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Vertical Stratification of Epiphytic Orchids in a South Florida Swamp Forest

Ruben P. Sauleda

22585 S. W. 187 Avenue, Miami, Fl 33170

Introduction

In a forest the average illumination, temperature, humidity, and air circulation tends to vary from ground level to the highest tree story (Richards, 1964). Spatial heterozygosity caused principally by these four factors results in the evolution of special microhabitats (Pianka, 1966), which may be filled by especially adaptive epiphytic organisms. As these microhabitats are filled by the migration or evolution of adaptive individuals, a vertical stratification of species occurs.

The effects of animals can further influence vertical stratification. Grazing would exclude some epiphytic species from lower levels. The level preference of pollinators will restrict the vertical distribution of the epiphytic species they pollinate.

The level preference of symbiotic fungi necessary for the germination of most orchid seeds may limit the vertical distribution of the epiphytic orchids.

This paper will document and compare three levels of vertical stratification of epiphytic orchids observed in a South Florida swamp forest.

Materials and Methods

A swamp forest located in the Fahkahatchee Strand of the Big Cypress area in Collier county, Florida, was chosen as the study site. An area approximately 300 feet by 300 feet located on the north east corner of a large pond was surveyed for the study. A count was made of trees supporting epiphytes and the species and number of trees recorded. The number of epiphytic orchids and their habitation level were recorded. The first habitation level was chosen as 0-4 feet, the second level was between 4-9 feet and the third level was above 9 feet.

The light intensity was measured at the mid-point of each level for the first two levels and at twelve feet for the third level using a G. E. light meter.

The temperature was measured three times daily at 900, 1200 and 1400 hours. The average difference between the temperatures at the three levels was recorded. The light and temperature observations were made during a three-day period in the month of December and the results reflect the conditions, which prevailed during that time of the year.

The concentration of dominance in one or more species at each level was calculated using the Simpson index of dominance formula (Odum, 1971).

The species diversity for each level was calculated using the Shannon index of general diversity formula (MacArthur, 1965).

Results and Discussion

Thirty trees supporting epiphytes were counted in the area surveyed. The majority of the epiphytes were on twenty-one trees of *Fraxinus caroliniana* Mill. (pop ash) and six trees of *Annona glabra* L. (pond apple). None of the epiphytic orchid, species observed demonstrated any host preference. One tree of *Taxodium distichum* (L.) Rich. (bald cypress) hosting two plants of *Encyclia tampensis* (Lindl.) Small and two *Acer rubrum* L. (maple) without orchid epiphytes were also observed.

Light intensity measurements revealed a 25-40% reduction in light intensity at the 4-9 feet level and 45-70% reduction at the 0-4 feet level from the light intensity recorded above the 9 feet level.

The temperature was 1°F higher at the 4-9 feet level and 4°F higher above 9 feet than recorded at the 0-4 feet level.

A total of 734 epiphytic orchids were counted (Table 1). Level one had 84, level two had 401, and level 3 had 219. The most abundant orchid species were *Epidendrum rigidum* Jacq. and *Epidendrum floridense* Hagsater respectively.

The orchid species displayed definite level preference. *E. tampensis* (Lindl.) Small and *E. rigidum* demonstrated a strong preference for the upper level. *E. tampensis* is pollinated by a series of bees usually associated with the upper level of the tree canopy, accounting for its preference for the upper level. *E. rigidum* is autogamous, therefore not pollinator dependent. The leaves form a sharp angle with the stem causing a reduction in the amount of light striking the leaves, permitting *E. rigidum* to inhabit the upper level where less interspecific competition exists.

Epidendrum anceps Jacq., *E. floridense* and *Dendrophylax lindenii* (Lindl.) Benth. ex. Rolfe are moth pollinated and showed a preference for the middle level where most moths are usually found.

Anacheilium cochleatum var. *triandrum* (Ames) Sauleda, Wunderlin & Hansen and *Epidendrum nocturnum* Jacq. both autogamous, were found at all three levels, but exhibited a preference for the middle level. This preference may be in part due to the presence of a greater concentration of symbiotic fungi at the middle level that aid with the germination of orchid seeds.

Liparis elata Lindl. and *Bletia purpurea* Ruiz & Pav. were found only at the lowest level growing semi-terrestrially around the base of trees and stumps where large amounts of organic material had gathered and decayed. The level preference appeared to be due to a preference for decayed organic material, since both species are autogamous, therefore not pollinator dependent.

Campylocentrum pachyrrhizum (Rchb. f.) Rolfe, *Pleurothallis gelida* Lindl., and *Epidendrum strobiliferum* Rchb. f. were found mainly at the middle level and *Ionopsis utricularioides* (Sw.) Lindl. was found equally distributed between the middle and upper levels. The relatively few numbers of individuals found of these four species coupled with the lack of knowledge concerning their pollination mechanism prevents any conclusions on their level preference.

Comparison of the percent similarity values calculated, indicated greater similarity exists between level 1 and 2 (72%) than between level 1 and 3 (34%). Less difference in temperature and light intensity between levels 1 and 2 than between 1 and 3 may account for the difference in species composition.

Comparison of the concentration of dominance values calculated shows level 3 (.28) has a greater concentration of dominance than level 1 (.16) or 2 (.17). The greater numbers of individuals of *E. rigidum* and *E. tampensis* at level 3 accounts for the concentration of dominance observed. Although 8 species were found at level 3; 2 species (*E. rigidum* and *E. tampensis*) accounted for 65% of the total individuals.

The Shannon index was calculated for each level to illustrate the species diversity of each level. As the H_S increases the randomness increases and greater uncertainty exists as to what species an individual picked at random will belong to. The greatest diversity is attained when all the species are equally abundant. The three levels are similar in species diversity; but level 3 (1.6) has less species diversity than level 1 (1.9) or 2 (1.9).

Conclusions

The special heterozygocity found in the swamp forest results in microhabitats that are filled by specially adaptive epiphytic species. A stratification results, which is not only maintained by light intensity, temperature, humidity, and air circulation but by other selective pressures.

Competition for nutrients, light, and growing space contributes to the natural selection of organisms with specially adaptive structures. *E. rigidum* has leaves at sharp angles to the stem reducing the amount of light striking the leaves, allowing survival at a level with higher light intensity. *D. lindenii* and *C. pachyrrhizum* are leafless requiring reduced space and light intensity. Both species produce a small leaf after germination that is lost after approximately one years growth. All metabolic processes are then carried out in specialized root cells. These adaptations allow the organisms to survive at a level where the competition is reduced or gives the organism a competitive edge at a highly competitive level.

Another important factor influencing stratification is the level preference of pollinators. Bee pollinated species are usually restricted to the upper portions of the tree canopy; while moth pollinated species are usually found within the tree canopy.

The presence of large concentrations of symbiotic fungi at the middle level that aid the germination of orchid seed may also account for the larger numbers of orchids at that level.

Temperature, humidity, light intensity, interspecific competition, and the location of pollinators and symbiotic fungi appear to be contributing factors to the stratification of epiphytic orchids.

Table 1

Distribution of Orchid Species

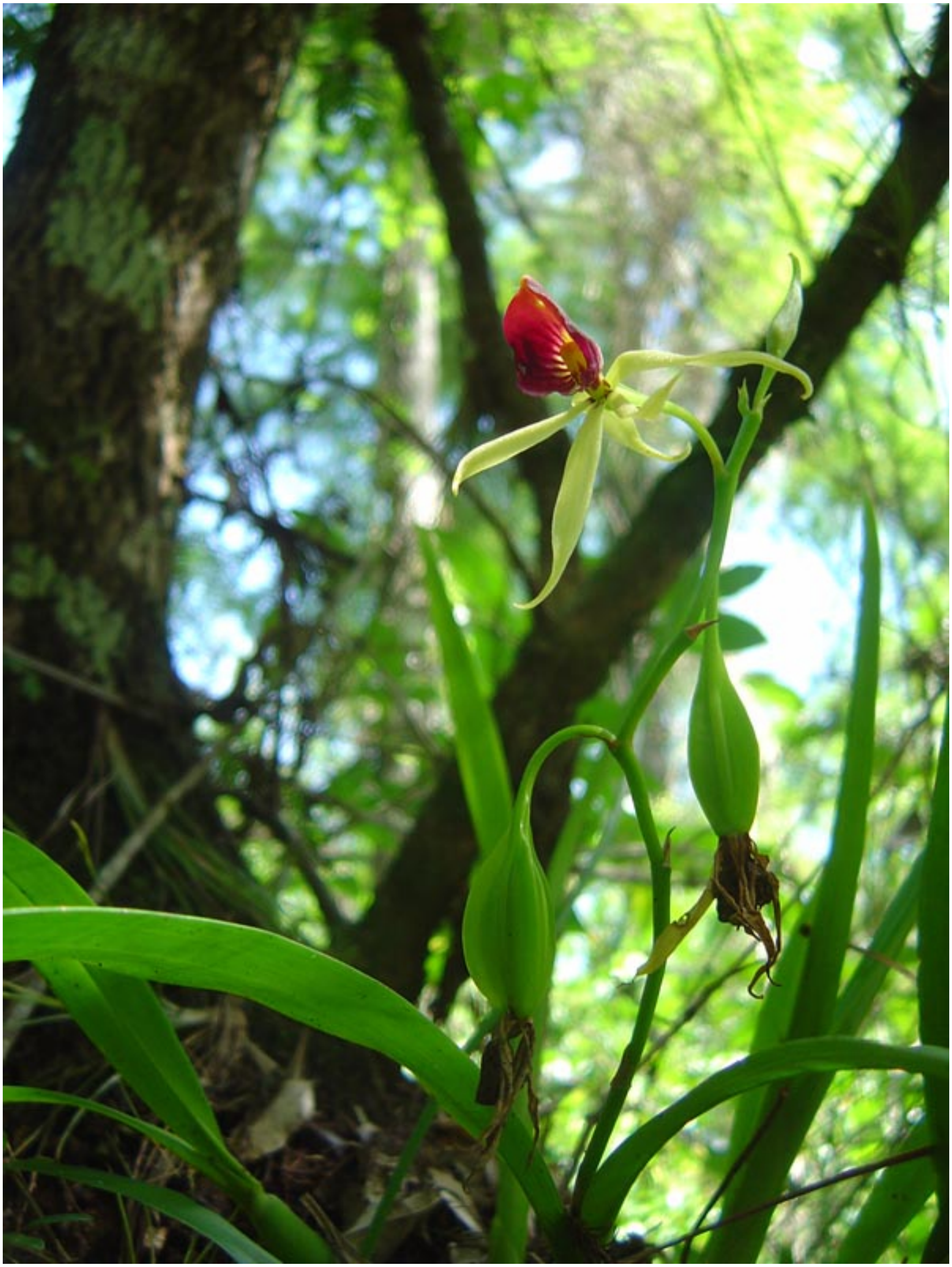
Species	Level 1	%	Level 2	%	Level 3	%	Totals	%
Liparis elata Lindl.	6	100 %	0		0		6	0.8
Pleurothallis gelida Lindl.	0		4	100 %	0		4	0.5
Encyclia tampensis (Lindl.) Small	0		20	30 %	47	70 %	67	9.1
Anacheilium cochleatum var. triandrum (Ames) S	4	14 %	18	62 %	7	24 %	29	4
Epidendrum anceps Jacq.	12	14 %	51	61 %	21	25 %	84	11.4
Epidendrum floridense Hagsater	21	12 %	121	71 %	27	17 %	169	23
Epidendrum nocturnum Jacq.	6	12 %	29	58 %	15	30 %	50	7
Epidendrum rigidum Jacq.	0		60	35 %	115	65 %	175	23.8
Epidendrum strobiliferum Rchb. f.	0		4	100 %	0		4	0.5
Bletia purpurata (Lam.) de Candolle	12	100 %					12	1.6
Ionopsis utricularioides (Sw.) Lindl.	0		2	50 %	2	50 %	4	0.5
Campyloentrum pachyrrhizum (Rchb. f.) Rolfe	8	28 %	21	72 %	0		29	4
Dendrophylax lindenii (Lindl.) Benth. ex Rolfe	15	15 %	71	70 %	15	15 %	101	13.8
Totals	84		401		249		734	

Dendrophylax lindenii (Lindl.) Benth. ex. Rolfe

E. tampensis (Lindl.) Small

Ionopsis utricularioides (Sw.) Lindl.

Epidendrum anceps Jacq.



Anacheilium cochleatum var. *triandrum* (Ames) Sauleda, Wunderlin & Hansen

Epidendrum nocturnum Jacq.

Epidendrum rigidum Jacq.

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