



An Inventory Study on the Cigar Orchid (*Cyrtopodium punctatum*) in Big Cypress National Preserve

Final Report

Natural Resource Report NPS/BICY/NRR—2024/2627



ON THE COVER

A cigar orchid found during the survey in Big Cypress National Preserve.

NPS / HONG LIU

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Natural Resource Report NPS/BICY/NRR—2024/2627

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Executive Summary

The cigar orchid is a Florida state-listed endangered species, made rare in southern Florida by historical over-collection for its unique beauty, in addition to habitat loss. It is largely restricted to a small number of cypress domes and freshwater sloughs in southwestern Florida, including the Big Cypress National Preserve (BICY). We established a baseline dataset on the population of cigar orchid at BICY, based on extensive field surveys within the following seven regions: Fire Prairie Trail-East, Gator Hook Trail, Florida Trail, Nobles Grade, North of Tamiami Trail (mainly the Skillet Strand and Monument Lake), the Oasis strands, and North of I-75. These regions were chosen based on past or current known occurrences of cigar orchids. We conducted a total of 25 field searches of cigar orchids in BICY. We found a total of 85 cigar orchids and recorded their GPS locations along with their microhabitat information, including host tree species, host tree diameter at breast height, location of individual and orientation on host tree. The total search area across regions totaled 284.9 ha (705 acres).

Acknowledgments

The authors would like to acknowledge Big Cypress National Preserve Supervisory Botanist, Dr. Courtney Angelo, for championing this project, providing logistical support, compiling the background information needed for this project, and joining a few field searches. Dennis Giardina provided critical help to the implementation of the project by driving the search team in his UTV to remote field sites. Thank you to the following people for assistance with fieldwork: Savanna Zeiger, Mario Cisnero, Jason Flores, Dominic Mellone, Cynthia Fussell, Luis Garcia Galcon, Darleng Egea, Joshua McBride (staff member of BICY), Mike and Cheryl Reupert (Volunteers of BICY), Matthew Preiss, and Michelle Berndgen. This project was possible through the support from the National Park Service Inventory and Monitoring Division.

Introduction

The cigar orchid (*Cyrtopodium punctatum*) is an epiphytic plant native to the Neotropics that reaches the northern limit of its range in South Florida. It has been known to science for almost 250 years, being one of the earliest tropical American orchids to be described by Carl von Linne in 1759 (Bechtel et al. 1992). It is the largest orchid in southern Florida, with cigar-like fusiform pseudobulbs up to 50 cm in length. The orchid is usually found in the forked branches of trees, or atop tree stumps, and can develop a large, matted root system, which serves as a platform supporting a bulky assemblage of pseudobulbs. The fruits are large, pear-like capsules, and take a full year to mature (Luer 1972; personal observations). Cigar orchids rely on insect pollinators to set fruit (Pemberton and Liu 2008), and mycorrhizal fungi for seed germination and seedling growth (Downing et al. 2020). The high degree of dependency on other species such as insect pollinators and host trees make cigar orchid a good indicator of the ecosystem's health within Big Cypress National Preserve (BICY).

The cigar orchid population in southern Florida has experienced habitat loss and historical over-collection, especially before the establishment of the National Parks in the region. The orchid was thought to be historically abundant throughout southern Florida (Luer 1972) but is now scarce within the state (Pemberton and Liu 2008). The orchid is now largely restricted to a small number of cypress domes and freshwater sloughs in southwestern Florida, including within BICY. In southeastern Florida, a small population persists near coastal areas in Everglades National Park, and a small semi-natural population also occurs in and around Fairchild Tropical Botanic Garden. The cigar orchid has been listed as an endangered species by the state of Florida (F.A.C. 1998) and is listed as critically imperiled in South Florida by the Institute of Regional Conservation (Gann et al. 2023). Occasional poaching is still ongoing and is a management concern. The insect, Boisduval scale (*Diaspis boisduvalii*), an orchid horticultural pest, is known to infest some wild orchids in the Florida Panther National Wildlife Refuge (Zettler et al. 2012) and the Everglades National Park (Borrero et al. 2023) and could also possibly impact cigar orchid populations. The swamp forests where cigar orchids are found are becoming more fire-prone habitats with changes to climate, though little is known about how fire impacts the populations of cigar orchid or other epiphytic plants in general.

The main objective of this project was to establish baseline population data on the cigar orchid such as population size, distribution, occurrence locations, plant size, reproductive status (reproductive or sterile), and microhabitats in BICY, so that Preserve staff can manage known populations and protect them from poaching more effectively. Secondly, we wanted to better understand the microhabitats in which cigar orchids occur in BICY to estimate likely habitat for future surveys. We also wanted to explore possible stressors impacting cigar orchid populations, such as Boisduval scale insects and fire history.

Methods

Sample Design

Field surveys were conducted in areas where past or current occurrences of cigar orchids were known. Prior to the field surveys, we collected and consolidated occurrence information based on records from past and current BICY staff members, as well as from other key informants who hike and guide nature walks in BICY. We additionally used social media postings to identify members of the local community that could assist with unknown cigar orchid locations.

Sites where previous cigar orchids had been reported included. Fire Prairie Trail-East, Gator Hook Trail, Florida Trail, Nobles Grade, North of Tamiami Trail (mainly the Skillet Strand and Monument Lake), the Oasis strands, and North of I-75. Sites were searched visually on foot by a team. Searches were also conducted along hiking routes to and from a site from a main trail where the Utility Task Vehicle (UTV) could travel. Efforts to locate new plants were also made by searching arbitrarily selected domes and strands along the way to known occurrence sites, which appeared to be similar to sites where cigar orchids occur. There were many domes and strands on our hiking routes that appeared to be similar to sites with known cigar orchid occurrences, but we could not search all similar habitat localities due to temporal and spatial constraints.

Field Methods

For each cigar orchid individual found, we recorded plant size (number of pseudobulbs and the length of the longest pseudobulbs) and reproductive status. In addition, we recorded data pertaining to host tree species, i.e., species and diameter at breast height (DBH) of the host tree, and location of cigar orchid on the host.

Locations that represented a group of cigar orchids typically fell within a cypress dome or strand, two common types of natural forest communities within BICY that host cigar orchids. The search team surveyed these sites by walking parallel lines, about 10 m apart from one another, to cover the entire, or most, of the domes or strands, depending on their sizes (which typically varied from 20 x 20 m to 100 x 50 m, some were larger). The exact sizes of the search areas were estimated based on GPS tracks and the final size and location of the search area were drawn and reported based on GPS route records.

When a cigar orchid was spotted at a previously known location or incidentally at a new location via transect-based searches or while hiking, efforts were made to search for additional plants as well as plants of small size that were not as visible as large plants. This search was done by using each plant occurrence as a center and searching every potential host tree in a 5-m radius circular plot. This approach maximizes the possibility of locating cigar orchids of all sizes and largely overcomes the bias induced by plant size, where large plants are more visible than small plants. Once new plants were located, we repeated this 5 m radius search, until no new plants were found (i.e., adaptive cluster sampling).

Community plots

To compare community attributes of habitat both with and without cigar orchid presence, we established 16 10 m x 10 m plots at selected places within the search area described above, eight of which were occupied by cigar orchids and eight which were unoccupied. At three sites (Fire Prairie Trail-East, Monument Lake, and North of I-75) we were able to pair plots where two or more cigar orchids were found within a ~20 m by 20 m area with control plots where no cigar orchids were found near plots occupied by cigar orchids. At Oasis South and Skillet Strand, where many cigar orchids were found, we established two cigar orchid-occupied plots at each site to capture the community characteristics. At these sites, cigar orchid-absence plots were not established due to time constraints. Instead, we established cigar orchid absence only lots at three sites (Gator Hook, Skillet Strand east, and Oasis North).

In these community plots, we identified each tree species, counted the number of trees, and measured the size (DBH and height) of each tree within the plots. We also recorded the epiphyte species and abundance (absolute quantity) within the plots on each tree. We differentiate between “true epiphytes”—those that are found exclusively as epiphytes—and “epiphytic terrestrials”—species that are found most typically growing terrestrially. We also examined the relative frequency (percentage of total plots) at which each species occurred.

Presence of disease and insect herbivory

We launched two additional field trips in December 2022 to inspect all wild orchids below 2 m tall in four of the eight habitat plots with full attention to the Boisduval scale insects. Two of the plots were located in the cypress domes south of Oasis Visitor Center, and two in the Fire Prairie Trail. In this survey we considered a plant infested if at least one mature female was present. Since immature scales can also be present but difficult to count, we classified the severity of the infestation on an orchid into three categories: (1) low if only two or fewer female scales were present and the total impacted area was less than 1 cm², (2) medium if three to five female scales were present and the total impacted area was greater than 1 cm² but less than 10% of the orchid’s total surface area; and (3) high if five or more female scales were present and the total impacted area was greater than 10% of the orchid’s total surface area.

Analysis methods

Search area calculations

The search area calculations were based on our on-foot tracks of the hand-held GPS units (Garmin Inc.), along with a 10 m buffer, as described below. For each search event at least one GPS unit was used. In most cases, three or more GPS units were used during the search events depending on the search team size. The GPS units recorded the movement of the search team as tracks. For each search event, the GPS tracks from the multiple units were combined (dissolved) into a single event to create one feature. This process was repeated for each search event. Subsequently, all search events were combined into a track feature class. The GPS units collected the track information in Latitude and Longitude (Datum WGS84), therefore, the tracks were projected to Florida State Plane (Florida East FIPS 0901).

The projected track feature class (polylines) was used to calculate the search area by creating 10 m buffers on each side of the line (i.e., full side) for all search events. Given that most search events had multiple tracks, the resulting polygon buffer was dissolved into a single feature per search event to remove areas where the generated buffers resulted in overlapping areas. The area of each polygon was the active search area described above for each event. The area is reported in hectares (ha). The GIS analysis was done using ArcGIS PRO 2.9 (ESRI Inc.). The tool repair geometry (ESRI validation) was run after a geoprocessing tool was used.

Habitat analysis

A habitat analysis was conducted to determine the occurrence of cigar orchid individuals in different habitats. The analysis was done using a vegetation map created for the region by the National Park Service (Ruiz et al., 2020, Whelan et al., 2020) and the location of the cigar orchid individuals. The vegetation map used covers the entire land area of Big Cypress National Preserve. The analysis was conducted using geoprocessing tools (e.g., Overlay) in ArcGIS PRO 3.1 (ESRI Inc).

Fire frequency and burn date determination

Fire frequency was determined using a geodatabase provided by the National Park Service (NPS) with records of fires as polygons from 1970 to 2021. Using the individual orchid location, the fire frequency was extracted from the fire feature class using the geoprocessing tool “intersect,” resulting in an attribute for each occurrence describing the number of fires occurring in that location. From the resulting feature class, information about the most recent fire was used to calculate the last burn date for each orchid occurrence. Then, the individual orchids were grouped in two ways: 1) based on years since the last burn, resulting in 11 groups (e.g., a group 0 years since last burn with 16 individuals, a group 4 years since last burn with 13 individuals, etc.); and 2) based on the frequency of fire that each individual was exposed to, resulting in 7 groups with fire frequency ranging from 0 to 6 times.

We then analyzed the relationship between the last burn date and cigar orchid occurrence by determining the correlation between the number of orchids (grouped) and the number of years since the orchids’ location was last burned. Additionally, we grouped the number of orchids in based on fire frequency to determine if there was a correlation between fire frequency and cigar orchid occurrence.

Community analyses

Data from all community plots (paired and unpaired) were used in analyses. Comparison traits such as DBH between different groups were analyzed using ANOVA assuming unequal variances in SPSS (IBM, New York, NY). Community analysis consisted of biplot, non-metric, multidimensional scaling (NMS) ordinations of epiphyte community abundance data (adjusted based on maximum value for each species) as both the main and second matrix. The distance measure implemented was Sorenson (Bray-Curtis), with 200 runs with real data, 500 maximum iterations, and a stability criterion of 0.000001. Multi-Response Permutation Procedures (MRPP) were used to assess significant differences between epiphytic communities in plots with and without cigar orchids. Communities were then assessed using a Cluster Analysis and an Indicator Species Analysis (ISA). All community analyses were run using PC-Ord version 7.08 (Wild Blueberry Media, LLC, Corvallis, OR).

Results

The total number of search events in the entire project was 25. We found a total of 85 cigar orchids. The total search area added up to 284.9 ha and the total search time was 4,283 minutes.

Demography and microhabitat

Demographic pattern of the cigar orchids in Big Cypress

A plant's probability of survival and reproduction is often correlated with plant size variables (Moloney 1986; Silvertown and Lovett Doust 1993). Cigar orchid's probability of reproduction, as indicated by the number of flower stems, is influenced by both the stem length and number of stems. Cigar orchid plant size was best characterized by a size index (length of longest stem in centimeters plus number of stems), as it correlated with the number of old flowering stalks (an indication of past plant reproductive attempts). Figure 1 shows that the minimum plant size index that a plant can flower is 34. Plant size index was used as the cutoff to classify plants as adults, where an adult cigar orchid had a plant size index greater than or equal to 34. The bigger the plant, the more flowering stalks it produced.

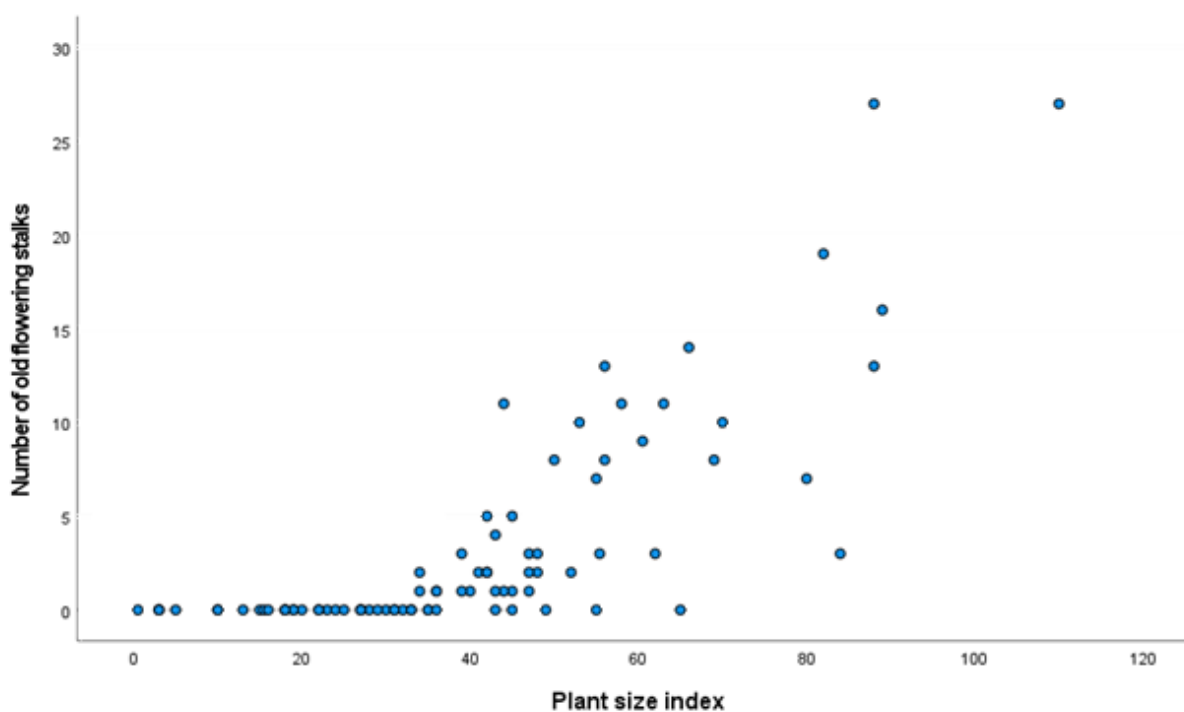


Figure 1. Scatter plot of plant size index and number of old flowering stalks showing the minimum size of a plant for onset of flowering capability and the relationship between plant size and reproductive output.

We classified the cigar orchid's life history into the following stages based on plant size and reproductive capacity: juvenile, adult, and super adult. Classification of seedling was based on prior knowledge of cigar orchid seedling appearance, instead of the size index. Seedlings were those that have only one very small stem of 1–5 cm long with one to several leaves. These were noted as

seedlings on site when spotted (Figure 2). Juveniles were those with a size index value less than 34 that were not seedlings. Adults had a size index of 34 or greater and super adults had a size index of 34 or greater with 20 or more stems.

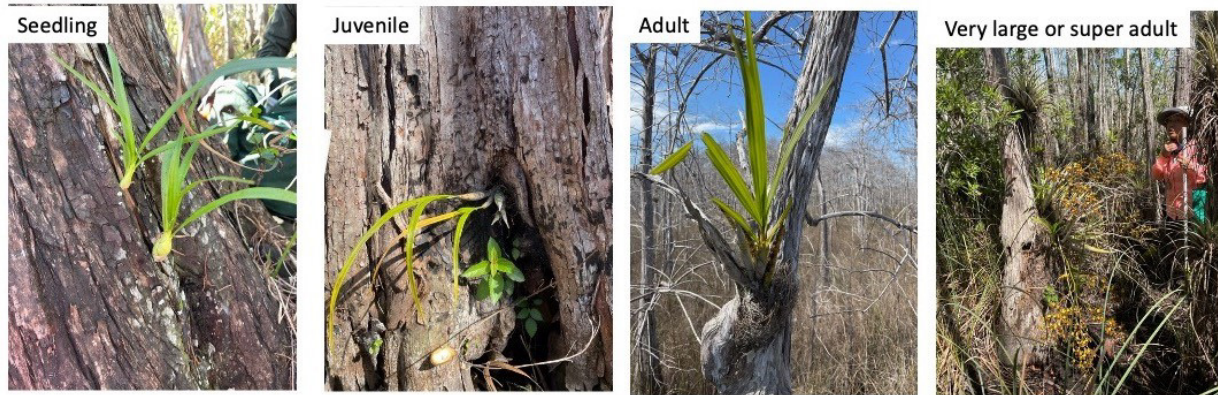


Figure 2. Pictures of cigar orchids showing different life history stages.

The majority (61%) of the cigar orchids found in BICY were adult plants (Figure 3). Among these 22% were very large-sized plants, super adults with 20 or more stems each. Only 4% of individuals were seedlings, and 35% were juveniles. Together with the observation that no plant had produced any fruit in the 2021 and 2022 seasons, this population structure indicates that recruitments of the cigar orchid population in BICY were sparse.

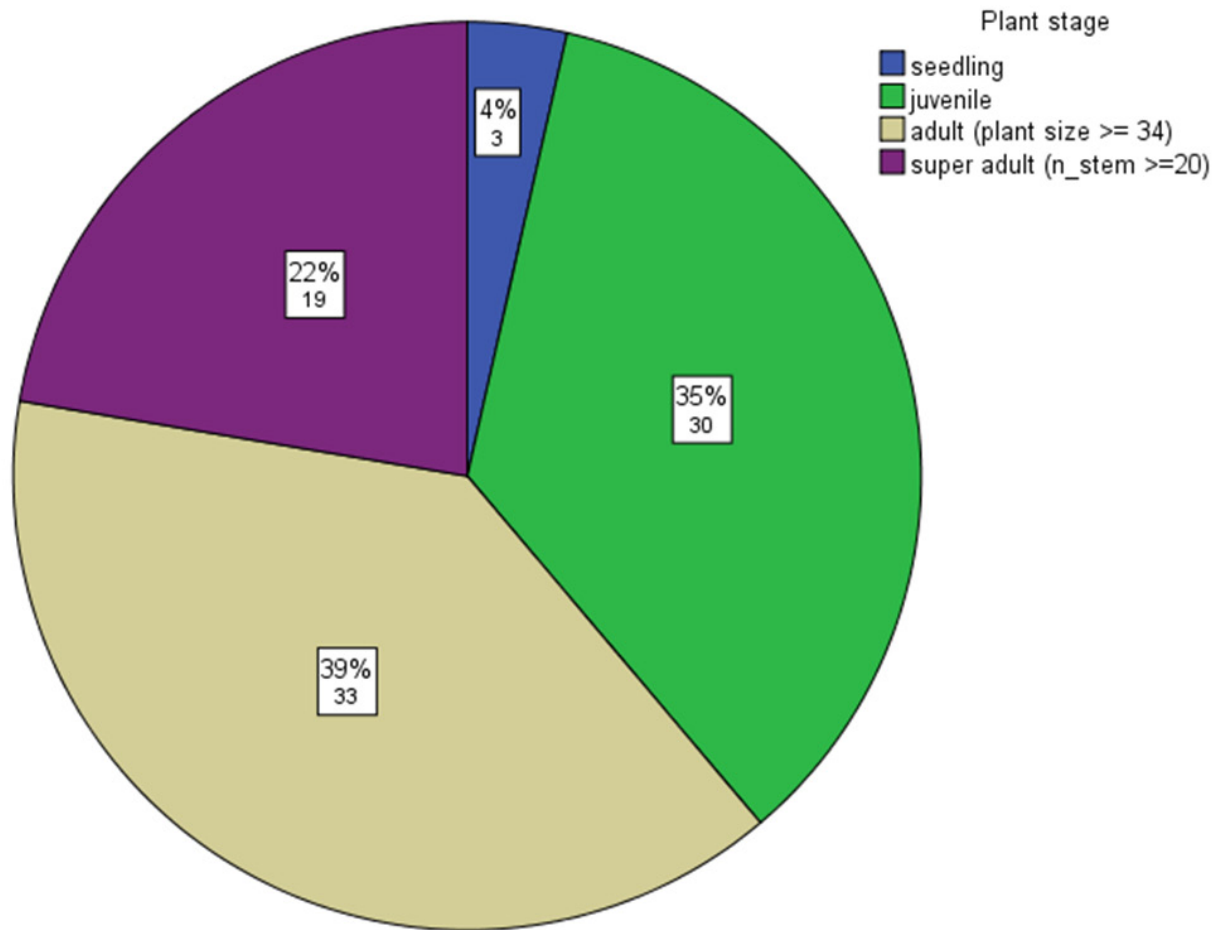


Figure 3. Population structure of cigar orchids found in Big Cypress National Preserve in spring 2022. Percentages and numbers in pie chart reflect percent of total BICY population and the number of plants in each plant stage. Seedlings were those that had only one small stem of 1–5 cm long with one to several leaves. Juveniles were those with a size index value less than 34 that were not seedlings. Adults had a size index of 34 or greater with less than 20 stems while super adults had a size index of 34 or greater with 20 or more stems.

Cigar orchid distribution and microhabitat characteristics

All cigar orchids were found growing on cypress trees (*Taxodium distichum* or *T. ascendens*).

Overall, 47.6% of the orchids were east facing (including southeast, east, and northeast), with 27% facing strictly east, while only 28.5% were west or somewhat west facing (including southwest, west, and northwest; Figure 4). Eighty-five percent of the cigar orchids were located at or below 1.5 m on the host tree (Figure 5).

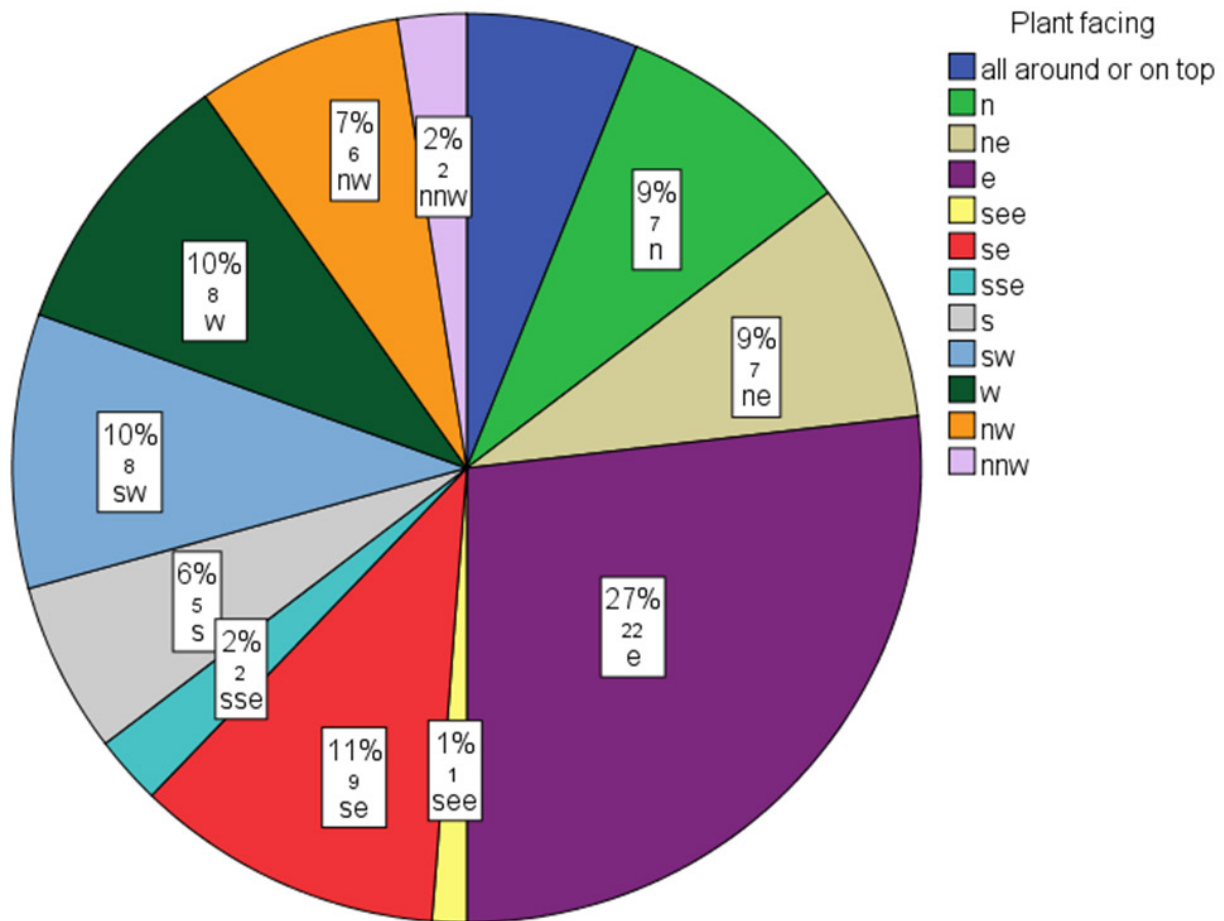


Figure 4. Distribution of cigar orchid plants' cardinal direction in Big Cypress National Preserve. Label in each pie slice indicates percentage and number of plants in each facing group. Note that the blue unlabeled pie slice represents plants that wrap around the tree or grew on top of stumps (6% and 5 plants, respectively).

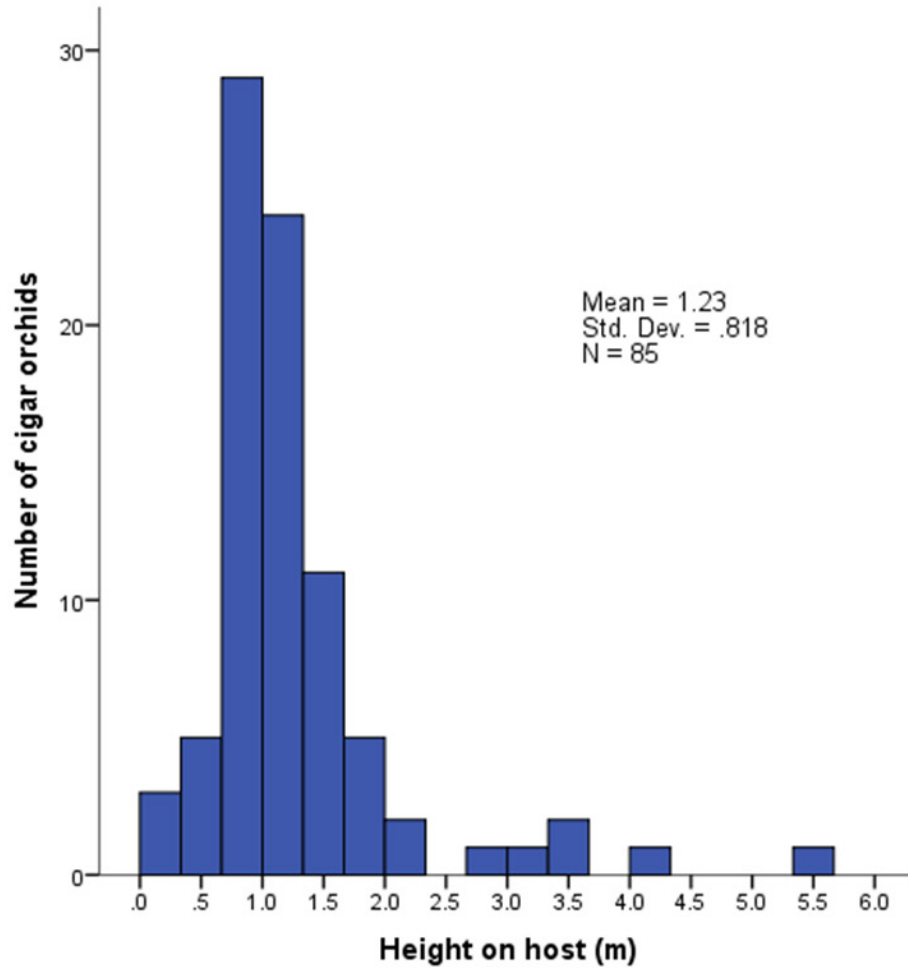


Figure 5. Cigar orchid plant height location on host trees in the Big Cypress National Preserve.

The mean diameter at breast height (DBH) of the host trees was 25.4 ± 14.3 cm standard deviation (Figure 6). The smallest tree DBH was 6.4 cm and the max was 82.6 cm. More than 90% of the host trees had their DBH range from 10–50 cm. The mean DBH of non-host trees was 11.1 ± 5.6 cm, significantly smaller than host trees (Figure 7; ANOVA, $F=195.021$, $p<0.01$). Note that Figures 5 and 6 have different sample sizes because not all host trees had a DBH measurements. Some cigar orchids were found on stumps without DBH measurements.

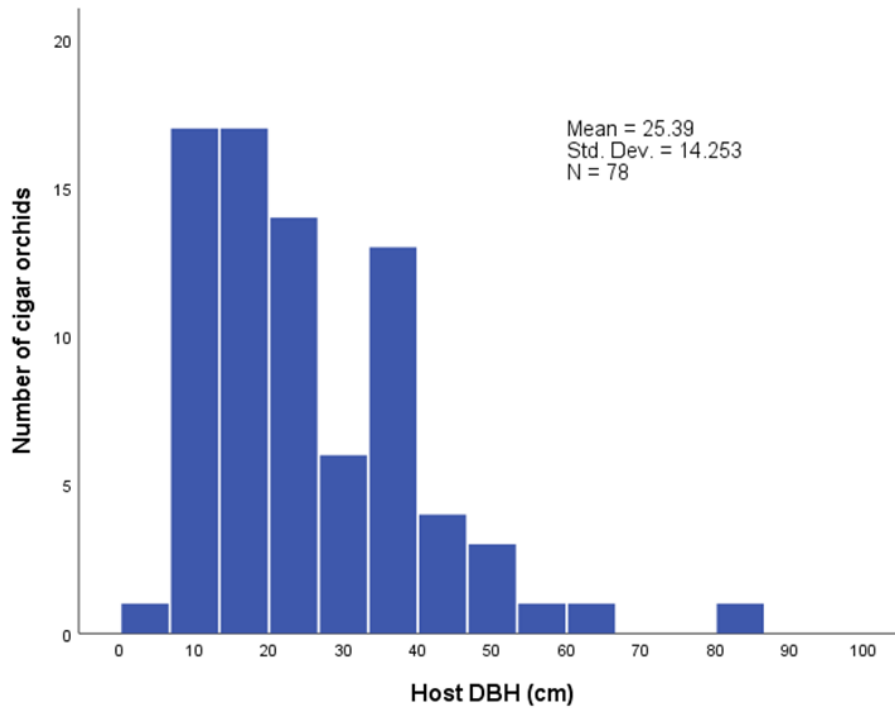


Figure 6. Diameter at breast height (DBH) in cm of cigar orchids host trees at the Big Cypress National Preserve.

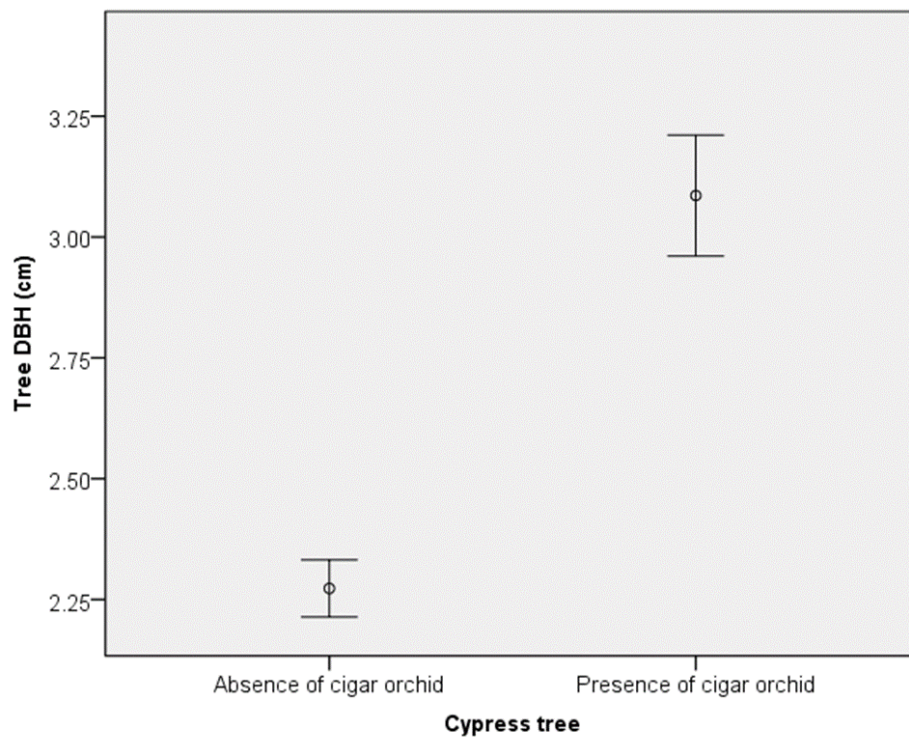


Figure 7. Comparison of mean tree DBH between cigar orchid host and non-host trees. The average DBH of non-host trees was significantly smaller than host trees (ANOVA, $F=195.021$, $P<0.01$).

Presence of disease and Boisduval scale insect herbivory

We did not observe any disease or Boisduval scales on cigar orchids during our cigar orchid surveys from Nov 2021 to April 2022. A total of 5 orchid species found in the plots were inspected (Table 1). Among the 16 cigar orchids inspected, 6 (37.5%) had scale insect present, but all at the low level. Only one orchid species, *Encyclia tampensis*, was found to have high Boisduval scale insect presence.

Table 1. Number and percent of orchids that were infested with the Boisduval scale insect (*Diaspis boisduvalii*) in Big Cypress National Preserve. Infestation was categorized as either none, low (two or fewer scales present, with total impacted area less than 1cm²), medium (three to five female scales present, with total impacted area greater than 1cm² and less than 10% of the orchid's total surface area), or high (five or more female scales present, with total impacted area greater than 10% of the orchid's total surface area.) Surveys were carried out in four 10x10 m² cigar orchid habitat plots.

Orchid species	None	Low	Medium	High
<i>Bletia purpurea</i>	6 (54.5%)	3 (27.3%)	2 (18.2%)	0
<i>Cyrtopodium punctatum</i>	10 (62.5%)	6 (37.5)	0	0
<i>Dendrophylax porrectus</i>	52 (100%)	0	0	0
<i>Encyclia tampensis</i>	11 (91.7)	0	0	1 (0.3%)
<i>Polystachya concreta</i>	1 (100%)	0	0	0

Habitat

The habitat analysis using the NPS vegetation map (Ruiz et al., 2020; Whelan et al., 2020) revealed that the majority of the individuals were found in Cypress Forest-Dome habitat (55%) followed by the Cypress Forest-Monotypic habitat (20%), and Cypress Forest-Strand habitat (13%). Similarly, a higher number of super-adult individuals were found in domes and monotypic cypress forests (53% and 26% respectively; Table 2; Figure 8). These habitat types are abundant across the Preserve with coverages of 6.6% of cypress dome, 14.3% of cypress monotypic habitat, and 4.3% of cypress strand habitats (Figure 9).

Table 2. Number of cigar orchid individuals per habitat type, determined using the existing vegetation map for Big Cypress National Preserve (Ruiz et al., 2020, Whelan et al., 2020). Total mapped area is 296,029 ha and includes all habitats, with and without registered of cigar orchid individuals.

Vegetation Name	Number of Individuals	Super Adults	Habitat Area (ha)	Habitat %*
Cypress Forest-Dome	47	10	19530.8	6.6
Cypress Forest-Monotypic	17	5	42189.2	14.3
Cypress Forest-Strand	11	2	12628.25	4.3
Cypress Scrub-Graminoid Prairie	4	1	25233.5	8.5
Cypress Woodland-Graminoid	2	0	3481.25	1.2
Cypress Woodland-Graminoid Marsh	2	1	9658.25	3.3
Cypress-Pine Forest	1	0	2488.75	0.8
Pine Flatwoods-Mixed	1	0	7620.5	2.6
Total	85	19	122,830.5**	41.6

* Percentage calculated based on the total mapped area (296,029 ha), which includes other vegetation classes with no cigar orchid individuals found.

** Total area represents the sum of habitat area where cigar orchid individuals where found.

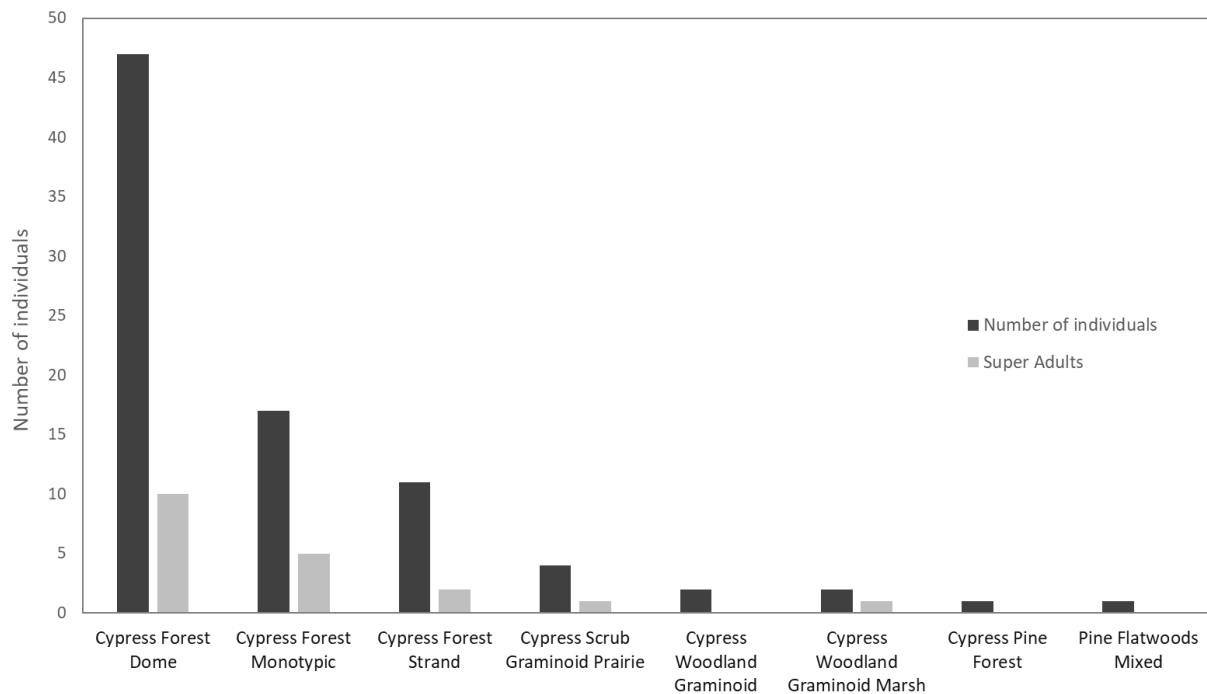


Figure 8. Occurrence of cigar orchids in the various habitat types as defined by Ruiz et al. (2020). Vegetation cover data was extracted from Ruiz et al., (2020) and Whelan et al., (2020).

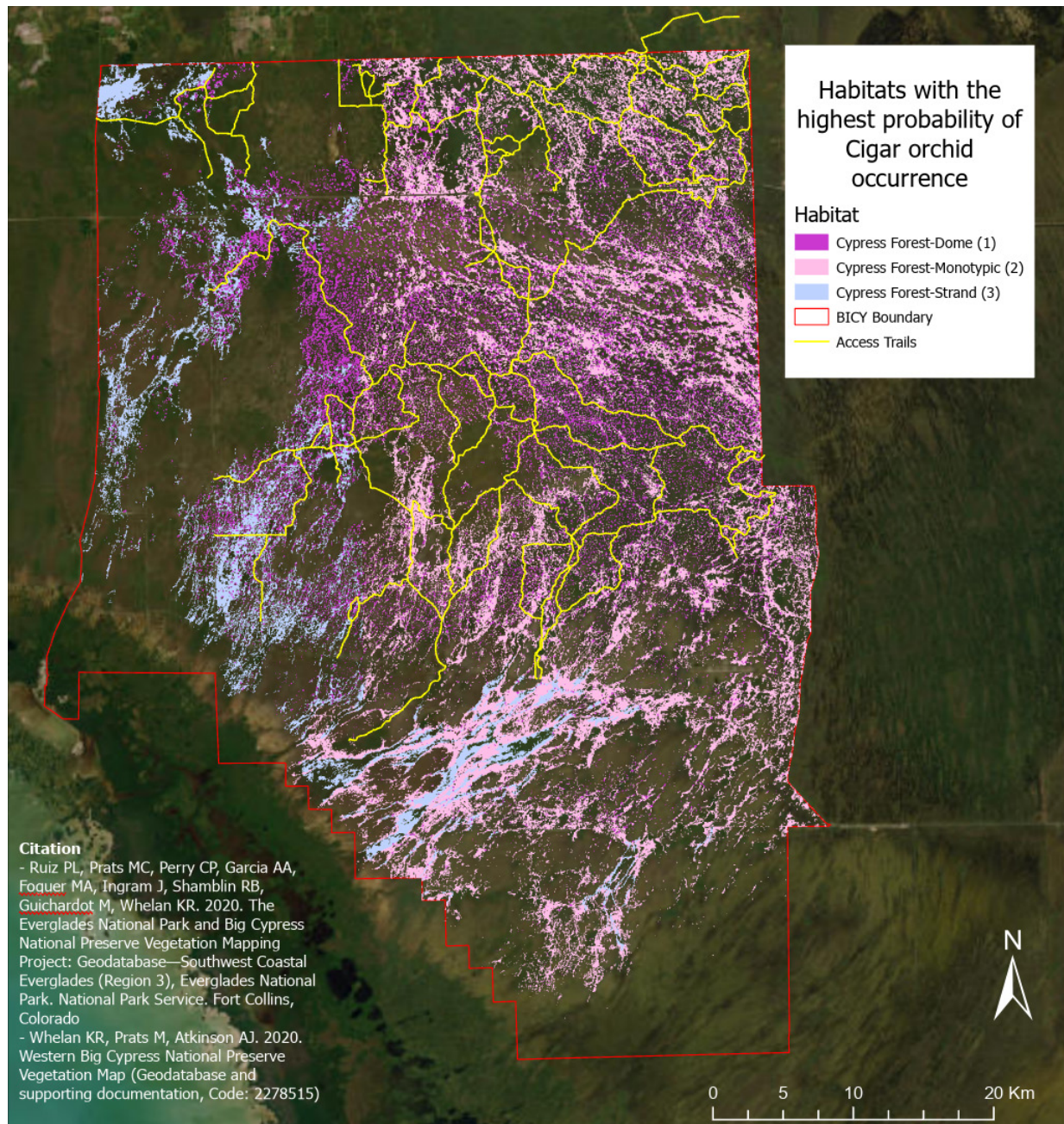


Figure 9. Map of likely cigar orchid habitats. The definition of the habitat types follows that of Ruiz et al. 2020 and Whelan et al. 2020.

Exploring the impact of fire on cigar orchid occurrence

The data did not show a significant pattern between the time since the last fire and the number of cigar orchids; Figure 10). Note that 16 cigar orchids occurred at locations that were not burned during the past 51 years covered by fire data. These individuals (red point in Figure 10) were excluded from the analysis because the zero value for the time since last fire can affect the analysis.

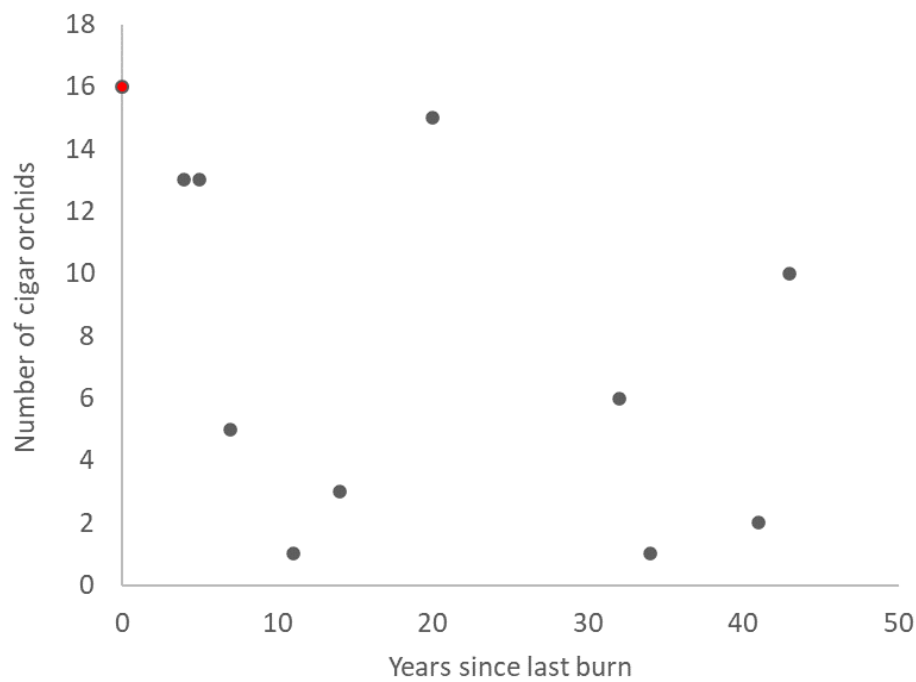


Figure 10. Scatter plot between the number of years since the last fire and the number of cigar orchids.

A negative but not statistically significant relationship between fire frequency and the number of cigar orchids was found ($R^2 = 0.436$, $p = 0.107$, $n = 7$; Figure 11).

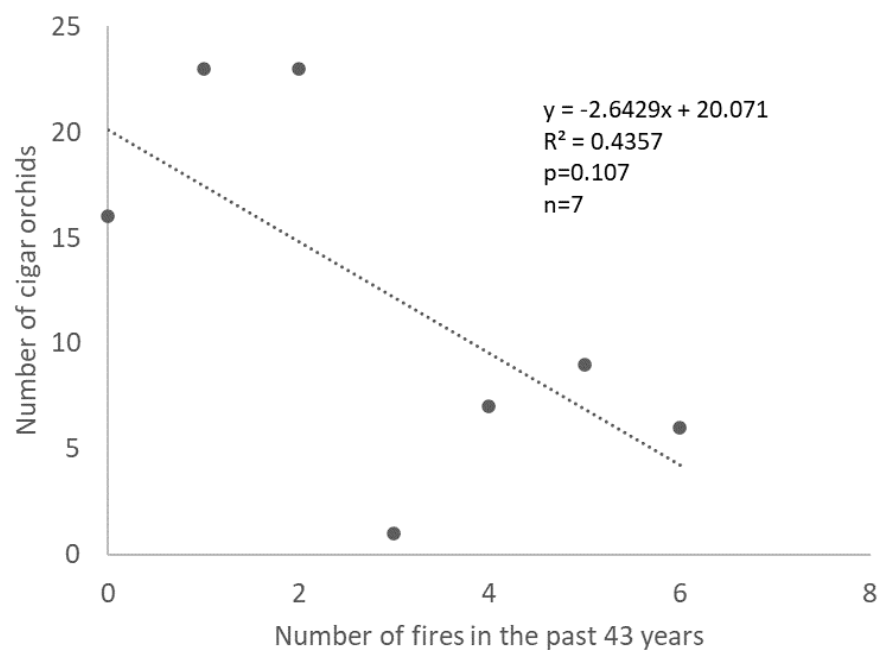


Figure 11. Scatter plot between the number of cigar orchids found and fire frequency in a search area.

Community Results

Trends were observed between plots occupied by cigar orchid and those that were unoccupied. Occupied plots displayed greater mean basal area/acre, greater mean DBH, greater mean tree density, greater mean tree height, and greater mean maximum basal area (i.e., largest tree). Of these, only the mean basal area/acre was statistically significant ($T = 1.89$, $p = 0.03$, Figure 12).

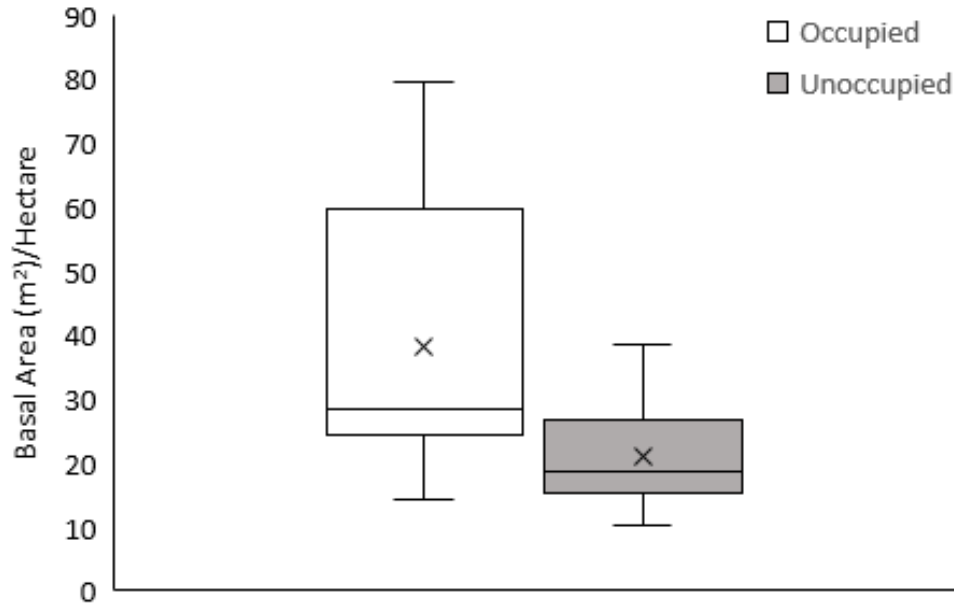


Figure 12. Basal area (m^2) per hectare for plots occupied and unoccupied by cigar orchid.

Epiphyte Community

True epiphyte abundance was 11% greater in plots occupied by cigar orchid relative to unoccupied plots (2034 vs 1806; Table 3). The mean abundance was greater in occupied plots as well (258.0 vs 226.4), though this difference was not significant. Overall true epiphyte species richness was also greater in occupied plots (12 vs 10). The mean species richness of epiphytes was higher in occupied plots (7.0 vs 5.25) though this difference was not significant. The mean relative frequency of true epiphytes was higher in occupied plots relative to unoccupied (49.0 vs 39.4), though this difference was not significant.

Table 3. True epiphyte species abundance and relative frequency in plots occupied vs unoccupied by cigar orchids (*Cyrtopodium punctatum*).

Taxon	Number of Individuals		Relative Frequency (%)	
	Occupied	Unoccupied	Occupied	Unoccupied
<i>Cyrtopodium punctatum</i>	9	0	100	0
<i>Dendrophylax porrectus</i>	19	0	31.3	0
<i>Encyclia tampensis</i>	42	17	75	75
<i>Phlebodium aureum</i>	4	3	37.5	25
<i>Pleopeltis michauxiana</i>	16	10	50	75
<i>Polystachya concreta</i>	0	2	0	12.5
<i>Tillandsia balbisiana</i>	286	202	87.5	100
<i>Tillandsia fasciculata</i> var. <i>densispica</i>	1539	1454	100	100
<i>Tillandsia paucifolia</i>	53	91	75	50
<i>Tillandsia recurvata</i>	2	0	25	0
<i>Tillandsia setacea</i>	10	17	37.5	25
<i>Tillandsia usneoides</i>	47	9	75	37.5
<i>Tillandsia x smalliana</i>	7	1	25	12.5
Total	2034	1806	–	–
Richness	12	10	–	–

There was a trend toward occupied plots having more orchid species than unoccupied plots. For example, *Dendrophylax porrectus* was present in 31.3% of occupied plots, while not present in unoccupied plots. *Encyclia tampensis* was present at the same relative frequency (75%) in both occupied and unoccupied plots, however, the abundance was over two times greater in occupied plots (42 vs 17). *Polystachya concreta* was the exception, where two individuals were found in a single unoccupied plot while this species was not present in occupied plots.

The total abundance of *Tillandsia* taxa in occupied plots was greater for all taxa except for *T. paucifolia* and *T. setacea*. The relative frequency was higher in occupied plots for all species except for *T. balbisiana* and *T. fasciculata* var. *densispica* (100% for both). Most notable in terms of relative frequency was *T. usneoides* which occurred twice as often in occupied plots. Further still, the abundance of *T. usneoides* was five times greater in occupied plots (47 vs. 9). *T. fasciculata* var. *densispica* was the most abundant epiphyte in all plots, occurring at rates orders of magnitude greater than other epiphytes (Table 3).

A notable trend was “epiphytic terrestrials” (hereafter ET), plants that were predominately terrestrial but in this case were found growing on trunks of trees. ETs were more abundant in plots where a

cigar orchid was found (Table 4). In fact, ET abundance was three times greater in occupied plots relative to unoccupied (108 vs 35). The mean abundance of ETs was roughly 68% higher in occupied plots, and this difference was statistically significant [$t(10) = -2.02$, $p = 0.04$]. Overall, ET species richness was also greater in occupied plots (17 vs 13), though this was not statistically significant. On average, the ET mean species richness was roughly 41% higher in occupied plots relative to unoccupied (4.25 vs 2.5). The mean relative frequency of ETs was significantly higher in occupied plots relative to unoccupied [$t(21) = -2.53$, $p = 0.01$], meaning on average, individual ET species were more likely to occur in plots with cigar orchid. The two species that stand out in terms of both abundance and relative frequency were *Boehmeria cylindrica* and *Nephrolepis exaltata*. The former was five times more abundant in occupied plots (25 vs 5) and was found in ~66% more plots (62.5% vs 37.5%). *Nephrolepis exaltata* was nearly eight times more abundant in occupied plots (39 vs 5) and was four times more likely to occur (50% vs 12.5%).

Table 4. Number of individuals (abundance) and relative frequency of all “epiphytic terrestrials” in plots occupied and unoccupied by cigar orchid.

Taxon	Number of Individuals		Relative Frequency (%)	
	Occupied	Unoccupied	Occupied	Unoccupied
<i>Andropogon glomeratus</i>	2	1	25	12.5
<i>Baccharis halimifolia</i>	1	0	12.5	0
<i>Bletia purpurea</i>	0	2	0	12.5
<i>Boehmeria cylindrica</i>	25	5	62.5	37.5
<i>Centella asiatica</i>	1	0	12.5	0
<i>Chrysobalanus icaco</i>	1	0	12.5	0
<i>Cladium jamaicense</i>	0	2	0	25
<i>Coleatania rigidula</i>	1	0	12.5	0
<i>Dichantherium erectifolium</i>	1	1	12.5	12.5
<i>Eupatorium mikanioides</i>	0	2	0	12.5
<i>Ficus aurea</i>	7	3	25	25
<i>Ficus citrifolia</i>	4	1	37.5	12.5
<i>Hyptis alata</i>	1	0	12.5	0
<i>Nephrolepis exaltata</i>	39	5	50	12.5
<i>Passiflora suberosa</i>	1	0	12.5	0
<i>Psilotum nudum</i>	10	7	50	50
<i>Sabal palmetto</i>	2	1	25	12.5
<i>Telmatoblechnum serrulatum</i>	8	4	25	12.5
<i>Thelypteris interrupta</i>	1	0	12.5	0

Table 4 (continued). Number of individuals (abundance) and relative frequency of all “epiphytic terrestrials” in plots occupied and unoccupied by cigar orchid.

Taxon	Number of Individuals		Relative Frequency (%)	
	Occupied	Unoccupied	Occupied	Unoccupied
<i>Thelypteris kunthii</i>	3	0	25	0
<i>Vitis rotundifolia</i>	0	1	0	12.5
Total	108	35	–	–
Richness	17	13	–	–

Ordination Results

Results of NMS ordination display a degree of grouping, though this was not truly distinct, and several plots showed overlap (Figure 13). A two-axis solution was recommended with a mean stress value of randomized data = 24.30 ($p = 0.02$). Five species arose as biplot vectors at $R^2 \geq 0.35$. These species (in order of vector length) driving placement along axis one were *Andropogon glomeratus*, *Sabal palmetto*, *Thelypteris kunthii*, *Tillandsia setacea*, and *T. paucifolia*. *A. glomeratus* and *T. kunthii*. Both *Tillandsia* species drove grouping along axis two. *S. palmetto* drove placement along both axes toward the top right corner of the plot. Placement of non-occupied plots tended toward the right side of the plot while occupied plots tended to group toward the center. Plots 9 and 12 broke this pattern for both groups.

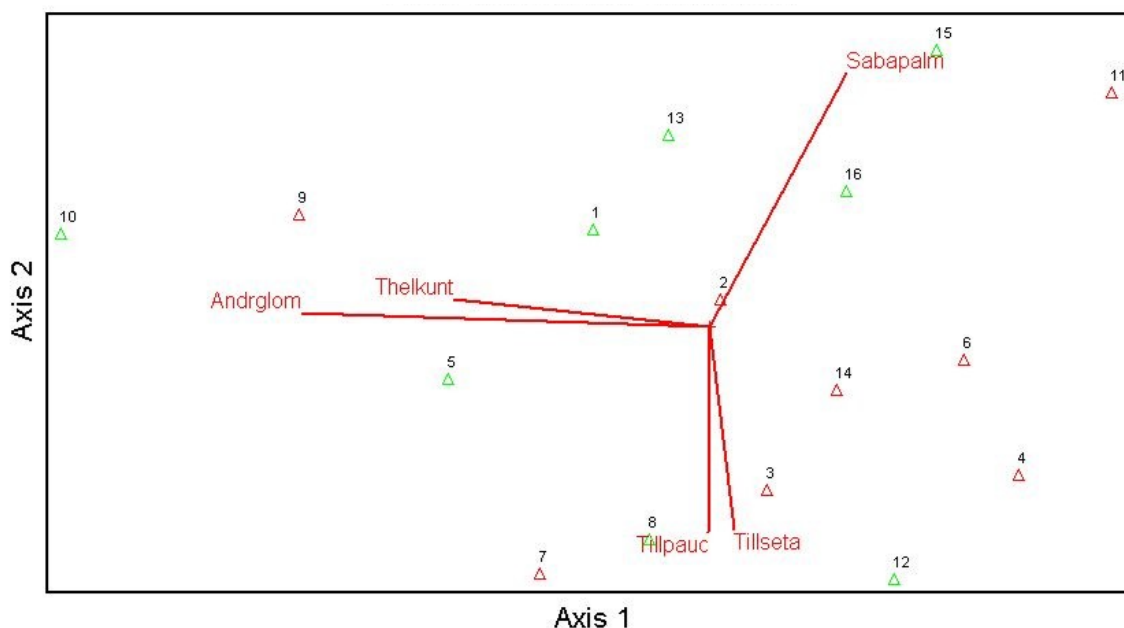


Figure 13. NMS ordination results (2D) with grouping by plots occupied (green) vs unoccupied (red) by cigar orchid. Biplot vectors display at R^2 values ≥ 0.35 . Eight-letter species codes: Andrglom = *Andropogon glomeratus*, Thelkunt = *Thelypteris kunthii*, Sabapalm = *Sabal palmetto*, Till pauc = *Tillandsia paucifolia*, Tillseta = *Tillandsia setacea*.

Overall MRPP and pairwise comparisons showed a marginally non-significant difference in species composition between plots with and without cigar orchid (overall $T = -1.46$, $p = 0.08$, chance-corrected within-group agreement $A = 0.02$). This level of grouping however is not supported by cluster analysis, where even the earliest branching did not separate groups.

The Indicator Species Analysis showed no significant indicators for either group, although *Tillandsia usneoides* was a marginally non-significant indicator for the cigar orchid group with an indicator value ($IV = 62.9$ $p = 0.06$).

Discussion

Demography and microhabitat

Current cigar orchid population status

Though not exhaustive, searches conducted in this study covered extensive and representative cigar orchid habitats in BICY and yielded a good baseline on the population status of cigar orchids in the Preserve. Several indications point to the limitation of recruitment, which include the fact that more than half of the cigar orchids found were of adult size, seedlings were rare, and no fruit or signs of fruit were observed during the surveys. All these findings point to a population that heavily relies on adult plant survival for existence and is highly vulnerable to poaching and environmental threats, along with disease. This is similar to what was observed for another large-sized rare orchid in southern Florida, the mule ear orchid (*Trichocentrum undulatum*; Borrero et al. 2023).

The phenomenon of scarcity in fruiting has also been observed in the neighboring Fakahatchee Strand State Preserve (personal observations). In the Everglades National Park, episodic fruiting events (many fruits in one year but only once in a while) can be observed (unpublished data). The difference in fruiting frequency and intensity may be attributed to difference in pollinator availability. The specialized and efficient pollinator of the cigar orchid, the oil bee (*Centris errans*) can be found in the southeastern Florida where Everglades National Park is located, but does not occur in southwestern Florida where the Big Cypress National Preserve and the Fakahatchee Strand State Park located (Pemberton and Liu 2008). Cigar orchids in the Big Cypress National Preserve and the Fakahatchee Strand are likely pollinated by non-specialist pollinators, such as the carpenter bees, on rare occasions.

Cigar orchid microhabitat

Cigar orchids seemed to prefer an eastern orientation and sat low (< 1.5 m height) on the host tree. This combination may reflect the orchids' need for certain light and humidity conditions or may simply reflect the predominant southeasterly winds in South Florida which would lead wind-dispersed seeds naturally toward this orientation. Height above ground has been negatively correlated with humidity in the swamp environment but positively correlated with light exposure (Liu, unpublished data). An easterly facing plant may receive morning light before the daily ambient temperature reaches its highest point in the afternoon, while a westerly facing plant receives sunlight in the afternoon hours when the daily temperature is at its highest. The latter may be a stressful condition, especially for a young plant.

Presence of Boisduval scale insect herbivory

We did not notice any disease during our initial survey but did record the presence of the Boisduval scale insect on cigar orchids during a follow-up survey at select sites. The Boisduval scale insect can be a serious pest for orchids in horticultural settings and were found to be present on several wild orchids in the Florida Panther National Wildlife Refuge. (Zettler et al. 2012). The scale insect is capable of killing adult plants of the highly endangered mule ear orchid (*Trichocentrum undulatum*) when infestation level is high (Borrero et al. 2023). We did not observe any Boisduval scales on cigar orchids during our first round of cigar orchid surveys, but did find 37.5% of the cigar orchids

harbored the scale, all at a ‘low’ level, with no visible impact observed during a second round of plot assessments. This discrepancy is likely due to the fact that the infestation on cigar orchids at BICY is very low and therefore difficult to detect. In contrast, we found heavier infestation of the scale insect on orchids in Everglades National Park, such as on the mule ear orchids and the butterfly orchids (*Encyclia tampensis*) (unpublished data). Overall impact of scale insect herbivory on wild orchids is poorly known. It is recommended to have an in-depth study to understand systematically the impact of this scale insect herbivory on cigar orchids and other wild orchid species in the region.

Habitat

We found that the majority (88%) of the cigar orchid individuals were found in three primary habitats: Cypress Forest-Dome, Cypress Forest-Monotypic, and Cypress Forest-Strands. The same habitat type occurrence structure was also observed for the super adults (89%). For a more detailed description of the vegetation classes or habitats see Ruiz et al., (2020) and Whelan et al. (2020).

Both field observations and habitat mapping indicated that cigar orchid individuals were found on the outskirts (i.e., inside perimeter) of Cypress Forest-Domes instead of the centers where the water is deepest (Figure 14). The observation that cigar orchids do not occur in locations with the deepest water is consistent with that found in the neighboring Fakahatchee Strand State Preserve, where only 3 of the total 24 naturally occurring cigar orchids are located in the Central Slough, where the water is the deepest (unpublished data). Additionally, within the domes, canopy density tends to decrease towards the edges (keeping in mind that some large domes might have low canopy density in the middle), which may suggest some relationship with light availability. A further assessment of the location of these individuals within the strand revealed that their location was in areas with moderate canopy density. We found that about 88% of the cigar orchids were found in habitats with some canopy protection, but not too dark like the center of a dome or strand nor too bright like marshes or prairies. Future studies of cigar orchid habitat should consider measuring canopy openness or light availability in the field.

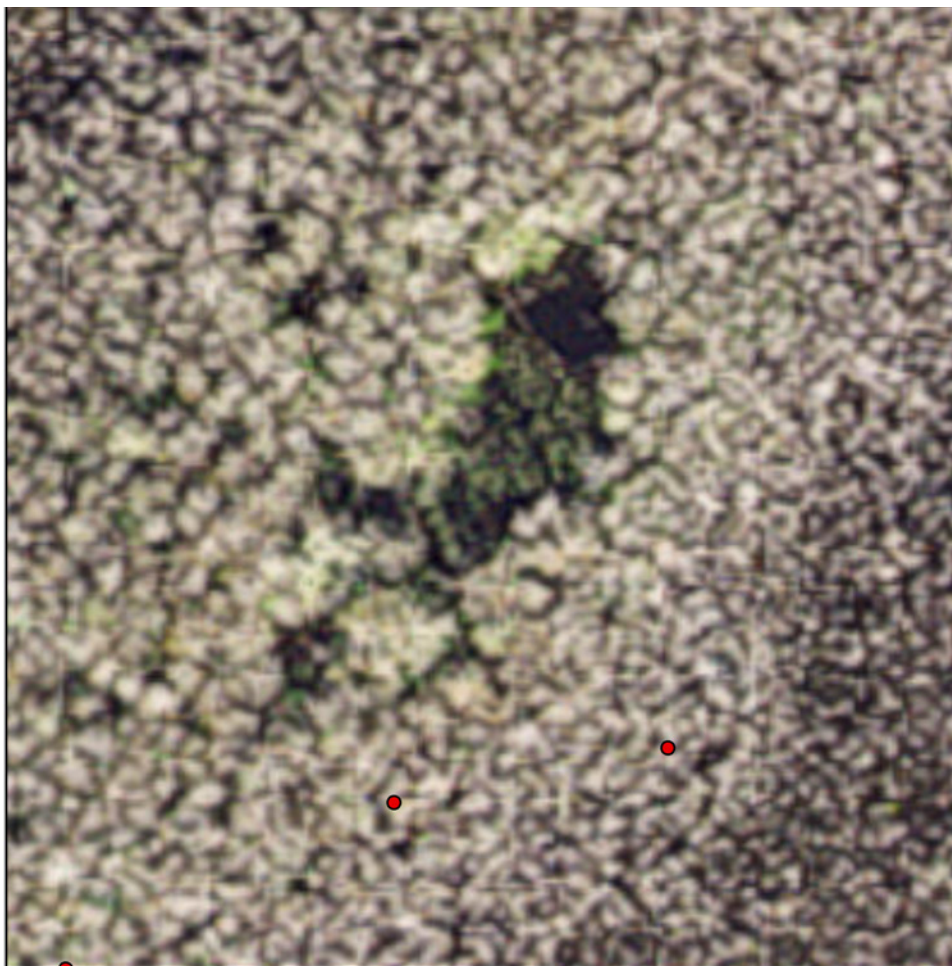


Figure 14. Example of cigar orchid individuals (red dots) within a cypress dome.

Impacts of fire and invasive species

Very little information is available on the impact of fire on epiphytic orchids in general. This study was not designed to understand the impact of fire on populations of cigar orchids and the analysis on fire and cigar orchid occurrence should be considered preliminary. We found a negative trend between fire frequency and the number of cigar orchids, possibly due to mortality caused by fire, and no correlation between years since the last fire and the number of cigar orchids. In addition, the prevalence of *Tillandsia* spp., particularly *T. usneoides*, in cigar orchid occupied plots also suggests that fire is infrequent in areas that support cigar orchid based on their sensitivity to fire. However, the relationship between fire and cigar orchid occurrence may be nuanced. While fire may have directly caused mortality to orchids, as suggested by a few of our observations, it may also promote seedling germination, as the few seedlings that we observed were found on trees that experienced fire recently. Experiments to understand whether fire and post-fire environments may limit or promote cigar orchid may be needed.

We observed during our surveys that the invasive orchid *Eulophia graminea* (Chinese crown orchid) may occupy similar niches as the cigar orchid, i.e., growing on the lower part of the cypress trees

(Figure 15), and seems to be abundant in recently burn sites. It is desirable to manage the occurrence of this invasive orchid by launching field campaigns to pull them out whenever possible.



Figure 15. A small individual of *Eulophia graminea*, an invasive orchid growing on a bald cypress tree at the Big Cypress National Preserve.

Community

Cypress trees that hosted cigar orchids had larger DBH on average than non-host trees, and plots occupied by cigar orchids hosted more diverse epiphytes than those that were not occupied. This data may indicate that cypress domes and strands with larger and older trees are better habitats for cigar orchids and other orchid species. This is reinforced by our findings that occupied plots had a notably higher relative frequency and mean abundance of ETs, which tended to be found on larger trees that boast prominent buttresses which provide horizontal space and accumulate organic matter, allowing for the support of these species. The most common associated ET epiphytes were *Psilotum nudum*, *Boehmeria cylindrica*, and *Nephrolepis exaltata*. These data may indicate that these species prefer the same microhabitat as cigar orchids. However, it is not known whether these species facilitate or compete with the establishment of cigar orchids.

Conclusion

An analysis of the cigar orchid populations in southern Florida (Liu and Borrero, unpublished data) suggest that the Big Cypress National Preserve (BICY) may be the most important habitat for the species, hosting the largest number of cigar orchids in southern Florida. In addition, preliminary population modeling (not presented here) indicated that the BICY cigar orchid population is relatively stable for the time being. Additional work to test these hypotheses is needed. We suggest that BICY management continue to monitor the populations and conduct surveys similar to this one once every five years, or sooner if impacted by a major disturbance such as a major hurricane or high-intensity fire. There are a few known cigar orchid hotspots within BICY with large clusters of cigar orchids, i.e., Oasis South (event ID = T3-OS), Fire Prairie Trail (event ID = T8-FP), Skillet Strand (event ID = T10-SS), and Nobles Grade (event ID = T20-NG). It should be noted that only a small fraction of cypress habitat was surveyed in this study and further efforts should be made to survey other areas of the Preserve.

Even though the Boisduval scale insect did not appear to be a serious concern for cigar orchids in Big Cypress, future population monitoring should evaluate for the presence of the Boisduval scale insect. If the scale insect is observed to reach threatening levels, intervention should be considered. The wetting agent, Silwet® L-77 with added horticultural petroleum oil has been shown to be effective at removing Boisduval scale in cultivation with no phytotoxicity observed, and seemingly causing no harm to natural enemies of the scale (Cating et al. 2010).

In the case of a population decline, in-situ hand pollination to boost fruit production in cigar orchid hotspots mentioned above may be considered as an effective approach to increase the population. This method was used in Fakahatchee Strand State Preserve two times on cigar orchids, with seedling regeneration observed. However, the number of seedlings observed at the artificial seed dispersal sites was very small (~5 seedlings), and they perished later during a high-water event (unpublished data). Successful orchid restoration cases are limited and expensive, but hand pollination may be an option to boost individual recruitment. In the case of the cigar orchid, selecting sites with a sufficient number of large-sized cypress trees (measured by DBH) and presence of other orchids is recommended to implement this augmentation approach.

It is very important to prevent poaching as much as possible, since adult survival is essential in maintaining population stability. We also encourage pulling the invasive orchid *Eulophia graminea* opportunistically. Perhaps in the cigar orchid hotspots the management can arrange some periodic inspections to ensure the invasive orchid does not become a prominent issue.

Literature Cited

- Borrero, H., Oviedo-Prieto, R., Alvarez, J., Ticktin, T., Cisneros, M. and H. Liu. 2023. Populations of a tropical epiphytic orchid are destabilized in its peripheral range by hurricane and an exotic herbivore. *Ecosphere*. DOI: 10.1002/ecs2.4355.
- Bechtel, H., Cribb, P. and E. Launert. 1992. *The Manual of Cultivated Orchid Species*: 3rd Edition. The MIT Press, Cambridge, MA, USA.
- Cating, R. A., Hoy, M. A., and A. J. Palmateer. 2010. Silwet L-77 improves the efficacy of horticultural oils for control of Boisduval scale *Diaspis boisduvalii* (Hemiptera: Diaspididae) and the flat mite *Tenuipalpus pacificus* (Arachnida: Acari: Tenuipalpidae) on orchids. *Florida Entomol.* 93: 100–106.
- Downing, J. L., Liu, H., McCormick, M., Arce, J., Alonso, D., and J. Lopez. 2020. Generalized mycorrhizal interactions and fungal enemy-release drive range expansion of orchids. *Ecosphere* 11(8). Article e03228. <https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1002/ecs2.3228>
- Florida Administrative Code. Plants in the Preservation of Native Flora of Florida Act. Chapter 5B-40. 1998, amended.
- Gann G. D., Trotta L. B., and Others. 2001–2023. Floristic Inventory of South Florida Database Online. The Institute for Regional Conservation. Delray Beach, Florida.
- Liu H. and H. Borrero. Effects of reintroduction efforts on population dynamics of cigar orchid (*Cyrtopodium punctatum*) in southern Florida. In progress.
- Luer, C. A. 1972. *The Native Orchids of Florida*. Botanical Garden, New York, New York, USA.
- Moloney, K. A. 1986. A generalized algorithm for determining category size. *Oecologia* 69:176–180.
- Pemberton, R. W., and H. Liu. 2008. Potential of invasive and native solitary specialist bee pollinators to help restore the rare cowhorn orchid (*Cyrtopodium punctatum*) in Florida. *Biological Conservation* 141: 1758–1764.
<https://irma.nps.gov/DataStore/Reference/Profile/2244641>
- Ruiz P. L., Prats M. C., Perry C. P., Garcia A. A., Foguer M. A., Ingram J., Shamblin R. B., Guichardot M., and K. R. Whelan. 2020. The Everglades National Park and Big Cypress National Preserve Vegetation Mapping Project: Geodatabase—Southwest Coastal Everglades (Region 3), Everglades National Park. National Park Service. Fort Collins, Colorado.
<https://irma.nps.gov/DataStore/Reference/Profile/2256787>
- Silvertown, J., and J. Lovett Doust. 1993. *Introduction to plant population biology*. Blackwell Science, Oxford, UK.

- Whelan K. R., Prats M., and A. J. Atkinson. 2020. Western Big Cypress National Preserve Vegetation Map (Geodatabase and supporting documentation, Code: 2278515)
<https://irma.nps.gov/DataStore/Reference/Profile/2278515>
- Zettler, J. A., Zettler, L. W., and L. W. Richardson. 2012. Pestiferous Scale Insects on Native Epiphytic Orchids in South Florida: A New Threat Posed by Introduced Species. *Southeastern Naturalist* 11: 127–34.

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