

THE HISTORY AND CULTIVATION OF *ETLINGERA* – THE TORCH GINGERS – AT THE ROYAL BOTANIC GARDEN EDINBURGH*Helen Yeats*¹

ABSTRACT

The ginger family, Zingiberaceae, is a pan-tropical family comprising 51 genera and c. 1,200 species predominantly found in Asia and the Pacific regions. The collection at the Royal Botanic Garden Edinburgh (RBGE) has been actively researched since the 1950s (Newman, 2000) and taxonomists from a variety of institutions around the world have discovered, described, verified, named and renamed many taxa within this diverse group of plants. One genus, *Etilingera*, has been extensively worked on recently, with over 30 new species identified from Sulawesi alone and probably between 150 and 200 species altogether within the genus (Poulsen, 2012). A list of the 25 species of *Etilingera* cultivated at RBGE is provided. Most of these were collected from the wild as seed. Scientific and horticultural field trips to collect members of the ginger family have provided an extensive and ever-expanding unique living research resource and over the last ten years the collection has doubled in size. This paper describes the cultivation of *Etilingera* at RBGE and discusses some of the features and challenges associated with the genus.

INTRODUCTION

The genus *Etilingera* is one of the largest in Zingiberaceae, referred to as the ginger family, which includes more than 1,200 species, the best known of which is the common spice – ginger (*Zingiber officinale*) (Poulsen, 2006). The type specimen of *Etilingera* was originally collected in southern Thailand by Johann Gerhard König in 1779 as *Amomum littorale*. It was described in 1792 by Paul Dietrich Giseke and named after the German botanist Andreas Ernst Etilinger. However, it wasn't until nearly 200 years later, in 1986, that B.L. Burt and Rosemary Smith of RBGE concluded that several species of *Etilingera* had been incorrectly included in other genera: *Nicolaia* Horaninow (1862), *Achasma* Griff. (1851), *Geanthus* Reinw. (1826), *Diracodes* Blume (1827) and *Phaeomeria* (Ridl.), K.Schum. (1904) (Poulsen, 2012). Since then revisions of *Etilingera* have been made from plants collected in Peninsular Malaysia (Khaw, 2001), Borneo (Smith, 1986b; Poulsen, 2006), Sulawesi (Poulsen, 2012) and Java (Poulsen, 2007; 2012). This range covers a relatively small area given that *Etilingera* ssp. are found in equatorial evergreen rainforests ranging from Sikkim in India to Tahiti in the Pacific Ocean and from as far north as China to Australia in the south (Poulsen, 2012). Indeed, Poulsen's recent monograph of *Etilingera* has shown there to be as many as 150–200 species (Poulsen, 2012).

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RBGE has a strong history of plant collection and research in South-East Asia due to targeted floristic research programmes. Expansion of the Zingiberaceae Living Collection began in the 1960s with collections made by B.L. Burt and P. Woods in Sarawak (Burt & Smith, 1972). This was followed by a significant period between 1970 and 1990 spent by these two workers on the clarification of the taxonomy of Zingiberaceae, a notoriously difficult family to classify. This work continued when Mark Newman was appointed to the scientific staff of RBGE in the 1990s and led to further expansion of the Collection thanks to his research into the family. A steady stream of staff and student projects and wild collections have followed since then, meaning that the Living Collection now comprises 266 species within 33 genera, and a total of 720 accessions accounting for 1,461 plants (see Table 1). This is in contrast to the respective figures in 2001 which were 150 species, 28 genera, 415 accessions and 422 plants (Govier *et al.*, 2001). At that time only two of these were *Etilingera* species and Appendix 1 provides collection details for the Living Collection of this genus as it stands now. Collecting trips and subsequent taxonomic work by Axel Dalberg Poulsen since the early 2000s on *Etilingera* in particular has increased numbers of the genus in the Collection. It is thanks in part to his collections and work that there has been an increase in familiarity with and consequential use of *Etilingera* and that the author has seen the need to publish this paper on the cultivation of the genus.

Sadly, with present anthropogenic pressures on land and the consequential conversion of forested land to other uses, many rainforest habitats are now greatly degraded, fragmented or lost entirely. Some *Etilingera* species are found at forest margins and can exhibit vigorous growth in disturbed areas. *Etilingera fimbriobracteata* (Fig. 1) exhibits such behaviour, but fortunately in Borneo the leafy shoots are useful for making mats. However, many of the Zingiberaceae are found in primary and secondary forests under the shade of taller trees and will not tolerate increased exposure. Removal of the canopy layer modifies the microclimate, alters the nutrient cycling processes, causes erosion and brings about a loss of quality rainforest, reducing diversity of both flora and fauna. Loss of pollinators and seed dispersers further reduces the ability of plant populations to recover from depleted habitats. In the future it is likely that many more members of the ginger family will become scarce (Fig. 2) and further discovery of new taxa may be limited.

The Zingiberaceae are globally and locally important; modern pharmacological research is validating the antioxidant and antibacterial healing properties of medicinal and cosmetic plants used for over 5,000 years (Leong-Škorničková & Gallick, 2010). They are increasingly grown as ornamental plants (Bordelon & Kress, 2005) and regularly used in religious ceremonies. Turmeric, aromatic oils from cardamom and a variety of other gingers and their flowers are presented as offerings to Hindu and Buddhist gods (Leong-Škorničková & Gallick, 2010) and the spices cardamom, ginger, turmeric and Grains of Paradise (*Aframomum melegueta*) provide flavour in cooking (Legner, 2006). The shoots, flower buds and fruits of *Etilingera* sp. such as *E. elatior* (Fig. 3) provide an important food resource for indigenous people: 20 different species of *Etilingera* are used as a vegetable in Borneo (Poulsen, 2006).



Fig. 1 *Etilingera fimbriobracteata*. Photo: Helen Yeats.



Fig. 2 Endangered *Etilingera orbiculata*. Photo: Helen Yeats.



Fig. 3 *Etilingera elatior*. Photo: Helen Yeats.

ETLINGERA IN THE LIVING COLLECTION AT THE ROYAL BOTANIC
GARDEN EDINBURGH

The population of *Etilingera* in the RBGE Living Collection has increased in recent years largely through collections made by a number of expeditions to South-East Asia. This means that the majority of living specimens are of known wild origin with good collection information (see Table 1).

Etilingera is a terrestrial perennial herb which is found between sea level and 2,700m and can range in height from less than 50cm to nearly 10m (see Appendix 1). The larger species have strong, stout, leafy shoots called pseudostems arising from thick rhizomes which become robust with age. Some species are clump-forming in habit while others are more spreading with longer rhizome distances between the leafy shoots. Several *Etilingera* have stilt roots; these are adventitious support roots growing laterally and downwards from the rhizome (Figs 4 & 5). Creeping close to the surface through the leaf-litter, the roots provide stability and anchorage on steep slopes in montane habitats and elevate the rhizome from wet ground in lowland forest. The flowering shoot is a cone-like spike composed of bracts and flowers which are held on a peduncle of various lengths. Some inflorescences are partially subterranean such as *Etilingera megalochilos* (Figs 6 & 7) while many are held upright on the long stalks giving the genus the common name of torch ginger (Figs 8 & 9). Colourful tubular flowers (Figs 10 & 11) open a few at a time each day and are pollinated by territorial spider-hunter birds (*Arachnothera longirostra*) and long-tongued *Amegilla* bees (Poulsen, 2012). The seed is surrounded by a juicy aril and enclosed by the fleshy pericarp of the indehiscent fruit (Fig. 12), which invites consumption by people and other organisms thereby aiding seed dispersal away from the parent plant (Poulsen, 2012).

	<i>Zingiberaceae</i>	<i>Etilingera</i>
Number of genera	33	1
Number of species	266	25
Number of accessions	720	46
Number of plants	1461	67
Wild origin accessions	609	43
Indirect wild origin accessions	25	1
Garden origin accessions	81	2

Table 1 Summary data from *BG-BASE*TM (Walter & O'Neal, 1985–2010) of the collection of *Zingiberaceae* at RBGE in May 2013.

Due to their diversity of form and flowering complexity the Zingiberaceae are a fascinating group of plants to grow. *Etilingera* offer many possibilities for an attractive display in a large glasshouse environment. With their elegant arching habit, varied leaf shape and colour, and interesting flowering torches, they provide an architectural dimension to many planting schemes (Fig. 13).



Fig. 4 Stilt roots of *Etilingera polycarpa* ssp. *ligulata*. Photo: Helen Yeats.



Fig. 5 Stilt roots of *Amomum* sp., a close relative of the genus *Etilingera*. Photo: Helen Yeats.



Fig. 6 *Etilingera megalocheilos*. Photo: Christopher Walker.



Fig. 7 *Etilingera megalocheilos* showing the underground section of inflorescence. Photo: Helen Yeats.



Fig. 8 Torch ginger *Etilingera* sp. Photo: Christopher Walker.



Fig. 9 Torch ginger *Etilingera hemisphaerica*. Photo: Helen Yeats.



Fig. 10 *Etilingera alba*. Photo: Helen Yeats.

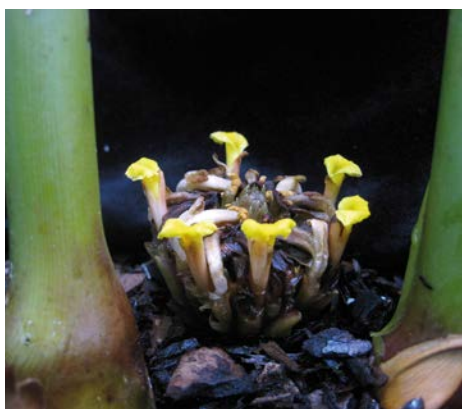


Fig. 11 *Etilingera calophrys*. Photo: Helen Yeats.



Fig. 12 Large infructescence of *Etilingera polycarpa* ssp. *ligulata*. Photo: Helen Yeats.



Fig. 13 Architectural pseudostems, a feature of many *Etilingera* species. Photo: Helen Yeats.

CULTIVATION AND PROPAGATION TECHNIQUES

Etilingera are demanding plants in their requirements for space, high temperatures (18–25°C minimum), high humidity (80% +), light in winter, shade in summer and frequent watering. Providing good growing conditions under glass in non-tropical areas is challenging; they grow quickly, requiring regular feeding and frequent repotting (Fig. 14). They need to be shaded during late spring and summer while lack of light over the winter period causes them to grow taller and weaker than they would if grown outside where they are exposed to stronger sunlight and air movement. This difference in plant size and growth habits of glasshouse-grown plants can sometimes perplex taxonomists if, for example, the inflorescence is smaller or the plant is larger than expected. However, when measuring the diagnostic features, such as corolla size and distance between nodes or pseudostems, they are found to be proportionally equal to the wild collected plants. Despite such morphological anomalies in cultivation there is still enormous value in being able to examine groups of plants in one location. The Living Collection at RBGE provides a vital and unique resource for researchers, allowing closer, more detailed study of actively growing plants than would be possible in the wild. This is particularly true for the study of the Zingiberaceae because investigation of these plants in the rainforest is difficult; the flowers last only one day, they are often covered in mucilage or damaged by animals and diagnostic features of the flowers are compromised when pressed and dried and so they have to be preserved in alcohol to keep them intact.

Vegetative propagation

When grown in the glasshouses clumps of *Etilingera* are kept within their allocated space by regular division. Over time the thick rhizomes become very tough and fibrous and a sharp implement is required to divide the plant. Some of the larger species quickly outgrow their space and after a few years the whole plant needs to be dug up and split. This disturbance will be tolerated by the plant if undertaken during its growing season and it will establish better if a clump of rhizome with at least two or three leafy shoots is taken and potted up. The roots can be shortened by one-third to a half and older rhizomes and dead roots pruned out. The pseudostems should be reduced by about one-half to two-thirds to prevent too much water loss through transpiration. Divided plants should be potted up with free-draining compost, with the rhizome lightly covered; burying it too deeply will cause it to rot. Bottom heat will encourage rooting but this is not practical with larger plants.

Cuttings are most easily taken from the younger growth located at the outer edges of the clump or pot. A section of rhizome 15–25cm long, with at least one developed leafy shoot and several growth buds, is cut away from the plant, potted into a shallow seed tray with free-draining compost and watered in. Cuttings are placed in a propagation case with bottom heat and high humidity until rooted. If cuttings are taken in winter they will take longer to root because of low light levels and are likely to rot if over-watered.

The large *Etilingera* are labour-intensive when grown in containers as they quickly outgrow their space and nutrients in the substrate and have to be pruned and repotted every one to two years. Stilt-rooted plants resent disturbance and should be carefully divided, keeping as much of the root system intact as possible. The leafy shoots are also shortened and supported with canes until new stilt roots are able to provide their own support. Once repotted, the plants are watered to settle in the compost around the roots. Careful watering and misting from then on is necessary until active growth is noticed because plants are again susceptible to rot following root disturbance.

Seed propagation

Fresh *Etilingera* seed germinates much more quickly than dried and viability greatly decreases with age. Most fresh seed germinates within the first two months of sowing; the fastest germination time recorded by the author is 15 days, while dried seed can take up to a year. Dried seeds are soaked for several hours in order to soften the tough seed coat. Changing the water during the soaking process helps to flush out any growth inhibitors that may be present. The seeds are sown into 5–10cm pots of sieved fine bark compost which is sterilised by pouring boiling water over the pots, and lightly covered with a thin layer of compost no deeper than the depth of the seed. Pots are placed in a plastic bag and sealed to keep moisture in and pests out, and placed in a heated propagator with a temperature of 25–30°C. As soon as the seeds have germinated



Fig. 14 When the growing conditions are not quite right *Etilingera* sp. roots seek preferable conditions. Photo: Helen Yeats.



Fig. 15 Three-week-old seedlings of *Etilingera minor* ready for pricking out. Photo: Helen Yeats.

(Fig. 15), often after one to four months, they can be removed from the heat. After the first leaves have appeared the bag is opened to prevent condensation on the inside of the bag damaging new leaves. Once they have acclimatised to cooler conditions the bag is removed and the seedlings pricked out into individual pots. It is important not to over-pot the seedlings as too much moisture in larger pots will rot the roots and newly forming rhizome. Sometimes germination can be sporadic, with one or two individuals appearing at first and several more sprouting a month or two later. If fewer than three seeds germinate, the pot with the ungerminated seed is returned to the heat in the hope that more will grow. After nine months it is very unlikely that more seed will germinate and the pots are discarded.

Growing medium

At RBGE *Etilingera* are grown in soil-less compost comprising large and medium-sized composted bark (see Table 3 in Appendix). Perlite, vermiculite and horticultural charcoal are added to help keep the mixture open and free-draining but moisture-retentive. Dolomitic limestone provides magnesium, and trace elements and slow-release granular fertiliser are added to the mix to provide essential nutrients. These are quickly used up and supplementary liquid feeding every few weeks throughout the growing season is necessary. During spring and early summer plants are fed with a proprietary fertiliser with an N:P:K ratio of 3:1:1, a balanced 1:1:1 feed is used over summer and towards the end of the season 3:1:6 is used to toughen the plants for the winter and to encourage flowering the following season. The plants are checked daily and watered when the top layer of compost is dry. High humidity is achieved by damping down benches and pathways at regular intervals and occasionally misting over the plants with a fine spray. Plant growth slows down during the winter and watering is more considered as the rhizomes will rot if kept too wet.

Zingiberaceae compost mix			
Ingredients	Particle size	Amount	Brand used
Potting bark	3–15mm	210l	Melcourt
Propagation bark	2–7mm	210l	Melcourt
Charcoal	3–15mm	15l	Various suppliers
Vermiculite	2–5mm	15l	Sinclair Professional
Perlite	2–5mm	15l	Sinclair Professional
Slow-release fertiliser	2–3mm	500–700g	Osmocote® 12–14m
Dolomitic limestone	<1mm	300g	Various suppliers
Trace elements	<1mm	300g	Chase Seaweed Meal

Table 3 General compost mix for Zingiberaceae.

Pest control

Pests of *Etilingera* under glass include mealy-bugs, root aphids, ants, cockroaches, spider-mites, scale, slugs and worms. A regular regime of mechanical, biological and chemical pest control combined with good glasshouse hygiene is necessary to limit the damage. Most harm is caused by scale and mealy-bugs sucking nutrients and moisture from the growing leaf tips or flowering buds. These pests are checked for regularly and when numbers increase to unacceptable levels they are controlled using an insecticide such as BANDU™, a pyrethroid insecticide based on deltamethrin 25g/l (2.8% w/w). Ants further exacerbate the aphid problem because they ‘farm’ the mealy-bugs and scale by actively moving them to the soft plant growth and harvest the honeydew excreted by them to feed to their young in ant nests in the pots. Repotting helps to reduce ant, root aphid, worm and cockroach numbers but total eradication of pests within the glasshouse is almost impossible. Spider-mite can be a problem during spring when light levels increase and the glass has not yet been shaded but the cold weather outside requires a higher heating input, resulting in drier conditions. When this occurs air circulation is improved, shading applied and the humidity increased and this usually reduces the egg-laying rate of the mites and overcomes the problem. Spider-mite can also be biologically controlled with its natural predator *Phytoseiulus persimilis*. Cockroach and slug damage on young growth are controlled with slug pellets, cockroach traps and by practising good hygiene. Biological control of slugs using nematodes, Nemaslug® and control of sciarid flies using *Hypoaspis miles*, a predatory mite, can be effective.



Fig. 16 Inflorescence of *Etilingera loerzingii*.
Photo: Helen Yeats.



Fig. 17 Towering stems of *Etilingera elatior* with researchers Jane Droop and Kaylene Bransgrove in the foreground at Singapore Botanic Gardens. Photo: Helen Yeats.



Fig. 18 Researchers Axel Dalberg Poulsen and Nicky Sharp take herbarium voucher specimens of the Living Collection at RBGE. Photo: Helen Yeats.

SUMMARY

Etilingera are interesting plants to grow in tropical biomes of botanic gardens, providing both an ornamental and an architectural element to planting schemes (Figs 16 & 17). Living collections provide an excellent resource for educational purposes and enable closer taxonomic study (Fig. 18). However, when grown in pots the plants are often compromised and extra nurturing is essential to ensure healthy plants. The ever-expanding collection of ginger at RBGE encompasses a wide range of genera from a variety of climatic zones and specialised habitats (see Appendix 1). Although these conditions are not easy to replicate in the glasshouse environment, good collection notes taken during the acquisition of wild plants and the subsequent dissemination of such information from taxonomists to horticulturists facilitate greater understanding of the growing conditions required for the cultivation of the Living Collection. More information on the Living Collection at RBGE is available at www.rbge.org.uk/science/tropical-diversity/Monographic-phylogenetic-research/zingiberaceae#The_ginger_family

ACKNOWLEDGEMENTS

The author would like to thank the following individuals for their help: Kate Hughes, Mark Newman, Axel Dalberg Poulsen and Helen Thompson.

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APPENDIX 1

The table below lists the Living Collection of *Etilingera* at the Royal Botanic Garden Edinburgh (RBGE). The accession number is the unique number the plant material has been given on entering the Collection. The first four digits are the year of accession and therefore give an indication of the year of collection from the wild. The habitat descriptions are the notes taken by the collector and recorded in the RBGE plant records database *BG-BASE*TM. N/d indicates that no data is available for this accession. 'Altitude' is the metres above sea level at which the plant was collected.

Accession number	Species name	Country	Altitude (m)	Habitat description
20051696	<i>Etilingera</i>	Sumatra	950m	n/d
20051699	<i>Etilingera</i>	Sumatra	850m	Protected forest but very disturbed
20070110	<i>Etilingera</i>	Papua New Guinea	1,800m	Montane forest margin next to cultivated land
20080595	<i>Etilingera</i>	Papua New Guinea	115m	Forested slope of river gorge near gardens
20080599	<i>Etilingera</i>	Papua New Guinea	800m	Roadside forest, disturbed
20090849	<i>Etilingera</i>	Papua (Irian Jaya)	912m	Forest relatively unspoilt, steep mountain sides, orange clay soil
20110265	<i>Etilingera</i>	Kalimantan	737m	Right next to a stream, sandy soil
20110279	<i>Etilingera</i>	Kalimantan	1,400m	Sub-montane rainforest
20021849	<i>E. alba</i>	Sulawesi	340m	Growing in deep shade on wet soils next to old logging track
20061115	<i>E. alba</i>	Indonesia	n/d	n/d
20080604	<i>E. alba</i>	Indonesia	375m	Forest margin
20081006	<i>E. aulocheilos</i>	Sulawesi	625m	Strongly disturbed forest margin next to abandoned plantation
20080410	<i>E. calophrys</i>	Sulawesi	800m	Gardens and secondary forest near trail
20080418	<i>E. calophrys</i>	Indonesia	n/d	n/d
20090620	<i>E. calophrys</i>	Sulawesi	n/d	Roadside, disturbed vegetation in forest
19981703	<i>E. elatior</i>	Garden origin	n/d	n/d
20051701	<i>E. elatior</i>	Malaysia	760m	Deep, narrow, heavily shaded valley
20121610	<i>E. elatior</i>	Garden origin	n/d	n/d
20000517	<i>E. elegans</i>	Sulawesi	1,300m	Sub-montane ridge forest
20051848	<i>E. fimbriobracteata</i>	Sarawak	250m	n/d

Accession number	Species name	Country	Altitude (m)	Habitat description
20040524	<i>E. flavovirens</i>	Sulawesi	900m	Damp, very poor soils, seasonally dry spell
20021880	<i>E. heliconiifolia</i>	Sulawesi	970m	Open position on side of large rock fall, poor soil
20080607	<i>E. heliconiifolia</i>	Sulawesi	1,100m	Secondary forest
20080609	<i>E. heliconiifolia</i>	Sulawesi	1,250m	Open forest, regularly burnt
20061116	<i>E. hemisphaerica</i>	Indonesia	300m	Next to road
20081001	<i>E. hyalina</i>	Sulawesi	1,100m	Waterlogged soil, full shade, mossy
20100744	<i>E. cf. littoralis</i>	Cambodia	n/d	n/d
20040693	<i>E. loerzingii</i>	Sumatra	600m	Arboretum: open park with trail system. Probably not planted
20112009	<i>E. maingayi</i>	Malaysia	n/d	Disturbed area, forest margin, favours smooth terrain
20081040	<i>E. megalocheilos</i>	Vietnam	n/d	n/d
20040692	<i>E. minor</i>	Sumatra	20m	Slope on a small hill near river in secondary forest
20021196	<i>E. orbiculata</i>	Sulawesi	1,340m	Damp rocky ground, dense shade, little ground cover
20080608	<i>E. pausodipsus</i>	Sulawesi	1,125m	Secondary forest
20021866	<i>E. polycarpa</i> ssp. <i>ligulata</i>	Sulawesi	430m	Primary lowland rainforest Dense canopy
20080415	<i>E. polycarpa</i> ssp. <i>ligulata</i>	Sulawesi	950m	Roadside in primary forest
20080606	<i>E. polycarpa</i> ssp. <i>ligulata</i>	Sulawesi	1,300m	Open, shrubby vegetation
20081003	<i>E. polycarpa</i> ssp. <i>ligulata</i>	Sulawesi	700m	n/d
20090630	<i>E. rubroloba</i>	Sulawesi	100m	By roadside in secondary forest and plantation area
20021202	<i>E. sarasinorum</i>	Sulawesi	1,460m	Dense forest, mossy ground; area very damp and cold
20090627	<i>E. sarasinorum</i>	Sulawesi	650m	In gap above stream
20040939	<i>E. solaris</i>	Java	1,100m	Bank of small stream
20040653	<i>E. steringophora</i>	Sulawesi	1,320m	Wet and boggy; area often floods
20051690	<i>E. subulicalyx</i>	Sumatra	1,400m	Disturbed forest
20080411	<i>E. tubilabrum</i>	Sulawesi	800m	Forest margin opposite coffee plantation

