







REVIEW ARTICLE

Zingiber: synonymy, accepted and excluded species

Carlos Eduardo Ferreira de Castro¹ [†], Charleston Gonçalves¹ , Vivian Loges² , Armando Reis Tavares¹ ,
Fábio de Barros³ , Ana Cecília Ribeiro de Castro⁴ 

¹ Instituto Agronômico, Campinas-SP, Brasil.

² Universidade Federal Rural de Pernambuco, Recife-PE, Brasil.

³ Instituto de Botânica, São Paulo-SP, Brasil.

⁴ Embrapa Agroindústria Tropical, Fortaleza-CE, Brasil.

[†] *In Memoriam*

Abstract

Among the species of the Zingiberaceae family, ginger (*Zingiber officinale* Roscoe) is the best known and studied species, with several reported ornamental, medicinal, and culinary properties. Many ornamental species of the genus *Zingiber* are commonly treated as gingers by analogy. This study provides a list of species of the genus *Zingiber*, information on synonyms and comments on ornamental aspects.

Keywords: botany, ginger, ornamental ginger, tropical plant, Zingiberaceae.

Resumo**Zingiber: sinonímia, espécies aceitas e excluídas**

Dentre as espécies da família Zingiberaceae, o gengibre (*Zingiber officinale* Roscoe) é a espécie mais conhecida e estudada, com diversas propriedades ornamentais, medicinais e culinárias relatadas. Muitas espécies ornamentais do gênero *Zingiber* são comumente tratadas como gengibres por analogia. Este estudo fornece uma lista de espécies do gênero *Zingiber*, informações sobre sinônimos e comentários sobre aspectos ornamentais.

Palavras-chave: botânica, gengibre, gengibre-ornamental, plantas tropicais, Zingiberaceae.

Introduction

The Zingiberaceae family is the largest in the order Zingiberales, and has been under intense revision in recent years. The list of currently accepted names presents 57 genera and 1,746 species (POWO, 2023). The Zingiberaceae family is characterized by rhizomatous herbaceous plants, producing aromatic oils, distic alternate large leaves, peninerveous, invaginating base, cymose spike inflorescences, usually with attractive bracts, zygomorphic, trimerous, dychlamyid. The flowers are heterochlamyid, with three sepals, three petals, one fertile stamen, petaliform staminodes, partly coalescent in a lip, inferior ovary, usually trilocular, fruit capsule or berry and seeds usually with plumose aril. Although this family is pantropical, is better represented in tropical Asia (Banaticla-Hilario and Altamirano, 2023). In Brazil, occurs

only a few species of *Renealmia* L.f. (Souza and Lorenzi 2008), and several species from other genera had been introduced, as medicinal, aromatic and ornamental.

Ginger (*Zingiber officinale* Roscoe) stands out among the economically important plants of the family. *Z. officinale* is the best known and studied species of the family, used as ingredient or flavoring agent in cooking, and for medicinal purposes, acting as a stimulant, antipyretic, carminative, and thermogenic. Many biological activities have already been reported, such as antimicrobial, anticancer, antioxidant, antidiabetic, anti-inflammatory, anti-obesity, anti-nausea, antiemetic, hepatoprotective, neuroprotective, cardiovascular, and respiratory protection (Mao et al., 2019). *Z. officinale* is widely used as a medicinal plant for the treatment of throat, lung and flu disorders in general, and also as a digestive and thermogenic in Brazil. Belonging to the same family, turmeric or saffron (*Curcuma longa* L.),

* Corresponding Author: charleston.goncalves@sp.gov.br

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cardamom (*Elettaria cardamomum* (L.) Maton) and several ornamental species, generally treated as ornamental ginger (e.g. *Z. spectabile* Griff.) also are cultivated (Anandaraj and Sudharshan, 2011).

The genus *Zingiber*, with over 200 species, is one of the largest within the family and was described by Philip Miller, in 1754 (Holttum, 1950, Theilade, 1998, Wu and Larsen, 2000). *Zingiber* is primarily characterized by the couplet leaves distributed in the same plane as the rhizome, the inflorescences generally in the shape of a cone formed by the relatively large bracts, the lip trilobed, the style much longer than the anther and the anther with a long crest with the edges close to the style like a curved beak. Each bract subtends a single flower; only *Z. clarkei* King ex Baker has 2-4 flowers on each bract. The bracts are frequently brightly colored and, in some species, change color when mature. The color of the lip is an important character of distinction; in some species it is cream or white, in others partially covered with dark pink, crimson or purple. The

bracts almost always retain a lot of water, delimiting a mucilaginous area, and the flowers and fruits develop in this environment. Fruit dehiscence occurs while still surrounded by the bracts (Holttum, 1950). The presence of a simple anther with a crest or beak-shaped appendage that embraces the upper part of the style is the origin of the Sanskrit word that gives rise to the name of the genus (Chaveerach et al., 2007). The genus stands out in terms of contemporaneity and versatility, due to the different ways in which the species are used.

Several species of the genus have ornamental usage as cut flowers, garden or vase plants, mainly *Z. spectabile* Griff. (Beehive ginger), and to a lesser extent, *Z. zerumbet* (L.) Sm. (pinecone ginger, wild ginger), *Z. ottensi* Valetton and *Z. newmanii* Theilade & Mood (Castro et al., 2018) (Figure 1). Certainly, when the different species of *Zingiber* become more widespread and their cultivation expands, many other species will be able to be used, expanding the market for flowers and ornamental plant.

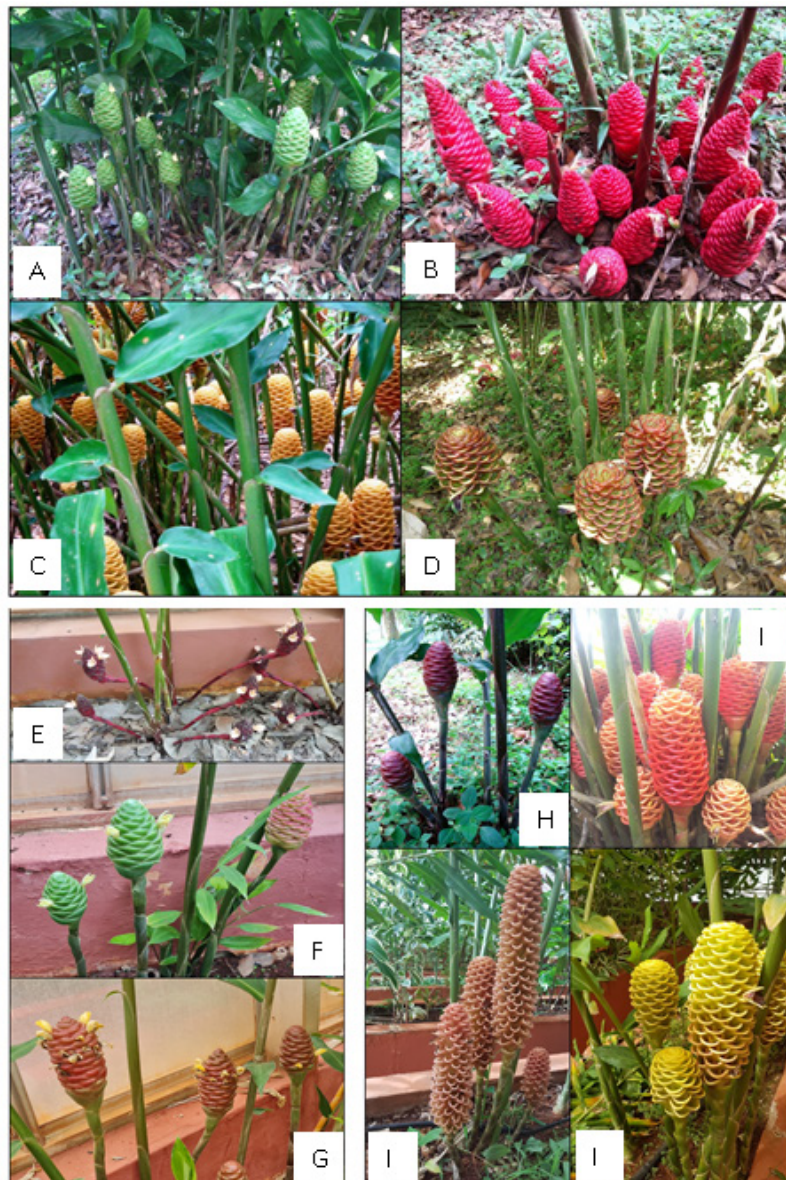


Figure 1. A. *Z. zerumbet*. B. *Z. newmanii*. C. *Z. spectabile*. D. *Z. macradenium*. E. *Z. pseudopungens*. F. *Z. zerumbet*. G. *Z. ottensi*. H. *Z. ottensi*. I. Different types of *Z. spectabile*.

The genus is native to tropical and subtropical Asia (POWO, 2023), in tropical to warm temperate regions, with greater diversity in monsoon areas (Kishor and Leong-Skornicková, 2013). *Zingiber* species have been reported to occur naturally in Bangladesh, Borneo, Cambodja, South Central and Southeast China, Hainan (China), East and West Himalayas, India, Andaman Islands (India), Assam (India), Nicobar Islands (India), Japan, Java (Indonesia), Laos, Malaysia, Myanmar, Nepal, Nansei-shoto (Japan), New Guinea, Philippines, Sri Lanka, Sulawesi (Indonesia), Sumatra, Taiwan, Thailand and Vietnam (POWO, 2023).

The current infrageneric classification of *Zingiber* recognizes four sections, based on the nature and position of the inflorescence: (1) section *Zingiber* which usually has a spike on a large erect peduncle; (2) section *Cryptanthium* Horan, characterized by a radical inflorescence composed of a spike at ground level with, usually, a short procumbent peduncle; (3) section *Pleuranthesis* Benth. with inflorescence from the leaf base; (4) section *Dymczewiczia* with terminal inflorescences (Triboun and Keeratikit, 2016). Molecular characterization study based on ITS rDNA, with 18 *Zingiber* species advises inconsistencies in the infrageneric classification based only on the type of inflorescence, in the case of sections *Dymczewiczia* and *Zingiber*; these sections should be put together on the basis of equal pollen morphology (Theerakulpisut et al., 2012).

The description of the genus in 1754, did not define a taxon as a type species. The first species described within the genus was *Z. spectabile* Griff., in 1754, but Linneus, in 1753, had described *Amomum zingiber* L., basionym of *Zingiber officinale* Roscoe and *Amomum zerumbet* L., basionym of *Zingiber zerumbet* (L.) Roscoe ex Sm. *Zingiber sylvestre* Gaertn. was described, in 1788. Soon after, *Z. mioga* Roscoe, *Z. purpureum* Roscoe and *Z. roseum* Roscoe were described (Roscoe, 1807). Later, in the 19th century, and until 1918, several publications featuring regional floras included the description of new species of *Zingiber*. Therefore, 11 species were reported in India (Roxburgh, 1810, 1820), 24 species for British India, a geographic area that included territories of India, Pakistan, Bangladesh and Myanmar (Baker, 1894). Currently, only 16 are within the geographic boundaries of India. Dalzell and Esq (1852), also highlighted the naturally occurring gingers in India.

Zingiber was studied in Java (Blume, 1827; Valetton, 1904, 1918), in Ceylon, currently Sri Lanka (Thwaites, 1864; Craib, 1912) and in Malaysia (Ridley, 1899, 1904, 1908; Schumann, 1900, 1904). Gagnepain (1908) was the only one to provide a comprehensive review of Zingiberaceae in Indochina, which currently includes areas in Vietnam, Laos, Cambodia, and parts of Thailand and Myanmar, listing 13 species in the *Zingiber* genus. The occurrence of species of the genus in China was reported by Diels (1900) and in Philippines by Ridley (1909) and Elmer (1915-1919). After 1918, and until 1990 there was not many studies on this genus, but the articles by Loesener (1930), Wallich (1830), Holttum (1950) and Smith (1988) studying Asian regional flora should be considered. Many new species have been described after 1990 focusing on the floras of Borneo-Malaysia (Burt; and Smith, 1969;

Smith, 1988; Poulsen, 2006; Sakai and Nagamasu, 2006; Lim and Meekiong, 2014), China (Wu and Larsen, 2000), India (Sabu, 2003), Indonesia (Ardiyani et al., 2017), Laos (Leong-Skornicková et al., 2014a), Sumatra (Nurainas and Arbain, 2017), Thailand (Theilade and Mood, 1997a, 1999b; Theilade, 1998, 1999; Triboun et al., 2014) and Vietnam (Pham, 2003; Leong-Skornicková et al., 2015). The record by Triboun et al. (2014) of the natural occurrence of 67 species in Thailand is an important evidence that Thailand is the center of biodiversity of the genus. China, with 42 species (36 endemic), presents the second most abundant diversity of the genus (Wu and Larsen, 2000).

Only two complete revisions of the genus have been made and that, more than one century ago, covering only 23 (Horaninow, 1862) and 55 species (Schumann, 1904). Other studies focus on regional floras, occurrence of new species and taxonomic revisions. The list of currently accepted names for the genus contains 205 species (POWO, 2023).

Our review accepted the names of the following species: *Z. acuminatum* Valetton (Valetton, 1904), *Z. aguingayae* Docot (Docot et al., 2019), *Z. album* Nurainas (Nurainas and Arbain, 2017), *Z. albiflorum* R.M. Smith (Smith, 1982), *Z. anamalanum* Sujanapal & Sassidh. (Sujanapal and Sasidharan, 2010), *Z. angustifolium* Lim & Meekiong (Lim and Meekiong, 2014), *Z. apoense* Elmer (Elmer, 1915-1919), *Z. argenteum* Mood & Theilade (Theilade and Mood, 1997a), *Z. arunachalensis* A. Joe, T. Jayakr., Hareesh & M. Sabu (Joe et al., 2017), *Z. atroporphyreum* Skornick. & Q.B. Nguyen (Leong-Skornicková et al., 2015), *Z. atrorubens* Gagnep. (Gagnepain, 1903), *Z. aurantiacum* (Holt.) Theilade (Theilade, 1998), *Z. banhaoense* Mood & Theilade (Mood and Theilade, 2001), *Z. barbatum* Wall. (Wallich, 1830), *Z. belumense* Lim & Meekiong (Lim and Meekiong, 2014), *Z. bipinianum* D.K. Roy, D. Verma, Talukdar & Dutta Choud. (Talukdar et al., 2015), *Z. bisectum* D. Fang (Fang and Qin, 1996), *Z. brachystachys* Triboun & K.Larsen (Triboun et al., 2014), *Z. bradleyanum* Craib (Craib, 1912), *Z. brevifolium* N.E.Br. (Brown, 1886), *Z. bulusanense* Elmer (Elmer, 1915-1919), *Z. calcicola* Y.H.Tan & H.B.Ding (Ding et al., 2021), *Z. callianthum* Triboun & K.Larsen (Triboun et al., 2014), *Z. campanulatum* T. Jayakr, A. Joe, Hareesh & M. Sabu (Joe et al., 2017), *Z. capitatum* Roxb. (Roxburgh, 1810), *Z. cardiocheilum* Skornick. & Q.B. Nguyen (Leong-Skornicková et al., 2015), *Z. castaneum* Skornick. & Q.B. Nguyen (Leong-Skornicková et al., 2015), *Z. caudatum* Biseshwori & Bipin (Biseshwori and Bipin, 2018), *Z. cernuum* Dalzell (Dalzell and Esq, 1852), *Z. chataranothaii* Triboun & K. Larsen (Triboun et al., 2014), *Z. chengii* Y.H. Tseng, C.M. Wang & Y.C. Lin (Wang et al., 2020), *Z. chlorobracteatum* Mood & Theilade (Theilade and Mood, 1999b), *Z. chrysanthum* Roscoe (Roscoe, 1824), *Z. chrysostachys* Ridl. (Ridley, 1899), *Z. citriodorum* Theilade & Mood (Mood and Theilade, 2002), *Z. clarkei* King ex Baker (Baker, 1894), *Z. cochleariforme* D. Fang (Fang, 1980), *Z. collinsii* Mood & Theilade (Theilade and Mood, 1999a), *Z. coloratum* N.E.Br. (Brown, 1879), *Z. corallinum* Hance (Hance, 1880), *Z. cornubracteatum*

- Triboun & K.Larsen (Triboun et al., 2014), *Z. curtisii* Holttum (Holttum, 1950), *Z. cylindricum* Thwaites (Thwaites, 1864), *Z. densissimum* S.Q. Tong & Y.M. Xia (Tong and Xia, 1987), *Z. discolor* Skornick., Tran, Rybková (Leong-Skornicková et al., 2015), *Z. eberhardtii* Gagnep. (Gagnepain, 1907a), *Z. eborinum* Mood & Theilade (Theilade and Mood, 1997b), *Z. elatius* (Ridl.) Theilade (Theilade, 1998), *Z. elatum* Roxb. (Roxburgh and Wallick, 1820), *Z. ellipticum* (S.Q. Tong & Y.M. Yang) Q.G. Wu & T.L. Wu (Wu et al., 1996), *Z. engganoensis* Ardiyani (Ardiyani, 2015), *Z. fallax* (Loes.) L. Bai, Juan Chen & N.H. Xia (Chen et al., 2019), *Z. flagelliforme* Mood & Theilade (Theilade and Mood, 1999b), *Z. flammeum* Theilade & Mood (Theilade and Mood, 1997b), *Z. flaviflorum* C.K. Lim & Meekiong (Lim and Meekiong, 2014), *Z. flavofusiforme* M.M. Aung & Nob. Tanaka (Tanaka and Aung, 2017), *Z. flavomaculosum* S.Q. Tong (Shao-Quan, 1987), *Z. flavovirens* Theilade (Theilade, 1999), *Z. fragile* S.Q. Tong (Tong and Xia, 1987), *Z. fraseri* Theilade (Theilade, 1998), *Z. georgeai* Mood & Theilade (Theilade and Mood, 1999b), *Z. gracile* Jack (Jack, 1820-1822), *Z. gramineum* Noronha ex Blume (Blume, 1827), *Z. griffithii* Baker (Baker, 1894), *Z. guangxiense* D.Fang (Fang, 1980), *Z. gulinense* Y.M. Xia (Xia, 1996), *Z. hainanense* Y.S. Ye, L. Bai & N.H. Xia (Ye, et al., 2015), *Z. idae* Triboun & K. Larsen (Triboun et al., 2002), *Z. incomptum* B.L. Burth & R.M. Sm. (Burt and Smith, 1969), *Z. inflexum* Blume (Blume, 1827), *Z. integrilabrum* Hance (Hance, 1882), *Z. integrum* S.Q. Tong (Tong and Xia, 1987), *Z. intermedium* Baker (Baker, 1894), *Z. isanense* Triboun & K.Larsen (Triboun et al., 2014), *Z. jiewhoei* Skornick. (Leong-Skornicková et al., 2014b), *Z. junceum* Gagnep. (Gagnepain, 1906), *Z. kangleipakense* Kishor & Skornick. (Kishor & Leong-Skornicková, 2013), *Z. kawagooi* Hayata (Hayata, 1921), *Z. kelabitianum* Theilade & H. Chu (Theilade and Christensen, 1998), *Z. kerrii* Craib. (Craib, 1912), *Z. kunstleri* King ex Ridl. (Ridley, 1899), *Z. lambii* Mood & Theilade (Theilade and Mood, 1997a), *Z. laoticum* Gagnep. (Gagnepain, 1907a), *Z. larsenii* Theilade (Theilade, 1999), *Z. latifolium* Theilade & Mood (Theilade and Mood, 1997a), *Z. lecongkietii* Skornick. & H.Đ. Trần (Leong-Skornicková et al., 2015), *Z. leptorrhizum* D. Fang (Fang, 1982), *Z. leptostachyum* Valetton (Valetton, 1908), *Z. ligulatum* Roxb. (Roxburgh, 1810), *Z. limianum* Meekiong (Lim and Meekiong, 2014), *Z. linyunense* D. Fang (Fang, 1980), *Z. loerzingii* Valetton (Valetton, 1918), *Z. longibracteatum* Theilade (Theilade, 1999), *Z. longiglande* D. Fang & D.H. Qin. (Fang and Qin, 1996), *Z. longiligulatum* S.Q. Tong (Shao-Quan, 1987), *Z. longipedunculatum* Ridl. (Ridley, 1908), *Z. longyanjiang* Z.Y. Zhu (Zhu, 1992), *Z. macradenium* K. Schum. (Schumann, 1900), *Z. macrocephalum* (Zoll.) K. Schum. (Schumann, 1900), *Z. macroglossum* Val. (Valetton, 1918), *Z. macrorrhynchus* K. Schum. (Schumann, 1904), *Z. magang* N.S. Lý & Skornick. (Jayakrishnan et al., 2021), *Z. malaysianum* C.K. Lim (Lim, 2002), *Z. marginatum* Roxb. (Roxburgh, 1810), *Z. martini* R.M. Sm. (Smith, 1988), *Z. matangense* Noor Ain, Tawan & Meekiong (Ain et al., 2015), *Z. matupiense* M.M. Aung & Nob. Tanaka (Tanaka and Aung, 2017), *Z. matutumense* Mood & Theilade (Mood and Theilade, 2001), *Z. mawangense* Noor Ain & Meekiong (Ain et al., 2015), *Z. meghalayense* Sushil K. Singh, Ram, Kumar & Mood (Kumar et al., 2013), *Z. mekongense* Gagnep. (Gagnepain, 1907b), *Z. mellis* Skornick., H.Đ. Trần & Šida f. (Leong-Skornicková et al., 2015), *Z. microcheilum* Skornick., H.Đ. Trần & Šida f. (Leong-Skornicková et al., 2015), *Z. mioga* (Thumb.) Roscoe (Roscoe, 1807), *Z. mizoramense* Ram, Kumar, Sushil K. Singh & S. Sharma (Kumar et al., 2015), *Z. molle* Ridl. (Ridley, 1909), *Z. monophyllum* Gagnep. (Gagnepain, 1903), *Z. montanum* (J. Koenig) Link ex A. Dietr. (Wildenow, 1831), *Z. multibracteatum* Holttum (Holttum, 1950), *Z. murlenica* Ram, Kumar, Sushil K. Singh & S. Sharma (Kumar et al., 2015), *Z. nanlingensis* (Chen et al., 2011), *Z. natmataungense* S.S. Zhou & R. Li (Li et al., 2002), *Z. nazrinii* C.K. Lim & Meekiong (Lim and Meekiong, 2014), *Z. neesamum* (J. Graham) Ramamoorthy (Saldanha and Nicolson, 1976), *Z. neglectum* Valetton (Valetton, 1904), *Z. negrosense* Elmer (Elmer, 1915-1919), *Z. neotruncatum* T.T. Wu, K. Larsen & Turland (Wu et al., 2000), *Z. nigrimaculatum* S.Q. Tong (Tong, 1989), *Z. nimmonii* (J. Graham) Dalzell (Dalzell and Esq, 1852), *Z. nitens* M.F. Newman (Newman, 2015), *Z. niveum* Mood & Theilade (Mood and Theilade, 2002), *Z. odoriferum* Blume (Blume, 1827), *Z. officinale* Roscoe (Roscoe, 1807), *Z. oligophyllum* K. Schum. (Schumann, 1904), *Z. olivaceum* Mood & Theilade (Mood and Theilade, 2002), *Z. orbiculatum* S.Q. Tong (Tong and Xia, 1987), *Z. ottensi* Valetton (Valetton, 1918), *Z. pachysiphon* B.L. Burth & R.M. Smith (Burt and Smith, 1969), *Z. panduratum* Roxb. (Roxburgh and Wallick, 1820), *Z. papuanum* Valetton (Valetton, 1918), *Z. pardocheilum* Wall. ex Baker (Baker, 1894), *Z. parishii* Hook.f. (Hooker et al., 1873), *Z. pauciflorum* L. Bai, Skornick., D.Z. Li & N.H. Xia (Bai et al., 2017), *Z. pellitum* Gagnep. (Gagnepain, 1906), *Z. pendulum* Mood & Theilade (Theilade and Mood, 1997a), *Z. petiolatum* (Holttum) Theilade (Theilade, 1998), *Z. pherimaense* Biseshwori & Bipin (Thongan and Konsan, 2014), *Z. phillippsiae* Mood & Theilade (Theilade and Mood, 1999b), *Z. phumiangense* Chavein & Makkamil (Chaveerach et al., 2007), *Z. pleiostachyum* K. Schum. (Schumann, 1904), *Z. plicatum* Skornick. & Q.B. Nguyen (Leong-Skornicková et al., 2015), *Z. popaense* Nob. Tanaka (Tanaka, 2012), *Z. porphyrochilum* Y.H. Tan & H.B. Ding (Ding et al., 2020), *Z. porphyrosphaerum* K. Schum. (Schumann, 1904), *Z. pseudopungens* R.M. Smith (Smith, 1988), *Z. pseudosquarrosus* L.J. Singh & P. Singh (Singh and Singh, 2016), *Z. puberulum* Ridl. (Ridley, 1899), *Z. purpurealbum* Nob. Tanaka & M.M. Aung (Tanaka and Aung, 2020), *Z. purpureum* Roscoe (Larsen, 1996), *Z. pyroglossum* Triboun & K. Larsen (Triboun et al., 2014), *Z. raja* K. Lim & Kharuk (Lim, 2003), *Z. recurvatum* S.Q. Tong & Y.M. Xia (Tong and Xia, 1987), *Z. reflexum* Nob. Tanaka & M.M. Aung (Tanaka and Aung, 2020), *Z. roseum* (Roxb.) Roscoe (Roscoe, 1807), *Z. rubens* Roxb. (Roxburgh, 1810), *Z. rufopilosum* Gagnep. (Gagnepain, 1903), *Z. sabuanum* K.M.P. Kumar & A. Joe (Prabhumar et al., 2016), *Z. sabun* K. Lim (Lim and Meekiong, 2014), *Z.*

sadakornii Triboun & K. Larsen (Triboun et al., 2014), *Z. salarkanii* Rahman & Yusuf (Rahman and Yusuf, 2013), *Z. shuanglongense* L. Yeh & S.W. Chung (Yeh et al., 2012), *Z. sianginensis* (Mibang and Das, 2016), *Z. simaoense* Y.Y. Quan (Quan, 1988), *Z. singaporense* Skornick. (Leong-Skornicková et al., 2014b), *Z. skornickovae* N.S. Lý (Lý, 2016), *Z. smilesianum* Craib (Craib, 1912), *Z. spectabile* Griff. (Griffith, 1851), *Z. squarrosum* Roxb. (Roxburgh, 1810), *Z. stenostachys* K. Schum. (Schumann, 1904), *Z. striolatum* Diels (Diels, 1900), *Z. subroseum* Docot (Docot et al., 2019), *Z. sulphureum* Berkill ex Theilade (Colley and Theilade, 1995), *Z. sylvestre* Gaertn. (Gaertner, 1788), *Z. tamii* N.S. Lý & Skornick. (Lý et al., 2021), *Z. tenuifolium* L. Bai, Skornick. & N.H. Xia (Bai et al., 2015), *Z. tenuiscapus* (Triboun et al., 2014), *Z. thorelii* Gagnep. (Gagnepain, 1907), *Z. tuanjuum* Z.Y. Zhu (Zhu, 1984), *Z. ultralimitale* Ardyani & Poulsen (Ardiyani et al., 2017), *Z. vanlithianum* Kd. (Koordts, 1918), *Z. velutinum* Mood & Theilade (Theilade and Mood, 1999b), *Z. ventricosum* L. Bai, Skornick., N.H. Xia & Y.S. Ye (Bai et al., 2015), *Z. vinosum* Mood & Theilade (Theilade and Mood, 1997a), *Z. viridiflavum* Mood & Theilade (Theilade and Mood, 1999b), *Z. vittacheilum* Triboun & K. Larsen (Triboun et al., 2014), *Z. vuquangense* N.S. Lý, T.H. Lê, T.H. Trinh, V.H. Nguyen & N.D. Do (Le et al., 2019), *Z. wandiangense* S.Q. Tong (Shao-Quan, 1987), *Z. wightianum* Thwaites (Thwaites, 1864), *Z. wrayi* Prain ex Riedl (Ridley, 1904), *Z. yersinii* Skornick., H.D. Trần & Rybková (Leong-Skornicková et al., 2015), *Z. yingjiangense* S.Q. Tong (Shao-Quan, 1987), *Z. yunnanense* S.Q. Tong & X.Z. Lui (Tong and Lim, 1991), *Z. zerumbet* Sm. (Smith, 1804-1806), *Z. zhuxiense* (Hu et al., 2015).

Table 1. Synonyms for Zingiber species

Species	Synonymy
<i>Z. aurantiacum</i> (Holttum) Theilade	<i>Z. gracile</i> var. <i>aurantiacum</i> Holttum, The Gardens' Bulletin Singapore 13: 63. 1950.
<i>Z. capitatum</i> Roxb.	<i>Dymczewiczia capitata</i> (Roxb.) Horan., Prodr. Monogr. Scitam: 26. 1862.
<i>Z. chrysanthum</i> Roscoe	<i>Z. flavescens</i> Link ex A. Dietr., Sp. Pl. 1: 54. 1831.
<i>Z. elatum</i> Roxb.	<i>Dymczewiczia elata</i> (Roxb.) Horan., Prodr. Monogr. Scitam 26. 1862. <i>Z. capitatum</i> var. <i>elatum</i> (Roxb.) Baker, Fl. Brit. India 6: 249. 1892.
<i>Z. ellipticum</i> (S.Q. Tong & Y.M. Xia) Q.G. Wu & T.L. Wu	<i>Plagiostachys elliptica</i> S.Q. Tong & Y.M. Xia, Acta Phytotax. Sin. 25: 460. 1987.
<i>Z. fraseri</i> Theilade	<i>Z. besar</i> C.K. Lim & Meekiong, Folia Malaysiana 15(1):16.2014. nom. illeg. <i>Z. besar</i> C.K. Lim & Meekiong var. <i>fraseri</i> (Theilade), Folia Malaysiana 16(1):18.2014. <i>Z. besar</i> C.K. Lim & Meekiong var. <i>nervifolium</i> C.K. Lim & Meekiong, Folia Malaysiana 16(1): 18. 2015.
<i>Z. gramineum</i> Noronha ex Blume	<i>Dymczewiczia graminea</i> (Noronha ex Blume) Horan., Prodr. Monogr. Scitam 26. 1862. <i>Z. gramineum</i> var. <i>validior</i> K. Schum, Pflanze., IV, 46: 175. 1904.
<i>Z. griffithi</i> Baker	<i>Z. citrinum</i> Ridl. – J. Straits Branch Roy. Asiat. Soc. 32: 129. 1899. <i>Z. griffithii</i> var. <i>citrinum</i> (Ridl.) Holttum, The Gardens' Bulletin Singapore 13: 63. 1950.
<i>Z. idae</i> Triboun & K. Larsen	<i>Z. villosum</i> Theilade, Nordic J. Bot. 19: 396.1999.
<i>Z. kawagoi</i> Hayata	<i>Z. koshunense</i> Hayata ex C.T. Moo, Fl. Taiwan 5: 850.1978. nom. inval.
<i>Z. kerri</i> Craib.	<i>Z. menghaiense</i> S.Q. Tong, Acta Phytotax. Sin. 25(2): 145. 1987. <i>Z. stipitatum</i> S.Q. Tong, Acta Phytotax. Sin. 25: 146. 1987.
<i>Z. leptostachyum</i> Valetton	<i>Z. flavidum</i> Riedl., J. Straits Branch Roy. Asiat. Soc. 54: 58. 1910.
<i>Z. longibracteatum</i> Theilade	<i>Z. mythianum</i> C.K. Lim, Folia Malaysiana 2: 37. 2001.
<i>Z. longipedunculatum</i> Ridl.	<i>Z. longipedunculatum</i> var. <i>lambirensense</i> S. Sakai & Nagam., Blumea 51: 112.2006.
<i>Z. macrocephalum</i> (Zoll.) K. Schum.	<i>Cardamomum macrocephalum</i> (Zoll.) Kuntze, Rev. Gen. Pl. 2: 687. 1891. <i>Donacodes macrocephala</i> Zoll., Natuur-Genesks. Arch. Ned. Indië 2: 211. 1854. <i>Ellettaria macrocephala</i> (Zoll.) Miq., Fl. Ned. Ind. 3: 603. 1859.
<i>Z. mioga</i> (Thunb.) Roscoe	<i>Amomum mioga</i> Thunb., Syst. Veg. 14: 51. 1784. <i>Z. echuanense</i> Y.K. Yang, Acta Phytotax. Sin. 26: 158. 1988. <i>Z. mijooka</i> Siebold, Verh. Batav. Genootsch. Kunsten 12: 18. 1830. <i>Z. mioga</i> var. <i>variegatum</i> Makino, J. Jap. Bot. 6: 10. 1929. <i>Z. sjooka</i> Siebold, Verh. Batav. Genootsch. Kunsten 12: 18. 1830.
<i>Z. molle</i> Ridl.	<i>Z. sylvaticum</i> Elmer, Leafl. Philipp. Bot. 8: 2919. 1915.

Table 1. continuation

<i>Z. montanum</i> (J. Koenig) Link ex A. Dietr.	<p><i>Amomum cassumar</i> (Roxb.) Donn, Hortus Cantabrig 7: 1. 1812. <i>Amomum montanum</i> J. Koenig, Observ. Bot. 3: 51. 1783. <i>Amomum xanthorrhiza</i> Roxb. ex Steud., Nomencl. Bot. 2, 1: 78. 1840. <i>Cassumar roxburgh</i> Colla, Nov. Scitam. Gen. 10. 1830. <i>Jaegera montana</i> (J. Koenig) Giseke, Prael. Ord. Nat. Pl. 203. 1792. <i>Z. anthorrhiza</i> Horan., Prodr. Monogr. Scitam 27. 1862. <i>Z. cassumar</i> Roxb., Asiat. Res. 11: 347. 1810. <i>Z. cassumar</i> var. <i>palamaense</i> Haines, Bot. Bihar Orissa 1144. 1924. <i>Z. cassumar</i> var. <i>subglabrum</i> Thwaites, Enum. Pl. Zeyl. 315. 1861. <i>Z. cliffordiae</i> Andrews, Bot. Repos. 9: t.555. 1809. <i>Z. luridum</i> Salisb., Trans. Hort. Soc. London 1: 284. 1812. <i>Z. purpureum</i> Roscoe, Trans. Linn. Soc. London 8: 348. 1807. <i>Z. purpureum</i> var. <i>palamaense</i> (Haines) K.K. Khana, Fl. Bihar, Analysis 513. 2001. <i>Z. xantorrhizon</i> Steud., Nomencl. Bot. 2, 2: 799. 1841.</p>
<i>Z. multibracteatum</i> Holttum	<i>Z. multibracteatum</i> var. <i>multibracteatum</i>
<i>Z. neesatum</i> (J. Graham) Ramamoorthy	<p><i>Alpinia neesana</i> J. Graham, Cat. Pl. Bombay 207. 1839. <i>Z. macrostachyum</i> Dalzell, Bot. Kew Gard. Misc. 4: 342. 1852.</p>
<i>Z. neotruncatum</i> T.L. Wu, K. Larsen & Turland	<i>Z. truncatum</i> S.Q. Tong, Acta Phytotax. Sin. 25: 147. 1987.
<i>Z. nimmonii</i> (J. Graham) Dalzell	<i>Alpinia nimmonii</i> J. Graham, Cat. Pl. Bombay 206. 1839.
<i>Z. montanum</i> (J. Koenig) Link ex A. Dietr.	<p><i>Z. newmanii</i> Theilade & Mood. Nordic J. Bot. 19: 407 <i>Z. nudicarpum</i> D. Fang, Guihaia 2(3): 139–140, pl. 1, f. 4 <i>Z. peninsulare</i> Theilade, Nordic J. Bot. 19: 401</p>
<i>Z. odoriferum</i> Blume	<p><i>Z. aquosum</i> Blume, Enum. Pl. Javae 43. 1790. nom. inval. <i>Z. odoriferum</i> var. <i>odoriferum</i> <i>Z. pachystachys</i> Valetton, Bull. Jard. Bot. Buitenzorg, sér. E 27: 147. 1818. <i>Z. tongtak</i> K. Schum, Pflanzenr. IV, 46: 177. 1904.</p>
<i>Z. officinale</i> Roscoe	<p><i>Amomum angustifolium</i> Salisb., Prodr. Stirp. Chap. Allerton: 4. 1796. <i>Amomum zinziba</i> Hill, Veg. Syst. 16: 50. 1770, orth var. <i>Amomum zingiber</i> L., Sp Pl. 1: 1. 1753. <i>Z. aromaticum</i> Noronha, Verh. Batav. Genootsch. Kunsten 5(4): 28. 1790, nom. nud. <i>Z. cholmondeleyi</i> (F.M. Bailey) K. Schum., Pflanzenr. IV, 46: 172. 1904. <i>Z. majus</i> Rumph. (herb) <i>Z. missionis</i> Wall., Number. List {Wallich} n.6565. 1832. <i>Z. officinale</i> var. <i>cholmondeley</i> F.M. Bailey, Queensland Agric. J. 6: 498. 1900. <i>Z. officinale</i> var. <i>macrorhizonum</i> Makino, J. Jap. Bot. 8: 45. 1933. <i>Z. officinale</i> var. <i>rubens</i> Makino, J. Jap. Bot. 8: 45. 1933. <i>Z. officinale</i> var. <i>rubrum</i> Theilade, The Gardens' Bulletin Singapore 48: 218. 1996 publ. 1998. <i>Z. officinale</i> var. <i>sichuanense</i> Z.Y. Zhu, S.L. Zhang & S.X. Chen, Fl. Sichuanica 10: 624. 1992. <i>Z. officinale</i> f. <i>macrorhizonum</i> (Makino) M. Hiroe, Pl. Basho's & Buson's Hokku Lit. 8: 258. 1971 <i>Z. officinale</i> f. <i>rubens</i> (Makino) M. Hiroe, Pl. Basho's & Buson's Hokku Lit. 8: 258. 1971 <i>Z. sichuanense</i> Z.Y. Zhu, S.L. Zhang & S.X. Chen, Bull. Sichuan School Chin. Med. 19878 (1): 39. 1987. <i>Z. zingiber</i> (L.), Deut Fl. 471. 1880, nom. inval.</p>
<i>Z. petiolatum</i> (Holttum) Theilade	<i>Z. gracile</i> var. <i>petiolatum</i> Holttum, The Gardens' Bulletin Singapore 13: 64. 1950.
<i>Z. puberulum</i> Ridl.	<p><i>Z. chryseum</i> Riedl., J. of the Straits Branch of the Royal Asiatic Society 50: 149. 1908. <i>Z. puberulum</i> var. <i>puberulum</i></p>
<i>Z. roseum</i> (Roxb.) Roscoe	<i>Amomum roseum</i> Roxb., Pl. Coromandel 2: t.126. 1800.
<i>Z. smilesianum</i> Craib	<i>Z. teres</i> S.Q. Tong & Y.M. Xia, Acta Phytotax. Sin. 25(6): 468-470, pl. 7. 1987.

Table 1. continuation

<i>Z. striolatum</i> Diels	<i>Z. didymoglossa</i> K. Schum. = <i>Z. didymoglossum</i> K. Schum., Pflanzenr. IV, 46: 186. 1904. <i>Z. emeiense</i> Z.Y. Zhu, Acta Bot. Yunann 6(2): 185. 1984. <i>Z. hupehense</i> Pamp., Nuovo Giorn. Bot. Ital. 17: 244. 1910. <i>Z. liangshanense</i> Z.Y. Zhu, Bull. Sichuan School Chin. Met. Med. 9(3): 33. 1987
<i>Z. thorelii</i> Gaenep.	<i>Z. xishuangbannaense</i> S.Q. Tong, Acta Phytotax. Sin. 25: 461. 1987.
<i>Z. wightianum</i> Thwaites	<i>Z. squarrosum</i> Wight, Icon. Pl. Ind. Orient.: t. 2004. 1853, nom. illeg.
<i>Z. wrayi</i> Prain ex Ridl.	<i>Z. wrayi</i> var. <i>halabala</i> C.K. Lim, Folia Malaysiana 2(1): 50. 2001.
<i>Z. zerumbet</i> (L.) Roscoe ex Sm.	<i>Amomum spurium</i> (J. Koenig) J.F. Gmel, Syst. Nat. 13 [bis]: 6. 1791 <i>Amomum sylvestre</i> Lam, Encycl. 1: 134. 1783, nom. superfl. <i>Amomum zerumbet</i> L., Sp Pl., 1753. <i>Cardamomum spurium</i> (J. Koenig) Kuntze, Revis. Gen. Pl. 2: 687. 1891. <i>Dieterichia lampujang</i> Giseke, Prael Ord. Nat. Pl. 199. 1792. <i>Dieterichia lampuyang</i> Giseke, Prael Ord. Nat. Pl. 208. 1792. <i>Dieterichia major</i> Raeusch., Nomencl. Bot. 3: 1797. <i>Dieterichia minor</i> Raeusch., Nomencl. Bot. 3: 1797. <i>Dieterichia spuria</i> Giseke, Prael Ord. Nat. Pl.: 199. 1792. <i>Zerumbet zingiber</i> T. Lestib, Ann. Sci. Nat. Bot., sér. 2, 15: 329. 1841. <i>Z. amaricans</i> Blume, Enum. Pl. Javae 43. 1790. <i>Z. aromaticum</i> Valetton, Bull. Jard. Bot. Buitenzorg II, 27: 131. 1918. <i>Z. blancoi</i> Hassk., Flora 47:20. 1864. <i>Z. cochinchinense</i> Gaenep., Bull. Soc. Bot. France 54: 167. 1907. <i>Z. darceyi</i> H.J. Veitch, Cat. 1890: 13. 1890. <i>Z. littorale</i> (Valetton), Bull. Jard. Bot. Buitenzorg II 27: 135. 1918. <i>Z. ovoideum</i> Blume, Enum. Pl. Javae: 43. 1827. <i>Z. spurium</i> J. Koenig, Observ. Bot. 3: 60. 1783. <i>Z. sylvestre</i> Garsault, Fig. Pl. Méd. t. 34b. 1764, opus utique oppr. <i>Z. truncatum</i> Stokes, Bot. Mat. Med. 1: 68. 1812. <i>Z. zerumbet</i> subsp. <i>cochinchinense</i> (Gagnep.) Triboun & K. Larsen, Acta Phytotax. Sin. 45: 404. 2007. <i>Z. zerumbet</i> var. <i>littoralis</i> Valetton, Icon. Bogor. 3: t. 250. 1907. <i>Z. zerumbet</i> var. <i>magnum</i> Elmer, Leafl. Philipp. Bot. 8: 2922. 1919. <i>Z. zerumbet</i> var. <i>valenzuelae</i> Oliveros & Cantoria, Philipp. J. Sci., 111: 105. 1982, nom. inval.

The type material of the species in the Zingiberaceae family is usually poor or absent, making it difficult to preserve important floral characters in herbarium specimens through traditional drying methods, as well as the variability of certain morphological characters, together with hybridization and polyploidy in some genera, make Zingiberaceae one of the most taxonomically challenging plant groups (Bai et al., 2015; confirming Larsen (1980) and Theilade (1999)). In addition, the deficiency in the study of the genus, as well as the larger genera of the family Zingiberaceae, is further exacerbated by the fact that many researchers have limited their area of study to a single country, rather than working monographically, leading to repeated descriptions of the same taxa. Several taxonomists have recommended that

the ideal method for the taxonomic study of *Zingiber* should be to work with living, fertile or well-preserved material in liquid medium. The solution, for Burtt & Smith (1979) involves revisiting and collecting plants from the type localities in order to take accurate notes with good photographic documentation, and to preserve at least the fertile bracts, bracts and flowers (or, better still, the entire inflorescence) in liquid medium, including several flowers preserved separately to avoid damage. Additionally, Bai et al. (2015) suggest that reviewing the pertinent literature on species across their phylogeographical range and good communication between taxonomists working with gingers is also crucial. Thus, during a series of species initially belonging to the family were reconsidered and excluded from the genus (Tables 2 and 3).

Table 2. Described *Zingiber* species transferred to other genera.

Species	Original Description	Genus and Citation
<i>Z. alliaceum</i> (Teijsm. & Binn) K. Schum.	Pflanzer. IV 46: 179. 1904	<i>Hornstedtia conica</i> Riedl., J. Straits Branch Roy Asiat. Soc. 32: 142. 1899.
<i>Z. borneense</i> K. Schum.	Pflanzer. IV 46: 178. 1904.	<i>Amomum borneense</i> (K. Schum.) R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 45: 337. 1988 publ. 1989.
<i>Z. compactum</i> (Sol. ex Maton) Stokes	Bot. Mat. Med. 1: 68. 1812.	<i>Amomum compactum</i> Sol. ex Maton, Trans. Linn. Soc. London 10: 251. 1811.
<i>Z. corynostachyum</i> (Wall.) Steud.	Nomencl. Bot. ed 2, 2: 798.1841.	<i>Amomum corynostachyum</i> (Wall.) Steud., Nomencl. Bot. 2, 2: 798. 1841.
<i>Z. dubium</i>	Rem. Guin. 2: 9. 1813.	<i>Costus dubius</i> (Afzel.) K. Schum, Pflanzer. IV, 46: 409. 1904.
<i>Z. ensai</i> Gaertn.	Fruct. Sem. Pl. i. 35. 1788	<i>Elettaria ensai</i> (Gaertn.) Abeyw., Ceylon J. Sci., Biol. Sci. 2: 83. 1959.
<i>Z. galanga</i> (L.) Stokes	Bot. Mat. Med. 1: 72. 1812.	<i>Alpinia galanga</i> (L.) Willd., Sp. Pl. 1: 12. 1797.
<i>Z. gigantifolium</i> Elmer	Leafl. Philipp. Bot. 8: 2916. 1915.	<i>Alpinia gigantifolia</i> (Elmer) R.M.Sm. Edinburgh J. Bot. 47: 65. 1990.
<i>Z. globosum</i> Stokes	Bot. Mat. Med. 1: 72. 1812.	<i>Alpinia globosa</i> Horan, Prod. Scitam. 34. 1862.
<i>Z. insipidum</i> Noronha	Verh. Batav. Genootsch. Kunsten 5(4): 28. 1790, nom. inval.	<i>Hornstedtia paludosa</i> (Blume) K. Schum., Pflanzer. IV, 46: 200. 1904 .
<i>Z. medium</i> Stokes	Bot. Mat. Med. 1: 72. 1812.	<i>Alpinia galanga</i> (L.) Willd., Sp. Pl. 1: 12. 1797.
<i>Z. melegueta</i> Gaertn.	Fruct. Sem. Pl. 1: 34. 1788.	<i>Afromomum angustifolium</i> (Sonn.) K. Schum., Pflanzer. IV 46: 218. 1904.
<i>Z. minus</i> Gaertn.	Verh. Batav. Genootsch. Kunsten 12: 1830.	<i>Elettaria cardamomum</i> (L.) Maton, Trans. Linn. Soc. London 10: 254. 1811.
<i>Z. nigrum</i> Gaertn.	Fruct. Sem. Pl. 1: 35. 1788.	<i>Alpinia nigra</i> (Gaertn.) Burt, Notes Roy. Bot. Gard. Edinburgh 35: 213. 1977.
<i>Z. ramosum</i> Noronha	Verh. Batav. Genootsch. Kunsten 5(4): 28. 1790, nom. inval.	<i>Hornstedtia pininga</i> (Blume) Valetton var. <i>pininga</i> , Bull. Inst. Bot. Buitenzorg 20: 93. 1904
<i>Z. sylvestre</i> Gaertn.	Fruct. Sem. Pl. 1: 34. 1788.	<i>Alpinia galanga</i> (L.) Willd., Sp. Pl. 1: 12. 1797.
<i>Z. sylvestre</i> Stokes	Bot. Mat. Med. 1: 67. 1812, nom. illeg.	<i>Renealmia striata</i> (Stokes) Govaerts ex Maas, Edinburgh J. Bot. 70: 450. 2013.
<i>Z. uncinatum</i> Stokes	Bot. Mat. Med. 1: 73. 1812, nom. illeg.	<i>Renealmia jamaicensis</i> (Gaertn.) Horan., Prodr. Monogr. Scitam. 32. 1862.
<i>Z. villosum</i> (Lour.) Stokes	Bot. Mat. Med. 1: 63. 1812.	<i>Amomum villosum</i> Lour., Fl. Cochinch.: 4. 1790, nom. cons.

Table 3. Species excluded from *Zingiber* genus.

Species	Reference
<i>Z. brevifolium</i> K. Schum. nom. illeg.	Bot. Jahrb. Syst. 27: 228.1899.
<i>Z. confine</i> Miq. unplaced name	J. Bot. Neerl. 1: 94.1861.
<i>Z. jucundum</i> F. Muell. unplaced name	Fragmenta Phytographiae Australiae. 4: 165.1864.
<i>Z. railletii</i> T. Durand unplaced name	Bull. Mens. Soc. Linn. Paris 1: 401.1883.

Conclusions

The complete list of species of the genus *Zingiber* presented here reflects the current status of the taxonomy of the genus, but it is to be considered that future changes are very likely due to the series of existing difficulties as described in our study.

Author Contribution

CEFC: Conceptualization, data curation, formal analysis, investigation, methodology, visualization and writing-original draft. **CG:** Conceptualization, data curation, formal analysis, investigation, methodology, and writing-review. **VL:** Conceptualization, data curation, formal analysis, investigation, methodology, and writing-review. **ART:** Data curation, formal analysis, methodology, writing-review and editing. **FB:** Data curation, formal analysis, methodology, and writing-review. **ACRC:** Conceptualization, data curation, formal analysis, investigation, methodology, and writing-review.

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