BM000574691 herbarium specimen is identified as *H. speciosum* (Fig. 1) and the BM000574717 herbarium specimen is identified as *H. villosum*, both collected in 1815.

Sanoj et al. (2013) while studying *H. villosum* specimens, also linked the sheet BM000574717 (labelled in Wallich’s hand with the year 1815 but no collector name) with the specimen collected by Matthew Robert Smith and referred by Wallich in 1820 (Carey 1820).

Only In 1832, in *Plantae Asiaticae rariores* book, Wallich publishes a plant draw in Tab 285 to support the plant description published in 1820 (Fig. 1). Later in the 1853 Hooker’s journal of botany and Kew Garden miscellany, Wallich links the 1820 description and the 1832 illustration to the ‘first specimen sent by post, from the Kasia range by Mr M. E. Smith, nearly 40 years ago’ (Wallich, 1853, p 370). Again, he does not indicate any specimen number and again we assume that he refers to the BM000574691 specimen collected in 1815. Also, in the 1853 publication, Wallich recognizes that *H. speciosum* and *H. gardnerianum* are the same species and he retains the *H. gardnerianum* name in honour of his friend Edward Gardner.

**Mr Gardner’s garland flower from Kathmandu (Nepal)**

During the latter end of 1817 and the whole 1818, Edward Gardner (the first Resident to the Court of Nepal from 1816 to 1829) and his team, will have collected an *Hedychium* plant at the Kathmandu Valley and sent it to Wallich in India (Ker-Gawler 1824; Roscoe 1828; Smith 1832; Fraser-Jenkins 2006). In 1819, Wallich sends a living plant of Mr Gardner’s Garland-flower to William Roscoe at the Liverpool Botanical Garden under the name *H.*
The plant arrived in September 1819 and it grew at the conservatory under the care of the Garden Curator John Shepherd, blooming on 4th October 1820 (Roscoe 1828; Law 2007; Greenwood et al. 2018). The produced seeds germinated and certainly due to the scarcity of plants produced in the first year, the nephew of the Curator and also sub-curator Henry Shepherd, takes only a flower on 7th September 1821 (allowing the other flowers developing seeds) to produce much probably the first herbarium specimen (LINN-HS 8.8.) of this species collected in the UK (Roscoe 1828; Greenwood et al. 2018; The Linnean Society of London 2021). In 1824, Ker Gawler uses the manuscript notes on *H. gardnerianum* made by John Shepherd and publishes this first description along with the scientific name ‘*Hedychium gardnerianum*’ in the horticultural magazine ‘The Botanical Register’, accompanied by an illustration of the flowering plant made from another specimen grown in Mr Hatfield greenhouse at the Alpha Cottages (Ker-Gawler 1824; Law 2007) (Table 1). In 1828, Roscoe also published an illustration of this species in bloom on his book about the Monandrian plants of the order Scitaminea. Fig. 2.

**Hedychium speciosum or Hedychium gardnerianum?**

We can argue that the name *H. speciosum* was not validly published in 1820 since no illustration or dried specimen (nomenclatural type specimen) is clearly identified: ‘My examination of this stately plant has hitherto been confined to a well-preserved spike and a few leaves only, which however point it out as the largest of the genus’ (Carey 1820, pp 13–14).

Only in 1832 Wallich would validly published *H. speciosum* adding an illustration to the previous description, nevertheless, for the same species, the name *H.
H. gardnerianum was already validly published in 1824 by Ker-Gawler. In addition Wallich recognises in 1853 that they are the one and the same species and accepts the name H. gardnerianum.

In a second point of view, using the information published later by Wallich in 1853 where he clarifies that the illustration published in 1832 was made from a dried specimen that Matthew Robert Smith collected in 1815 and assuming that the 1815 BM000574691 specimen is, in fact, the specimen observed by Wallich, this specimen could be considered the lectotype of H. speciosum name and this name would be accepted (Natural History Museum 2021).

However, even we accept this reasoning, there are at least two main motives to propose H. gardnerianum as nomina conservanda: the extended use of H. gardnerianum name (Table 2) and the expressed will of Nathaniel Wallich to retain the H. gardnerianum name: "The magnificent series of specimens, even as to colour, preserved by Drs. Hooker and Thomson, with the fine drawing of the flower and the excellent figure in Roscoe's work, prove that my H. speciosum and my H. gardnerianum are identically one and the same species. I retain the latter name, being that of a very valued and honoured friend, who, himself ardently attached to flowers and gardening, has done a great deal of service to the cause of botany in its most extended sense' (Wallich, 1853, p 370) (Fig. 3).

In the protologue (Bot. Reg. 9: t. 774 1824) the author is cited as Sheppard but refers to John Shepherd, curator of Liverpool Botanical Garden (IPNI 2021).

Kathmandu and Khasi Hills specimens as two varieties of the same species
Horaninow (1862) and Sanoj (2011) consider that the specimens collected in these two regions are varieties of the same species; however, although Wood et al. (2000) emphasises that the most important factor in the evolution of Hedychium genus is geographic and ecological isolation, the geographic range of these two varieties needs to be established: H. gardnerianum var. gardnerianum from Kathmandu (Nepal) and H. gardnerianum var. speciosum (Wall.) Horan. from the Khasi Hills (India) (Fig. 3). At the moment the illustration published in 1824 in The Botanical Register is the holotype of the species H. gardnerianum and its variety gardnerianum, while the BM000574691 specimen is the lectotype of H. gardnerianum var. speciosum (Ker-Gawler 1824; Natural History Museum 2021). However, Roscoe in 1828 states that, before September 1819 he received a dried specimen of H. gardnerianum under the name H. excelsum send by Wallich from Calcutta, and if this specimen did not disappeared in the 1940 bombing raids on Liverpool, it could be chosen to be the lectotype specimen of H. gardnerianum. At the moment the extant Wallick herbarium specimens are candidates and the formal work of lectotypification need to be done.

Native range of the species
H. gardnerianum is native to the Central and Eastern Nepal (Shrestha et al. 2018), Bhutan (Noltie 1994), Northeast India (e.g. Nirola and Das 2017) and North Myanmar (Tanaka et al. 2016) (Table 3). H. gardnerianum is not native to Vietnam (Tan et al. 2012) or Thailand (Wongsuwan and Picheansoonthon 2011, 2012). According to Wongsuwan and Picheansoonthon (2011) some herbarium specimens previously collected from north-eastern Thailand, were erroneously

| Authority                      | World digital databases                                                                 | Nations/Countries' digital databases                                                                 |
|--------------------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Shep. ex Ker Gawl              | IPNI (2021)                                                                              | Swaziland's Alien Plants Database (2021)                                                              |
| Ker Gawl                       |                                                                                         | Flora of Zimbabwe (Hyde et al. 2021)                                                                  |
| Ker Gawl                       |                                                                                         | Flora of New Zealand (2021)                                                                          |
| Sheppard ex Ker Gawl           | The Plant List (2013)                                                                    | India Biodiversity Portal (2021)                                                                       |
|                                | Plants of the World Online (2021)                                                        | Borbonica – Réunion (2021)                                                                            |
|                                | CABl (2021a)                                                                            | Atlas of Living Australia (2021)                                                                        |
|                                | Encyclopedia of Life (2021)                                                              | Flora-on Açores (Portugal) (2021)                                                                       |
|                                | Catalogue of Life (2021)                                                                 | Alien Invasive Plants List for South Africa (2021)                                                       |
|                                | Reflora (2021)                                                                          |                                                                                                       |
| Shepard ex Ker Gawl            | Integrated Taxonomic Information System (2021)                                           | USDA Plants Database (2021)                                                                             |
| Shepard ex Ker Gawl            |                                                                                         | Nepal National Herbarium and Plant Laboratories KATH (2020)                                           |
| –                              | Barcode of Life Data System v4 (2021)                                                    |                                                                                                       |
|                                | Global Invasive Species Database (2021)                                                  |                                                                                                       |
|                                | Royal Horticultural Society (U.K.) (2021)                                                |                                                                                                       |

Table 1 Hedychium gardnerianum: authority variations, incorrect spelling of authority and absence of authority in digital databases of reference

The protologue (Bot. Reg. 9: t. 774 1824) the author is cited as Sheppard but refers to John Shepherd, curator of Liverpool Botanical Garden (IPNI 2021)
identified as *H. gardnerianum* instead of *H. neocarneum* T.L.Wu, K.Larsen and Turland. But *H. gardnerianum* was recorded by Tanaka et al. (2016) from north Myanmar corresponding to the eastern limit of the natural distribution of this species.

From 1815 to 1858 the British territory of Bengal included Sylhet (Bangladesh) and the Khasia Hills (India) (The Map Archive 2021) and down to 1868 'Khasia' was under the Judge of Sylhet (Watson 2013). In 2015, the species was not present at Khadimnagar National Park.
northeast of Sylhet (maximum altitude of 50 m) (Uddin 2015), in fact the alluvial lowlands of Bangladesh are not the habitat of this species. Considering that Wallich distinguished between ‘Sillet,’ and the ‘Mont. Sillet’ or ‘Mont. Sillet vicinae’ by which he indicated Khasia (Watson 2013), the Wallich’s specimens from ‘North-East of Bengal’ (Carey 1820), ‘montosis ad Sillet’ (Wallich 1832) or ‘Mt. Sillet’ (6550 / K001124174—Kew Royal Botanic Gardens, 2021) indicate the Khasi Hills (the bordering hill regions of Meghalaya at India and not the Sylhet region of Bangladesh). ‘The Kasia range’ is later mentioned by Wallich in 1853.

Although under the name *H. speciosum*, the species is considered endangered in the Red Data Book of Vascular Plants of Bangladesh (Khan et al. 2001), we have not found any dry specimens, photographs or other information about the presence of this species in the present territory of Bangladesh, and at the moment Bangladesh should not be considered belonging to the natural area of *H. gardnerianum* distribution.

### Travelling as an ornamental plant

Soon after the publication of *H. gardnerianum* name in February 1824, several magazines give notice of this very ornamental plant, e.g.: in England (Tilloch and Taylor 1824), in France (Brongniart 1824), and in Germany (Bernhardi and Völker 1825). From England, the plant is quickly distributed to several European gardens, e.g. Fromont Garden (Bodin 1824) and to their overseas countries or colonies of influence, but according to the Calcutta Royal Botanic Garden Report (Wallich 1840), besides the Liverpool garden and other English gardens (e.g. Royal Botanic Garden of Edinburgh), many seeds and plants were sent to France, North America, Egypt, other parts of India (Chennai, Mumbai, Sri Lanka), China, Malay countries, Australia, islands of Réunion and Mauritius and the Cape (South Africa) and *H. gardnerianum* plants and/or seeds could have been sent to those destinations. In fact, the 1823 catalogue of plants cultivated in the Cambridge Botanical Garden indicates that *H. gardnerianum* is cultivated in that garden since 1818 (Fig. 4). This finding changes the official arrival date to Europe from 1819 to 1818, puts this species as one of the first to be collected by Gardner and sent to Europe (Lindley et al. 1823, 1826; Sweet 1826) and shows the use of this name before its valid publication in 1824.

During the nineteenth century the botanical journals, gardens, fairs, and other horticultural events, contributed to the disclosure of this species (Fig. 5). Meanwhile, the seed and plant exchanges between gardens and the
horticulturists actively contributed to the world distribution of this species (Table 4). More difficult to document is the possible plant transport linked with the slave trade and escaped slaves (Fleury 1994; Kull et al. 2015). Consequently, in the nineteenth century but also in the twentieth century this ornamental species was introduced throughout the world. Already, in the twenty-first century, the electronic commerce allows seeds selling all over the world without any indication of their invasive potential (e.g. Rare Exotic Seeds 2021; Fleurs des Tropiques 2021).

**Escaping from cultivation**

A revision of the literature and CABI, POWO, GISP and PIER databases (2021) allowed to update the world distribution and status of *H. gardnerianum* (Table 5). From all the French overseas communities *H. gardnerianum* is only considered invasive at Réunion (Soubeyran 2008). Although *H. gardnerianum* is mentioned as cultivated at Saint-Claude in 1897 (the Atlantic Guadeloupe Island) (Duss and Heckel 1897), the plant is not mentioned as escaped from cultivation in Flora de Guadeloupe (Stehlé 1935).

Concerning Rodrigues Island, this species is not mentioned in Botany of Rodrigues (Balfour 1879), Flora of Mascareignes—La Réunion, Maurice, Rodrigues (Antoine et al. 1983), and in Mascarine Cadetiana (2021) database. Although *H. gardnerianum* is on the checklist of the vascular plants of Trinidad and Tobago (Baksh-Comeau et al. 2016), the island(s) where it occurs and the origin of that information are not specified: literature, herbarium specimen or field survey; for these reasons, we attain only to Caracciolo et al. (1892) where the species is referred as escaped from cultivation only on Trinidad Island.

Also, to both Rodrigues and Tobago islands, we were not able to find any reference of its use as a garden plant (Table 5).

In Japan (Ryukyu or Nansei Islands), the species is not mentioned in the book ‘Garden Plants of Japan’ (Levy-Yamamori and Taaffe 2004), but Tanaka et al. (2016) refers to a cultivar of *H. gardnerianum* cultivated on Koshikawa Botanical Gardens at Tokyo. The establishment of this species has not been confirmed and the Government of Japan (2012) puts *H. gardnerianum* only on a
H. gardnerianum is not present at Galapagos (the species escaped from cultivation at Galapagos is *H. coronarium*) (CABI 2021b) (Table 5) and is under cultivation in the United Kingdom (Fig. 2k), Dominican Republic/Haiti (Maas and Maas 1990), Guadeloupe (Duss and Heckel 1897; Fournet 2002), Kenya (Witt and Luke 2017), Tasmania (PAHSMA 2014; AVH 2021), New Caledonia (Grande Terre) (MacKee 1994; Hequet et al. 2009), Cook Islands (Rarotonga and Mangaia) (Space and Flynn 2002; McCormack 2013), French Polynesia (Tahiti) (Florence et al. 2013), Federated States of Micronesia (Pohnpei) (Fosberg et al. 1987; Herrera et al. 2010), and China (Wu and Raven 2000) (Table 5).

References, dry specimens and/or photos support that *H. gardnerianum* had or is escaped from cultivation at Galicia (Spain), Azores archipelago, Madeira Island, Tenerife Island, Cuba, Jamaica, Martinique, Trinidad, Ascension, Mexico, Honduras, Brazil, South Africa, Swaziland, Zimbabwe, Réunion, Mauritius, Australia (QLD, NSW, VIC, SA) New Zealand, Fiji, Hawaii, and Vietnam (Table 6). We found references of the presence of this species in the nineteenth century (cultivated or escaped) in all of those regions with exception of Cuba, Mexico, Honduras, Ascension, South Africa, Swaziland, and Zimbabwe (Table 6).

Concerning Brazil, in 1890 Martius et al. states that *H. gardnerianum* is cultivated at Rio de Janeiro and indicates the specimen collected by Glaziou in 1871 (Reflora 2021). In another specimen label collected in 1895 (Reflora 2021) we can read: ‘arbusto silvestre de solo úmido fl vermelhadas aromáticas’ (wet soil wild shrub with aromatic reddish flowers), pointing out its spontaneous occurrence in a suitable habitat.

At Mexico, Matuda (1950) found *H. gardnerianum* in favourable conditions at 1000–1500 m altitude in a wet ravine of Cerro Ovando (Chiapas). Although no recent botanic studies were made to prove the spreading of this species, the species is mentioned in 3 environmental impact assessments at Mapastepec (Chiapas) and the nearby states of Oaxaca and Campeche (Ayuntamiento Municipal de Mapastepec 2005/07; Dirección General de Impacto y Riesgo Ambiental 2019; González-Lazo 2011).

### Table 3 Native distribution of *Hedychium gardnerianum*

| Regions       | Reference and/or Place, Collector (c) | Herbarium specimens | Collection year |
|---------------|---------------------------------------|---------------------|-----------------|
| Bhutan        | Chukka                                | E00507940           | 1979            |
|               | Punakha                               | E00507938           | 1914            |
|               | Trongsa                               |                     |                 |
| Nepal         | Bagmati Pradesh                       |                     |                 |
|               | Kathmandu Valley                      |                     |                 |
|               | E. Gardner (c)                        |                     |                 |
|               | Wallich (1853)                        |                     |                 |
|               | Fraser-Jenkins (2006)                 |                     |                 |
|               |                                      | L1NN-HS 8.26        | [1817—Before Sept. 1819] |
|               |                                      | BM000589480         | [1817—1819]     |
|               | E00886869                             | 2016                |
|               | E00644827                             | 2008                |
|               | Gandaki Pradesh                       |                     |                 |
|               | Province nº 5                         |                     |                 |
|               | Gubhaju and Gaha (2019)               |                     |                 |
| Northeast India| Arunachal Pradesh                     |                     |                 |
|               | Basak et al. (2014)                   |                     |                 |
|               | Assam                                 | MKB-499             | 2014            |
|               | Darjeeling                            |                     |                 |
|               | Nirola and Das (2017)                 |                     |                 |
|               | Manipur                               |                     |                 |
|               | Daimei and Kumar (2011)               |                     |                 |
|               | Meghalaya                             |                     |                 |
|               | Wallich (1820)                        | K17103.000          | 1946            |
|               | The Khasi Hills                       | BM000574691         | 1815            |
|               | Matthew Robert Smith (c)              |                     |                 |
|               | Meghalaya                             | K001124174 (n. 6550) | [1821–1832]    |
|               | Nagaland                              | E00507942           | [1847–1851]     |
|               | Wallich (1853)                        | E00507941           | 1992            |
| North Myanmar | Kachin                                |                     |                 |
|               | Tanaka et al. (2016)                  |                     |                 |

Herbaria: L1NN-HS (The Linnean Collections-The Smith Herbarium 2021); BM (Natural History Museum 2021); E (Royal Botanic Garden Edinburg 2021); MKB (Department of Life Science and Bioinformatics of Assam University); K (Kew Royal Botanic Gardens 2021). [yyyy-yyyy] Estimated years of collection

a Roscoe (1828)

b The Wallich Catalogue Online (2021)
**H. gardnerianum** is also a well-known flower in the island of Ascension (The Islander 2003), that appears on a stamp collection of wild flowers in 1985 (Colnect 2021) and in the field guide of Fairhurst (2004). Although it is not mentioned in a botanical survey (Lambdon and Darlow 2008) or listed in Pagad and Wong (2020) database, a picture taken at 26th June 2020 at Elliot's path by Croson (2020), supports the hypothesis that the species is naturalized.

At Zimbabwe, **H. gardnerianum** escaped from cultivation at Vumba, Juliasdale, Chimanimani, and Harare (Hyde et al. 2021). In Chatham Island (New Zealand) a plant specimen (HO521919) was harvested but is not referred if it was a cultivated or a spontaneous plant (AVH, 2021).

To Viti Levu Island (Fiji) a 2006 Master thesis (Boseto 2006) about freshwater fishes identifies **H. gardnerianum** escaped from cultivation near three creeks, but it remains to explain the source and the reason of this recent escape.

**H. gardnerianum** is also a recent escape with invasive characteristics in European mainland (Spain, Galicia) with no reference of the putative source of this escape (Silva-Pando et al. 2009).

Regarding the regions where the species escaped from cultivation, we looked for the first references to its cultivation (Table 6) and according to the literature we classified the severity of these escapes in: escaped from cultivation; escaped from cultivation and potentially invasive; Invasive process started; Invasive process established (Table 7).

Although it is historically and environmentally important to know the year of introduction of an invasive species, this knowledge is often missing (Table 6). Regarding the Azorean Islands we found in a recent bequest to the Azores University Library (still not
Fig. 5 Ink-photo (Sprague & Co.) of *Hedychium gardnerianum* flowering at Glasgow Botanic Garden in 1892; probably the first photo of the species (Gardeners’ Chronicle 1892)
| Year | Botanical Garden                                      | Country | Reference(s)                        |
|------|------------------------------------------------------|---------|-------------------------------------|
| 1818 | Cambridge Botanic Garden                             | England | Lindley et al. (1823, 1826)         |
| 1819 |Liverpool Botanical Garden                           | England | Roscoe (1828)                       |
| 1824 | Royal Botanic Garden of Edinburgh                    | Scotland| Graham (1825)                       |
| 1824 | Jardin Botanique de Fromont                          | France  | Bodin (1824)                        |
| 1825/1892 | Royal Botanical Garden of Glasgow                    | Scotland| Hooker (1825); Gardeners’ Chronicle (1892)* |
| 1828 | Dresden Botanical Garden                             | Germany | Felbel (1828)                       |
| 1829 | Jardin des Plantes (Paris)                           | France  | Desfontaines (1829)                 |
| 1831 | Bonn Botanical Garden                                | Germany | Eisenbeck & Sinning (1831)          |
| 1834/1842 | Hamburg Botanical Garden                             | Germany | Lehmann (1834); MNHN (2021)         |
| 1836 | Jardin de l’école de Médecine de Strasbourg          | France  | Fée (1836)                          |
| 1838 | Saint Petersburg Botanical Garden                    | Russia  | Fischer & Meyer (1838)              |
| 1845 | Orto Botanico Di Napoli                               | Italy   | Tenore (1845)                       |
| 1846 | Breda Botanical Garden                               | Italy   | Banfi & Visconti (2014)             |
| 1851 | José do Canto Garden (S.Miguel Island)               | Azores  | Canto (1851)                        |
| 1852/1853 | Horticultural Society’s Garden (Chiswick)           | England | Wallich (1853)                      |
| 1854 | Giardino del Comte de Medici Spada                   | Italy   | Amicucci (1854)                     |
| 1858 | Jardin Zoologique de Bruxelles                      | Belgium | Galeotti (1858)                     |
| 1859 | Crystal Palace, London                               | England | Beaton (1859)                       |
| 1865 | New Zealand Gardens                                  | New Zealand | Ludlam (1865)           |
| 1867 | Iles du bois de Boulogne at Paris                   | France  | Alphand (1867–1873)                |
| 1875 | Queensland Botanic Gardens                           | Australia| Hill (1875)                        |
| 1875 | Hatfield Gardens                                     | England | Gardeners’ Chronicle (1875)         |
| 1878 | Botanical Garden of Coimbra University               | Portugal| Henriques (1879)                    |
| 1880 | Conservatory at Buxted Park (Sussex)                 | England | Hogg (1880)                         |
| 1883 | Melbourne Botanic Gardens                            | Australia| Guflfoyle (1883)                    |
| 1884 | Santiago de Chile Botanical Garden                   | Chile   | Philippi (1884)                     |
| 1885 | Royal Botanic Gardens (Kew)                          | England | Hooker (1887)                       |
| 1892 | Mr. Conybear’s Gardens (Tregullow)                   | England | Napper (1892)                       |
| 1896 | Joseph Chamberlain Garden (King’s Heath)             | England | Watson (1896)                       |
| 1896 | Mr. Mark Rolle Gardens (Bicton, Devon)              | England | Fraser (1896)                       |
| 1898 | Park of Pillnitz Castle (Dresden)                    | Germany | Rösner (1900)                       |

Presence on exhibition events

| Year | Botanical Garden                                      | Country | Reference(s)                        |
|------|------------------------------------------------------|---------|-------------------------------------|
| 1830 | Massachusetts Horticultural Society                  | U.S.A   | Fessenden (1831); Hovey (1834); Walker (1847); Strong et al. (1880) |
| 1853 | Société Royale Linnéenne de Bruxelles                | Belgium | Galeotti (1853–54)                  |
| 1875 | Société d’Horticulture de Cherbourg                  | France  | Angran (1876)                       |

Presence on nurseries and seed/plant catalogues

| Year | Botanical Garden                                      | Country | Reference(s)                        |
|------|------------------------------------------------------|---------|-------------------------------------|
| 1830 | Catalogue, New-York                                   | U.S.A   | Wm. R. Prince & Co. (1830)          |
| 1838 | Catalogue, St. Petersburg                             | Russia  | Fischer & Meyer (1838); Fischer et al. (1839/42); Kuester et al. (1858); Regel & Herder (1860–61/63–66) |
| 1854/1871 | Catalogue, Boston                                    | U.S.A   | Hoveys & Co. (1854/1871–72)          |
| 1854 | Nursery, Planitz                                      | Germany | Ender (1854)                        |
| 1859 | Nurseries, Belgium                                    | Belgium | Funk (1859)                         |
| 1866 | Catalogue, Stuttgart                                   | Germany | Pfützer (1866)                      |
| 1870 | Nursery, Chelsea                                      | England | Messrs. Vetch & Sons (1870)          |
| 1872 | Nursery, Porto                                        | Portugal| Junior (1872)                       |
| 1885 | Catalogue, New Jersey                                 | U.S.A   | Sturtevant (1885)                   |
| 1897 | Catalogue, Santa Barbara, California                  | U.S.A   | Southern California Acclimatizing Association (1897) |
H. gardnerianum is abundantly naturalized with no mention of the year of introduction.

Regarding Jamaica, a reference of the species being cultivated at Chinchona Botanical gardens after its constitution (1868) and before becoming naturalized (1893) is still missing (Goodland and Healey 1996). The analysis of the following references, Bellingham et al. (2005) and Grubb and Tanner (1976), did not allow to confirm the year of introduction pointed out by Hulme (2011). Finally to the Réunion island we could not find any reference to support the year of introduction. In 1817 the botanical garden of Réunion Island (Jardin du Roi at Saint-Denis) receives the first plants from Europe and in 1820 it’s Director Nicolas Bréon acknowledges the gifts sent by several personalities including N. Wallich, but in its catalogue, the only cultivated species of Hedychium is H. coronarium; in its 1825 catalogue two more Hedychium species are cultivated: H. ellipticum and H. flavescent. In 1856, the next Director of this garden, Jean-Michel Claude Richard, also publishes a catalogue with the cultivated plants, where no species of Hedychium is mentioned. Nevertheless, due to the Malagasy-origin creole name (Creole name: longouze with longouza as Malagasy root), it is possible that slaves and marooned slaves had their role in this species propagation at Réunion; in fact, Hedychium spp. are identified among the food plants of marooned slaves from East Africa, Madagascar, and the Mascarene Islands (Kull et al. 2015). Lastly, Cordemoy (1895) only states that H. gardnerianum is abundantly naturalized with no mention of the year of introduction.

Regarding the severity of these escapes (Table 7) to Mauritius, Honduras, and Trinidad there is little information about the presence and abundance of this species and fieldwork is needed to confirm the species current status; to Vietnam the risk is considered insignificant; to Martinique the species is naturalized around gardens, and at Cuba is considered only potentially invasive. At Galicia, Canaries, Mexico, Ascension, Swaziland, Zimbabwe, and Fiji the invasive process already started but the severity of its progress would be modulated by the environment and control actions on the field. The invasive process is well established at Azores, Madeira, Jamaica, Réunion, New Zealand and Hawaii and the same in some countries of Central and South America, Southern Africa, and Mainland Australia, but in these mainland areas the species still continues to expand its distribution area.

**Conclusions**

This research was only possible due to the valuable resources already available online, namely, the Herbaria digitalized specimens or the digitalized historical documents at Biodiversity Heritage Library and Internet Archive. However, although the word search tool is extremely useful to accelerate the research inside documents, in some situations the names are not detected, e.g. a lack of a letter due to digitalization quality, letters not perfectly printed or misspelt words (e.g. Fessenden 1831). Also, this tool cannot be used in handwritten or gothic script documents slowing the research process. A conjoint effort between linguistic, historic, and botanic fields would also improve the access and interpretation of old documents and documents in different idioms.

In synthesis, this study updated the information about H. gardnerianum scientific discovery, nomenclature, types, native range and regions where it is considered escaped from cultivation and the severity of these escapes. This research found some new information as the introduction of H. gardnerianum in José do Canto Garden after 1847 and before 1851 and identified new information with interest to plant data bases as the escapes from cultivation of H. gardnerianum at Viti Levu and Mexico, or with historic interest as the reference of the presence of H. gardnerianum since 1818 at Cambridge Botanical Garden. This study also clarified some aspects of its native range as the exclusion of the present Bangladesh as a natural area of the species distribution; detected and clarified same lapsus at the data bases about
Table 5  *Hedychium gardnerianum* distribution on the PIER, GISD, POWO and CABI databases and the present update proposal from this study

| Location                        | PIER (2021) | GISD (2021) | POWO (2021) | CABI (2021a, ) | This study |
|---------------------------------|-------------|-------------|-------------|---------------|------------|
| Europe mainland                 |             |             |             |               |            |
| Spain (Galicia)                 | INV         |             |             |               |            |
| Atlantic Islands                |             |             |             |               |            |
| Ascension                      | INV         | INT         | INV         | INV           |            |
| Azores                          | INV         | INT         | INV         | INV           |            |
| Canaries                        | INV         | INT         | INV         | INV           |            |
| Cuba                            | INV         | INT         | CUL         |               |            |
| Dominican Republic/Haiti        | INV         | INT         | CUL         |               |            |
| Guadeloupe                      | INV         | INT         | CUL         |               |            |
| Jamaica                         | INV         | INT         | CUL         |               |            |
| Madeira                         | INV         | INT         | CUL         |               |            |
| Martinique                      | INV         | INT         | CUL         |               |            |
| Tobago                          | INV         | INT         | WR          |               |            |
| Trinidad                        | INV         | INT         | ESC         |               |            |
| United Kingdom                  | INT         | INT         | CUL         |               |            |
| Americas                        |             |             |             |               |            |
| Brazil                          | INV         |             |             |               |            |
| Honduras                        | INV         | INT         |             |               |            |
| Mexico                          | INV         | INT         |             |               |            |
| Africa                          |             |             |             |               |            |
| Kenya                           | INV         | INT         | CUL         |               |            |
| South Africa                    | INV         | INT         | INV         |               |            |
| Swaziland                       | INV         | INT         | CUL         |               |            |
| Zimbabwe                        | INV         | INT         | CUL         |               |            |
| Indian Ocean Islands            |             |             |             |               |            |
| Mauritius                       | INV         | INT         | INT         | ESC           |            |
| Réunion                         | INV         | INT         | INT         | INV           |            |
| Rodrigues                       | INV         | INT         | INT         | WR            |            |
| Australia mainland              |             |             |             |               |            |
| New South Wales                 | INV         | INT         | INV         |               |            |
| Queensland                      | INV         | INT         | INV         |               |            |
| South Australia                 | INV         | INT         | INV         |               |            |
| Victoria                        | INV         | INT         | INV         |               |            |
| Pacific Ocean Islands           |             |             |             |               |            |
| Cook Islands                    | CUL         | CUL         | INT         | CUL           |            |
| Federated States of Micronesia | CUL         | EST         | INT         | CUL           |            |
| Fiji                            | CUL         | INT         | CUL         |               |            |
| French Polynesia                | CUL         | EST         | INT         | CUL           |            |
| Galapagos                       | INV         | INV         | INV         |               |            |
| Hawaii                          | INV         | INV         | INV         |               |            |
| Japan                           | INV         | INT         | CUL         |               |            |
| New Caledonia                   | CUL         | CUL         | INT         | CUL           |            |
| New Zealand                     | INV         | INV         | INT         | INV           |            |
| Tasmania                        | INT         | CUL         |             |               |            |
| Asia                            |             |             |             |               |            |
| China                           | CUL         |             |             |               |            |
| Vietnam                         | CUL         |             |             |               |            |

✓ Updated information; WR: Without reference; NP: Not present; INT: Introduced; CUL: Cultivated; EST Established; ESC: Escaped from cultivation; NTS: Naturalised; PI: Potentially Invasive; INV: Invasive. QLD: Queensland; NSW: New South Wales; VIC: Victoria; SA: South Australia
Table 6  Documented dates and regions where *Hedychium gardnerianum* was mentioned as cultivated or escaped from cultivation [Specimen number]. Lines within each region ordered by the year of column: Escaped from cultivation

| Region                      | Not mentioned | Cultivated | Escaped from cultivation |
|-----------------------------|---------------|------------|--------------------------|
|                             | Year          | Reference  | Year                      | Reference  |
|                             |               |            |                           |            |
| Europe                      |               |            |                           |            |
| Spain                       |               |            |                           |            |
| Galicia: Muros and peninsula del Morrazo |               |            |                           |            |
| Atlantic Islands            |               |            |                           |            |
| Trinidad                    |               |            |                           |            |
|                             | 2000          | Silva-Pando et al. (2009) |            |            |
|                             | 1864          | Grisebach (1864) |                           |            |
|                             | 1869          | Prestoe (1869) |                           |            |
|                             | 2020          | Government of Trinidad and Tobago (2021) |            |            |
| Jamaica                     |               |            |                           |            |
| Cinchona                    |               |            |                           |            |
| Madeira                     |               |            |                           |            |
| Madeira Island              | 1832-55^a     | Lowe (1857) |                           |            |
| São Vicente                 |               |            |                           |            |
| Funchal Gardens             | 1914          | Menezes (1914) |                           |            |
| Azores                      |               |            |                           |            |
| S. Miguel                   | 1847          | Canto (1847) | 1851                     | Canto (1851) |
| Flores                      | 1894–96       | Trelease (1897) |                           |            |
| Ascension                   |               |            |                           |            |
|                             | 1836          | Darwin (1845) |                           |            |
|                             | 1851          | Seemann (1852–1857) |                 |            |
| Ellots path                 |               |            |                           |            |
| Cuba                        |               |            |                           |            |
|                             | 1989          | Esquivel et al. (1989) | 2003             | Shagarodsky (2003) |
|                             | 2008          | De Zayas (2008) |                           |            |
| Canaries                    |               |            |                           |            |
| Tenerife Island             |               |            |                           |            |
| Orotava                     | 1893          | Wilks & Weathers (1896) | 1923             | Menéndez (1923) |
| Parque Garcia Sanabria      | 1990          | Rodriguez (1990) |                           |            |
| Parque Garcia Sanabria      | 2000          | Reyes Y Pérez (2001) |                           |            |
| Rural Park of Anaga         |               |            |                           |            |
| Martinique                  |               |            |                           |            |
| Surroundings of Saint Pierre | 1853          | Reflora (2021) (probably cultivated) |            |            |
| Americas                    |               |            |                           |            |
| Brazil                      |               |            |                           |            |
| Minas Gerais                |               |            |                           |            |
| Ouro Preto [MO1344768]      | 1895          | Reflora (2021) |                           |            |
| Universidade Federal de Juiz de Fora | 2018          | Tavares-Silva et al. (2018) |            |            |
| Paraná                      |               |            |                           |            |
Table 6 (continued)

| Region | Not mentioned | Cultivated | Escaped from cultivation |
|--------|---------------|------------|--------------------------|
|        | Year          | Reference   | Year | Reference | Year | Reference |
| Antonina (Specimen 32.755) | | | | | 1974 | IBN Brasil (2021) |
| Tijucas do Sul, Represa do Vossoroca (Guaratuba Environmental Protection Area) | | | | | 2004 | Blum et al. (2005) |
| Guaraqueçaba | | | | | 2008 | IBN Brasil (2021) |
| São Paulo | | | | | 2009 | Marçon (2009); IBN Brasil (2021) |
| Municipal Natural Park of Cratera de Colônia | | | | | 2009 | Marçon (2009); IBN Brasil (2021) |
| Rio de Janeiro | 1890 | Martius et al. (1890) | | | 2013 | IBN Brasil (2021) |
| Andarai Grande [P01674255] | 1871 | Reflora (2021) | | | | |
| Tijuca [R010065496] | 1886 | Reflora (2021) | | | | |
| Jardim Botânico | 1937 | Penna (1937) | | | | |
| Itaitia National Park | | | | | 2013 | IBN Brasil (2021) |
| Santa Catarina | | | | | | |
| São Bento do Sul | | | | | | |
| Mexico | | | | | | |
| Chiapas (Cerro Ovando) | | | | | 1950 | Matuda (1950) |
| Chiapas (Mapastepec) | | | | | 2005–07 | Ayuntamiento Municipal (2005/07) |
| Oaxaca | | | | | 2019 | Dirección General de Impacto y Riesgo Ambiental (2019) |
| Campeche | | | | | 2011 | González-Lazo (2011) |
| Honduras | | | | | | |
| South Africa | | | | | | |
| Africa | | | | | | |
| KwaZulu-Natal | 1898 | Baker (1898) | 1894b | Wood (1895) | 1998 | Smith (1998); Henderson (2001) |
| Kruger National Park (Mpu- malanga and Limpopo) | 1891 | Macdonald (1991) | | | | |
| Zimbabwe | | | | | | |
| Vumba Botanic Garden | | | | | 2004 | | |
| Harare | | | | | 2006/2020 | | |
| Juliasdale | | | | | 2014 | | |
| Chimanimani | | | | | 2015 | | |
| Swaziland | | | | | 1998 | Smith (1998) |
| | | | | | 2021 | Swaziland’s Alien Plants Database (2021) |
| Milliwane Wildlife Sanctuary/islanddweller | | | | | 2021 | BioDiversity4All (2021) |
| Indian Ocean Islands | | | | | | |
| Réunion Island | | | | | | |
| Saint Denis Botanical Garden | 1820/25 | Breon (1820, 1825) | | | | |
| Region                        | Not mentioned | Cultivated | Escaped from cultivation |
|------------------------------|---------------|------------|--------------------------|
|                              | Year          | Reference  | Year                     | Reference                          |
| Saint Denis Botanical Garden | 1825          | Breon (1825)| 1910/11 Commissioner of Agriculture for the West Indies (1912) | 1895 Cordemoy (1895) |
| Saint Denis Botanical Garden | 1856          | Richard (1856) |                           |                                    |
| Mauritius                    | 1877          | Baker (1877) | 2021                     | Mascarine Cadetiana (2021)          |
| Rivière Noir                 | 1837          | Bojer (1837) |                           |                                    |
| Australia                    |               |            |                          |                                    |
| Queensland, Brisbane         | 1875          | Hill (1875) |                           |                                    |
| Victoria, Melbourne          | 1883          | Guilfoyle (1883) |                        |                                    |
| New South Wales, Morriset  [NSW 687345] | 1920 | AVH (2021) |                           |                                    |
| New South Wales, Ingleburn   |               |            | 1968                     | Csurhes & Hannan-Jones (2016)      |
| South Australia [AD 281835]  |               |            | 2018                     | AVH (2021)                          |
| Pacific Ocean Islands        |               |            |                          |                                    |
| New Zealand                  |               |            |                          |                                    |
| North Island                 | 1841          | Hooker (1853) | 1940                     | Allan (1940)                       |
| South Island [CHR: 81,349, 481,420; 326,334 A, HOS38398] | 1953/75/77/86 | AVH (2021) |                   |                                    |
| Auckland                     | 1949          |             | 1940                     | Williams et al. (2003)             |
| Chatham Island [AK307272]    |               | Before 2009, AVH (2021) (cultivated or escaped) |               |                                    |
| Hawai‘i                      | 1934          | Degener (1934) | 1947                     | Fagerlund (1947)                   |
| Hawai‘i Volcanoes National Park (Park residential area) | | | | |
| Hawai‘i                      |               |             | 1947                     | Fagerlund (1947)                   |
| O‘ahu                        | 1954          |             | 1947                     | Fagerlund (1947)                   |
| All islands                  | 1975          |             | 1947                     | Fagerlund (1947)                   |
| Fiji                         |               |             | 1947                     | Fagerlund (1947)                   |
| Viti Levu                    | 1979          | Smith (1979) | 1947                     | Fagerlund (1947)                   |
| Viti Levu: Nukunuku, Nadala and Qaliwana Creeks | | | | |
| Asia                         |               |             | 1947                     | Fagerlund (1947)                   |
| Vietnam                      | 1993          | Ho (1993)   | 1909                     | IHU (2021)                         |
| Cat Ba national park         | 2012          | Tan et al. (2012) |                   |                                    |

*Hedychium* sp.; *Hedychium* sp. from East Indies; *Under H. speciosum name*
the years of introduction at Réunion and Jamaica (still not known) or about the species distribution (Galapagos and Kenya) or even about the name authority. Moreover lacks of information were identified as the years of introduction of the species (e.g. who send the seeds or rhizomes to the Cambridge Botanical Garden?), or about the severity of its escapes in certain regions. Although *Hedychium* spp. are cultivated worldwide, there is a substantial paucity of studies about the presence and spreading of this species in Central and South America, Africa and several oceanic islands. Finally, *H. gardnerianum* is a serious pest in Azores, Madeira, Jamaica, Réunion, New Zealand and Hawaii and continues to expand its distribution area in South and Central America, Australia and Southern Africa. The species continues to escape from cultivation as the recent escapes in Tenerife and Viti Levu islands and Galicia.

While in some regions two or three species of the genus are considered invasive (e.g. Brazil) in others although two species are considered escaped from cultivation one woned the invasive status above the other (e.g. Azores); a future analysis of expansion risk of this species should consider all the *Hedychium* spp. too. The same for several specially frequent trouble associations as *H. gardnerianum* plus *Pittosporum undulatum* (e.g. in Azores, Jamaica and Hawaii).

| Region               | Severity | Reference                                                                 |
|----------------------|----------|---------------------------------------------------------------------------|
| Europe               |          |                                                                           |
| Spain (Galicia)      | 3        | Moderate                                                                  |
| Atlantic Islands     |          |                                                                           |
| Ascension            | 3        | Present (Flora Guide)                                                    |
| Azores               | 4        | Invasive                                                                  |
| Canaries (Tenerife)  | 3        | Initial state of dispersion                                               |
| Cuba                 | 2        | Potentially invasive                                                      |
| Jamaica              | 4        | Invasive                                                                  |
| Madeira              | 4        | Invasive                                                                  |
| Martinique           | 2        | Naturalized around the gardens                                             |
| Trinidad             | 1        | Present (Flora Checklist)                                                 |
| Americas             |          |                                                                           |
| Brazil               | 4        | Invasive                                                                  |
| Honduras             | 1        | Present (Flora checklist)                                                 |
| Mexico (Mt. Ovando)  | 3        | Invasive                                                                  |
| Africa               |          |                                                                           |
| South Africa         | 4        | Emerging invader                                                          |
| Swaziland            | 3        | Invasive, potential problem species                                       |
| Zimbabwe             | 3        | Naturalized                                                               |
| Indian Ocean Islands |          |                                                                           |
| Réunion              | 4        | Invasive                                                                  |
| Mauritius            | 1        | Present                                                                   |
| Australia            |          |                                                                           |
| New South Wales      | 4        | Naturalised in New South Wales and adventive in Victoria, Potential range  |
| Queensland           |          |                                                                           |
| South Australia      |          |                                                                           |
| Victoria             |          |                                                                           |
| Pacific Ocean Islands|          |                                                                           |
| Fiji                 | 3        | Spontaneous on creeks                                                     |
| Hawaii               | 4        | Invasive                                                                  |
| New Zealand          | 4        | Environmental weed; Pest plant                                            |
| Asia                 | 1        | Insignificant                                                             |

The species status in each region is here classified as: 1. Escaped from cultivation; 2. Escaped from cultivation and potentially invasive; 3. Invasive process started; 4. Invasive process established.
In summary, the analysis of the available information allowed to conclude that: (a) *Hedychium gardnerianum* is a validly published name, the authority of the name is Sheph. ex Ker Gawl., the species holotype is the illustration published along with the species name, and the Natural History Museum BM000574691 specimen collected in 1815 is the first dried specimen of *H. gardnerianum*; (b) This species is native to the Central and Eastern Nepal, Bhutan, Northeast India and North Myanmar; (c) The species was cultivated at Cambridge Botanical Garden since 1818 and the first known herbarium specimen collected in Europe dates back to 1821; (d) Kathmandu (Nepal) and Khasi Hills (India) specimens are considered two varieties of the same species and the BM000574691 specimen is the lectotype of *H. gardnerianum var. speciosum*; (e) Specimens, references, and/or pictures support that *H. gardnerianum* escaped from cultivation at Galicia (Spain), Azores archipelago, Madeira, Tenerife, Cuba, Jamaica, Martinique, Trinidad, Ascension, Mexico, Honduras, Brazil, South Africa, Swaziland, Zimbabwe, Réunion, Mauritius, Australia, New Zealand, Fiji, Hawaii, and Vietnam; and (f) *H. gardnerianum* is a serious pest in Azores, Madeira, Jamaica, Réunion, New Zealand and Hawaii and continues to expand its distribution area in South and Central America, Australia and Southern Africa.

**Abbreviations**

CABI: Centre for Agriculture and Bioscience International; e.g.: exempli gratia; et al.: et alii; GISD.: Global Invasive Species Database; H.: Hedychium; IPNI: International Plant Names Index; NSW: New South Wales; PIER: Pacific Island Ecosystems at Risk; POWO: Plants of the World Online; QLD: Queensland; SA: South Australia; UK: United Kingdom; var.: variety; VIC: Victoria.

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![Fig. 6](image) Manuscript list of the cultivated plants in José do Canto Garden, in the year 1851 (S. Miguel Island, Azores). *Hedychium gardnerianum* (Courtesy of Azores University Library)
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Authors' contributions
All authors contributed to the study conception and literature research. Data collection and analysis were performed by MJP and TE. The first draft of the manuscript was written by MJP and TE and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
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Declarations

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