BULLETIN

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Heliconia agronomic characteristics for use as cut flowers and ornamental plant: research developed in Pernambuco, northeast part of Brazil

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Figure 1: Clump and inflorescences characters evaluated in heliconia genotypes: Internal shoots (IS); Clump base area (CBA); Bracts depth (BD) with exudates, water and flowers into bracts; Flowers number (FN); Flowers removal (FR); Wax in the inflorescence (WAX); spiraled bracts arrangement (BA); Senescence symptoms at postharvest durability (H) (Loges et al., 2012).

Introduction

The demand for Heliconia inflorescences is increasing in many countries around the world. Currently many species are known worldwide as cut flowers and landscape plants. This increasing popularity of Heliconia inflorescences is stimulating many pre-breeding studies to characterize agronomic traits of interest for the cut flower agribusiness. Breeding programs to support uniform and stable production during the year, according to quality standards and market demands, is necessary for tropical cut flower agribusiness development (Pizano, 2005). Nevertheless, only few heliconia species have been evaluated for shooting and flowering parameters (Criley, 2000; Criley et al., 2001; Criley and Uchida, 2004; Castro et al., 2006). Such information is essential to aid growers in planning production and marketing activities related to the local or regional environmental conditions.

The weather conditions are very suitable for growing Heliconia plants in the many regions of Brazil. Since 2003, Federal Rural University of Pernambuco State (UFRPE) has maintained the Heliconia Germplasm Collection, localized at longitude 34º59'33''W, latitude 8º1'19''S, and altitude of 100 m, in the Northeast Region of Brazil, with more than 50 genotypes. Some of these genotypes have been evaluated in terms of agronomic parameters (clump, plant and inflorescence characteristics), ornamental attributes, postharvest aspects and molecular markers (Costa et al., 2009a; Costa et al., 2009b; Costa et al., 2011a; Costa et al., 2011b; Loges et al., 2007; Loges, 2009; Loges et al., 2011; Loges et al., 2012; Pinheiro et al., 2010; Rocha et al., 2010). The results answered some of the initial questions from growers and researchers currently working on crop management and plant selection. The information obtained with this study also serves as guidelines for studies on heliconia plant breeding programs and to suggest the agronomic characteristics for heliconia use as cut flowers (CF) and ornamental plant (OP).

Methodology

The Heliconia Germplasm Collection experiment areas are in a randomized block design, with four replications of each genotype. The plant spacings are 1.5 m between plants in the line and 3.0 m between lines for the experiment developed during December 2003 to May 2006 and of 3.0 m between plants in the line and 4.0 m between lines during January 2007 to July 2011. The genotypes were planted under two conditions: full sun - *H. bihai*; *H. latispatha* 'Distans', 'Red-Yellow Gyro' and 'Yellow'; *H. orthotricha* 'She'; *H. pseudoaemygdiana*; *H. psittacorum; H. psittacorum* 'Red Gold', 'Red Opal', 'Strawberries & Cream' and 'Suriname Sassy'; *H. psittacorum* × *H. spathocircinata* 'Alan Carle', 'Golden Torch' and 'Golden Torch Adrian'; *H. rauliniana*; *H. rostrata* '10 days' and '3 days'; *H. wagneriana*; *Heliconia* × *nickeriensis*; and at 50% artificially shaded condition – *H. bihai*; *H. bihai* 'Kamehameha' and 'Nappi Yellow'; *H. caribaea* × *H. bihai* 'Carib Flame'; *H. collinsiana; H. episcopalis*; *H. pendula*; *H. rostrata*; *H. stricta*; *H. stricta* 'Fire Bird' and *H. psittacorum* × *H. spathocircinata* 'Golden Torch' (identification based on Berry and Kress, 1991). The *H. psittacorum* hybrids and cultivars and *Heliconia* × *nickeriensis* were grouped as short heliconia genotypes (SH) and the others genotypes as tall heliconia (TH). The characteristics were classified based on clump, plant and inflorescence characteristics were measured and described as follows:

Clump characteristics

Rhizome Viability three months after planting (RV%); Cumulative Shoots per Clump (CSC) [shoots emerged were marked with numbered tags representing time of emergence (Criley et al., 2001)]; Cumulative Flower Stem per Clump (YIELD); Commencement of Flowering Stage (CFS) [early flowering < 8 MAP; late flowering > 8 MAP); Flowering Period (FP); Clump Height (CH) [short: < 1.50 m; medium: within 1.51 and 2.50 m; tall: > 2.51 m]; Internal Shoots (IS), shoots in the internal part of the clump; Internal Shoots (IS) in the clump; Growth Habit (GH) classified as grouped (clump area smaller than 2.25 m^2) and open (clump area larger than 2.25 m^2); Clump Base Area (CBA) and Clump Projection Area (CPA) measured at 52 MAP; Bending Down Tendency (BDT); Clump Maintenance Requirements (CMR).

Plant and inflorescence characteristics

Inflorescence Type (IT); Bracts Arrangement (BA); Bracts Color (BC); Inflorescence Visualization (IV); Leaf Color (LC); Hair on leaves or inflorescences (HAIR); Wax on leaves or inflorescences (WAX); Inflorescence Durability in the Clump (IDC), considering flowering commencement; Bracts Number In The Clump (BNC); Flowering Cycle (FC), which is the sum of days for inflorescence emergence after shoot emergence (the inflorescence was marked with numbered tags representing the day of emergence) with the days from inflorescence emergence to harvesting; Height of Flowering Stem (HFS); Inflorescence Width (IW); Inflorescence Length (IL); Diameter of Flowering Stem (DFS); Weight of Flowering Stem (WFS); Postharvest Durability (PHD) - all the inflorescences with 3 to 4 bracts were cut at 20 cm above ground level, and taken to the laboratory to observe the durability; Bract Firmness (BF); Rachis Firmness (RF); Bract Depth (BD); Aquatic Insects Occurrence (AIO); Odors (O); Flowers Removal (FR) (Figure 1).

The Purpose of HSI

The purpose of HSI is to increase the enjoyment and understanding of *Heliconia* (Heliconiaceae) and related plants (members of the Cannaceae, Costaceae, Lowiaceae, Marantaceae, Musaceae, Strelitziaceae, and Zingiberaceae) of the order Zingerberales through education, research and communication. Interest in Zingiberales and information on the cultivation and botany of these plants is rapidly increasing. HSI will centralize this information and distribute it to members.

The **HELICONIA SOCIETY INTERNATIONAL**, a nonprofit corporation, was formed in 1985 because of rapidly developing interest around the world in these exotic plants and their close relatives. We are composed of dues-paying members. Our officers and all participants are volunteers. Everyone is welcome to join and participate. HSI conducts a Biennial Meeting and International Conference.

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Discussion

Agronomic characteristics suggested and not recommended for heliconia species use as cut flower (CF) and ornamental plant (OP) are present in Table 1.

Clump characteristics

Heliconia rhizome viability (RV) is associated with genetic characteristics and weather conditions at the cultivation area. RV at three months after transplanting indicates the maximum waiting time of replacing the rhizomes, depending on the genotype. Replanting rhizomes later than this period will cause uniformity problems under field conditions. On the other hand, low rhizome viability from some genotypes indicated limitations for planting rhizomes directly to the field. Apparently, the less amount of water from rain and the irrigation applied when needed during the dry season, contributed for the better performance of the rhizomes. Producers have been transplanting portions of the clump as a propagation method of heliconia, but this could increase disease and pest dissemination by the soil aggregated to the rhizome. Nevertheless, heliconia rhizomes could be directly transplanted to the field, although it could cause high percentage of mortality, low shooting rates, and a long time to produce new shoots, depending on the genotype. Transplanting portions of the clump, planting the rhizomes in pots or using rooting beds are suggestions for further studies in other to mitigate the problem with rhizome viability.

The cumulative shoots per clump (CSC) are different between cultivars and hybrids of heliconia species. CSC could vary from 16.34 to 94.00 at 12 month after transplanting. Short heliconia genotypes (SH) such as *H.* x *nickeriensis* and *H. psittacorum* cultivars and hybrids had a larger NSC than tall heliconia genotypes (TH). It was observed that many of the shoots did not develop inflorescences (value not quantified), indicating that shoot emergence does not assure the inflorescence formation. Thus, a high CSC alone does not indicate good genotype performance, since many shoots did not develop an inflorescence (SDI%). Criley et al. (2001) related the reduced flowering of the 'Guadaloupe' hybrid, when compared to 'Keanae' and 'New Yellow Parrot' hybrids, to the death of the shoot apex, however without indicating the reason for that. This information needs to be taken in consideration at the selection genotypes.

The clump base area (CBA), that reflected the clump expansion, demonstrated high variability among heliconia genotypes. In general, genotypes with high rates of shoot emission presented fast clump expansion, with positive correlation between CBA and CSC (r=0.71, at 1% significance level). Genotypes with this characteristic must be planted in spacing larger than 1.5 x 3.0 m, or pruning will be needed to avoid excessive density of shoots between rows. However, smaller plant spacing will reduce production and anticipate the need of renewing the crops more frequently, and excessively large plant spacing will cause inefficient usage of cultivated area and increase production costs. The clump projection area (CPA) is also important to the definition plant spacing.

Independent of plant spacing, another aspect to be observed for certain genotypes are the absence of internal shoots (IS) in the clump. This is an undesirable characteristic, due to the incomplete soil coverage, compromising the visual aesthetic of landscape compositions, reduction of the productivity and anticipate the necessity of renewing the crop area, as observed in *H. caribaea* x *H. bihai* 'Carib Flame', *H. collinsiana*, *H. stricta* 'Fire Bird' and the three cultivars of *H. rostrata*.

Among all the evaluated heliconia genotypes, the ones with short clump height (CH < 1.5 m) were the *H. psittacorum* cultivars and hybrids 'Red Gold', 'Strawberries & Cream', 'Suriname Sassy', 'Alan Carle', 'Golden Torch', 'Golden Torch Adrian' and the *Heliconia* x *nickeriensis*. The other genotypes were identified as medium height (CH between 1.51 and 2.50 m) or tall genotypes (CH > 2.51 m). The variation in height of heliconia genotypes allow for different plant compositions in the landscape design and could be used as cut flower if the stems are longer than 0,80 m (Table 1).

Plant and inflorescence characteristics

The hair presence (HAIR) and wax presence (WP) was observed on the leave and inflorescence of some heliconia. These characteristics produces a certain contrast with the inflorescence colors, However they can be considered negative issues in the landscape design as well as for cut flowers due to the possibility of dust accumulation and color brightness reduction of the bracts.

Heliconia species flowering period (FP) is influenced by precipitation and photoperiod (Criley, 2000). This is essential information in selecting plants mainly for cut flower production. The genotypes *H. bihai* 'Kamehameha', *H. caribaea* x *H. bihai* 'Carib Flame', *H. collinsiana*, *H. rauliniana*, *H. rostrata* (10 days), *H. pendula* and *H. wagneriana*, showed seasonal flowering, with specific flowering season during the year. All other genotypes kept flowering during the whole year.

The inflorescence visualization (IV) is influenced by the inflorescence type (IT) and its position on the stem and in the clump. The genotypes with difficult inflorescence visualization were *H. rauliniana* and *H. wagneriana*. Trimming or removing leaves can improve inflorescence visualization. The bracts and leaves color (BC and LC) were classified according to the predominant color. The yellow, yellow-orange, orange, red-orange or red colors of the bracts combined with light to dark green color of the leaves contributed to the ornamental aspects of heliconia plants.

Bending down tendency (BDT) of plants and the necessity of maintenances (CMR) on what concerns to the removal of plants or leaves are not desired characteristics. As long as the inflorescence kept the quality in the clump (IDC) and higher the number of bracts (BNC) better was the species' ornamental aspects.

The heliconia plants' ornamental characteristics permit their easy incorporation in tropical landscape design. There are many possibilities for combining heliconia with other ornamental plants, if their particular characteristics are taken into consideration (Loges et al., 2007). The agronomic characteristics expected from a heliconia genotype as cut flower are: production of inflorescences during the whole year (FP); short flowering cycle (FC); light flowering stems for lower transportation costs (WFS); stems longer than 80 cm (HFS); stems with diameter (DFS) thick enough for better resistance to handling and for lighter total weight of inflorescence; inflorescences with no wax and no hair; and bracts arranged (BA) in one plane for easier handling and packing. In addition, other characteristics must be observed: inflorescence width and length (IW and IL); rachis diameter and firmness (RF), mainly in erect inflorescences, that support rupture; firmness of bracts (BF); bracts not too deep (BD) and with a few or no flower inside, to reduce time and cost of cleaning and minimize occurrence of insects (AIO), odors (O) from water accumulation and organic matter deterioration; and postharvest durability longer than seven days (PHD).

Figure 2: *Heliconia rauliniana* clump in the Heliconia Germplasm Collection -UFRPE, Camaragibe-PE, Brazil (A) and used as an ornamental plant in Recife-PE, Brazil (B) (Loges et al., 2011).

Considering those characterizes, the results observed from *Heliconia rauliniana* aspects for cut flower and ornamental plants were presented in Table 1 and Figures 2 and 3. Agronomic characteristics suggested and not recommended for heliconia species use as cut flower (CF) and ornamental plant (OP) are presented in Table 1 and illustrated with the results observed from *Heliconia rauliniana*.

Figure 3: *Heliconia rauliniana* inflorescences in the clump: A - inflorescence at the flowering commencement; B-15 days after the flowering commencement; C-27 days after the flowering commencement; D-42 days after the flowering commencement Heliconia Germplasm Collection -UFRPE, Camaragibe-PE, Brazil (Loges et al., 2011).

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Literature Cited
See HSI web site at www.heliconia.org

Editor's Note
This paper was presented at the 2012 HSI conference in Panama by Dr. Loges. She notes that some of the results presented herein previously appeared in Acta Horticulturae papers (see literature citations). Some species/cultivar names used in this paper are not in concordance with the regulations of the International Cultivar Registration Authority (ICRA) and corrections should be understood as follows:

1) These are not ICRA accepted cultivar names, but in Dr. Bryan Bruner's opinion 'Rauliniana' and 'Nickeriensis' should be considered cultivar names and not scientific names, accordingly:
H. rauliniana = *H. bihai* x *H. marginata* 'Rauliniana', *H.* x nickeriensis = *H. marginata* x *H. psittacorum* 'Nickeriensis', *H. rostrata* (10 days) = *H. rostrata* 'Ten Day'. And 2) These are synonyms of cultivar names that are accepted by the ICRA for *Heliconia* [Brunner, B.R. 2005. The heliconia checklist and register. Bull. HSI 12(3):1-36]: *H. psittacorum* x *H. spathocircinata* 'Keanae' = *H. psittacorum* x *H. spathocircinata* 'Keanae Red', *H. psittacorum* x *H. spathocircinata* 'New Yellow Parrot' = *H. psittacorum* x *H. spathocircinata* 'Yellow Parrot', and *H. psittacorum* x *H. spathocircinata* 'Guadaloupe' = *H. psittacorum* x *H. spathocircinata* 'Guyana'.

Table 1: Agronomic characteristics suggested and not recommended for heliconia use as cut flower (CF) and ornamental plant (OP) and the results observed from *H. rauliniana*. January 2007 to July 2011, *Heliconia* Germplasm Collection - UFRPE, Camaragibe-PE, Brazil (Loges et al., 2011)

Characteristics	Suggested	Not recommended	Observed (*H. rauliniana*)	Indication
Rhizome Viability 3 MAP (RV%)	>70%	<50%	87%	Positive
Cumulative Shoots/Clump (CSC)	>80	<80	698	Positive
Cumulative Flower Stem/Clump (YIELD)	>50	<40	227	Positive
Shoots develop in inflorescences (SDI%)	> 65%	< 50%	17.25%	Negative
Commencement of flowering stage (CFS)	< one year (early flowering)	> one year (late flowering)	9 MAP	Positive
Flowering period (FP)	Annual	Seasonal	Seasonal	Negative
Clump height(CH)	-	-	3.4m	Positive
Internal shoots (IS)	Presence	Absence	Presence	Positive
Growth Habit (GH)	Grouped	Open	Open	Positive
Clump base area (CBA)	<2.5 m^2	>2.5 m^2	3.11m^2	-
Clump projection area (CPA)	-	-	8.27 m^2	-
Bending Down Tendency (BDT)	Absence	Presence	Absence	Positive
Clump maintenance requirements (CMR)	Low	Higth	Low	Positive
Inflorescence type (IT)	Upright or pendent	_	Upright with 3 bracts and after pendent	Positive for OP Negative for CF
Bracts arrangement (BA)	One plane	Spiraled	One plan and spiraled with 2 bracts	Positive for OP Negative for CF
Bracts color (BC)	Vibrant, exotic	_	Red	Positive
Inflorescence visualization (IV)	Visible or partial visible	Hardly visible	Partial visible	Negative for OP
Leaf Color (LC)	-	-	Green	Positive
Hair in the inflorescence or Leaves (HAIR)	Absence	Presence	Presence	Negative for CF
Wax in the inflorescence or Leaves (WAX)	Absence	Presence	Absence	Positive
Inflorescence durability in the clump (IDC)	> 30 days	< 30 days	73	Positive
Bracts number in the clump (BNC)	>6	<6	10 or more	Positive
Flowering cycle (FC)	<150 days	>150 days	290 days	Negative
Inflorescence emergence to harvesting (IEH)	-	-	19 days	Positive
Height of flowering stem (HFS)	0,80 to 1,5 m	<0,8 and > 1,5 m	1.35 m	Intermediated
Inflorescence width (IW)	< 0.30 m	> 0.30 m	0.34 m	Negative for CF
Inflorescence length (IL)	< 0.50 m	> 0.50 m	0.35 m	Positive
Diameter of flowering stem (DFS)	< 30 mm	> 30 mm	31 mm	Negative for CF
Weight of flowering stem (WFS)	< 0.20 kg	> 0.20 kg	0.23 kg	Negative for CF
Postharvest durability (PHD)	> 10 days	< 7 days	12 (2 to 3 bracts)	Positive
Bracts firmness (BF)	Presence	Absence	Presence	Positive
Rachis firmness (RF)	Support itself	Falling down or break	Support itself	Positive
Bracts depth (BD)	Absence	Presence	Absence	Positive
Aquatic insects occurrence (AIO)	Absence	Presence	Absence	Positive
Odors (O)	Absence	Presence	Absence	Positive
Flowers removal (FR)	Not necessary	Necessary	Not necessary	Positive
Flowers number (FN)	< 5	> 10	9	Positive

Chamaecostus of Cristalino

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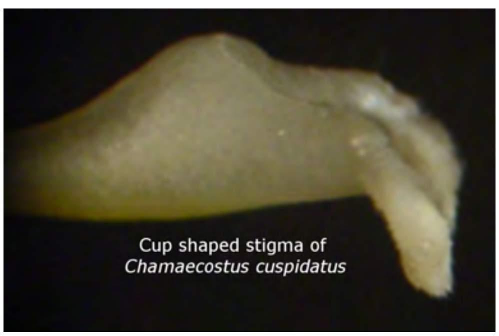
The genus *Chamaecostus* was split off from *Costus* in 2006 based on the work of HSI board member Chelsea Specht. Dr. Specht completed cladistic analysis of 64 plant samples from the family *Costaceae*, including 4 of the 7 species that were in the subgenus *Cadalvena* as classified by Paul Maas. The molecular analysis revealed that those 4 species were clearly separated from other Costus and were closest to the genera *Monocostus* and *Dimerocostus*. She also studied the morphological characters of the 7 species in subgenus *Cadalvena* and concluded that all 7 should be placed in a new genus *Chamaecostus*.

Chamaecostus is described as having low or very small plants under 1 meter in height, usually with a capitate inflorescence and a large labellum which forms a long narrow tube that opens broadly to ovate at the apex and greatly exceeds the length of the petals and bracts. Another distinguishing characteristic is the stigma which is cup-shaped like *Monocostus* and *Dimerocostus* but unlike the stigmas in *Costus,* which have two distinct lobes.



Chamaecostus are found only in certain areas of South America with the main center of diversity in the southern Amazon rainforest of central Brazil. There are only two species of Chamaecostus that are widely cultivated and available in US horticulture, and I had never seen any of them in habitat, so in November 2012, I made a trip to the Alta Foresta area of Mato Grosso state in Brazil to see these plants in the wild.

In 1999 Sra. Vitoria Da Riva Carvalho established the Cristalino Ecological Foundation www.fundacaocristalino.org.br and built an eco-lodge along the Cristalino River in a large private reserve of mostly primary forest. The area includes over 20 miles of trails that cover eight different habitats and a tremendous diversity of plants. The Cristalino area has a very distinct and long dry season with little or no rain at all in July and August, with regular rains starting in late September or October. Three species of *Chamaecostus* are recorded in this area by the Royal Botanic Gardens, Kew, in their Flora Cristalino program.

Chamaecostus subsessilis

Chamaecostus subsessilis is a wide ranging species found from the Cerrado areas of eastern Brazil and throughout the southern Amazon rainforest to Bolivia. There were originally 10 described species that were combined in 1972 into *Costus warmingii* by Paul Maas, and later renamed to the earlier name of *Costus subsessilis.* Maas noted that the differences in vegetative characters (leaf shape, size and hairines) were insufficient to justify separate species as there is no clear geographic isolation of each form.

Chamaecostus subsessilis – cultivated plant

According to HSI member Tim Chapman, the *C. subsessilis* in cultivation in the U.S. was collected in Bolivia many years ago by the late Bob See of Miami. This form has very hairy vegetative parts and is deciduous, making it adaptable to growing in areas with light frost or even freezing conditions. It has been reliably hardy here in my USDA Zone 8B garden. While in Brasilia, I saw another form growing in a forest patch in a city park in the seasonally dry Cerrado habitat of the area. The plant was smaller and glabrous compared against the plant that is in U.S. cultivation.

C. subsessilis – from Brasilia, Brazil

The flowers were quite similar and the only other difference I could see was in the very deeply lobed calyx and perhaps the shape of the anther crest.

In Cristalino the plants I saw were similar to the form in cultivation, except that the leaves were mostly somewhat broader and shorter. All vegetative parts were densely covered with hairs. The most striking observation I made there was the

Calyx of *Chamaecostus subsessilis*

C. subsessilis growing in leaf mulch on rocky outcrop

Above and below, *C. subsessilis* growing between and beside large boulders at Cristalino

Two views of *C. subsessilis*, top and above. Below, floral and vegetative parts carefully separated for detailed descriptions and recording of measurement data

fact that this species was only found in rocky areas and was most commonly found at higher elevations growing on rocky outcrops or between or beside large boulders.

Chamaecostus lanceolatus

Chamaecostus lanceolatus is a much sought-after species with its bright red showy flowers, but is difficult to find in cultivation. In his 1972 monograph, Dr. Maas described two subspecies of *C. lanceolatus* – subsp. *lanceolatus* and subsp. *pulchriflorus*. The former has an elongated inflorescence and the calyx length approximately equal to the bracts whereas subsp. *pulchriflorus* is distinguished by a subcapitate inflorescence and with the calyx being 2 to 2 ½ times the length of the bracts. The form found at Cristalino is subsp. *lanceolatus*.

Chamaecostus lanceolatus young plants

The plant is quite common in the Alta Floresta area and in Cristalino I found it nearby to *C. subsessilis* but not actually growing on the rocky outcrops. It was often found at the base of large trees and small non-flowering plants are easily recognizable by the silvery midrib, very much like *Costus laevis* in the Central American tropics.

Thickened tuberous roots of *C. lanceolatus*

This species, like other *Chamaecostus*, has adapted to the dry season by forming thickened tuberous roots.

C. lanceolatus subsp. *lanceolatus* is absolutely beautiful!

The broad labellum usually folds backward and is bright red, often with two or three flowers showing. As shown here, the infloresecence is the elongated type for subsp. *lanceolatus.* (Photos of subsp. *pulchriflorus* can be seen on the internet at www.flickr.com/photos/grandma-shirley/5874278239)

The plant at Cristalino has calyx and bract approximately the same length, as shown in this photo (not with the calyx 2 to 2 ½ times the length of the bract.)

Chamaecostus fusiformis

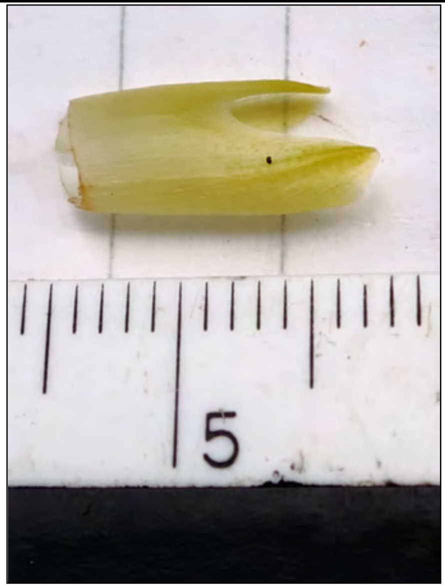
Chamaecostus fusiformis is a very different looking *Chamaecostus*, and I cannot help but wonder if it is placed in the wrong genus or at least could be intermediate between Chamaecostus and Costus. It was not included in the molecular analysis that split off this genus.

In the Alta Floresta area it was very common, but found in a different habitat from the other two. It was always found on the forest floor in clay soil versus the other two in sandy or rocky soil. This plant is a little taller than the other two species I saw at Cristalino. The foliage is beautiful with large plicate leaves and purplish undersides.

Underside of foliage of *C. fusiformis*

I was there early in the rainy season and only found one small patch starting to flower, in a sunny area along the entrance road to Cristalino. I did not see fresh flowers as the plant was only beginning to bloom, but in looking at photos from the Flora Cristalino project by the Royal Botanic Gardens, Kew, it is clear that this species has a tubular flower and the overall appearance is much like *Costus* species.

Chamaecostus fusiformis in flower



This species has tightly imbricate bracts unlike the others, but does have the tubular bicarinate bracteole (at left).

Photo credit:: http://www.kew.org/science/tropamerica/cristalino.htm

C. fusiformis in habitat

Root tuber morphoanatomy of *Chamaecostus subsessilis* (Costaceae), a drought-tolerant ground herb from seasonal forests of central South America

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"Vitality shows in not only the ability to persist but the ability to start over"
F. Scott Fitzgerald

The genus *Chamaecostus* C.Specht & D.W.Stev. is comprised of seven South America endemic species found in the forest understory (Specht & Stevenson 2006). The species *Chamaecostus subsessilis* (Nees & Mart.) C.Specht & D.W.Stev., locally known as '*campo alegre*' or '*flor de oro*', occurs in seasonally dry forests of Brazilian Cerrados, South Brazilian Amazonia, and Eastern Bolivia. It is found in sandy and well-drained soils inside riparian dry forests of savanna ecosystems (Figure 1). This region presents a conspicuous seasonal contrast between dry and rainy seasons, with dry seasons from mid-July to mid-October showing almost no rainfall and air humidity commonly reaching less than 20% (Castro et al. 1994).

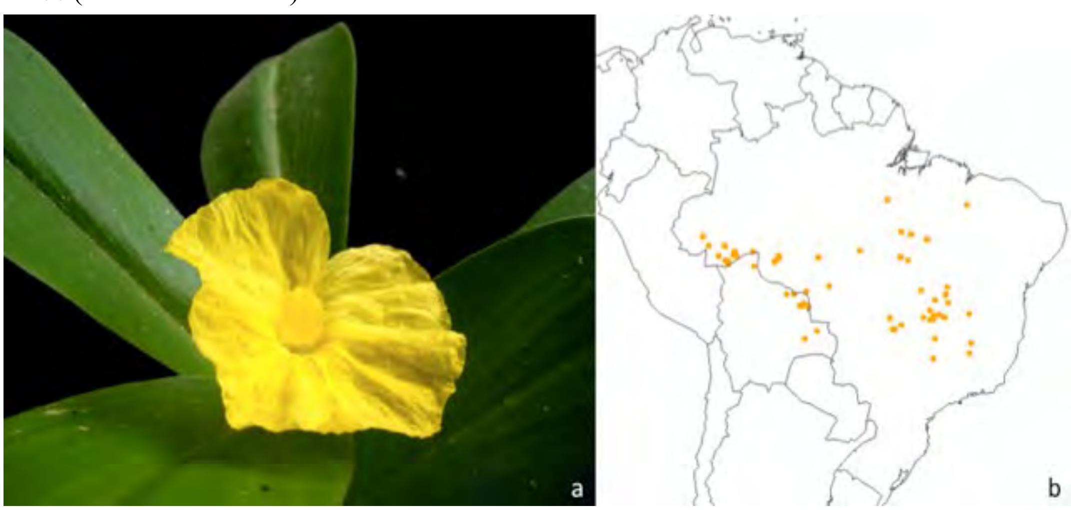


Figure 1 a – b. *C. subsessilis*. (a) Flowering individual; (b) Occurrence records.

Unlike most Costaceae, *C. subsessilis* is almost acaulescent, with thick, fleshy, hairy leaves. Additionally, it exhibits shoot intermittency, an apparent adaptive phenological strategy to rainfall seasonality, with plant individuals being restricted to dormant subterraneous water and carbohydrate storage structures during dry seasons (Figure 2), a feature shared with some other *Chamaecostus* species (e.g *C. lanceolatus* and *C. fusiformis*). Immediate growth at the onset of rain from rhizome and tuber reserves is a common feature of unrelated plant species in strong seasonal ecosystems (Smith *et al*. 1964, Lewis 1984, Eiten 1993).

Despite their importance to environmental tolerance and plant survival, such adaptive characteristics have been overlooked so far in the study of the natural history of the Costaceae. Indeed, water stress is one of the key environmental factors regulating individual plant physiological development (Jones & Corlett 1992, Zobayed et al. 2007, Ranwala & Miller 2008) and phenological behavior (Morellato & Leitão Filho 1990, Wright & van Schaik 1994). It is central to morphological and ecological adaptation as a driver of plant speciation and diversification processes in heterogeneous landscapes.

Carbohydrate production and concentration within plant tissues is dependent on many factors, such as nutritional and physiological stage and environmental conditions (George et al. 1989; Humphreys 1991). Being the primary source of energy for shoot regrowth (Duffus 2000), starch is the most important of these reserve carbohydrates (Zeeman *et al*. 2004) and can quickly be converted to a soluble energy source in adverse situations.

To describe and analyze the morphoanatomy of the main reserve organ found in *Chamaecostus subsessilis*, we collected root tubers in two rainy season periods: February 2011 and April 2012, and in two dry season periods: August 2011 and August 2012. Rainfall variation (Figure 2) was analyzed from climate data obtained at the Brazilian Aeronautic Meteorological Network climate station located at Alta Floresta's airport (http://bancodedados.cptec.inpe.br), Brazilian Mato Grosso state. Plant individuals were sampled at a 90 ha forest fragment known as "*Sítio Ecológico Santa Cruz das Paineiras*", 32 km east of downtown Alta Floresta, South Brazilian Amazonia (ca. 09°57' S; 55°51' W).

Root tubers were preserved in FAA 50% (formalin, glacial acetic acid and ethanol 50%, 5:5:90), for 48 hours and subsequently stored in 70% ethanol after Johansen (1940). Organs were hand cut in the middle region and stained using basic fuchsin and astra blue (Roeser 1962). Additionally, fresh tissue was cut and stained with lugol for starch detection (Johansen 1940). Glass slides were mounted and analyzed with a trinocular light microscope Leica® ICC50® connected to a computer.

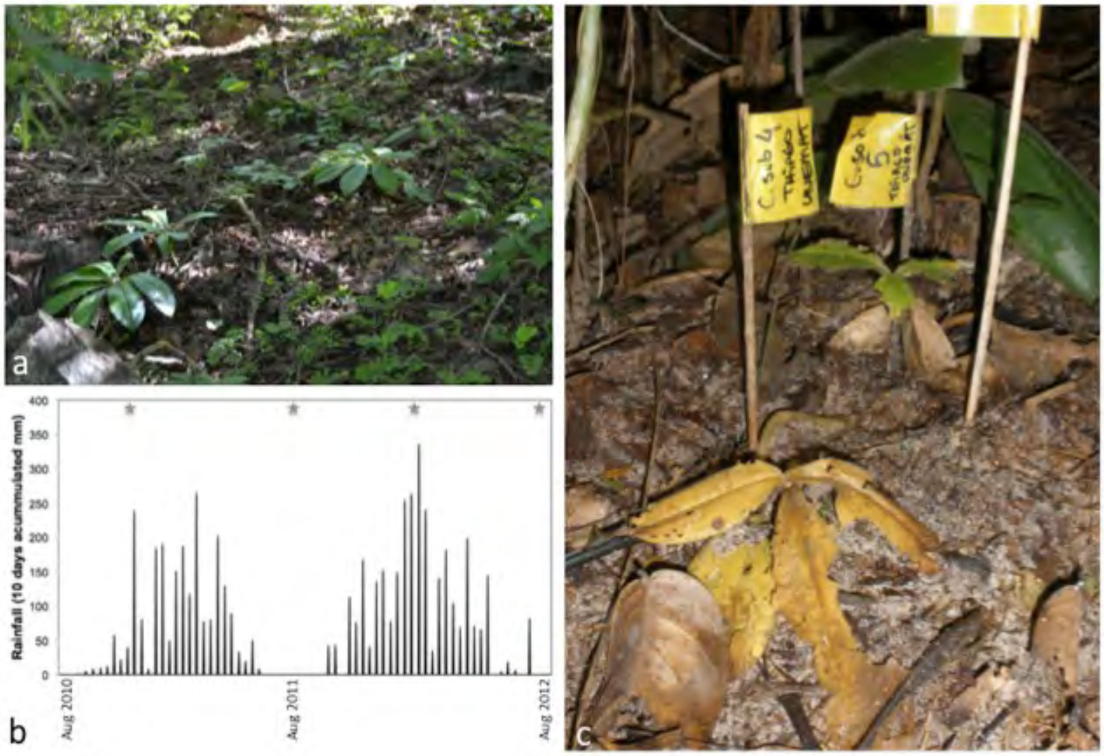
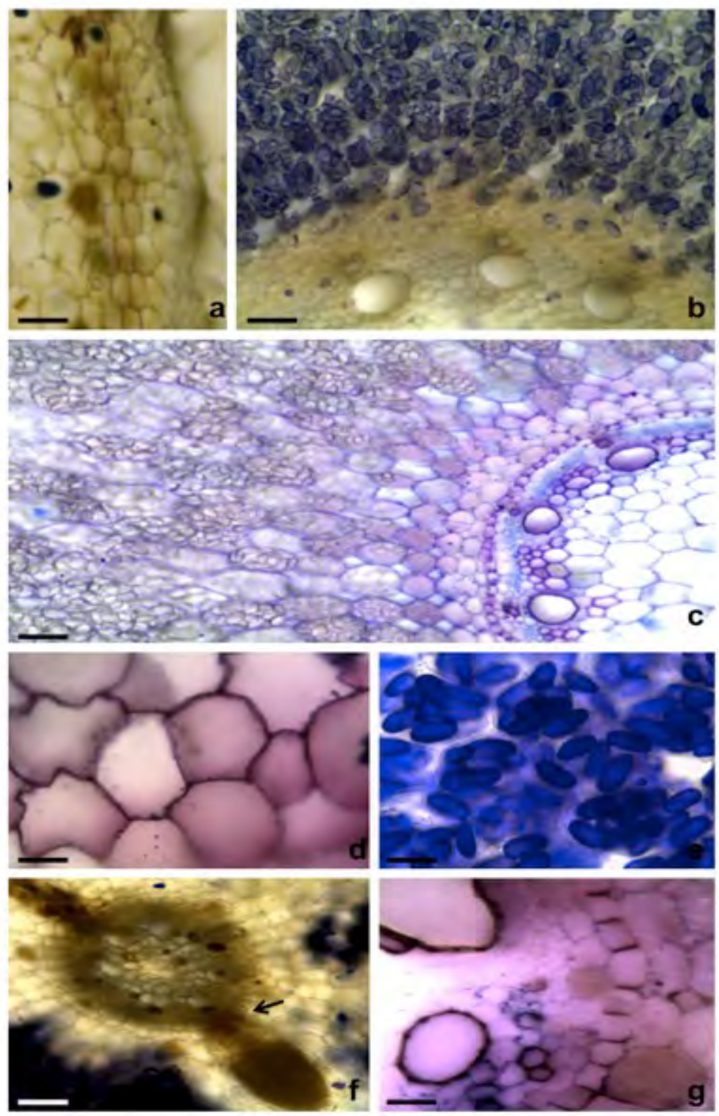


Figure 2 a – b, at left. *Chamaecostus subsessilis* populations. (a) Rainy season; (b) Rainfall chart; stars mark period when root tubers were collected for anatomical analysis; (c) Beginning of dry season; note dead leaves and shoot senescence.

The cross-section of the root tuber shows a unistratified epidermis coomprised by small rectangular thin-walled cells showing suber formation (Figure 3a). The cortex is wide and filled with round parenchymatous cells varying in size (Figure 3b); some walls show sinuous contours (Figure 3c). Starch grains are evident and abundant within the majority of parenchymatous cortex cells (Figure 3d), especially during the dry season. Starch grains are usually long, but round or oval shapes can also be seen, and they primarily accumulate close to the vascular cylinder. An endodermis can be easily distinguished dividing the cortical and vascular regions (Figure 3g). The pericycle exhibits thin-walled round cells where collateral vascular bundles and secondary roots arise, confirming the root aspect of the organ.

One of the most consistent patterns of tropical forest systems is that species physiology is affected by seasonality (Swaine 1996; Engelbrecht *et al.* 2005). Plant phenological patterns usually optimize reproductive events, but they can also regulate growth, where carbohydrate reserves play an important role in the maintenance of an individual's survival in its natural habitat (Marquis *et al*. 2002). Here we described the fleshy root system of *Chamaecostus subsessilis*, which accumulates reserve compounds as a source of energy for plants during the growth-unfavorable dry season when shoots are absent. We have also shown that carbohydrate reserves within the rooting zone visually vary in quantity in different annual seasons.

Figure 3 a – g, at right. Anatomical aspects of *Chamaecostus subsessilis* root tuber. (a) Epidermis; (b) Cortical region; (c) Overview of the root tuber cross-section; (d) Sinuous walls of cortex parenchyma; (e) Starch grains; (f) Pericycle, arrow points to secondary root formation; (g) Vascular cylinder. Bar scales = 65 µm (a); 90 µm (b); 100 µm (c); 50 µm (d, e, g); 110 (f).



Literature Cited: See HSI web site at www.heliconia.org

New? New? *Newmania*...the Ginger Surprise from Vietnam

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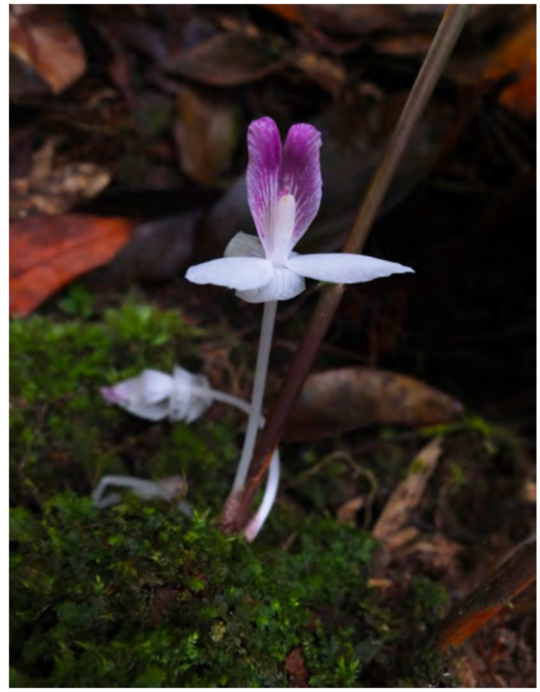
All photos by Jana Leong-Škorničková, unless otherwise stated

Left: *Newmania orthostachys*, right: *Newmania serpens* (Photo credit: Ngọc-Sâm Lý)

New species are considered great botanical finds, heralding the recognition of new biological entities in the biodiversity around us. Species are indeed the building blocks of biodiversity, with groups of sufficiently distinctive species placed into a genus. While new plant species are still being discovered fairly often, the recognition of a new plant genus is much less common. Some studies have estimated that for every thousand species newly identified, only one new genus is discovered. However, in some plant groups, like the gingers, several new genera (plural of genus) have cropped up in recent years. A "double novelty" has recently been discovered in central Vietnam, two new ginger species that form a new genus. The story of this special discovery shares the exciting part of a botanist's job.

A few years ago, Ngọc-Sam Ly, my colleague from the Institute of Tropical Biology in Ho Chi Minh City, showed me pictures of a slender, pretty ginger he found during his explorations of central Vietnam. It had inflorescences creeping on the ground, like snakes adorned with white, purple and red flowers. I was also show pictures of another plant, one which looked similar, but was more robust, with erect inflorescences and violet and white flowers. My first thought was that it very much resembled *Haniffia cyanescens*, which has slender leafy shoots and white and purple flowers arising at the ground level. My other ginger colleagues who also saw these pictures thought likewise. However, the small genus *Haniffia*, with only three species, occurs in Peninsular Malaysia and southern Thailand, localities some 1200 km distant from central Vietnam, hinting at the possibility that the mysterious Vietnam gingers might be exciting finds.



A close up preview of the flower of an undescribed *Newmania* species from Vietnam.

It was obvious that more material for herbarium and "spirit" specimens (those that are preserved in solution rather than by drying) was needed. My colleague Sam returned to the field twice, and when enough flowering and fruiting material had been collected to advance our studies, we tabulated all the characters of these two gingers and compared them with those of all the other known genera in the family Zingiberaceae. When this arduous task was finished, we found no good match, not even to *Haniffia*, the most (superficially) similar genus, from which they differ by having leafless sheaths that are tubular at the base, as well as bracteoles which are often tubular at the basal part and lack epigynous glands. All flower parts of the new species (including the anthers) are completely glabrous, while *Haniffia* flowers are covered by short glandular hairs, a difference that is visible to the naked eye. In addition, the fruits of both new species are smooth and glabrous, which is in contrast to those of the three known *Haniffia* species (the fruits of *H. flavescens* and *H. cyanescens* are bluntly ridged, and those of *H. flavescens* are also rough and covered with small warts).

Some ten years back, the morphological differences of our finds would perhaps have been enough to convince us about the novelty of their genus. But in this molecular age, we knew that it would be foolish not to test if the genetic codes conveyed the same message. We are very grateful to Sam Yen Yen, our ginger colleague from the Forest Research Institute Malaysia, who sent us leaf tissue samples of *Haniffia* species for inclusion in our comparative analyses. These investigations were performed in the laboratory at the Royal Botanic Garden Edinburgh. After a few weeks, the exciting results were revealed, which confirmed that the two strange species were indeed formed of a distinct "branch" of evolution. The taxonomic conclusion: a new genus should be recognised to accommodate these species. This new genus would have to be published according to scientific protocol, which was accomplished in the October 2011 issue of *Taxon*, a journal devoted to plant taxonomy.

The inflorescences of *Newmania serpens*, the type species of the new genus, creep on the floor. The flowers have a purple labellum with a red patch in the centre—a colour combination which is unique amongst gingers so far. (Photo credit: Ngọc-Sâm Lý)

This new genus has been named *Newmania*, in honour of Dr. Mark Fleming Newman, a prominent ginger specialist at the Royal Botanic Gardens Edinburgh, and who has made many remarkable scientific contributions to Zingiberaceae research in the past two decades. He has also increased our knowledge of the fascinating floras of Cambodia, Laos and Vietnam, and supervised students and researchers from the Indochinese region.

Dr. Mark Fleming Newman on a fieldtrip in Vietnam

The two specific epithets *serpens* (creeping) and *orthostachys* (for erect spike) were chosen to reflect the main difference in the inflorescences of the two species.

Newmania fruits are smooth, irregularly dehiscing capsules.

Since the publication of the new genus in 2011, we have conducted fieldwork in central Vietnam. There, I was delighted to finally see *Newmania* in the wild, those plants with which I had become so familiar from pictures and specimens. They are fairly rare gingers, growing in the moist and shady understorey of broadleaved forests. As a result of logging, the forests that we visited are quickly disappearing. Given that the *Newmania* species, like many other gingers, have a very limited range, this could well have been my last opportunity to see them in their natural habitat.

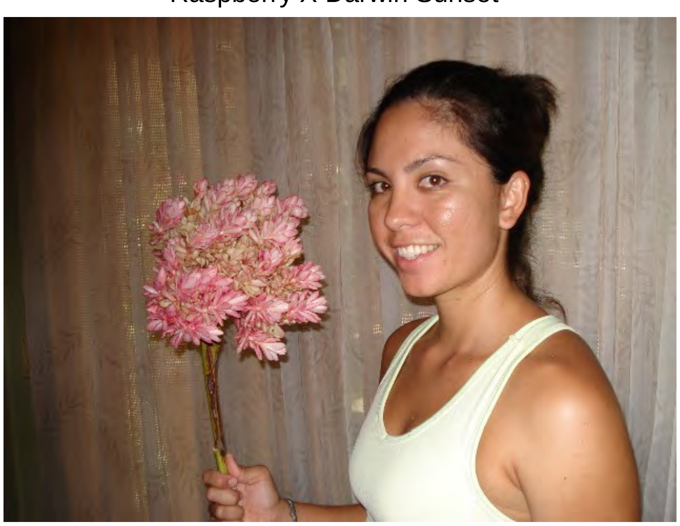
Typical habitat of *Newmania* species in Vietnam

Alpinia seedlings under evaluation at the University of Hawaii

Ken Leonhardt

Common red X (Jungle King X Jungle Queen)

Raspberry X Darwin Sunset



Alpinia 'Georgette', shown by Georgette Leonhardt
Common red X (Jungle King X Jungle Queen)

Registration of *H.* 'Lisanne's Fan'

Lisanne L. Lindmark, Triple L Tropicals, 335 Loma Avenue, Long Beach, California 90814
(lthreeisme@yahoo.com)

Registered 2 April 2011. Registrant/Nominant: Lisanne Lindmark. Description: Erect inflorescence; 28 cm wide, 34.3 cm long; 17 to 29 distichous bracts with cup on distal tip; red/slightly maroon on cheeks with lower half of bract covered with light fuzz, top edge of lip folds over; basal bract red/slightly maroon proximally, green distally; sepal deep yellow proximally and orange distally; ovary yellow proximally and green distally; rachis red/slightly maroon and straight; inflorescence 2.5 m tall. Vegetation musoid, with maroon-mottled sheaths and stem. Leaf blade 17.1 cm x 55.9 cm. Height 2.5m to 4m (8-13 feet). Notes: This was sent to me by Fred Berry in 1999 while he was working in Colombia, and was marked as an unnamed heliconia. It has been growing at my home in Southern California with average annual rainfall of 33 cm. Additionally, climate is less humid except for coastal moisture and temperatures average between 7.8°C and 28.9° C. It has been grown on the north (shady) side of a building. It is tall and healthy under these conditions.

Heliconia 'Lisanne's Fan'

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