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## Further travels and discoveries in Colombia's Western Range

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In July 2014 Bruce Dunstan, my husband, Angel Rodriguez, and I made yet another trip to Colombia's western range, called the Cordillera Occidental in that country.

Bruce wrote about two of his previous trips in HSI Bulletins issues 17(3), 18(2) and 18(3). We returned to one area of special interest, the Anchicayá Valley. But all the others were new to us, and some had not been visited by the great *Heliconia* taxonomists in Colombia, Abalo & Morales. It was no surprise that we saw a couple of red pendents that defied classification!

Angel and I arrived in Cali 24 hours before Bruce, so we took a day trip to the nearby tourist destination called Km. 18 in wooded highlands, at about 1800 meters elevation. *H. burleana* and *H. montana* were just as pretty as on my other visits. Bruce arrived that evening; by the next morning he pretended to be over jetlag, so we headed out early, and the real adventure was underway.

*Heliconia burleana*

When Bruce and I visited Colombia for the first time in 2011, our guide Emilio Constantino took us to the Anchicayá Valley where we spent two days in the richly biodiverse zone. The 2012 conference post-tour group ventured a short distance down this road, with police escort, but we weren't allowed to go far. The one-lane dirt road, that was once the main route to Colombia's only Pacific port city, hangs precariously on a densely wooded slope that's so steep it's hard to get off the road, even on foot. But even so, repeating the route let us see plants we missed the first time around.

*Heliconia montana*

Even though the time of year was the same, we didn't see inflorescences of *H. badilloi* on our first trip, and mistook its speckled, tightly packed pseudostems for the more common *H. obscuroides*. We were lucky to see the pretty species in flower this time. In the upper stretches of the Anchicayá road we also saw basal blooming *Costus plowmanii* and a new species of *Calathea* that Helen Kennedy is describing from material collected in Eduardo Calderon's private reserve during the HSI trip. Somehow both of these escaped our attention on the first visit, in spite of careful explorations. *Calathea congesta* is also resident in this area, with its graceful long petioles and starburst inflorescence.

Carla is dwarfed by a huge *Xanthosoma*

*Calathea aff congesta*

All HSI members were treated to a photo of dingy-red *H. rhodantha* in one of Bruce's

*H. rhodantha*

articles, but the attractive feature of this species is its spectacular pink flowers. They almost make up for the prize-winning "Ugliest Bud in the Heliconia World". We saw *H. rhodantha* throughout the Cordillera Occidental, at elevations ranging from 500m to 1500m. We were soon able to recognize the species merely with a glimpse of the wide, asymmetrical leaf.

Unlike the first trip, when we went back to the largish town at the upper extreme of the valley for the night, on this trip we stayed in El Danubio, right in the middle of the forest. The town, or rather, the hotel, restaurant and general store accompanied by 10 houses, exists primarily because of the comings and goings at the nearby hydroelectric plant. Other tiny communities in the Anchicayá Valley get by on subsistence farming, which is severely limited by the steep slope of the valley.

The not quite Hilton jungle hotel

Leaving El Danubio we dropped into warmer elevations, and found once again a stunning heliconia we'd seen three years earlier. Back then, Bruce and I had the idea the plant could be a new species, but with subsequent travels, and with variations we would see in the next few weeks on this trip, we felt confident that we were looking at a very interesting form of *H. regalis*. Bruce has informally named the cultivar (though it's not in cultivation!) for his wife, Eleesa, who cheerfully lets him cross the sea to adventure with mosquitos and mud.

Jungle town financial district

Another red pendent is very common throughout this lowland area, but it doesn't match well with the descriptions we have in hand. The shape of the flower is similar to *H. regalis* and *H. nigripraefixa*, both found in the valley. Three years after receiving seeds, Sergio Tejedor in Puerto Rico has grown this plant to flower, and it is identical to his that goes by the unaccepted species name *H. giraldesi*.

To move northward in the Western Range, you must go back to the main highway and find the next road penetrating the long ridge. We were guided by a very complete book, *Birdwatching in Colombia*, by Jurgen Beckers and Pablo Florez, that helped us find locations of interest by describing elevation and habitat of natural areas throughout the country. Returning to Pueblo Rico, we found new access to forest. The Montezuma road is well-known to birders and other naturalists. It was enchanting, covering various elevations and vegetation types.

*H. regalis* 'Eleesa'

**The Purpose of HSI**

The purpose of HSI is to increase the enjoyment and understanding of *Heliconia* (Heliconiaceae) and related plants (in the families 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 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.

Membership dues are (in $US): Individual $40, Family $45, PDF $25, Student $10, Contributing $50, Corporate $100, Sustaining $500, Lifetime Member $1000. Membership fees constitute annual dues from 1 July through 30 June. All members receive the BULLETIN (usually published quarterly) and special announcements. Join or renew your membership at www.heliconia.org.

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*Heliconia cordata*

I saw *H. cordata* for the first time ever, even though its range is quite wide. Its flat flower makes identification simple. A plant with very long, narrow leaves and a fuzzy petiole was probably *H. mutisiana.* Both were at about 1500m elevation. Climbing higher and entering older forest, we began to see *H. chrysocraspeda*, a common plant at higher elevations in the Western Range. Because heliconia botanists have not visited this little Montezuma area, it did not surprise us to come across another red pendent that defied identification; the small, rounded leaves, heavily lacerated in spite of a very sheltered location, were an unusual feature. I was lucky to get two seeds, also small and roundish, one of which has germinated and is growing well.

*Heliconia* sp. 'Giraldesi'

Also on the Montezuma road, we saw the pendent inflorescence of *Dimerocostus cryptocalyx*. This was only the second time I'd seen it, the first was three years earlier, not far from this location. A high elevation *Calathea* was not easily identified by Helen Kennedy from photos. With red bracts and purple flowers, it was quite attractive.

Angel ? Taking a photo of *H.* sp. 'Montezuma'

Moving farther north in the Cordillera Occidental, we dropped down into the Rio Atrato Valley. This was the only time on the whole trip we felt security tensions, and it was due to labor unrest rather than now tightly reined-in guerrilla activity. On the national patriotic holiday, truck drivers did not want to make the trip to the Pacific lowlands along the Rio Atrato. So we didn't take the chance, either. They went the next day, and so did we, but we had to be back in Cali in the late afternoon, so our search for *H. atratensis* became a race. By the time we were in the hot, swampy habitat it prefers, we had only 20 minutes to run into as many dark, damp spots we could, scanning each for a magnificent red upright inflorescence.

*Calathea aff congesta*

Not surprisingly, we were out of luck! However, once again we were not surprised to find another red pendent we could not match to descriptions. The purplish upright leaf, red egg-smooth bracts and mostly straight flower were all distinctive characters.

*Dimerocostus cryptocalyx*

*Heliconia* sp. 'Rio Atrato', both images

Next August we'll be back on the track of the elusive, unusual heliconias of western Colombia. I can hardly wait!

## Heliconia Society International Conservation Program

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In the December 2014 issue of the Bulletin, we explained the Heliconia Society's Conservation Program, how we will leverage off the IUCN Red List assessments to determine species of Zingiberales that are endangered, and how we will consult the BGCI data to determine whether an endangered species has been conserved *ex situ* in a public botanical garden.

Here is the list of *Heliconia* species showing which ones have been assessed by IUCN and how many BGCI gardens are reporting it in their live collections. Of 206 species (excluding varieties, subspecies or cultivars), only 54 have been assessed, and most of these were done under the old IUCN system published in the 1997 Red List.

Clearly there is a strong need for better information on the threat status for *Heliconia.*

**You** can be a part of this program and contribute to the conservation of these plants. Please look over the listings below.

If you see a *Heliconia* species that you believe to be rare or endangered in the wild, but it has not yet been formally assessed by IUCN in either the 1997 list or the current (2014) list, please bring it to our attention by emailing the Conservation Coordinator, Dave Skinner at conservation@heliconia.org and we will work towards getting a formal assessment conducted.

If you can help by donating a living plant of a species that is not already listed in the BGCI data, let us know and we can coordinate your donation to a participating public botanical garden, to ensure the species will be available for scientific study or repopulation in the wild as might be needed.

### Heliconia Species with number of BGCI locations and IUCN statuses

| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. abaloi* | | | |
| *H. acuminata* | 12 | | |
| *H. adflexa* | | | |
| *H. aemygdiana* | 12 | | |
| *H. albicosta* | 1 | | |
| *H. angelica* | | | |
| *H. angusta* | 29 | Vulnerable | |
| *H. antioquiensis* | | | |
| *H. apparicioi* | | | |
| *H. arrecta* | | | |
| *H. atratensis* | 1 | | |
| *H. atropurpurea* | | Rare | |
| *H. aurantiaca* | 27 | | |
| *H. auriculata* | | | |
| *H. badilloi* | | | |
| *H. barryana* | | Endangered | |
| *H. beckneri* | 5 | Endangered | |

| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. bella* | 1 | Endagered | |
| *H. berriziana* | | | |
| *H. berryi* | 1 | | Vulnerable |
| *H. bihai* | 118 | | |
| *H. boultoniana* | 1 | | |
| *H. bourgaeana* | 13 | | |
| *H. brachyantha* | | | |
| *H. brenneri* | | | Vulnerable |
| *H. burleana* | | | |
| *H. calatheaphylla* | | Endagered | |
| *H. caquetensis* | | | |
| *H. carajaensis* | | | |
| *H. caribaea* | 66 | | |
| *H. carmelae* | 2 | | |
| *H. chartacea* | 35 | | |
| *H. chiriquina* | | | |
| *H. chryocraspeda* | | | |

| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. clinophila* | 3 | Vulnerable | |
| *H. colgantea* | 5 | Rare | |
| *H. collinsiana* | 26 | Rare | |
| *H. combinata* | | | |
| *H. cordata* | | | |
| *H. crassa* | | Endangered | |
| *H. cristata* | 1 | | |
| *H. cucullata* | | | |
| *H. curtispatha* | 4 | | |
| *H. danielsiana* | 1 | Vulnerable | |
| *H. darienensis* | | | |
| *H. dasyantha* | 1 | Rare | |
| *H. densiflora* | 9 | | |
| *H. dielsiana* | 1 | | |
| *H. donstonea* | | | |
| *H. episcopalis* | 19 | | |
| *H. estherae* | 1 | | |
| *H. estiletioides* | 1 | | |
| *H. excelsa* | 4 | | Vulnerable |
| *H. farinosa* | 3 | Vulnerable | Least Concern |
| *H. faunorum* | 1 | | |
| *H. fernandezii* | 1 | | |
| *H. flabellata* | 1 | | Data Defcient |
| *H. foreroi* | | | |
| *H. fragilis* | 1 | | |
| *H. fredberryna* | | | Vulnerable |
| *H. fugax* | | | |
| *H. gaiboriana* | | | Vulnerable |
| *H. gigantea* | | | |
| *H. gloriosa* | 1 | | |
| *H. gracilis* | 2 | | |
| *H. griggsiana* | 10 | | |
| *H. harlingii* | 1 | | |
| *H. hirsuta* | 23 | | |
| *H. holmquistna* | | | |
| *H. huilensis* | 1 | | |
| *H. ignescens* | 4 | Rare | |

| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. imbricata* | 8 | | |
| *H. impudica* | | | |
| *H. indica* | 44 | | |
| *H. intermedia* | | | |
| *H. irrasa* | 11 | | |
| *H. julianii* | | | |
| *H. juruana* | 1 | | |
| *H. kautzkiana* | | | |
| *H. lanata* | 2 | | |
| *H. lankesteri* | 3 | | |
| *H. lankesteri* var. *rubra* | | Rare | |
| *H. lasiorachis* | 3 | | |
| *H. latispatha* | 60 | | |
| *H. laufao* | 2 | | |
| *H. laxa* | 1 | | |
| *H. lentiginosa* | | | |
| *H. librata* | 5 | | |
| *H. lingulata* | 15 | | |
| *H. litana* | | | Vulnerable |
| *H. longiflora* | 4 | | |
| *H. longissima* | 4 | | |
| *H. lophocarpa* | | Rare | |
| *H. lourteigiae* | | | |
| *H. lozanoi* | | | |
| *H. luciae* | | | |
| *H. lutea* | 5 | Vulnerable | |
| *H. luteoviridis* | | | |
| *H. lutheri* | | | Vulnerable |
| *H. maculata* | 1 | Endangered | |
| *H. magnifica* | 6 | Endangered | |
| *H. mantenensis* | | | |
| *H. marginata* | 8 | | |
| *H. mariae* | 15 | | |
| *H. markiana* | | | Vulnerable |
| *H. mathiasiae* | 8 | | |
| *H. meridensis* | | | |
| *H. metallica* | 28 | | |

| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. monteverdensis* | 1 | | |
| *H. mooreana* | | | |
| *H. mucilagina* | | | |
| *H. mucronata* | | | |
| *H. mutisiana* | 5 | | |
| *H. nariniensis* | | | |
| *H. necrobracteata* | 2 | Endangered | |
| *H. nickeriensis* | 6 | | |
| *H. nigripraefixa* | 2 | | |
| *H. nitida* | | | |
| *H. nubigena* | | | |
| *H. nutans* | 2 | Rare | |
| *H. obscura* | 5 | | Vulnerable |
| *H. obscuroides* | 1 | | |
| *H. oleosa* | | | |
| *H. orthotricha* | 1 | | |
| *H. osaensis* | 4 | Rare | |
| *H. paka* | 4 | | |
| *H. paludigena* | | | Vulnerable |
| *H. papuana* | 5 | | |
| *H. pardoi* | | | Vulnerable |
| *H. pastazae* | 4 | | |
| *H. paulii* | | | |
| *H. peckenpaughii* | | | Vulnerable |
| *H. pendula* | 36 | | |
| *H. penduloides* | 2 | | |
| *H. peteriana* | | | Vulnerable |
| *H. plagiotropa* | 1 | | |
| *H. platystachys* | 16 | | |
| *H. pogonantha* | 4 | | |
| *H. pogonantha* var. *pubescens* | | Rare | |
| *H. pogonantha* var. *veraguasensis* | | Vulnerable | |
| *H. pruinosa* | | | |
| *H. pseudoaemygdiana* | 7 | | |
| *H. psittacorum* | 140 | | |
| *H. ramonensis* | 6 | | |

| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. ramonensis* var. *glabra* | | Endangered | |
| *H. ramonensis* var. *lanuginosa* | | Endangered | |
| *H. ramonensis* var. *ramonensis* | | Rare | |
| *H. ramonensis* var. *xanthotricha* | | Vulnerable | |
| *H. rauliniana* | 9 | | |
| *H. regalis* | 4 | | |
| *H. reptans* | 3 | | |
| *H. reticulata* | | | |
| *H. revoluta* | | | |
| *H. rhodantha* | | | |
| *H. richardiana* | 9 | | |
| *H. rigida* | 1 | | |
| *H. riopalenquensis* | 1 | | Vulnerable |
| *H. rivularis* | | | |
| *H. robertoi* | | | |
| *H. robusta* | | | |
| *H. rodriguensis* | | | |
| *H. rodriguezii* | | Vulnerable | |
| *H. rostrata* | 91 | | |
| *H. sanctae-martae* | | | |
| *H. sanctae-theresae* | 1 | | |
| *H. santaremensis* | | | |
| *H. sarapiquensis* | 3 | | |
| *H. scarlatina* | 1 | | |
| *H. schiedeana* | 14 | | |
| *H. schumanniana* | 2 | | |
| *H. sclerotricha* | 2 | | Near Threaened |
| *H. secunda* | 2 | Vulnerable | |
| *H. secunda viridiflora* | 2 | | |
| *H. sessilis* | 1 | Endangered | |
| *H. signa-hispanica* | | | |
| *H. solomonensis* | 5 | | |
| *H. spathocircinada* | 7 | | |
| *H. spiralis* | 1 | | |

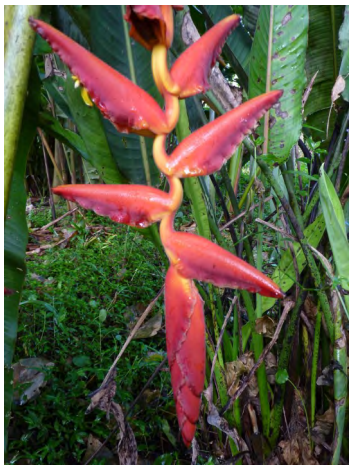
| Species | BGCI Locations | IUCN Status 1997 | IUCN Status 2014 |
|---|---|---|---|
| *H. spissa* | 6 | | |
| *H. standleyi* | 5 | | |
| *H. stella-maris* | | | |
| *H. steyermarkii* | 1 | | |
| *H. stilesii* | 4 | Rare | |
| *H. stricta* | 113 | | |
| *H. subulata* | 11 | | |
| *H. sucrei* | | | |
| *H. sylvicola* | | | |
| *H. tacarcunae* | | | |
| *H. talamancana* | 4 | | |
| *H. tandayapensis* | 1 | | |
| *H. tenebrosa* | | | |
| *H. terciopela* | | | |
| *H. thomasiana* | 4 | Vulnerable | |
| *H. timothei* | | | |
| *H. titanum* | 1 | | |
| *H. tortuosa* | 13 | | |
| *H. trichocarpa* | 5 | | |
| *H. tridentata* | | | |
| *H. triflora* | | | |
| *H. umbrophila* | 2 | Endangered | |
| *H. uxpanapensis* | 1 | | |
| *H. vaginalis* | 10 | | |
| *H. vellerigera* | 13 | | |
| *H. velutina* | | | |
| *H. venusta* | | | |
| *H. villosa* | 1 | | |
| *H. virginalis* | 1 | | Vulnerable |
| *H. wagneriana* | 36 | | |
| *H. willisiana* | | | Data Deficient |
| *H. wilsonii* | 2 | | |
| *H. xanthovillosa* | 5 | Endangered | |
| *H. zebrina* | 4 | Rare | |

Images of some unusual and beautiful heliconias.

*Heliconia cucullata*

*H. impudica*

*H. lophocarpa*



*H. lozanoi*

*H. nitida*

*H. pardoi*

*H. peteriana*

# Chilling Injury Symptoms in Species of *Heliconia*

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**Keywords**: refrigerated storage, postharvest, *Heliconia* spp, tropical flowers

The abstract for this article, along with figures 1 and 2 appeared in the Bulletin 20(4).

## Introduction

Many flowers of tropical origin may suffer chilling injury at temperatures below 10 °C (Reid, 1991) and the critical temperature that promotes chilling injury to the majority of tropical products vary between 10 and 13 °C. For *Heliconia* species, in general, transportation and storage at temperatures above 10 °C is recommended (Jaroenkit and Paull, 2003). Costa et al. (2011a) observed that *Heliconia bihai* 'Lobster Claw' inflorescences stored at 12 °C for six and eight days showed symptoms of chilling injury.

The severity of chilling injury in plants could depend on the sensitivity of each species too (Kays, 1991). The study regarding chilling injury symptoms of different species of *Heliconia* is important to compare and show the differences between the senescence symptoms and chilling injury symptoms. Two cultivars of *Heliconia bihai* ('Lobster Claw' and 'Halloween') kept at 6.5 ◦C and 85% relative humidity, showed different symptoms of chilling injury and senescence symptoms. The chilling injury symptoms were discoloration bracts tissue, slightly darkened spots in bracts, brownish aspect and dark-brown tone, and darker tones. The initial symptoms of senescence were wilted areas at the apex of bracts and after the withering advanced towards the bract base and spread to the edges (Costa et al. 2011b).

According to Costa et al. (2011b) further studies should compare the symptoms of senescence and chilling injury in different *Heliconia* species or their cultivars. The aim of the present study was to induce and describe the chilling injury in eleven Heliconia genotypes.

## Materials and Methods

Flowering stems of *Heliconia* genotypes were harvested from a commercial field of tropical flower producer farm (7°56' S, 34°55' W14 m a.s.l., Atlantic Rainforest Zone) located in the municipality of Paulista (Pernambuco - Brazil), with micro-irrigation system.

Flowering stems of eleven *Heliconia* genotypes were evaluated: *H. bihai* 'Peachy pink'; *H. caribaea*; *H. caribaea* x *H. bihai* 'Jaquini'; *H. foreroi*; *H. orthotricha* 'Candy cane'; *H. rostrata*; *H. stricta* 'Bucky', 'Dwarf Jamaican', 'Iris Red' and 'Tagami'; and *H. wagneriana*. Flowering stems were harvested early in the morning with one to six open bracts. The inflorescences were washed and standardized to 80 cm long.

In order to evaluate the chilling injury symptoms, three flowering stems of each species were put into refrigerator (Refrigerated Treatment - RT) at 6.5 °C and relative humidity of 81%. The flowering stems kept at the refrigerator conditions were evaluated every day to observe the appearance of chilling injury symptoms. When the first chilling injury symptoms were observed, the flowering stems were remove from the refrigerator and kept in water, at room temperature, to be daily evaluated for the evolution of chilling injury symptoms. Simultaneously, the senescence symptoms, from three flowering stems, with the pseudostem base immerse in water, were kept at the room temperature (Control Treatment - CT) at 24.7 °C and relative humidity of 66%.

The senescence symptoms were described to compare with the chilling injury symptoms.

## Results and discussion

Chilling injury symptoms on the bracts of *H. bihai* 'Peachy Pink' initially appeared as slightly darkened spots near the junction with the rachis after five days of RT (Fig. 1a). These spots evolved to darker tones and green spots appeared in the base of bracts after seven days (Fig. 1b). After fourteen days, all the bracts were spotted (Fig. 1c). The initial symptoms of senescence, in the CT, were wilted areas at the apex of inflorescence bracts after five days from harvest (Fig. 1d).

The first chilling injury symptoms of *H. caribaea* were observed after six days of the RT, with darkened spots near the junction of the bracts with the rachis (Fig. 2a). The spots became more evident and spread to over all the bracts tissue at the ninth day (Fig. 2b). The senescence symptoms were wilted areas at the apex of bracts, which occurred on the sixth day (Fig. 2c). The senescence symptoms showed slight variation between sixth and ninth day (Fig. 2d).

Chilling injury symptoms on the bracts of *H. caribaea* x *H. bihai* 'Jaquini' initially appeared as dark spots near the junction with the rachis and on the unopened bracts after five days at RT (Fig. 3a). After nine days, chilling injury symptoms evolved to all the bracts (Fig. 3b). The senescence symptoms appeared as wilted area at the apex on the first bract, which occurred after five day (Fig. 3c). Only on the ninth day, others bracts appeared wilted in the apexes, nevertheless the flowering stems were still considered with fair good quality for vase life (Fig. 3d).

Chilling injury symptoms on the bracts of *H. foreroi* initially appeared as dark spots in the rachis and unopened bracts base (Fig. 4a) six days after kept at RT. After nine days, the dark spots spread to all the bracts (Fig. 4b).

**Figures**

(a) (b) (c) (d)

Fig. 1. *H. bihai* 'Peachy Pink': chilling injury symptoms on the fifth (a), seventh (b) and on the fourteenth day (c); senescence symptoms on the fifth day (d)

(a) (b) (c) (d)

Fig. 2. *H. caribaea:* chilling injury symptoms on the sixth (a), ninth (b) and sixth day (c); senescence symptoms on the ninth day (d).

(a) (b) (c) (d)

Fig. 3. *H. caribaea* x *H. bihai* 'Jaquinii': chilling injury symptoms on the fifth (a) and ninth day (b); senescence symptoms on the seventh (c) and ninth day (d).

The senescence symptoms were withering of the apex of the inflorescence bracts and occurred on the sixth day (Fig. 4c). The inflorescences were still considered with fair good quality for vase life on the ninth day despite the presence of senescence symptoms (Fig. 4d).

The chilling injury symptoms of *H. orthotrica* 'Candy cane' appeared on the two firsts bracts on the seventh day after RT (Fig. 5a). Dark spots evolved to the junction of the bract and rachis on the ninth day (Fig. 5b). Flowering stems kept the quality until tenth day at CT (Fig. 5c) and the senescence symptoms were not as evident as in the others species, nevertheless slight withering were observed in the bracts apexes.

Chilling injury symptoms of *H. rostra*ta became more evident on the fifth day with the darkening of the bracts and rachis (Fig. 6a). On the fourteenth day, the rachis was completely darkened and necrotic spots appeared in the surface tissue of the bracts (Fig. 6b). Senescence symptoms were withed bracts apexes and dark bracts base after the fifth day (Fig. 6c). The symptoms became slightly darkened after the fourteenth day (Fig. 6d).

Chilling injury symptoms on the bracts of *H. stricta* 'Bucky' appeared as slightly darkened spots that covered almost all the area of the bracts tissue, after six days of the RT (Fig. 7a). These spots evolved to brownish aspect on the ninth day (Fig. 7b) and became darker after the fourteenth day. The senescence symptoms were wilted areas at the apex of the bracts that appeared on the ninth day (Fig. 7c). Dark spots, different from chilling injury symptoms, appeared on the base of all open bracts and on the apex of last bract (still unopened) after fourteenth day (Fig. 7d).

Chilling injury symptoms of *H. stricta* 'Dwarf Jamaican' were dark spots on the bracts after six days of the RT (Fig. 8a). The senescence symptoms on the inflorescence were initial withering of bracts apexes after six days (Fig. 8b).

The first chilling injury symptoms of *H. stricta* 'Iris Red' were slightly dark spots that appeared initially on the bracts after six days of the RT (Fig. 9a). After nine days the bracts were completely spotted (Fig. 9b). On the sixth day, the senescence symptoms were withered apex of the bracts (Fig. 9c) and became more evident on the ninth day (Fig. 9d). As in *H. stricta* 'Bucky', those dark spots were different from the dark spots of chilling injury symptoms.

The first chilling injury symptoms of *H. stricta* 'Tagami' appeared as dark spots at the junction of the bract and rachis five days after the RT (Fig. 10a). On the ninth day, the inflorescence was completely dark (Fig. 10b). The senescence symptom was withering of the apex of the bracts on the fifth day (Fig. 10c) and became more evident on the ninth day (Fig. 10d). Dark spots were observed on the bracts of *H. stricta* 'Tagami' (Fig. 10d) as occurred to H. stricta 'Bucky' (Fig. 7d) and *H. stricta* 'Iris red' (Fig. 9d).

*H. wagneriana* showed chilling injury symptoms as slightly darkened areas on the whole inflorescence, six days after of the RT (Fig. 11a). On the ninth day, dark spots appeared at the junction of the bract and rachis (Fig. 11b) that were more evident after fourteen days. The senescence symptom was withering of the apex of the bracts, appeared after six and nine days (Fig. 11c e 11d).

Comparing all the species, the chilling injury symptoms were spots with different aspects and tones of darkening on tissue of rachis and bracts of inflorescences.

The senescence symptoms were withering of apex of the bracts and were similar in the majority species. Nevertheless, *H. stricta* cultivars 'Bucky', 'Iris Red' and 'Tagami' presented dark spots different from the dark spots of chilling injury.

Costa et al. (2011b) observed in two cultivars of *Heliconia* of the same species (*H. bi*hai 'Lobster Claw' and 'Halloween') that the symptoms of chilling injury were visually different from those of the senescence process. In this case, the *H. bihai* 'Halloween' initially showed discoloration bracts tissue and after evolved to brownish aspect and dark-brown tone, while the *H. bihai* 'Lobster Claw' showed slightly darkened spots that evolved to darker tones. The initial symptoms of senescence were wilted areas at the apex of bracts. The withering advanced towards the bract base and spread to the edges.

The chilling injury symptoms at the *H. orthotricha* 'Candy cane' evolved slowly, while in the *H. rostrata* the chilling injury symptoms evolved rapidly. Both species has hairy bracts and the kind of hair and aspects of the anatomy of the bracts tissue can be related with this result. Anatomic studies are necessaries to elucidate this question.

**Conclusions**

The chilling injury symptoms are different from senescence symptoms. Inflorescences with chilling injury symptoms show color alterations of bracts and inflorescences with senescence symptoms show withering and darkening of the bracts.

The chilling injury symptoms are different among the species, where the spots present different tones of darkening on the bracts.

The senescence symptoms of three cultivars of *Heliconia stricta* were similar among cultivars and different of all other species, mainly considering the different pattern of spots of three cultivars and the withering of the bracts of other species. The senescence symptoms, withering of the bracts, were similar for the majority species. Nevertheless, *H. stricta* cultivars 'Bucky', 'Iris Red' and 'Tagami' presented dark spots different from the dark spots of chilling injury.

(a) (b) (c) (d)

Fig. 4. *H. foreroi*: chilling injury symptoms on the sixth (a) and ninth day (b); senescence symptoms on the sixth (c) and on the ninth day (d).

(a) (b) (c)

Fig. 5. *H. orthotricha* 'Candy cane': chilling injury symptoms on the seventh (a) and ninth day (b); senescence symptoms on the tenth day ©

(a) (b) (c) (d)

Fig. 6. *H. rostrata*: chilling injury symptoms on the fifth (a) and fourteenth day (b); senescence symptoms on the fifth (c) and fourteenth day (d).

(a) (b) (c) (d)

Fig. 7. *H. stricta* 'Bucky': chilling injury symptoms on the sixth (a) and ninth day (b); senescence symptoms on the ninth (c) and fourteenth day (d).

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(a) (b)

Fig. 8. *H. stricta* 'Dwarf Jamaican': chilling injury symptoms on the sixth day (a); senescence symptoms on the sixth day (b).

(a) (b) (c) (d)

Fig. 9. *H. stricta* 'Iris Red': chilling injury symptoms on the sixth (a) and ninth day (b); senescence symptoms on the sixth (c) and ninth day (d).

(a) (b) (c) (d)

Fig. 10. *H. stricta* 'Tagami': chilling injury symptoms on the fifth (a), and ninth day (b); senescence symptoms on the fifth (c) and ninth day (d).

( a) (b) (c) (d)

Fig. 11. *H. wagneriana:* chilling injury symptoms on the sixth (a) and ninth day (b); senescence symptoms on the sixth (c) and ninth day (d).

## HSI Member Profile

David Lorence, PhD
Kalaheo, Hawaii, USA

**When did you join HSI?**
In about 1989, when I was designated as the NTBG representative to HSI.

**What is your professional position?**
Director of Science and Conservation Department, National Tropical Botanical Garden, Kauai, Hawaii, USA

**What is your work with Zingiberales?**
Curator of Zingiberales collections at NTBG. Also Treasurer of HSI since 2004, and formerly served as coordinator of Student Grants Committee (2001-2011) and Conservation Center Committee (2004-2012).

**What is your attraction to Zingiberales?**
I'm interested in their value as spices, medicinal properties and use as ornamentals and cut flowers. Plus my wife Ginette loves to use them in floral arrangements.

**What is your favorite in the Order?**
Torch Gingers (Etlingera ssp.) because of their floral beauty and impressively huge pseudostems. However, my research interests focus on the taxonomy of ferns and Rubiaceae.

**What do you hope for in the future?**
I hope to see more young society members and young members on the board of directors. We need new ideas

## HSI Awards For Botanical And Horticultural Research Projects on the Zingiberales

The Heliconia Society International sponsors a small grants program supporting research projects on any aspects of the botany and horticulture of the Zingiberales conducted by undergraduate, graduate and post-doctoral students enrolled at recognized universities and research institutions. Annual grants up to $1,000 are available. A student or postdoc can receive a single grant in a three year period. Proposals may be submitted at any time and will be reviewed periodically by the Society's Grants Committee.

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*Heliconia oleosa*

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