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REVIEW Open Access

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

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advertence 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 (Haddawaya and Baylissb 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 fulfil, 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.*

Fig. 1 At left, original drawing taken from the first collected specimen sent to Nathaniel Wallich from the Kasia range by Mr. Matthew Robert Smith and printed as Tab 285 in Plantae Asiaticae Rariores (1832). At right, the BM000574691 specimen collected in 1815, presumably by Mr. Matthew Robert Smith (Courtesy of UK Natural History Museum)

gardnerianum. 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.*

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

Authority	World digital databases	Nations/Countries' digital databases
Sheph. ex Ker Gawl	IPNI (2021)	
Ker Gawl		Swaziland's Alien Plants Database (2021)
Ker Gawl		Flora of Zimbabwe (Hyde et al. 2021) Flora of New Zealand (2021)
Sheppard ex Ker Gawl	The Plant List (2013) Plants of the World Online (2021) CABI (2021a) Encyclopedia of Life (2021) Catalogue of Life (2021) Reflora (2021)	India Biodiversity Portal (2021) Borbonica – Réunion (2021) Atlas of Living Australia (2021) Flora-on Açores (Portugal) (2021) Alien Invasive Plants List for South Africa (2021)
Shepard ex Ker Gawl	Integrated Taxonomic Information System (2021)	USDA Plants DataBase (2021)
Sheppard ez 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)	

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)

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).

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

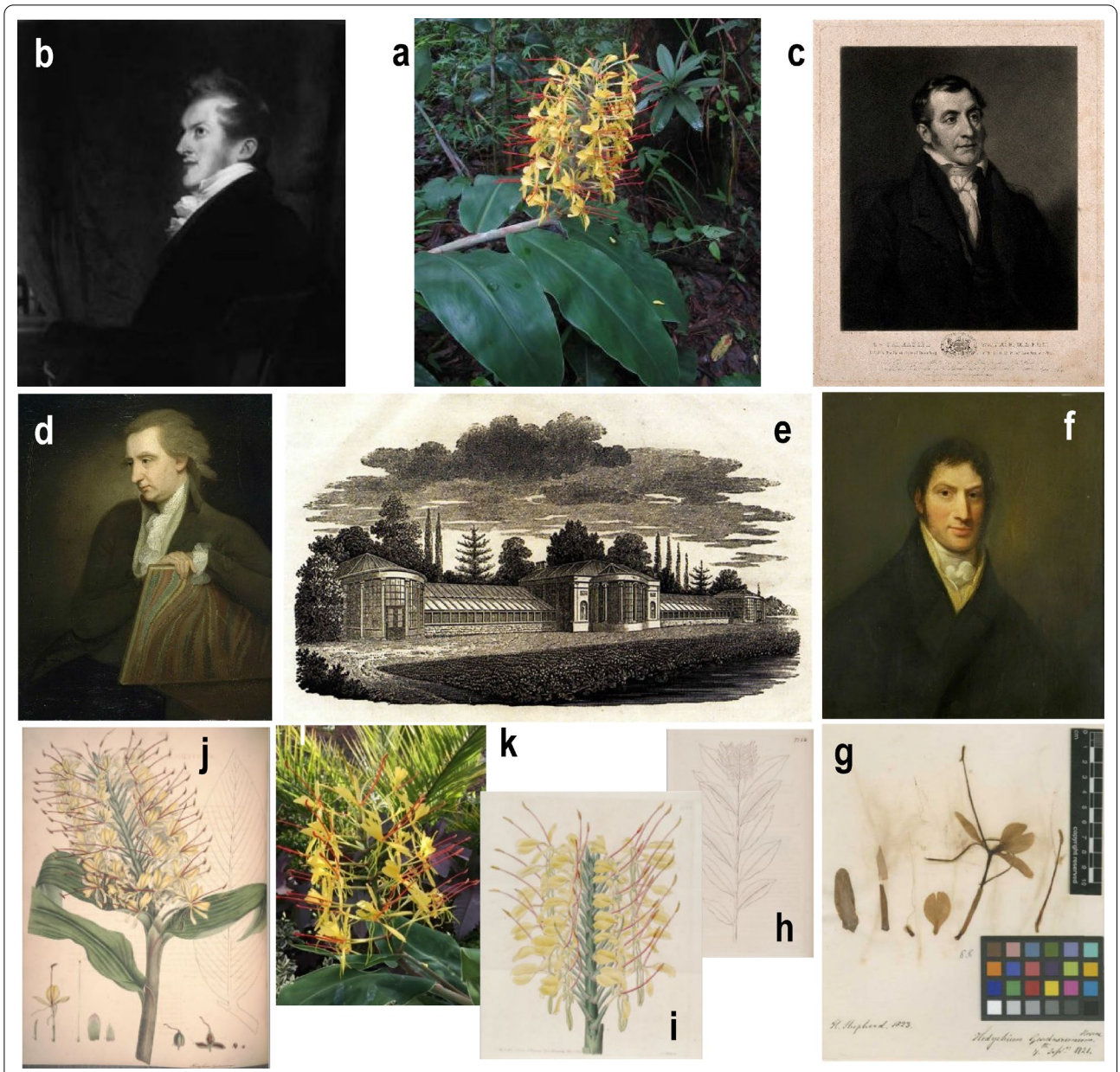


Fig. 2 **a** Flowering plant of *Hedychium gardnerianum* in its native habitat at Nepal (Lalitpur district of Kathmandu Valley) (Photographer B. Adhikari) (Flora of Nepal 2021). **b** Edward Gardner (Resident to the Court of Nepal from 1816 to 1829) (Bilder aus Nepal 2021; Fraser-Jenkins 2006); **c** Nathaniel Wallich in 1833 (Director of the Calcutta Botanical Garden from 1817 to 1846) (Welcome Collection 2021; Das Gupta 2011); **d** William Roscoe (Co-founder of the Liverpool Botanic Garden in 1802) (Walker Art Gallery 2021a; Roscoe 1833); **e** Conservatory in 1808 at Liverpool Botanical Garden in Mount Pleasant (1802–1831) (Kaye 1820; Law 2007). **f** John Shepherd (curator of Liverpool Botanic Garden at Mount Pleasant from 1802 to 1831) (Greenwood et al. 2018; Walker Art Gallery 2021b); **g** First dried specimen made by Henry Shepherd in the second year of plant blooming (LINN-HS 8.8—The Linnean Society of London 2021); **h**, **i** Illustrations published in February, 1824 by Ker-Gawler along with John Shepherd first description of *H. gardnerianum*; **j** Illustration published in 1828 by William Roscoe, on his book about the Monandrian plants of the order Scitamineae. K. *H. gardnerianum* at Walled Garden in Croxteth Hall and Country Park in the summer of 2017 (Cable 2017)

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

Table 2 Presence of *Hedychium gardnerianum* and/or *Hedychium speciosum* names in digital databases of reference (retrieved on June 21, 2021)

Digital source	*Hedychium gardnerianum*	*Hedychium speciosum*
Browser: Google	63 700	853
Nepal National Herbarium and Plant Laboratories-KATH	+	−
India Biodiversity Portal	+	−
Myanmar (Tanaka et al. 2016)	+	
CABI Invasive Species Compendium	+	−
Global Invasive Species Database	+	−
European Vegetation Archive	+	−
Royal Horticultural Society (U.K.)	+	−
Flora-On Açores (Portugal)	+	−
USDA Plants DataBase	+	−
Reflora	+	−
Flora of New Zealand	+	−
Atlas of Living Australia	+	−
Borbonica—Réunion	+	−
Flora of Zimbabwe	+	−
Alien Invasive Plants List for South Africa	+	−
Barcode of Life Data System v4	+	−
Integrated Taxonomic Information System	Accepted	−
Catalogue of Life	+	+
Encyclopedia of Life	58 media/96 data/12 articles	7 data/2 articles
The plant list 2013 / Plants of the World Online	Accepted	Accepted

+ Present; − Absent

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

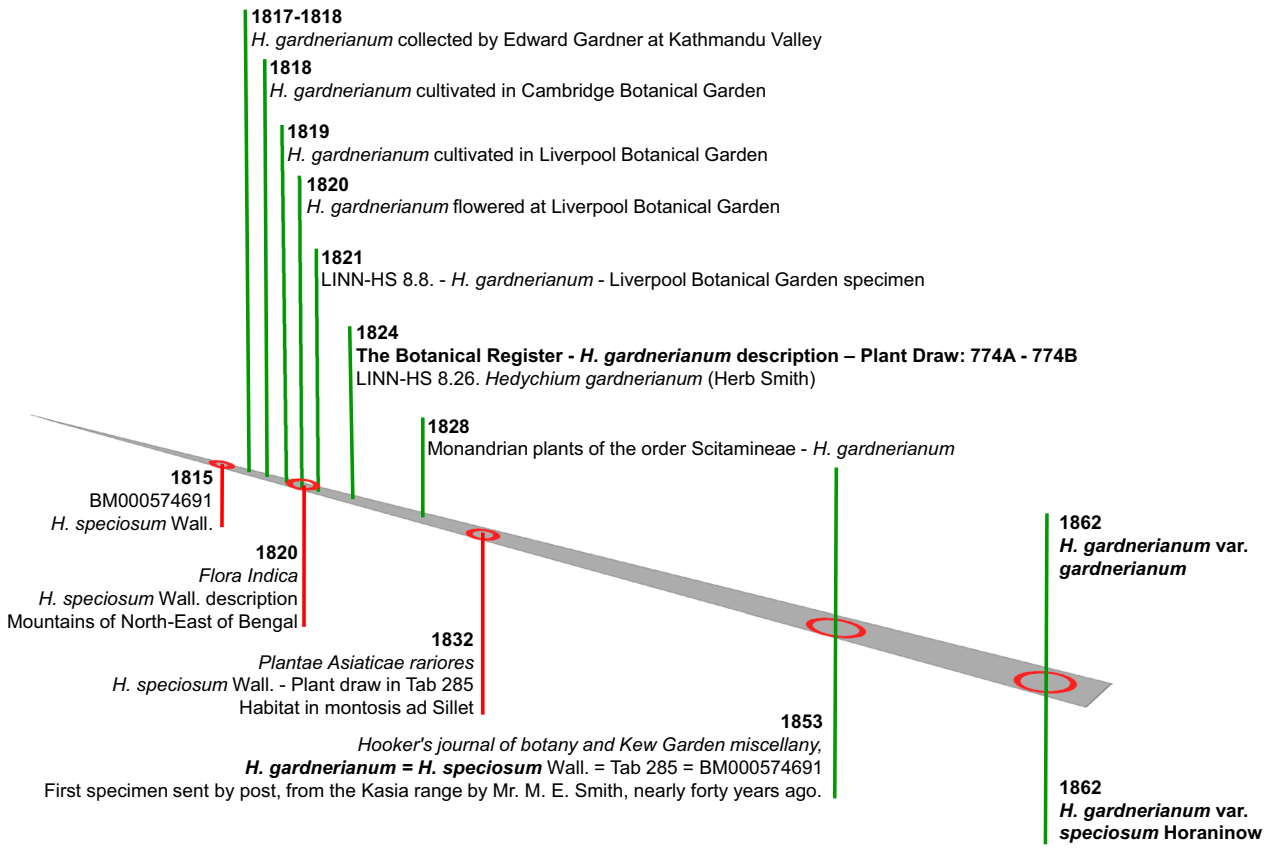


Fig. 3 *Hedychium gardnerianum* timeline of nomenclatural events

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 invasiveness potential (e.g. Rare Exotic Seeds 2021; Fleurs des Tropiques 2021).

Escaping from cultivation

A revision of the literature and CABI, POWO, GISD 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 Koishikawa 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

Table 3 Native distribution of *Hedychium gardnerianum*

	Regions	Reference and/or Place, Collector (c)	Herbarium specimens	Collection year
Bhutan	Chukka		**E**00507940	1979
	Punakha		**E**00507938	1914
	Trongsa	Tangsibji Hydro Energy Limited (2015)		
Nepal	Bagmati Pradesh	Kathmandu Valley E. Gardner (c)	**LINN-HS** 8.26	[1817—Before Sept. 1819[a]]
		Wallich (1853) Fraser-Jenkins (2006)	**BM**000589480	[1817- 1819]
			E00886869	2016
	Gandaki Pradesh	Manaslu Expedition (2008) (c)	**E**00644827	2008
	Province nº 5	Gubhaju and Gaha (2019)		
Northeast India	Arunachal Pradesh	Basak et al. (2014)		
	Assam	Baruah and Choudhury (2014)	**MKB**-499	2014
	Darjeeling	Nirola and Das (2017)		
	Manipur	Daimei and Kumar (2011)	**K**17103.000	1946
	Meghalaya	Wallich (1820) The Khasi Hills Matthew Robert Smith (c)	**BM**000574691	1815
	Meghalaya Nagaland	Wallich (1853) The Khasi Hills W. Gomez and Francis de Silva (c)	**K**001124174 (n. 6550)[b]	[1821–1832]
		Jain and Prakash (1995)	**E**00507942	[1847–1851]
		Bose (2015–2016)		
	Sikkim	Wallich (1853)	**E**00507941	1992
North Myanmar	Kachin	Tanaka et al. (2016)		

Herbaria: LINN-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)

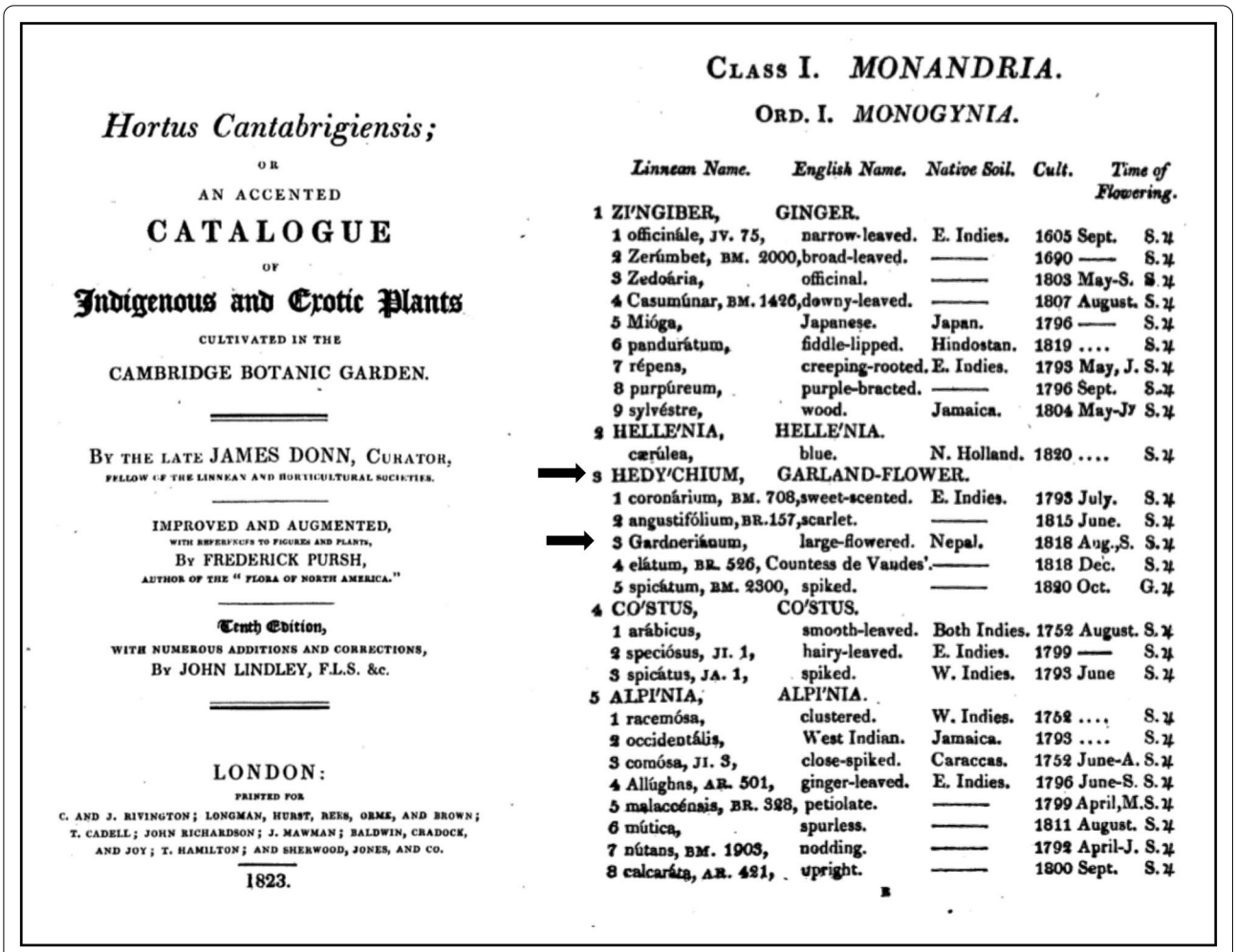
list of candidate species to be invasive on their islands (Table 5).

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).



Hortus Cantabrigiensis;

OR

AN ACCENTED

CATALOGUE

OF

Indigenous and Exotic Plants

CULTIVATED IN THE

CAMBRIDGE BOTANIC GARDEN.

BY THE LATE JAMES DONN, CURATOR,
FELLOW OF THE LINNEAN AND HORTICULTURAL SOCIETIES.

IMPROVED AND AUGMENTED,
WITH REFERENCES TO FIGURES AND PLANTS,
BY FREDERICK PURSH,
AUTHOR OF THE "FLORA OF NORTH AMERICA."

Tenth Edition,
WITH NUMEROUS ADDITIONS AND CORRECTIONS,
BY JOHN LINDLEY, F.L.S. &c.

LONDON:
PRINTED FOR
C. AND J. RIVINGTON; LONGMAN, HURST, REES, ORME, AND BROWN;
T. CADELL; JOHN RICHARDSON; J. MAWMAN; BALDWIN, CRADOCK,
AND JOY; T. HAMILTON; AND SHERWOOD, JONES, AND CO.
1823.

CLASS I. *MONANDRIA.*

ORD. I. *MONOGYNIA.*

Linnean Name.	*English Name.*	*Native Soil.*	*Cult.*	*Time of Flowering.*
1 ZI'NGIBER,	GINGER.			
1 officinále, JV. 75,	narrow-leaved.	E. Indies.	1605 Sept.	S.♃
2 Zerúmbet, BM. 2000,	broad-leaved.	———	1690 ——	S.♃
3 Zedoária,	officinal.	———	1803 May-S.	S.♃
4 Casumúnar, BM. 1426,	downy-leaved.	———	1807 August.	S.♃
5 Mióga,	Japanese.	Japan.	1796 ——	S.♃
6 pandurátum,	fiddle-lipped.	Hindostan.	1819	S.♃
7 répens,	creeping-rooted.	E. Indies.	1793 May, J.	S.♃
8 purpúreum,	purple-bracted.	———	1796 Sept.	S.♃
9 sylvéstre,	wood.	Jamaica.	1804 May-Jy	S.♃
2 HELLE'NIA,	HELLE'NIA.			
cærúlea,	blue.	N. Holland.	1820	S.♃
3 HEDY'CHIUM,	GARLAND-FLOWER.			
1 coronárium, BM. 708,	sweet-scented.	E. Indies.	1793 July.	S.♃
2 angustifólium, BR. 157,	scarlet.	———	1815 June.	S.♃
3 Gardnerianum,	large-flowered.	Nepal.	1818 Aug.,S.	S.♃
4 elátum, BR. 526,	Countess de Vaudes'.	———	1818 Dec.	S.♃
5 spicátum, BM. 2300,	spiked.	———	1820 Oct.	G.♃
4 CO'STUS,	CO'STUS.			
1 arábicus,	smooth-leaved.	Both Indies.	1752 August.	S.♃
2 speciósus, JI. 1,	hairy-leaved.	E. Indies.	1799 ——	S.♃
3 spicátus, JA. 1,	spiked.	W. Indies.	1793 June	S.♃
5 ALPI'NIA,	ALPI'NIA.			
1 racemósa,	clustered.	W. Indies.	1752	S.♃
2 occidentális,	West Indian.	Jamaica.	1793	S.♃
3 comósa, JI. 3,	close-spiked.	Caraccas.	1752 June-A.	S.♃
4 Allúghas, AR. 501,	ginger-leaved.	E. Indies.	1796 June-S.	S.♃
5 malaccénsis, BR. 328,	petiolate.	———	1799 April,M.	S.♃
6 mútica,	spurless.	———	1811 August.	S.♃
7 nútans, BM. 1903,	nodding.	———	1792 April-J.	S.♃
8 calcaráta, AR. 421,	upright.	———	1800 Sept.	S.♃

Fig. 4 The 1823 catalogue of plants cultivated in the Cambridge Botanical Garden indicate that *H. gardnerianum* is cultivated on that garden since 1818, which change the official arrival date to Europe from 1819 to 1818

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 Elliots 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)

Table 4 Documented presence of *Hedychium gardnerianum* Sheph. ex Ker Gawl., Bot. Reg. 9: t. 774 (Feb. 1, 1824) as an ornamental plant in the nineteenth century

Presence on Botanical Garden			
1818	**Cambridge Botanic Garden**	**England**	Lindley et al. (1823, 1826**)**
1819/1845	**Calcutta Botanical Garden**	**India**	Roscoe (1828) **/** Voigt (1845)
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)[a]
1828	**Dresden Botanical Garden**	**Germany**	Felbel (1828)
1829	Jardin des Plantes (Paris)	France	Desfontaines (1829)
1831	Bonn Botanical Garden	Germany	Esenbeck & 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	Brera 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 Conte de-Medici Spada	Italy	Amicucci (1854)
1858	**Jardin Zoologique de Bruxelles**	**Belgium**	Galeotti (1858)
1859	Crystal Palace, London	England	Beaton (1859)
1865	António Borges Garden (S.Miguel Island)	Azores	Medeiros (1865)
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	Guilfoyle (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 exhibitiona events			
1830 /34/ 43/45/66	**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			
1830	Catalogue, New-York	U.S.A	Wm. R. Prince & Co. (1830)
1838 1839/42/58/ 60–61/63–66	Catalogue, St. Petersburg	Russia	Fischer & Meyer (1838); Fischer et al. (1839/42); Kuester et al. 1858); Regel & Herder (1860–61/63–66)
1854/71/72	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	Pfitzer (1866)
1870	Nursery, Chelsea	England	Messrs. Veitch & Sons (1870)
1872	Nursery, Porto	Portugal	Junior (1872)
1885	Catalogue, New Jersey	U.S.A	Sturtevant (1885)
1897	Catalogue, Santa Barbara, Calfornia	U.S.A	Southern California Acclimatizing Association (1897)

Table 4 (continued)

In bold: the first documented presence in each nation/country

[a] First published photograph

inventoried), a manuscript list of the plants cultivated at Ponta Delgada made by José do Canto in 1847 where *H. gardnerianum* is not listed, while in 1851 the species is already cultivated at S. Miguel Island according to the same gentleman farmer (Canto 1851) (Fig. 6). *H. gardnerianum* is also present in another manuscript list of cultivated plants at Ponta Delgada written by António Borges da Câmara de Medeiros in 1865 (António Borges Garden), found at Ponta Delgada Public Library and Regional Archive. Other nineteenth century documents available online allowed to verify the presence of this species as an ornamental plant at Canaries (1893), Martinique (1882), Brazil (1871), Australia (1875/83) and New Zealand (1865) (Table 6). Regarding the islands of Madeira, Jamaica and Réunion, where the species escaped from cultivation, we still did not find a reference of its first presence as an ornamental plant in the nineteenth century. In Madeira, only the genus is referred to be under cultivation (Lowe 1857). Concerning 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. flavescens.* 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 longoza 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

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

✓ 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	Year	Reference
Europe						
Spain						
Galicia: Muros and peninsula del Morrazo					2000	Silva-Pando et al. (2009)
Atlantic Islands						
Trinidad						
	1864	Grisebach (1864)			1892	Caracciolo et al. (1892)
	1869	Prestoe (1869)			2016	Baksh-Comeau et al. (2016)
	2020	Government of Trinidad and Tobago (2021)				
Jamaica						
	1864	Grisebach (1864)			1893	Fawcett (1893)
Cinchona					1913	Goodland & Healey (1996)
Madeira						
Madeira Island			1832-55[a]	Lowe (1857)		
São Vicente					1894	Menezes (1894)
Funchal Gardens			1914	Menezes (1914)		
Azores						
S. Miguel	1847	Canto (1847)	1851	Canto (1851)	1894–96	Trelease (1897)
Flores					1894–96	Trelease (1897)
Ascension						
	1836	Darwin (1845)				
	1851	Seemann (1852–1857)				
					2004	Fairhurst (2004)
Elliots path					2020	Croson (2020)
Cuba						
	1989	Esquivel et al. (1989)	2003	Shagarodsky (2003)		
Parque Nacional La Bayamesa					2005	Sanchez-Ruiz (2005)
			2008	De Zayas (2008)	2011	Gonzaléz et al. (2012)
Canaries						
Tenerife Island						
Orotava			1893	Wilks & Weathers (1896)		
Orotava			1923	Menéndez (1923)		
Parque García Sanabria			1990	Rodriguez (1990)		
Parque García Sanabria			2000	Reyes Y Pérez (2001)		
Rural Park of Anaga					2011	Dela Rosa et al. (2014)
Martinique						
Surroundings of Saint Pierre [P01674257]			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	I3N Brasil (2021)
Tijucas do Sul, Represa do Vossoroca (Guaratuba Environmental Protection Area)					2004	Blum et al. (2005)
Guaraqueçaba					2008	I3N Brasil (2021)
São Paulo						
Municipal Natural Park of Cratera de Colônia					2009	Marçon (2009); I3N Brasil (2021)
Rio de Janeiro			1890	Martius et al. (1890)		
Andarai Grande [P01674255]			1871	Reflora (2021)		
Tijuca [R010065496]			1886	Reflora (2021)		
Jardim Botânico			1937	Penna (1937)		
Itatiaia National Park					2013	I3N Brasil (2021)
Santa Catarina						
São Bento do Sul					2019	Meyer and Schwirkowski (2019)
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						
			1975	Molina (1975)	2008	Sutherland (2008)
Africa						
South Africa						
	1898	Baker (1898)				
	1991	Macdonald (1991)				
Kwazulu-Natal			1894[b]	Wood (1895)	1998	Smith (1998); Henderson (2001)
Kruger National Park (Mpumalanga and Limpopo)					1999	Foxcroft et al. (2003); Henderson (2001)
Zimbabwe						
Vumba Botanic Garden					2004	Hyde et al. (2021)
Harare					2006/2020	Hyde et al. (2021)
Juliasdale					2014	Hyde et al. (2021)
Chimanimani					2015	Hyde et al. (2021)
Swaziland						
	1998	Smith (1998)			2021	Swaziland's Alien Plants Database (2021)
Mlilwane Wildlife Sanctuary/islanddweller					2021	BioDiversity4All (2021)
Indian Ocean Islands						
Réunion Island						
Saint Denis Botanical Garden	1820/25	Breon (1820, 1825)				

Table 6 (continued)

Region	Not mentioned		Cultivated		Escaped from cultivation	
	Year	Reference	Year	Reference	Year	Reference
Saint Denis Botanical Garden	1825	Breon (1825)				
Saint Denis Botanical Garden	1856	Richard (1856)				
			1910/11	Commissioner of Agriculture for the West Indies (1912)	1895	Cordemoy (1895)
Mauritius						
	1877	Baker (1877)			2021	Mascarine Cadetiana (2021)
Rivière Noir			1837[c]	Bojer (1837)		
Australia						
Queensland, Brisbane			1875	Hill (1875)		
Victoria, Melbourne			1883	Guilfoyle (1883)		
New South Wales, Morisset [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						
	1841	Hooker (1853)	1865	Ludlam (1865)		
North Island					1940	Allan (1940)
South Island [CHR: 81,349, 481,420; 326,334 A, HO538398]					1953/75/77/86	AVH (2021)d
Auckland					1949	Williams et al. (2003)
Chatham Island [AK307272]			Before 2009, AVH (2021) (cultivated or escaped)			
Hawai'i						
	1934	Degener (1934)				
Hawai'i Volcanoes National Park (Park residential area)					1947	Fagerlund (1947)
Hawai'i					1954	Stone et al. (1992)
O'ahu					1975	Stone et al. (1992)
All islands					1985	Smith (1985)
Fiji						
Viti Levu			1979	Smith (1979)		
Viti Levu: Nukunuku, Nadala and Qaliwana Creeks					2002/04	Boseto (2006)
Asia						
Vietnam						
Ho Chi Minh (Saigon) [CLF082528]			1909	IHU (2021)		
					1993	Ho (1993)
Cat Ba national park					2012	Tan et al. (2012)

[a] *Hedychium* sp.; [b] *Hedychium* sp. from East Indies; [c] Under *H. speciosum* name

Table 7 Present status of invasiveness severity in the regions where the species escaped from cultivation according literature

Region	Severiry	Reference	
	Classification	Classification by the authors	In:
Europe			
Spain (Galicia)	3	Moderate	Ramil-Rego and Vales (2019)
Atlantic Islands			
Ascension	3	Present (Flora Guide)	Fairhurst (2004)
Azores	4	Invasive	Silva et al. (2008)
Canaries (Tenerife)	3	Initial state of dispersion	De La Rosa et al. (2014)
Cuba	2	Potentially invasive	González-Torres et al. (2012)
Jamaica	4	Invasive	Iremonger (2002)
Madeira	4	Invasive	Silva et al. (2008)
Martinique	2	Naturalized around the gardens	UICN|Comité Francais (2017a, b)
Trinidad	1	Present (Flora Checklist)	Baksh-Comeau (et al. 2016)
Americas			
Brazil	4	Invasive	I3N Brasil (2021)
Honduras	1	Present (Flora checklist)	Sutherland (2008)
Mexico (Mt. Ovando)	3	Invasive	Matuda (1950)
Africa			
South Africa	4	Emerging invader	Nel et al. (2004)
Swaziland	3	Invasive, potential problem species	Swaziland's Alien Plants Database (2021)
Zimbabwe	3	Naturalized	Hyde et al. (2021)
Indian Ocean Islands			
Réunion	4	Invasive	UICN Comité Francais (2017a, b)
Mauritius	1	Present	Mascarine Cadetiana (2021)
Australia			
New South Wales Queensland South Australia Victoria	4	Naturalised in New South Wales and adventive in Victoria; Potential range Queensland and Western Australia	Csurhes & Hannan-Jones (2016)
Pacific Ocean Islands			
Fiji	3	Spontaneous on creeks	Boseto (2006)
Hawaii	4	Invasive	Minden et al. (2010b)
New Zealand	4	Environmental weed; Pest plant	Howell (2008); New Zealand Government (2020)
Asia			
Vietnam	1	Insignificant	Tan et al. (2012)

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

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 recents 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 wined 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).

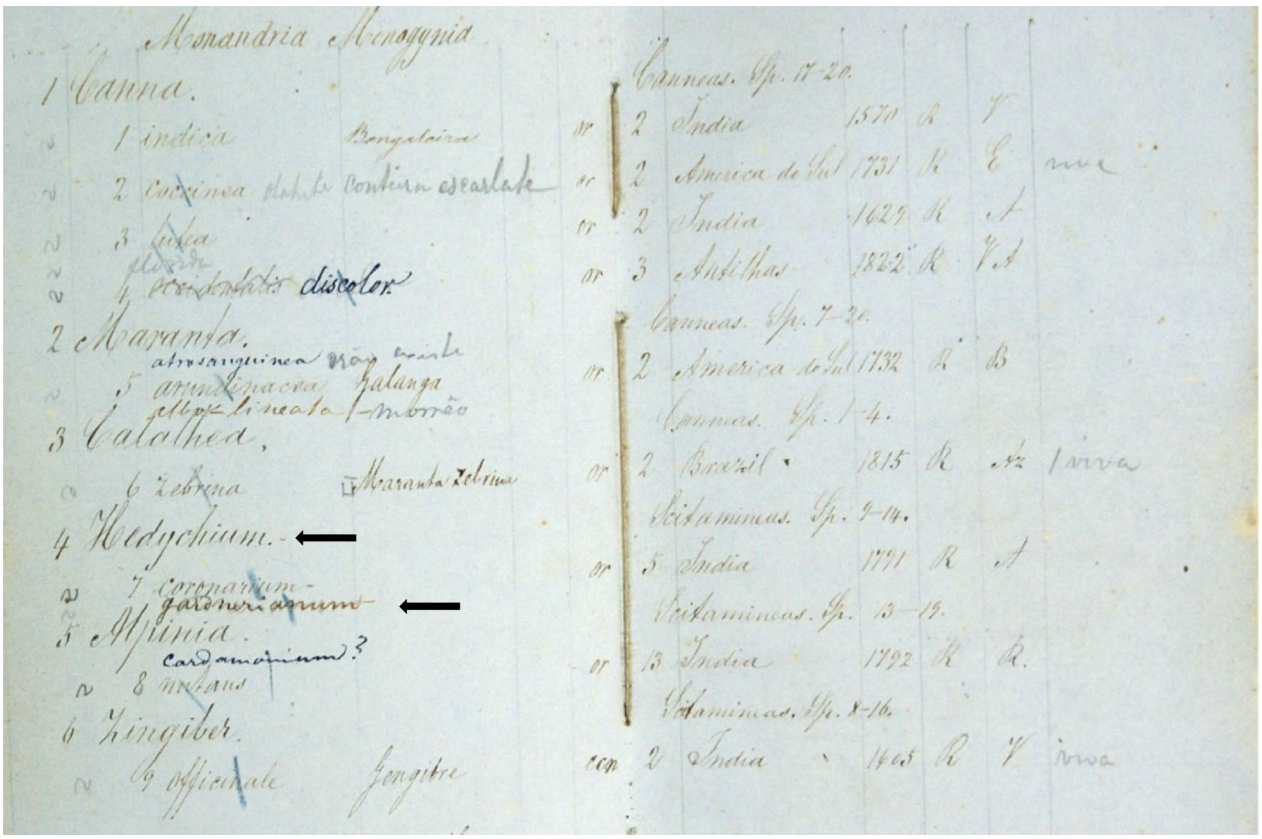


Fig. 6 Manuscript list of the cultivated plants in José do Canto Garden, in the year 1851 (S. Miguel Island, Azores). *Hedychium gardnerianum* (➡) (Courtesy of Azores University Library)

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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Availability of data and materials

All sources of information are are included in this published article. All data generated or analysed during this study are included in this published article.

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