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Cover photographs. Front: *Billbergia pyramidalis* (Sims) Lindley var. *pyramidalis*. First described in 1827; perhaps the third most-written-about bromeliad, inflorescence seemingly incandescent. Photo by T.U. Lineham. Back: *Tillandsia oaxacana*. Photo by Renate Ehlers.

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Racine Foster

Glenna Sherman Simmons

The part that Racine Foster played in Mulford Foster's work on bromeliads since 1935 when they were married can never be fully known. Few wives have shared so completely in their husband's careers. Some clues are given by looking at a list of bromeliad species and hybrids. Again and again one encounters the Latinised form of the rather unusual name of Racine. She earned that recognition fully from sharing with Mulford the numerous trips to the tropical rain forests, jungles, mountains, and deserts of Latin America. This work added over two hundred new species and varieties. Not only did she go on field trips but she did much of the work of organizing and reporting the findings.

The book, *Brazil, Orchid of the Tropics*, long out of print, written by Racine and Mulford tells of collecting trips to Brazil. It is hoped that the book will some day be republished, but that is uncertain. As those who have read it know, it is mostly about bromeliads, not about orchids. It tells of going into Brazil's back country regions over primitive roads and staying at lodgings that belie the name. Occasionally conditions were better but each night after a field trip Racine worked up her field notes, prepared live plants, and made herbarium specimens to send to Lyman Smith at the Smithsonian Institution while Mulford captured in oils and water colors the rare treasures they found. There were many other collecting trips to Mexico and other Latin American countries but Brazil was the focal point.

Racine played a big part in launching the international Bromeliad Society and was co-editor of the six-copies-a-year *Bulletin* for the first seven years without much recognition, although she wrote many articles over her name. Then the eighth year her name appears on the masthead as editor. Then a new editor was found the following year to give her respite.

After bearing the burden of Mulford's care during his long disability she has continued to prepare for publication the mass of his unpublished work and has organized the great number of his paintings for exhibits at bromeliad shows and at other places, and for a possible book.

Racine can tell of Mulford Foster's part in introducing from his travels such finds as *Tabebuia umbellata*, which brightens the scene in Orlando every March. She also has written of his many hybrids.

The Foster's huge garden, Bromel-La, with its acres of bromeliads, its greenhouses, and its modern home designed by Mulford, Racine has been unable to maintain. The hope that it would become a permanent garden open to bromeliad enthusiasts could not be realized and it was sold. But she has established a new home on Foster Lane nearby where she has transferred many choice specimens from Bromel-La where they are flourishing.

Fig. 1
Racine Foster

Members of the Bromeliad Society of Central Florida in Orlando and the Seminole Bromeliad Society in Sanford see Racine at meetings where she is a faithful member. In official capacity she is remembered for having put the library of the former on a workmanlike basis. Her presence is welcomed by all for her inexhaustible store of knowledge of the species and for her friendliness and ready smile.

She carries on a tremendous correspondence with bromeliad growers all over the world. Racine's breadth of interest is reflected in her hobby of collecting objects whose design embodies bromeliads, especially pineapples.

We congratulate her on her eightieth birthday and know that her interest in bromeliads will continue unabated.

Mount Dora, Florida

A Star Was Born

Herb Plever

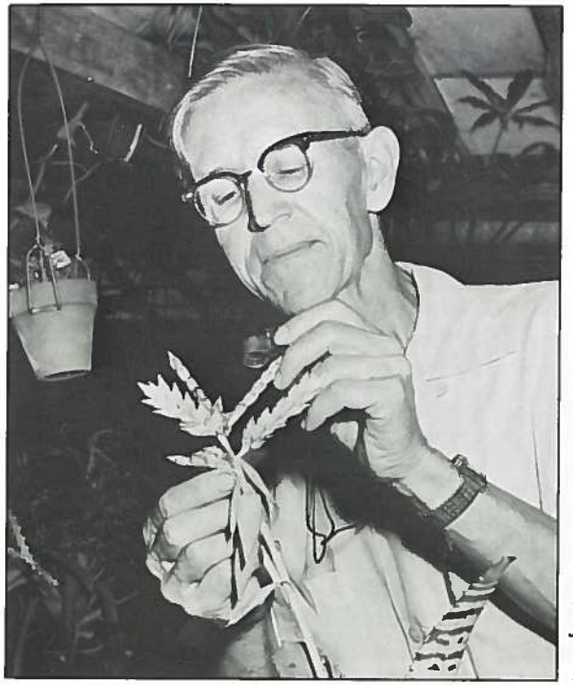
On Wednesday, December 28th, I was watering my bromels and I stopped to observe and admire three *Aechmea* hybrids growing side by side on capillary mats in a south window. They are all about 15 months old, about 15″ tall, close to maturity and similar in shape, being basically upright, tubular plants. Only the lowest leaves pend or diverge, or are slightly divergent near the top. They all have brown or purple-brown markings, and in fact they are related in that they owe their existence to the "Father of Bromeliads," the late Mulford B. Foster. The plants are: *Aechmea* Bert *(A. orlandiana* × *A. fosteriana),* ×*Canmea* Majo *(Canistrum fosterianum* × *A. fosteriana)* and ×*Canmea* Galaxy *(Canistrum fosterianum* × *Aechmea fasciata).*

Thinking about this relationship led me to reread the biographical material we had published about the great naturalist, collector, explorer, hybridizer, editor, horticulturist, taxonomist, artist, writer (you name it, he did it) on the occasion of his death on August 28, 1978. I was simply amazed to discover that Mulford was born 100 years ago on December 25, 1888. It is true one can hardly do anything with bromeliads that doesn't bring Mulford Foster to mind, but this strong coincidence impelled me to write this article.

Mulford began his many explorations and bromel collecting in Central and South America in 1934. In 1939, he discovered *Aechmea fosteriana* in the Brazilian state of Espírito Santo. *A. fosteriana* is a tall, tubular plant with upright or slightly divergent leaf blades 3–4 inches wide. The leaves are strongly marked with brown-purple spots forming somewhat uniform chevron bars, and the leaf tips have a large, dark purple blotch at the apex. *A. fosteriana* reaches 2 feet or more without its inflorescence, which rises on a tall scape and is branched, paniculate, and laxly tripinnate with dark red scape bracts and primary bracts. The floral bracts are red and the flowers are a pale orange.

Canistrum fosterianum was found by Mulford in Salvador, state of Bahia, Brazil in 1948. It is a tubular plant varying in height from 15–18 inches (and sometimes taller). Its leaves are densely covered with a thick, appressed lepidote coat of trichome scales that give them a gray-green color masking some dark brown spotting below. The floral-shaped, pretty inflorescence barely exceeds the tops of the leaves. It is a simple corymb with red bracts and yellow flowers in the center.

Aechmea Bert is one of the many great crosses made by Mulford Foster and it was named for his son. Like most of Mulford's hybrids, it is an improvement over its parents. It is smaller and its leaves are even more strongly marked than *A. fosteriana.* The brown-purple markings form evenly uniform chevrons and in



Orlando Sentinel-Star

Fig. 2
Mulford B. Foster

good light the leaves turn golden bronze, which dramatically sets off the stripes. *A.* Bert has also retained *A. fosteriana's* purple blotch at the leaf tips. While its inflorescence is not as large as *A. fosteriana's,* the floral head is much more colorfully red and yellow. Moreover, it is not much taller than its other parent, *A. orlandiana,* but its inflorescence is much larger and it rises on a taller scape.

×*Canmea* Majo is a hybrid by Ed Hummel which also is a improvement over its parents. It is smaller than *A. fosteriana,* reaching about 15–18 inches in height. In good light its leaves develop strong purple-brown, vaguely barred markings on a bronze background. Its beautiful inflorescence is similar to that of *Canistrum fosterianum,* a red, floral-shaped corymb, but is compound and larger with flowers emerging from all of the bright red primary bracts. Moreover, the scape of ×*Canmea* Majo is taller and it rises several inches above the tops of the leaves.

×*Canmea* Galaxy is a nice cross by Harvey Bullis. It is a midway compromise in size and shape between its parents. Its inflorescence favors the shape of *C. fosterianum,* but it is compound instead of simple. Its bright red bracts stay in color for 5–6 months. However, its characters may not have been cleaned up, or perhaps it reacts strongly to changes in light levels, as the plant is still highly variable. When I first saw a specimen a number of years ago its leaves were almost black with a little green showing. But when I bought a near mature specimen while visiting the Bullis Nursery, all of the Galaxies there had divergent green leaves with barely visible brown markings. (Bullis's lath house may have been over-shaded.) The plant now growing in my south window with presumably less light than in Florida is an offspring of the one I bought. Yet, the plant is more tubular-compact and the top half of each leaf is dark brown from irregular barring in brown blotches and only the bottom quarter is gray-green without markings.

These three beautiful hybrids growing side by side are taking up a total window space of a mere twenty inches. Thanks to Mulford B. Foster, the bromel

[continued on page 80]

Bromeliads in Space

Odean Head

The NINTH WORLD BROMELIAD CONFERENCE time is fast approaching: the dates—June 6–10; the place—the Wyndham Greenspoint in Houston, Texas.

We are very pleased with the number of registrations thus far and the tone is being set for a really great conference. You won't want to miss this one so if you have not registered already you should do so right away.

"Bromeliads in Space" is an appropriate theme for our show since many bromeliads are epiphytic and Houston is the home of the Johnson Space Center. Arrangements have been made for an optional tour of the space center and there will be other information available on the space program.

In addition to our goal of having great plants and a spectacular show, we will place major emphasis on hospitality. Beginning with the "Countdown Party" on Thursday evening and continuing with the "Blast-off Spectacular" on Friday evening, there will be "Tranquillity in Orbit" on Saturday evening before the "Set-down" banquet. These socials are being planned to provide fun and good fellowship.

The World Wide Show and Tell is another activity planned for good fellowship and the opportunity to learn more about growing conditions around the world as well as varied interests relating to our hobby. You will remember that we invited you to bring slides of your own special plants or noteworthy collections of growers in your area. With 10–15 slides from each participant we should have a wide spectrum of information. We want this program to concentrate on what our members have accomplished. Slides taken on collecting trips must be held back for another place and another time. If you have a problem with limiting the number to 15, bring more. We will not know how many participants we have until you get here.

We will have slide presentations, speeches and various demonstrations lined up for our seminars, which will provide both entertainment and useful information. Dr. David Benzing will be our principal speaker.

There will be only two gardens on tour during the conference because of the travel time required to others. The quality of Mollie Sheffield's and Don and Betty Garrison's gardens will more than make up for quantity. Other quality gardens will be on tour after the conference and you are encouraged to stay over to visit them. There will be slides and information available on all of the post-conference garden tours.

Registrations should be mailed to Betty Head, 7818 Braes Meadow, Houston, TX 77071, telephone (713) 774-7778: $100 through April 30; $125 thereafter. Hotel reservations should be made directly with Wyndham Greenspoint, 12400 Greenspoint Drive, Houston, TX 77060, telephone (713) 875-2222, United States only, (800) 822-4200.

Tentative Schedule of Events

Wednesday, June 6

9:00 a.m. -	Annual general meeting of the members of The Bromeliad Society, Inc. followed immediately by the annual BSI Board meeting.
1:00 p.m. - 8:00 p.m.	Exhibit set up, plant registration, guest registration.

Thursday, June 7

8:00 a.m. - 9:00 p.m.	Late plant registration (by advance arrangement).
8:00 a.m. - 6:00 p.m.	Guest registration.
8:30 a.m. - 2:30 p.m.	City tour.
9:00 a.m. - 4:00 p.m.	Judging.
6:00 p.m. - 8:00 p.m.	Show open to registrants; advance plant sales.
7:30 p.m. - 10:00 p.m.	Countdown Party.

Friday, June 8

8:00 a.m. - 9:00 a.m.	Show open to photographers.
8:00 a.m. - 6:00 p.m.	Plant sales.
8:30 a.m. - 3:00 p.m.	Johnson Space Center tour.
9:00 a.m. - 6:00 p.m.	Show open to the public.
9:30 a.m. - 2:00 p.m.	Garden tours.
10:00 a.m. - 5:00 p.m.	Raffle drawings (hourly).
11:00 a.m. - 12:00 noon	Slides and demonstrations.
1:00 p.m. - 2:00 p.m.	Worldwide Show and Tell.
2:00 p.m. - 5:00 p.m.	Seminars and slide presentations.
7:00 p.m. - 8:00 p.m.	Blast-off Spectacular.
8:00 p.m. -	Rare plant auction.

Saturday, June 9

8:00 a.m. - 5:00 p.m.	The schedule will be the same as for Friday.
7:00 p.m. - 8:00 p.m.	Tranquillity in Orbit.
8:00 p.m. - 11:00 p.m.	Touch-down banquet.

Sunday, June 10

8:00 a.m. - 9:00 p.m.	Show open to photographers.
8:00 a.m. - 4:00 p.m.	Plant sales.
9:00 a.m. - 3:00 p.m.	Show open to the public.
9:00 a.m. - 10:00 p.m.	Southwest Bromeliad Guild meeting.
10:00 a.m. - 12:00 noon	Raffle drawings (hourly).
12:00 noon	Show ends.

Monday, June 11

8:00 a.m. - 5:00 p.m.	Judges school.
9:00 a.m. -	Post-conference tours of local gardens.

Tuesday, June 12 through Thursday, June 14:
Post-conference garden tours outside the Houston area.

A New Species for an Old Friend: *Puya ramonii*

Lyman B. Smith

Ramón Ferreyra has been my very good friend ever since he came to the old Gray Herbarium at Harvard to study his native flora of Peru. He used to come to my home on weekends and play games with my family and friends. When returned to Peru he sent collections to us for identification and among these were specimens of *Puya*. *Puya* is difficult to collect since nearly all grow above tree line and require strong climbing to reach and then the plants are large and tough and protected by leaves with wicked thorns. Over the years Ramón has collected many new species and even now keeps on with one more.

***Puya ramonii* L.B. Smith, sp. nov.**
A *P. oxyantha* Mez, cui affinis, ramis subtriplo longioribus, dense florigeris, bracteis florigeris sepala subaequantibus, sepalis ellipticis vel ovatis, acutis differt.

Plant flowering at least 1.50–2.5 m high (! Ferreyra). *Leaves* over 6 dm long; sheaths unknown; blades narrowly triangular, 27 mm wide, minutely lepidote throughout, the basal half laxly retrorse-serrate with red 7-mm long spines. *Scape* unknown. *Inflorescence* compound; branches 6–8, ascending, densely flowered, to 4 dm long; primary bracts unknown. *Floral bracts* ovate, acuminate, about equaling the sepals, entire, soon glabrous, drying black; pedicels short, white-tomentose. *Sepals* elliptic (posterior) or ovate (anterior), acute, ca. 4 cm long, densely white-tomentose; petals dark green (! Ferreyra).

Peru. Lambayeque: Prov. Ferreñafe: jalca, pajonal (grassland), "tuyo," 3700–3800 m alt., 8.VII.1987, *Ramón Ferreyra 20910* (holotype US, isotype USM).

Smithsonian Institution, Washington, D.C.

Fig. 3 U.S. National Herbarium

Puya ramonii, a new species of relatively small size and not to be confused with the giant *Puya raimondii.*

Genetic Variation in Three Species of Florida *Tillandsia*

W. John Kress,[1] Harry E. Luther,[2] and Cheryl S. Roesel[1]

Advances in laboratory procedures in the last ten years have given taxonomists new methods for studying plant relationships. Enzyme electrophoresis, a tool commonly used by population geneticists and evolutionary ecologists, allows one to quantify genetic variation by directly observing the multiple forms of enzymes produced by individual plants. Plant systematists have used electrophoresis to obtain unique evidence for answering questions about the extent of genetic similarity within and between species, the nature of speciation events, and the inference of evolutionary relationships among taxa (e.g., Gottlieb, 1977; Crawford, 1983). For the most part these duties have centered on annual, or in some cases perennial, species of the temperate zone. Relatively few investigators have attempted to use enzyme electrophoresis to study the systematics of tropical plants (e.g., Hunziker & Schaal, 1983; Ashton et al., 1984; Sytsma & Schaal, 1985).

Electrophoresis is the electrically induced migration of particles through a supporting medium such as starch gel. Enzymes are particularly suitable for electrophoretic study because of their structural variability, specificity to a substrate and differences in net electrical charge. The various forms of an enzyme migrate to different positions on the gel depending upon differences in size, shape, and charge. Each enzyme acts upon a specific substance, the substrate, to catalyze a chemical reaction; those with the same substrate specificity but different electrophoretic mobilities are termed isozymes. The isozymes thus separated are visualized by submerging a slice of the supporting medium in a solution containing the substrate required by a particular enzyme and a dye that stains the products of the reaction that it catalyzes. Zones of enzyme activity typically appear as dark bands on a light background and represent the sites, or loci, at which different isozymes are genetically coded within a plant cell. Bands at a locus reflect the number of alleles, or alternative forms of a gene, present for that isozyme. The number and position of the bands allow the genetic makeup of an individual plant to be inferred for the enzyme examined. Thus, for any given enzyme one or more isozymes are produced, each slightly different physically but catalyzing the same chemical reaction and each represented by one or more alleles.

Only a single genus in the bromeliad family, *Tillandsia,* has been studied electrophoretically (Soltis et al., 1987). Their investigation demonstrated that two Mexican species differed in the degree of self- and cross-pollination (inbreeding

1. Dept. of Botany, NHB-166, Smithsonian Institution, Washington, D.C. 20560.
2. Marie Selby Botanical Gardens, 811 South Palm Ave., Sarasota, FL 34236.

and outcrossing, respectively) and in the frequency with which different alleles occurred: *T. ionantha* Planchon is an outcrossing species with little variation in allele frequencies among populations; *T. recurvata* (Linnaeus) L. is highly inbred with substantial genetic variation between populations. The authors concluded that "electrophoretic investigations of additional *Tillandsia* species, as well as of other epiphytic species, are clearly needed...."

Using isozyme electrophoresis we have recently completed a preliminary investigation of the genetic variation found in three species of *Tillandsia* native to Florida. As shown in the study of Mexican species cited above (Soltis et al, 1987), we wanted to see first if enzyme variation could be used to assess breeding systems (whether a plant is inbreeding or outcrossing) within populations of Florida species. Variation in the position and proximity of anthers and stigma in the flower among tillandsias suggests that levels of outcrossing may differ among species (Gardner, 1986; Soltis et al., 1987; Luther, unpubl.). In the flowers of *T. recurvata* and *T. usneoides* L. the sexual organs are close together within the corolla of the flower. In the former, both the anthers and stigma are held deeply in the corolla, which remains partially closed at anthesis, when the pollen is shed. In *T. usneoides,* the corolla lobes are spreading and open at anthesis exposing the anthers. In contrast, both the stamens and stigma are exserted at anthesis in the flowers of *T. utriculata* L. Based on these observations we predicted that inbreeding would be greater in *T. recurvata* than in either *T. utriculata* or *T. usneoides.* Data on fruit set of native tillandsias collected by one of us (H.E.L.) have shown that *T. utriculata* and *T. recurvata* set many fruits in proportion to the number of flowers produced *(T. utriculata:* $\bar{X} = 0.940$, $n = 11$ individuals; *T. recurvata:* $\bar{X} = 0.794$, $n = 30$) suggesting that these species are largely autogamous, or inbred, (Gardner, 1986). On the other hand *T. usneoides* is characterized by a very low fruit-to-flower ratio *(*$\bar{X} = 0.103$, $n = 5$) suggesting xenogamy, or outcrossing, in these plants. Data from isozyme studies on genetic variation within and between populations would provide another test of our predictions on breeding systems in these tillandsias.

Our second goal was to see if enzyme "fingerprints" could be used to distinguish species of *Tillandsia* and thus aid in their identification. Enzyme characters, compared to environmentally influenced physical features, more closely reflect the genotype or genetic makeup of the plant and so are particularly useful in unraveling the evolutionary relationships among species.

MATERIALS AND METHODS

In May 1988, 25 individual plants (presumably genetically distinct) for each of the three species, *Tillandsia recurvata, T. usneoides,* and *T. utriculata,* were collected from each of four central Florida populations for a total of 100 individuals per species (Table 1). Populations were separated by 30 miles or more, and a population sample was collected within a 100 m radius at each site. The plants were maintained outdoors at the Marie Selby Botanical Gardens, Sarasota, Florida, until required for electrophoresis.

Table 1. Collection data for populations of *Tillandsia usneoides, T. recurvata,* and *T. utriculata.* Voucher specimens deposited in the United States National Herbarium (US).

Species	Population	Locality
T. recurvata	RE1	Florida. Highlands County: Hwy 70, W of Arcadia, 6 mi E of Rt 27 junction, *Kress & Roesel 88-2472;* 25 plants from 15–20 shrubs and small trees.
	RE2	Florida. Okeechobee County: Hwy 441, 1 mi S of Ft. Drum, *Kress & Roesel 88-2476;* 25 plants from 15–20 shrubs and trees.
	RE3	Florida. Polk County: Hwy 60, 10 mi E of Lake Wales, *Kress & Roesel 88-2479;* 25 plants from 15–20 shrubs and small trees.
	RE4	Florida. Sarasota County: vicinity of the Marie Selby Botanical Gardens, Sarasota, *Kress & Roesel 88-2484;* 25 plants from 15–20 shrubs and large oaks.
T. usneoides	US1	same as RE1, *Kress & Roesel 88-2471;* 25 plants from 5–10 large oaks.
	US2	same as RE2, *Kress & Roesel 88-2475;* 25 plants from 15–20 shrubs and trees.
	US3	same as RE3, *Kress & Roesel 88-2480;* 25 plants from 15–20 shrubs and small trees.
	US4	same as RE4, *Kress & Roesel 88-2485;* 25 plants from 15–20 shrubs and large oaks.
T. utriculata	UT1	Florida. Highlands/Glades County: Hwy 70, 10 mi W of Rt. 27 junction, *Kress & Roesel 88-2473;* 25 plants from 5–10 large oaks.
	UT2	same as RE2; *Kress & Roesel 88-2477;* 25 plants from 10–15 shrubs and trees.
	UT3	same as RE3; *Kress & Roesel 88-2481;* 25 plants from 10–15 small oaks.
	UT4	same as RE4; *Kress & Roesel 88-2483;* 25 plants from 15–20 large oaks.

Each population and species was analyzed for four enzymes: isocitrate dehydrogenase (IDH), 6-phosphogluconate dehydrogenase (6PGD), phosphoglucose isomerase (PGI), and phosphoglucomutase (PGM). Basal leaf tissue from new leaves of *T. recurvata* and *T. utriculata* was ground in 3 drops of 0.1 M Tris-HCL grinding buffer pH 7.5, containing 0.1% w/v 2-mercaptoethanol, 0.001 M EDTA tetrasodium salt, 0.01 M potassium chloride, 0.01 M magnexium chloride hexahydrate, and 4% w/v PVP 40 (Soltis et al., 1983). Basal leaf tissue from mature leaves of *T. usneoides* was ground in

3 drops of 0.1 M phosphate buffer pH 7.5, containing 0.1% w/v 2-mercaptoethanol, 5% w/v sucrose, 50 mM ascorbic acid, 10 mM diethyldithiocarbamic acid, and 4% w/v PVP 40 (modified from Soltis et al., 1983). The crude extract was absorbed onto paper wicks (2 × 15 mm Whatmann 3MM) which were loaded onto 12% horizontal starch gels (Fisher S676-2) following system D of Cardy et al. (1980) for all four enzymes (electrode buffer 0.065 M L-histidine, 0.007 M citric acid monohydrate, pH to 6.5 with citric acid; gel buffer 1:3 dilution of electrode buffer, pH 6.5). As a standard for comparing enzyme migrations a sample of *Heliconia stricta* Huber was included on each gel (Kress, unpubl.). Samples were electrophoresed at 4° C for 6.5 hours at a constant 30 mA until 250 V were reached, then at a constant 250 V. All enzymes migrated anodally. Staining procedures were modified from Soltis et al. (1983; see Table 2).

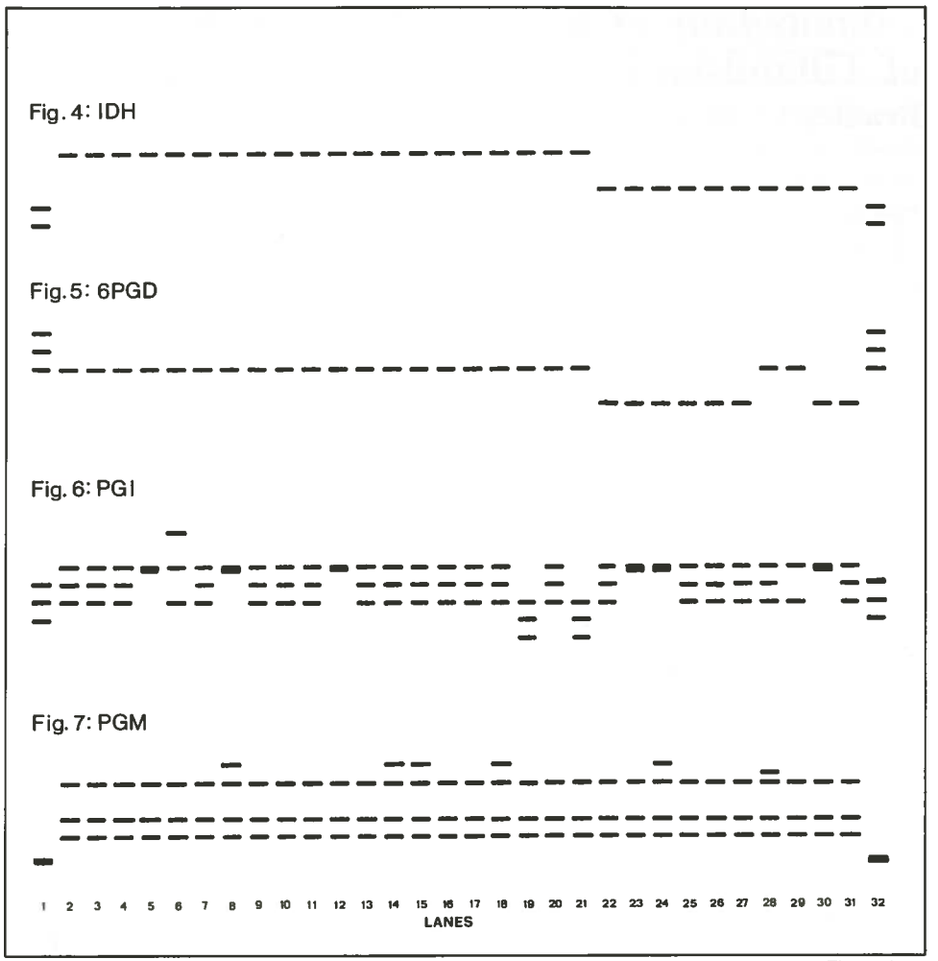
Table 2. Staining schedules for enzymes PGM, 6PGD, IDH, and PGI (modified from Soltis et al., 1983).

IDH	**6PGD**
50 ml 0.1 M Tris-HCL pH 8.0	50 ml 0.1 M Tris-HCL pH 8.0
50 mg DL-isocitric acid	20 mg 6-Phosphogluconic acid
1 ml $MgCl_2$	1 ml $MgCl_2$
5 mg NADP	0.1 ml glucose-6-phosphate dehydrogenase
10 mg MTT	5 mg NADP
5 mg PMS	10 mg MTT
	5 mg PMS
PGI	**PGM**
50 ml 0.1 M Tris-HCL pH 8.0	50 ml 0.1M Tris-HCL pH 8.0
50 mg fructose-6-phosphate	50 mg a-d-glucose 1-phosphate
0.1 ml glucose-6-phosphate dehydrogenase	1 ml $MgCl_2$
	0.1 ml glucose 6-phosphate dehydrogenase
5 mg NADP	5 mg NADP
10 mg MTT	10 mg MTT
5 mg PMS	5 mg PMS

RESULTS

Eight, and possibly ten, loci or isozymes were detected in the four enzymes examined. All bands migrated to the positive end of the gel (anodally). At least two (IDH, 6PGD) and possibly three (PGM, PGI) putative loci were located for each enzyme, but only one locus showed activity strong and consistent enough to be read (Figures 4–7).

Only one of the two loci in IDH was readable. No variation within the species was detected in any of the taxa at that locus. All individuals in all populations showed a single band and were assumed to be homozygous (to have received the same allele from each parent). Each species was characterized by bands migrating a specific distance from a reference point: *T. usneoides* most anodally; *T. utriculata* least anodally (Figure 4).



The authors

Fig. 4–7.
Diagrammatic representation of banding patterns on starch gels stained for four enzyme systems. Each "lane" corresponds to an individual plant of *Tillandsia.* A standard, *Heliconia stricta,* is in lanes 1 and 32. The origin (cathode) is at the bottom and the anode at the top. Figure 4. IDH, showing variation between *T. recurvata* (lanes 2–21) and *T. utriculata* (lanes 22–31). Figure 5. 6PGD, showing variation within *T. utriculata* (lanes 2–31). Figure 6. PGI, showing variation within *T. usneoides* (lanes 2–31) at PGI-2; one-, two- and three-banded patterns present. Figure 7. PGM, showing variation within *T. usneoides* (lanes 2–31) at PGM-1 and uniformity at PGM-2 and PGM-3.

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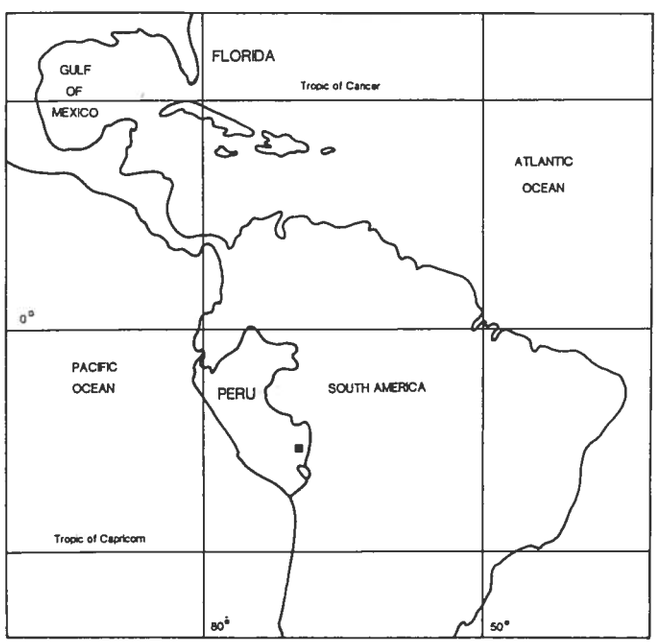
Ethnobotany of Bromeliads: Indigenous Uses of Tillandsias in the Southern Andes of Peru

Bradley C. Bennett

The study of plants used by humans is known as ethnobotany, a term first used in 1896 (Schultes 1979 cited in Corrigan 1981). The field itself is much older and is closely associated with the history of botany. Theophrastus (ca. 370–285 B.C.), Aristotle's famous student, described nearly 500 plants (Barkley 1986), many economically important. The resurgence of botany in the middle ages resulted largely from the herbalist's interest in medicinal and crop plants. The great 19th century naturalists including Ruiz who worked in Chile and Peru (Schultes 1980) and Spruce who worked in the northwestern Amazon and the northern Andes (Schultes 1968, 1983) made important ethnobotanical contributions. Darwin and Wallace, founders of the theory of natural selection, also made notable ethnobotanical observations (Stone 1962; Balick 1980). Although neglected during much of the 20th century, ethnobotany persists, especially as we realize the immense botanical knowledge indigenous people possess and its impending demise.

In 1985 and 1986 I participated in a research project in the Peruvian Andes. My objectives were twofold: to compare the biology of epiphytic and saxicolous tillandsias and to analyze vegetation across elevational gradients. While completing those two tasks I discovered a significant knowledge of local plants among Quechua-speaking Indians. Here I describe the tillandsias I found and how Quechuas use them.



We worked near Cuyo-Cuyo (Depto. de Puno, Prov. de Sandia) at an elevation of 3400 m. Located on the eastern Andean escarpment, Cuyo-Cuyo lies 120 km north of Lake Titicaca. The vegetation is diverse. Villagers use land up to 4300 m on the broad, treeless altiplano or puna.

Valleys contain pre-Inca terraces and many have been cultivated continually for 1200 years with no fertility loss. Weedy herb and shrub communities dominate the valley. Quechua Indians grow several root crops: potatoes *(Solanum tuberosum)* and oca *(Oxalis tuberosa)* are the most important. Below 3200 m they grow corn. At this elevation vegetation changes rapidly as Amazonian plants begin replacing Andean elements. Before widespread human disturbances forests were more common but now they occur only in inaccessible sites along streams. These isolated stands support several epiphytic genera including *Tillandsia, Epidendrum, Oncidium, Peperomia,* and *Polypodium.*

Bromeliads are common near Cuyo-Cuyo. Terrestrial puyas conspicuously dominate some shrublands and I describe these in a subsequent paper. Tillandsias are common epiphytes and saxicoles. Some species occur only on rocks, others only on trees, and few grow on both substrates. Vertical rock faces, several hundred meters high, support thousands of tillandsias. Although native trees are now uncommon, most support epiphytic tillandsias. The widely introduced eucalyptus, with its flaky bark, is a poor host which seldom supports epiphytes.

I found seven tillandsia species (Table 1) and describe their uses and common names below. Quechua names follow Cusihuaman (1976) where possible. "Huicunto" and cognates are commonly applied to bromeliads throughout the Andes. For example, *Tillandsia latifolia* is known as "guicundo" and *Pitcairnia pungens* as "urcohuicundo" (Joyal 1987). Soukup (1970) lists several similar names for Peruvian tillandsias including "huiccontoi," "huaccontoi," and "huaycontoy."

Table 1. Tillandsia species, their common name, and habit near the village of Cuyo-Cuyo.

Species	Common Name	Habit
T. biflora Ruiz & Pavon	huicunto	epiphytic, saxicolous
T. capillaris Ruiz & Pavon	qaqa sunkha huachuacsso[1] huayhuaco[1]	saxicolous
T. ionochroma André ex Mez	huicunto	epiphytic, saxicolous
T. recurvata (L.) L.	qaqa sunkha	saxicolous
T. sphaerocephala Baker	aya huicunto ccacca huicontoi[1]	saxicolous
T. tenuifolia L.	qaqa huicunto	saxicolous
T. usneoides (L.) L.	qaqa sunkha salvaje salvajina[1]	saxicolous

[1] Source: Smith 1936

Tillandsia biflora, although a common Andean bromeliad, is not abundant near Cuyo-Cuyo. One small saxicolous population grew near Río Awi-Awi (3000 m) with a few epiphytic individuals also. According to Smith and Downs

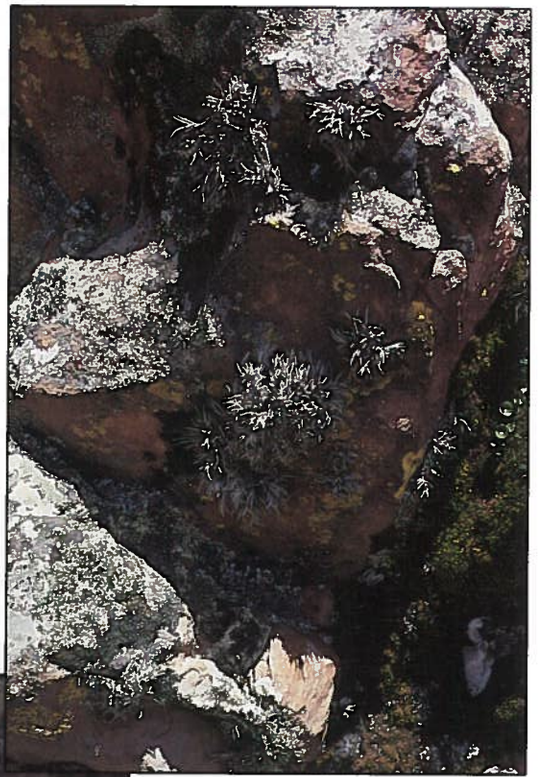


Fig. 8
Saxicolous *Tillandsia capillaris*, a common Andean bromeliad.

Photographs by the author

Fig. 9
Epiphytic *Tillandsia ionochroma*. This species also grows as a saxicole.

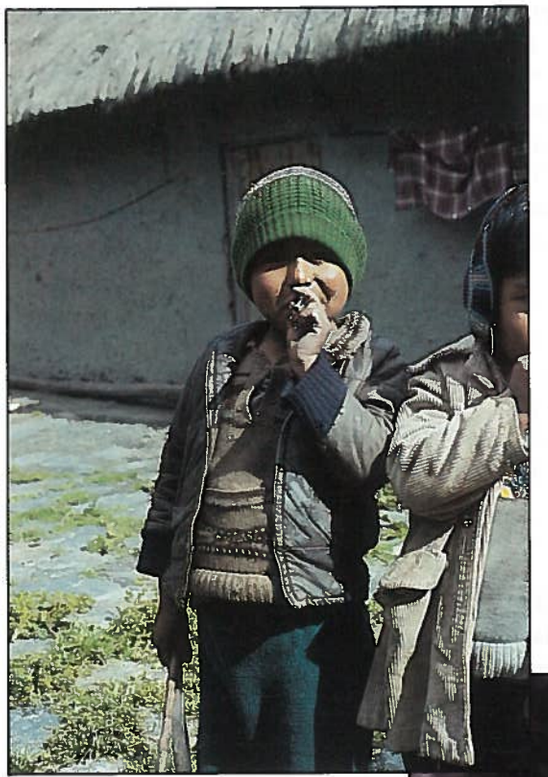


Fig. 10
Two young Quechua boys using the leaves of *Tillandsia ionochroma* as a whistle. The author's specimens provided an abundant supply of leaves.

Fig. 11
Tillandsia sphaerocephala, the dominant saxicole near Cuyo-Cuyo.

(1977) this species is mostly epiphytic. Known by the same common name "huicunto," it is morphologically similar to *T. ionochroma* but smaller.

Tillandsia capillaris is a common, diminutive Andean saxicole (fig. 8). Its common name "qaqa sunkha" means "rock beard," an appropriate name considering its shape and scruffy, gray trichome covering. It also grows on roof tiles used in larger, highland towns at elevations near 4000 m. Near Puno, it grows in ancient ruins at Sillustani. Local artists have recorded its presence there as well.

Tillandsia ionochroma is a common saxicole and epiphyte (fig. 9). Saxicolous populations occur at elevations up to 3600 m. Epiphytes grow mostly below 3100. Rock-dwelling forms are smaller with a less-branched inflorescence than the tree-dwelling ones. Also, called "huicunto" this species has several uses. Although not a preferred food, sheep and llamas will eat its leaves. Children roll the leaves to form whistles (fig. 10). Many specimens I left outside my house were defoliated quickly for this reason. Villagers also collect the plant for wedding decorations.

T. recurvata, also called "qaqa sunkha," grows on rocks around Cuyo-Cuyo up to 3200 m. In the United States "ball-moss" is predominantly epiphytic although saxicolous populations occur in Texas (Bennett 1985). Peruvian populations are morphological intermediate to the short-leaved saxicoles and longer-leaved epiphytes in the United States. Villagers do not use this species.

Tillandsia sphaerocephala is the dominant saxicole near Cuyo-Cuyo (fig. 11). Vertical rock faces support thousands of individuals, which grow over a 2000 m elevational range up to 4000 m. As with *T. ionochroma,* domestic animals sometimes eat its leaves. Its common name "aya huicunto" suggests the most common use, as decorations for funerals. "Aya" is a Quechua word meaning "death." *T. sphaerocephala* has short, narrow, gray leaves compared with *T. ionochroma's* longer, wider, red or green ones.

Tillandsia tenuifolia or "qaqa huicunto" becomes abundant below 3000 m. "Qaqa," a Quechua word meaning "rock," indicates the saxicolous habit of this species. The people of Cuyo-Cuyo reported no use for *T. tenuifolia.*

Tillandsia usneoides is the most widely distributed bromeliad. Like *T. recurvata* it is predominantly saxicolous in the region at elevations below 3200 m. Its common name "qaqa sunkha" or "rock beard" is similar to an American vernacular name "old man's beard" (Bennett 1986). Other Spanish names for the plant are "salvaje" and "musgo." The latter, similar to our common name "Spanish moss," refers to the plant's moss-like habit. Quechus prepare a hair rinse from *T. usneoides* by boiling it in water. In Ecuador they sell it as a Christmas decoration.

Tillandsias are conspicuous elements of the Andean flora around Cuyo-Cuyo but are under-utilized relative to their abundance. In part, this is because they are inaccessible in tree canopies or on vertical rock outcrops. The symmetry in use between *T. ionochroma* (huicunto) as a wedding decoration and *T. sphaerocephala* (aya huicunto) as a funeral decoration is intriguing. Are there reasons besides morphology and color that led to these uses? Why were these species selected? Tillandsias may have little economic importance in the southern Andes but their ceremonial value is significant.

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Notice of Annual Meetings

The annual meeting of the membership of The Bromeliad Society, Inc. will be held at 9:00 a.m., June 6, 1990 at the Wyndham Greenspoint hotel in Houston, Texas. It will be followed immediately by the annual BSI Board meeting. Members are invited to forward matters for consideration at either meeting to the president before the meeting date.

Aechmea alopecurus, Once More

Elton M.C. Leme

When Edmundo Pereira and I announced the finding of the second dried specimen of *Aechmea alopecurus* Mez without field data and known after the type collection, we hoped to encounter, some day, living material of such a bromeliad in nature.[1] At that time, the type of this species was supposed to be lost and for that reason we were encouraged to establish a neotype on the basis of the newly identified dried material. Such a decision generated an immediate reaction from Dr. Walter Till of the Botanical Institute, Vienna, who communicated that, in fact, the type of *A. alopecurus* was not lost but had survived the troubles of World War II.[2] There was no need, consequently, for establishing the neotype.

We used to visit Roberto Burle Marx and his interesting bromeliad collection from time to time. During one of these visits we were surprised to observe a big clump of a spiny *Aechmea* in full bloom growing terrestrially in Burle Marx's magnificent landscape. Such a group of bromeliads made us remember something very familiar. Yes, it was *A. alopecurus,* we concluded without much effort (fig. 12).

It is noteworthy that the unusual curving of the scape observed by Dr. Till in the type specimen was not confirmed in the two living and flowering specimens that we saw. On the other hand, we should stress here that we have observed in the field some species belong to the subgenus *Pothuava,* such as *Aechmea pineliana* (Brong. ex Planchon) Baker (fig. 13), sometimes presenting such a strange scape curve. We believe that the curve depends on the position of the plant when it starts to flower.

As far as Roberto Burle Marx's good memory is concerned, those specimens of *Aechmea alopecurus* were found growing terrestrially in the state of Mato Grosso during one of his numerous collecting trips to that part of the country.

From this information we now have field data to check in future excursions and, most important, we have living plants to study and enjoy.

Rio de Janeiro

1. J. Brom. Soc. 35:215-216; 1985.
2. J. Brom. Soc. 37:14-15; 1987.

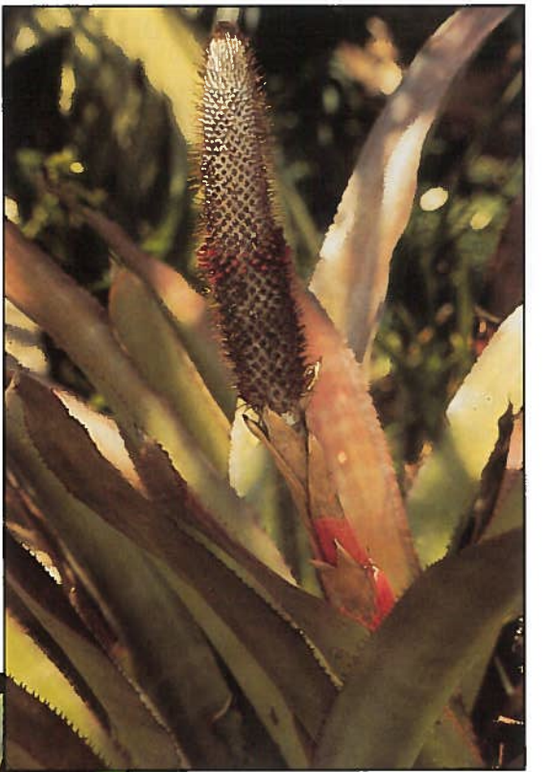


Fig. 12
Aechmea alopecurus, showing an essentially straight scape in contrast with the bent scape of the type specimen (see footnote 2).

Photographs by the author

Fig. 13
The author suggests that the curve, if any, of the scape depends on the position of the plant when it starts to flower and shows here a specimen of *A. pineliana* collected in the wild to illustrate that point.

Artificial Pollination of Tillandsias

Mark A. Dimmitt

A companion to this article[1] describes how to grow tillandsias from seed to maturity. This one describes how to pollinate them to produce quality seeds. Whether the goal is to maintain a wild type or to produce improved strains or hybrids, it is essential to carry out controlled pollination.

POLLINATION

Pollination is necessary to produce viable seeds. Most *Tillandsia* species are pollinated by hummingbirds, moths, or butterflies. Greenhouses usually lack these animals, so in cultivation pollination must be done by humans. Even in outdoor gardens where natural pollinators may be present, it is preferable to perform controlled pollination to insure that the best clones[2] are used as parents. It will also prevent accidental hybridization or deliberately create hybrids of known parentage.

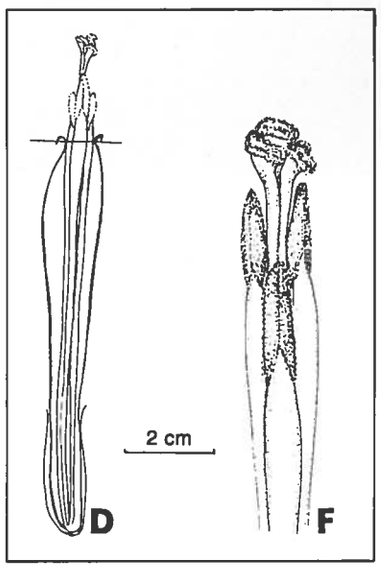


Fig. 14
D, Longitudinal section of *Tillandsia* flower showing arrangement of anthers and stigma; F, enlarged drawing of anthers and stigma.

Pollination is accomplished by transferring pollen from the anthers (the male organs) to the stigma (the female organ) of a flower (fig. 14). Since most tillandsias are not self-fertile, two different clones are necessary to produce seeds. (All vegetative divisions from an original mother plant belong to the same clone, so crossing two such plants won't work.) Most flowers are receptive (capable of being pollinated) during the morning hours, between sunrise and about noon. A few night-blooming species (e.g., *T. xerographica)* must be pollinated at night, as the stigmas are no longer receptive by morning.

In the irritating and fairly common situation in which two clones fail to produce flowers on the same day, one can pick a flower and store it in the refrigerator for a day or two. For plants that bloom at different seasons, the answer may be to freeze the pollen since it then should keep indefinitely. I have had poor results, however, with *Tillandsia;* this area needs work. (Don Beadle freezes *Billbergia* pollen successfully.) Another way to cross two species that bloom at different seasons is to induce one parent to bloom by chemical means when the other is about to flower. This is fairly simple

with species that remain in flower for several weeks, but "flash-bloomers" such as *T. stricta* require very careful timing to get both parents to bloom at the same time.

The ease of pollination varies among the subgenera. The subgenus *Tillandsia* (e.g., *T. streptophylla, T. bulbosa, T. concolor, T. fasciculata, T. ionantha,* etc.) is easiest (fig. 15). This very large group is easily recognized by the petals which form a narrow tube with the stamens and stigma extending well beyond them. Thus they are easily accessible to the pollinator. All you need is a small artist's brush. Or, if the plants are not too large, pick up a whole plant and touch the anthers of one to the stigma of the other (and vice versa). If there are plenty of flowers, some can be picked and carried to the other plant instead of using a brush. In this subgenus the stigma matures before the anthers release the pollen (protogyny), but by only a couple of hours. Each flower lasts but one day in all species that I have observed.

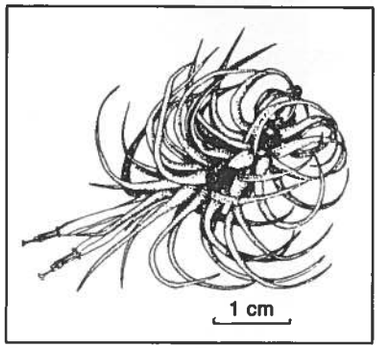


Fig. 15
Tillandsia ionantha with stamens and stigma exserted beyond the tube of petals.

Fig. 16.
Tillandsia ixioides:
A, habit; B, inflorescence.

The subgenus *Anoplophytum* (e.g., *T. aeranthos, T. stricta, T. meridionalis, T. ixioides)* (fig. 16) is also fairly easy. The petals in this group spread wide to form a funnel-shaped flower. Although the stamens and stigma are within the flower, they are usually visible in the throat and are accessible with a brush. In most of these species the flowers remain open for at least two days *(T. stricta)* and up to several days *(T. albertiana)* The anthers release their pollen first (protandry), then the stigma elongates and becomes visible and receptive a couple of days later. Pollen from young flowers should be transferred to the stigmas of older flowers for best results.

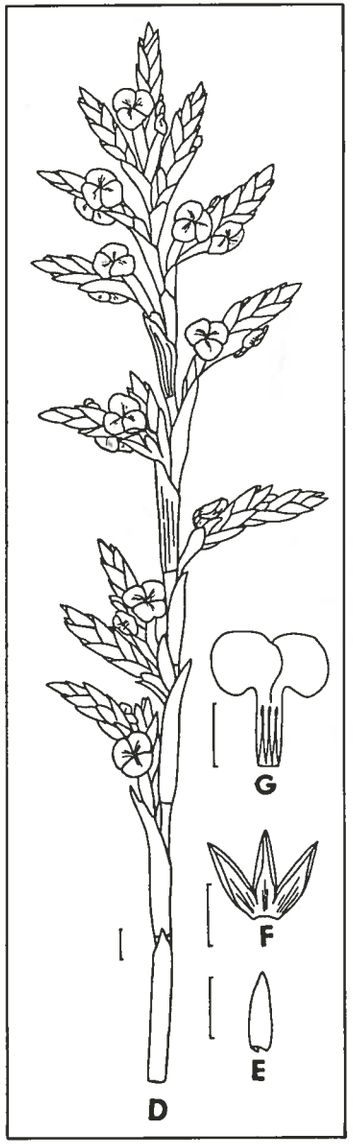


Fig. 17
D, *Tillandsia duratii* var. *saxatilis;* G, petals and stamens deep within the flower tube but taller than the stigma.

The subgenus *Phytarrhiza* (e.g., *T. cacticola, T. straminea, T. duratii, T. cyanea)* (fig. 17) is difficult to pollinate. As with the subgenus *Anoplophytum,* the flowers are funnel-shaped, but the stamens and stigma are hidden deep within the narrow flower tube. There are two ways to deal with these. You can use a very thin artist's brush or cat or dog whisker (look for shed ones where your pet spends the most time), and insert it deep into the flowers, alternating between different clones. This a haphazard method, but you will usually get some seed set. You may also dissect the flowers carefully to expose the sex organs. Often they are protected by very sturdy sepals and floral bracts, so exposing the delicate stigma and ovary (embryonic seed capsule) without damaging them can be difficult. A damaged ovary usually aborts. If you succeed, you can see what you are doing, and make sure the pollen is deposited in the proper location. The flowers of most species in this subgenus last several days, though some such as *T. cyanea* are ephemeral. They are protandrous, so try to transfer pollen from younger to older flowers.

Since most species are self-sterile, it is not necessary to remove the anthers of the seed parent. Some exceptions are: *T. pohliana, T. gardneri, T. schiediana,* some *T. funckiana,* and *T. exserta. Tillandsia exserta* from Sonora, Mexico has an interesting trait that may also exist in other species. As in all of the subgenus *Tillandsia,* the stigma is exserted beyond the anthers, preventing self-pollination. However, the filaments supporting the anthers continue to elongate during the day and by evening the longest anther contacts the stigma effecting self pollination if outcrossing did not occur earlier in the day (Felger and Dimmitt, in manuscript). You can try either of two procedures: remove the pollen of self-fertile species (not easy except in subgenus *Tillandsia),* or use these species only as pollen parents in hybrid crosses. It is good policy, however, to make hybrid crosses in both directions because sometimes they will take in one direction and not the other.

Author

Fig. 18
Seed capsules of *Tillandsia ixioides* beginning to split and release seeds. In most species the capsules will open wide and the seeds will disperse within one to three days after first beginning to split. Note the label tied around two spikes of the same cross.

LABELLING

Label each pollination as soon as you make it. *Tillandsia* seed capsules take three to eight months to mature, and there is no way you are going to remember that long! And I can say from personal experience that no matter how well you know the species, you can seldom ascertain parentage with confidence by looking at the hybrid progeny.

The easiest method is to do only one cross per spike and label the whole spike. I use either paper price tags tied onto the spike or plastic plant labels stuck into the rosette next to the inflorescence. Write with pencil or carbon-based ink only, or you will come to grief: by the time the seeds mature, the labels may be obscured by algae or mold. Do not try to scrape it off; the writing may come off too. Just drop the labels into bleach; in a couple of minutes all the organic gunk will become transparent and leave your carbon scribblings clearly visible. This remedy also works well with seedling labels that have been buried under a mass of plantlets for three years.

The usual custom is to write the female (seed) parent first. If you are using a superior clone, indicate its name or number, e.g., *T. stricta* 'Fire and Ice' × *T. meridionalis* "MAD #4." Remember, better parents usually produce better progeny; a cross between average parents that produces interesting plants may be worth repeating if you acquire better parent clones. Attach your initials to

[continued on page 80]

Growing Bromeliads from Seed; Experiments and Experiences

William L. Brickhill

Many of us would have larger, really impressive collections of our favorite bromeliads if it were not for the relative difficulty of growing them from seed. This difficulty may be real or imaginary, perhaps only a bad reputation started by the unsuccessful results of the efforts of a few less persistent souls. Nevertheless, it has certainly discouraged some enthusiasts from trying the route of seed propagation. What a shame! I have grown thousands of bromeliads from seed up to blooming size using only common, ordinary supplies available in any home and local garden centers. I will share some of my methods and experiences with you.

This discussion will be limited to bromeliads whose seeds can be sown on the surface of a medium such as peat or sphagnum moss. They include most of the species with the exception of the extreme xerophytes and those sensitive to too much moisture such as the gray-green, very heavily scurfed tillandsias and similar vriesias. The seeds of the moisture-sensitive bromeliads have significantly different cultural requirements and have not been included in these experiments.

My observations concern the two major problems encountered with seed culture. The first, which may seem obvious, is germination. Germination is impossible without viable seed. Most fresh, fully mature seed planted within a month after collection will germinate. To extend that period, the seed should be refrigerated. Even so, the rate of germination drops off rapidly after six months, especially for the seeds of the tillandsia family.

Certain genera have surprisingly different germination rates on different media as shown in the following table. If seeds do not germinate well on one medium, try another. While experimenting with fungus control, I was surprised to see that neoregelia seeds planted on a Terra-lite (and I shall describe that medium later) bed had a significantly higher germination rate than those planted on pure Canadian peat. The same results do not hold true for all other genera. Aechmeas, for instance, germinate about equally well on either. Dyckias prefer Terra-lite.

Sufficient warmth is absolutely essential to successful germination. Seeds should be kept at a minimum of 70 degrees F and 75–90 degrees is better. Higher temperatures can be tolerated but are not recommended. Percentage and speed of germination increased markedly at temperatures above 70 degrees. Using bottom heat such as provided by placing seed containers on top of a water heater or on soil heating cables is recommended for all but the warmest months.

Light, either natural or artificial, is usually very important to successful germination and initiation of growth. Seedlings will be soft and weak with elongated stems if not given enough light. Light also helps seedlings compete with fungus because the latter is not dependent on light. Sixteen hours a day of bright fluorescent light is not too much but full sun should always be avoided.

The second problem is fungus control. The remainder of this article will be on that subject.

I made a series of experiments to determine practical methods of controlling the growth of fungus and algae on germinating bromeliad seeds and seedlings. By practical methods I mean those available to the hobbyist under home conditions. I made no serious attempt to identify the various fungi and algae. I found blue-green molds, water molds, some resembling penicillin, powdery mildew, the slimy prothallial stages of ferns, and various forms of algae. The ferns and algae are not the most serious problem but they will compete with tiny bromeliad seedlings in a fertile, moist, high-light environment. They might overwhelm some of the slower-growing species such as vrieseas. Fungi, on the other hand, are almost always fatal to bromeliad seedlings if not treated.

Conditions of Experiment

Light. Bright daylight or 16 hours of fluorescent light provided by a mixture of 40-watt plant lights and cool white tubes suspended approximately one foot above the containers.

Temperature. 50–70 degrees F night, 70–90 degrees F day, depending on the season. The minimum temperatures were controlled, the upper were not.

Growing medium. Canadian peat and Terra-lite "Redi-Earth Peat-Lite" mix (a proprietary prepared seed starting mix of approximately equal parts sphagnum peat moss and vermiculite). Horticultural sphagnum moss also works well but was not used in this experiment. The pH values were 4.5 for the peat and 6.0 for the Terra-lite.

Chemicals. Physan 20, Captan, and household bleach (Clorox). Physan 20 is now called "R.D.-20."[1]

Containers. Covered polyethelene margarine tubs, 1-cup size, and clear plastic ice cream containers 1.5 gallon size.

Conduct of the Experiment

The first step was to sterilize whichever medium was being used. I used a microwave oven. I moistened the planting medium until it was wet enough to yield a few drops of water when very tightly squeezed then placed the moistened

1. Clorox consists of sodium hypochlorite at 5.25%. Captan=N[(trichloromethyl)thio]-4-cyclohexene-1, 2-dicarboximide 50%. Physan-20, or RD-20, is a broad-spectrum bactericide, fungicide, algicide used in hospitals and available from suppliers of chemicals for tropical plant/orchid growers.

medium in a fairly shallow microwaveable container loosely covered with a plastic wrap and microwaved it on 50% for 5–6 minutes. The medium prepared in the same way can be cooked in a conventional oven set at 180–200 degrees F for 30 minutes.

Next, I sterilized some seeds in the 20% Clorox solution. I put the seeds in a small bottle of the solution, capped it and shook it thoroughly. I removed the seeds after one to two minutes and rinsed them with distilled water. I used tweezers or a small spoon for seeds with hairs and captured other seeds in a fine-mesh strainer. The bottle and the tools were sterilized in Clorox.

I sowed another group of seeds on sterilized medium without any prior treatment and sprayed them with either of two solutions: Captan diluted with tap water at 8 tablespoons per gallon, or with Physan mixed with tap water at a rate of ½ tablespoon per gallon. The seeds were wet thoroughly. As a control, I planted some seeds on sterilized medium without any treatment. The containers for both groups were covered with snap-on lids.

Observations

The table on page 79 presents the raw results of my experiments. The various species were planted as the seed became available from the BSI Seed Fund but I have listed them in alphabetical order for easy reference. Most of the percentages were calculated on seed batches of 25 or 50 seeds.

Conclusions

1. Heat sterilization of the planting medium is beneficial.

2. Sterilization of the seed in a bleach solution is also beneficial.

3. Spraying the sown seeds and the surface of the medium with Captan appears to reduce significantly the growth of fungus for at least one month while Physan was not as effective. The container must be kept closed for at least the first month to prevent contamination with fungus spores.

4. Physan was very useful in eliminating any fungus growth that occurred on seedlings or medium after germination. It stayed effective when left standing in a spray bottle for up to two months. Neither chemical seemed to prevent germination.

5. Germination was promoted by higher temperatures and bright light.

Your chances of success with seed culture should be greatly improved if you follow these procedures. Good luck!

Alexandria, Virginia

Results of Experiment

Species	Medium	Treatment	Results After One Month		
			Germination	Rate	Other
Aechmea bracteata var. *rubra*	peat	Physan	0%		*fungus on all seeds,* none on medium
A. lueddemanniana var. *variegata*	peat	Physan	98%		*fungus on seeds,* none on medium
A. pectinata	peat	Clorox + Captan	0%		no fungus
A. tillandsioides	peat	Physan	0%		fungus on seeds, none on medium
Billbergia amoena	peat	Captan	50%		no fungus
Canistrum cyathiforme	T-Lite	Captan	0%		no fungus
Dyckia brevifolia	T-Lite	Captan	80%		no fungus
D. fosteriana	T-Lite	Physan	50%		50% fungus
Neoregelia "meyendorfii"	T-Lite	Physan	10%		no fungus
N. Strawberry Roan	T-Lite	none	50%		some fungus and algae
	T-Lite	Physan	50%		less fungus and algae
	T-Lite	Captan	70%		little fungus and algae
	peat	Physan	10%		little fungus and algae
	peat	Captan	0%		
	peat	none	4%		little fungus and algae
N. Takemura Grande	peat	Captan	10%		no fungus
	peat	Physan	4%		light fungus
	peat	none	10%		light fungus
N. zonata	T-Lite	Physan	40%		no fungus
Portea petropolitana var. *extensa*	peat	Clorox + Captan	70%		in 1 month. No fungus
Quesnelia imbricata	peat	Captan	98%		no fungus
Vriesea fenestralis	peat	Captan	0%		2% fungus
V. heliconioides	peat	Physan	8%		fungus on all other seeds
V. platynema var. *platynema*	peat	Captan	25%		no fungus
V. psittacina	peat	Captan	4%		no fungus
V. racinae	peat	Clorox + Captan	0%		no fungus
V. saundersii	peat	Clorox + Captan	80%		no fungus
V. splendens var. *major*	peat	Physan	20%		fungus on all other seeds

We are very grateful to **Anne Collings of Fort Myers, Florida** for her generous gift to the *Journal* color fund. Anne says that perhaps as a result of the recent severe cold members will have fewer plants to care of and, therefore, more time to write articles for the *Journal.* Her generosity and optimism are to be emulated.—TUL

ADVERTISEMENTS AND NOTICES to appear in the July–August 1990 *Journal* must reach the editor not later than 1 May 1990—ED.

A Star Was Born *[continued from page 54]*

grower who has decent light available can grow many beautiful bromeliads. Those of you who have been reading Mrs. Racine Foster's exciting accounts of Mulford's remarkable collecting trips in the recent issues of the *Journal of the Bromeliad Society*[1] can better appreciate his courage, resourcefulness, creativity and dedication to the cause of bromeliad science and education. Praise be to the star who was born 100 years ago. His name will shine in the hearts and minds of bromelphiles forever.

[Reprinted from Bromeliana *The New York Bromeliad Society, Inc., Feb. 1989 with the author's permission.]*

1. *Journal*, vol. 38, pages 23–27, and following (1988).

Artificial Pollination of *Tillandsias* *[cont. from page 75]*

numbered clones; someone else may have a "meridionalis #4," too, but it is extremely unlikely that anyone else will name a clone meridionalis "MAD #4." If you have named a cultivar, you should register it as soon as possible so no one else can duplicate the name. Of course, you don't need to be so formal in writing out the temporary label; I would write the above cross as 'F & I' × merid '4'. But don't be so sloppy with your permanent records (you do keep a permanent record, don't you?).

The first seed capsules you produce take seemingly forever to mature, but don't let your guard down. They tend to ripen and split open very suddenly. If you can't watch the capsules every day, place the plant on a fine screen in a windless location. This is effective if whole spikes are of the same cross. Once the capsules open, the seeds quickly expand into a great mass of tangled fluff, so mixed crosses on the same spike will mingle unless you catch each capsule as it splits. If you are impatient or simply fastidious, you can harvest the capsules as soon as they are brown and dry in appearance.

Tillandsia brachycaulos and perhaps some other species are exceptions; the capsules never seem to mature on the plant. I have had capsules more than two years old that were still green. After about a year, you can harvest these and the seed inside will be mature and viable (if it was properly pollinated).

Sow seeds soon after they ripen. Tillandsia seed remains viable for only a couple of months at room temperature. Long-term storage methods have yet to be worked out.

NOTES:

1. [*Journal* 40:17–20, 29–30]

2. The term clone has an exact definition: all material asexually descended from a single, original seed (propagule of sexual reproduction). This includes all plants produced by offsets, cuttings, tissue culture, graftings, root suckers, aerial plantlets, etc. from the same seedling. All such progeny constitute a single clone.

3. *Drawing credits. Fig. 14 and 15. C.S. Gardner. In:* Selbyana *9:132. Fig. 16 and 17. Smith & Downs.* Tillandsioideae, *p. 821, fig. 257 A & B; p. 862, fig. 274 D & G.*

[To be continued]

Genetic Variation in Three Species of Florida *Tillandsia*

[cont. from page 63]

Variation for the readable locus in 6PGD was observed in each species (Figure 5). In *T. utriculata* two of the four populations were identical (monomorphic) for a single allelle; all four populations of each of the other two species were variable (polymorphic). Three alleles were detected in the three species: one was common to all three species (although rare in *T. usneoides)*, the second was unique to *T. utriculata*, and the third was shared by *T. recurvata* and *T. usneoides*. A single presumed heterozygote (one which has received different alleles from each parent) was observed in one population of *T. recurvata;* all four populations of *T. usneoides* contained one or more presumed heterozygotes.

No intraspecific variation in banding patterns for PGI was observed in any population of *T. recurvata* or *T. utriculata*. For each of these species a four- to five-banded pattern was present for each individual. The migration distance was distinct for each of the two species. In *T. usneoides*, PGI was polymorphic for each of the four populations tested (Figure 6). At least five different readable banding patterns were present in this species; one of the patterns appeared to be the same as that characterizing *T. recurvata*. The interpretation of the genetic basis for the observed banding patterns in each taxon is discussed below.

The fourth enzyme, PGM, was poorly separated on most of the gels and no data are available on variation in *T. recurvata* and *T. utriculata*. However, in all taxa three distinct, possibly multibanded zones were always recognizable, one of which stained most intensely in each species. The distance from a reference point to this darkest zone varied among the three species: most anodal in *T. recurvata* and *T. usneoides;* least anodal in *T. utriculata*. In two of the gels, bands were sufficiently separated to allow interpretation of the patterns in the four populations of *T. usneoides* (Figure 7). In the most anodal band four alleles were detected in this species; three of the four populations were polymorphic for these alleles; presumed heterozygotes were present in each of the polymorphic populations. The two least anodal bands (two loci?) were monomorphic in *T. usneoides*.

In summary, *Tillandsia utriculata* was monomorphic for two (IDH, PGI) of the three readable enzyme systems. Two of the four populations were polymorphic for 6PGD. No heterozygotes were detected in this species.

Tillandsia recurvata showed no polymorphism in any population for IDH and PGI, but was variable for 6PGD in all four populations sampled. Only a single presumed heterozygote was detected for any enzyme.

The third species, *Tillandsia usneoides*, was polymorphic for 6PGD, PGI and PGM (where readable) for all populations (except one monomorphic population in PGM). Presumed heterozygotes were detected in all four of the populations at one to three of the polymorphic loci.

[To be continued]

Regional Reflections

On Ballmoss

Geoffrey Stanford

Many trees, and especially the live oak, *Quercus virginiana,* in the Austin [Texas] region are "infested" with ballmoss, *Tillandsia recurvata.* Several times in the past twenty years campaigns have been mooted to try to eradicate it; no doubt another will be proposed soon. That would be misguided because ballmoss is neither parasitic nor even harmful. On the contrary, it is beneficial to the tree on which it lodges: it fixes atmospheric nitrogen much of which, sooner or later, reaches the ground and so can become absorbed by the host tree. Its close relative, Spanish moss, *T. usneoides* of Houston and the warm southern Gulf states, does so too.

I well remember being amazed in my youth to see the tillandsias growing and flowering on the telegraph wires high above the ground far out in the arid pampas of Uruguay. This raised the question of their nitrogen supply. Some of the bromeliads get theirs by trapping insects in their tanks, but these tillandsias don't have such a structure. Instead, their stems and leaves are covered with overlapping trichomes, which somewhat resemble microscopic fish scales.

During rain- and dew-fall these trichomes separate and then close again as atmospheric humidity drops. In so doing they trap a tiny drop of water, and into this leaks sugars from the plant. Nitrofixing bacteria synthesize amino-acids for themselves and multiply in this enclosed anaerobic soup. But much of their production leaks back into the droplet and then becomes absorbed into the tillandsia. Comparable mechanisms work for grasses[1] and pine trees,[2]

Physiology

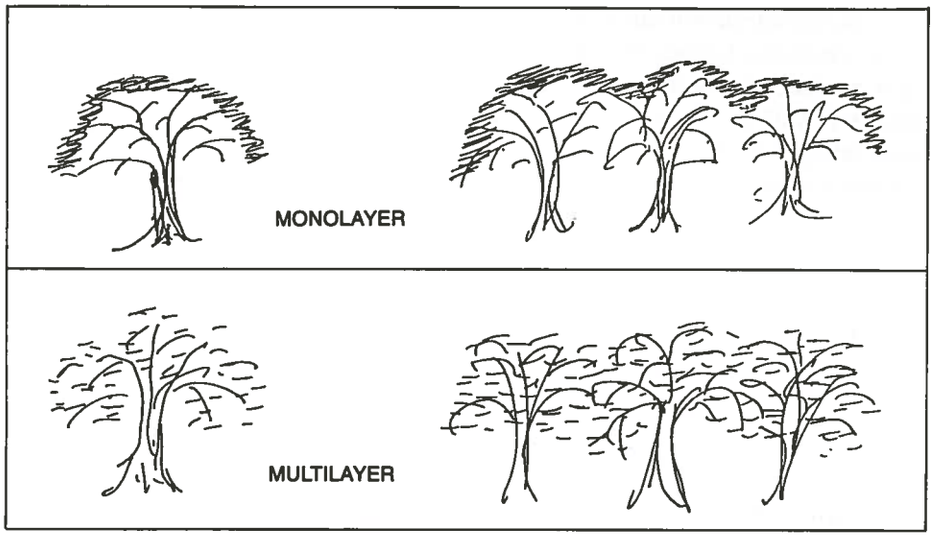
Ballmoss is not a moss. It is a true plant, which has flowers and sets seed. It is a member of the *Tillandsia* genus, which in turn is a unit of the bromeliad family. Many of this genus have special adaptations that enable them to flourish under conditions of very low water supply.[3]

The ballmoss plant is attached only to the bark of the tree on which it lives. Its roots do not penetrate into the living tissues underneath. There is no exchange of water or of nutrients between the two organisms; the ballmoss simply hangs up there. It derives its water needs from the dew and the rain. It derives its micronutrient needs from the dusts that blow onto its leaves. It is truly epiphytic.

So much for the bare facts. Now to some details. Better to understand these, we will consider the tree first.

Tree Structure

In general, the leaf of a tree absorbs less than one-fifth of the daylight that falls onto it, and the rest penetrates it and falls onto the leaf beneath. This, in its turn, absorbs less than one-fifth, and so on, until maybe only some 3% reaches the



soil surface. Obviously, there is no benefit to the tree in having any leaves at that low intensity.

Trees intercept all the light that they can by adopting one of two main patterns: the leaves are all at the top (and sides) of the tree in a close-packed layer; this is called the monolayer pattern. Seen from above, it looks almost as though the tree is covered with a blanket; hardly any light gets through this.

The second pattern is for the leaves to be loosely packed throughout the crown of the tree. Light passes between the branches and between the leaves to the leaves below and within; this is called the multilayer pattern.

In both cases, the light can be so fully used, and so little reach the ground below, that other plants cannot grow down there; or else the cover can be imperfect enough to allow more or less growth on the ground. Clearly, in a region of low water supply, the monolayer pattern may allow less escape of water from the system by windblow and by direct evaporation than the multilayer. Indeed, the air under a monolayer may be quite humid.

The Ballmoss

And so the ballmoss can live there. Since other limiting factors conspire to allow it to grow only very slowly, it requires very little light—indeed, it is perfectly adapted to this low light habitat beneath the monolayer over-story of the oaks of Texas.

Now, what happens as the tree grows upwards? Under the diffuse multilayer pattern each branch will grow, and the entire growth will remain leafy throughout: this is the pattern of the free-growing apple tree. But a tree of the

monolayer pattern will thrust out its terminal branches, and their tips will carry so dense a pattern of leaves that the older branches inside will be over-shaded, and so have no function: now they will die out. This is the pattern of the live oak. But there will still be enough light beneath for the ballmoss, which is adapted to low light intensities. With the moisture retention in the air provided by the dense monolayer leafy blanket above, it can grow securely on those dead branches.

That is why, seen from the ground, it can appear that the ballmoss has killed the branches. But it has not and the tree is not dying either. The canopy is complete—you can hardly see a speck of sky through it. All is well with the tree. That is why, at the outset, I said that there is no need to try to eradicate ballmoss from your trees. They just hang there, that's all.

Eradication

If, nonetheless, you want to eradicate ballmoss, your best way is to break the monolayer and to enforce a multilayer pattern into the crown. This you can do by selectively pruning out some large boughs and thinning out some smaller ones. You can see a beautiful example of this arboricultural husbandry from the windows of the dining room of the Faculty Club of Rice University in Houston. Under these new conditions of stronger lighting and free wind movement the ballmoss will die out without need for dangerous herbiciding. But tillandsia and quercus have lived together lo! these many years, and they know what they are at. Why should we interfere?

Summary

Does ballmoss kill trees? No. Should you approve a campaign to eradicate ballmoss? No: it benefits the tree on which it is hanging; it fertilizes it.

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NOTES:

1. Ruinen, J. The grass sheath as a site for nitrogen fixation. In: Preece, T.F. Dickinson, C.H., eds. Ecology of leaf surface micro-organisms. New York: Academic Press; 1971: p. 567–579.

2. Jones, K. Nitrogen fixation in the phyllosphere of the Douglas Fir. Ann. Bot. 34:239–244; 1970.

3. Benzing, D.H. Biology of the bromeliads. Eureka, CA: Mad River Press; 1980.

Questions & Answers
Conducted by Kathy Dorr

All readers are invited to send their questions and observations about growing bromeliads as a hobby to the editor. Answers will be sent directly to you and some questions will be published.

Q. I purchased an *Aechmea lagenaria*, but cannot find any information concerning this plant. Can you help me?

A. This plant is now known as *Aechmea lamarchei.* The name *A. lagenaria* has been placed in synonymy.

Q. What was the first cryptanthus introduced to horticulture?

A. According to Mulford Foster in *The Bromeliad Society Bulletin* vol. 2, no. 6, "the earliest record of a cryptanthus having been introduced into horticulture apparently was when Mrs. Arnold Harrison of Liverpool introduced *Cryptanthus undulatus* in 1827.

Q. Some of my vriesea offsets appear inside the basal leaves and when they are removed they have no roots and appear 'raw' at the base. I have lost some of them after potting. How should I handle these?

A. Do not remove such offsets until they have at least four or five leaves and are four or five inches tall. After removing, stand them upright in an empty pot for several days to harden off before potting.

Q. Is it possible to grow bromeliads directly in the ground?

A. This depends on where you live and the climatic conditions. In southern California and similar growing conditions, the answer is yes—some bromeliads can be grown in this manner. A number of the billbergias, such as *Billbergia nutans,* some of the aechmeas, *Aechmea distichantha, A. ornata,* etc., dyckias, hechtias, deuterocohnias, porteas and hohenbergias. For the best growing conditions, it is wise to dig the intended area down at least twelve inches deep and fill with three or four inches of gravel (for good drainage) and then finish filling with a good acid mix before planting.

My favorite method of planting bromeliads in the landscaping is to place a pot—slightly larger than the pot containing the plant—in the ground and then place the smaller pot inside. This procedure allows for easy access to the plant, making it easier to groom or remove offsets or even to change the landscape without too much effort and yet it appears to be planted and a part of the whole picture.

Q. How can I keep records of my plants without tedious bookkeeping?

A. Buy large labels and you can make notes of whatever data you wish to keep, such as date of repotting, fertilizing, etc. I even keep the hybridizing information in such a manner. I can pull the tag and note that it was hybridized on "date" with "name" and simply transfer such information by copying the tag to accompany the seed.

If you find that you cannot find tags large enough, save your bleach bottles or other such plastic bottles and cut tags from these to accommodate information required.

Q. Is seed always viable?

A. No, in some instances, the viability is very poor and even nil. This is true even though the seed is very fresh in some instances. However, the fresher the seed is, the higher the ratio of viability. Seed should be planted as soon as possible after harvesting.

Q. Why are the *Aechmea fasciata* specimens I have received in shipments from Brazil so different from those I find in cultivation? Those from Brazil are dark green with some silver banding and are usually smaller plants.

A. The plants you refer to as "in cultivation" are actually cultivars. I have never received an *Aechmea fasciata* that had been collected in native habitat that had the appearance of the plants commonly found at florists, nurseries, etc.

Q. Will plants always set seed if they are pollinated?

A. No, there are apparently a number of factors involved in this process. I have pollinated a plant one year and produced a quantity of seed. The next year I repeated the same procedure and no seed was produced.

Q. Have any bromeliads ever been patented and if so, what was the first?

A. *Aechmea* Foster's Favorite *(Aechmea racinae* × *Aechmea victoriana* var. *discolor)* was patented in 1949 by Mulford Foster. Actually, according to Mr. Foster (vol. 13, no. 3, *The Bromeliad Society Bulletin),* "the cross was made both ways and the results were the same regardless of which species was used as the maternal plant."

Q. Is it necessary to repot newly acquired plants?

A. It is a good idea to repot them. One cannot be sure just what a plant has been potted in or when. Plants need to be repotted periodically regardless. It is also a good idea to quarantine new plants in an isolated area for a period of time to be sure they are not harboring any pests.

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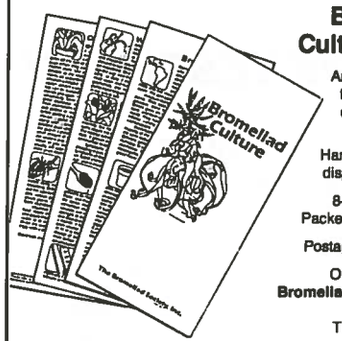

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You are cordially invited to become a member of The Bromeliad Society, Inc.

The Bromeliad Society, Inc., a nonprofit, educational, horticultural organization was formed to promote interest and disseminate knowledge in this interesting family of plants. Membership is worldwide, and includes apartment and home gardeners, greenhouse hobbyists, nurserymen, teachers, scientists, and directors and personnel of botanic gardens. Everyone interested in bromeliads, in learning more about them, in growing them, and participating in the activities of The Bromeliad Society is welcome to become a member.

The activities of the Bromeliad Society consist of

- The publication of the *Journal*, a bimonthly magazine for both amateur and professional, well illustrated in color and black and white.
- The publication of information booklets on bromeliads such as Cultural Handbook, Glossary, and the Handbook for Judges and Exhibitors, etc.
- The fostering of affiliated societies. There are many such groups throughout the world.
- The encouragement of exhibitions and competitive shows featuring bromeliads.
- The sale of bromeliad seeds through the Society Seed Fund.
- The encouragement of correspondence among growers of all countries in order that bromeliads may become better known and more widely appreciated.

Classes of Membership

- ANNUAL: A regular membership for an individual, society, or institution.
- DUAL: Two members at the same address to receive one *Journal*, each may vote, and have all benefits of membership.
- CONTRIBUTING: For an individual, society or institution. Additional funds are used to help underwrite cost of color plates in the *Journal*.
- FELLOWSHIP: Same as contributing, member will receive a copy of the Cultural Handbook.
- LIFE: No annual dues will again be paid for the lifetime of the member. Individual will receive a copy of the Cultural Handbook, a life membership certificate, card, and pin. Not available to societies or institutions.

All memberships commence upon receipt of dues and include the next bimonthly *Journal*. Current back issues are available. Memberships are tax deductible. To learn more, fill out the form below and send it in today.

. . . . . .

Application for Membership to The Bromeliad Society, Inc.

Please fill in every line that applies to you and type or print carefully. Your mailing label is made from this form. Every member should return this application to 2488 East 49th, Tulsa, Oklahoma 74105.

Please check type of membership. International memberships are increased by $5 to cover postage.

Choose one	Choose one	
☐ Individual	☐ Annual United States	$ 20.00
☐ Society	☐ Annual International	25.00
☐ Institution	☐ Dual United States	25.00
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Choose one	☐ Fellowship United States	35.00
☐ Renewal	☐ Fellowship International	40.00
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Name and address of affiliate president _____

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How did you find out about the BSI? _____

Checks should be made payable to The Bromeliad Society, Inc. Members outside the United States should remit by International Money Order or cashier's check payable in U.S.A. funds on any U.S. bank. Personal checks not drawn on U.S. banks will not be accepted.
☐ If money order is to come under separate mailing, please indicate and include a copy, or the number and type of order.

#_____ Money Order _____

Renate Ehlers

This is a picture of *Tillandsia oaxacana* with leathery leaves appearing gray because of close-lying scales. The inflorescence is nearly straight, with a short stalk. The plant shown in figure 4, page 248, November-December 1989 *Journal* is *T. macdougallii* and not *T.oaxacana.*

Calendar of Events

6 - 8 April	Acadiana Bromeliad Society with Louisiana Society for Horticulture Research Annual Show and Sale, "Festival des Fleurs de la Louisiane." Blackham Coliseum, Johnson Street, Lafayette, Louisiana. Show and sale hours: Friday, 1–5 p.m.; Saturday and Sunday, 9 a.m. to 5 p.m. Margo Racca 381-981-2171.
21 - 22 April	Shreveport Regional Bromeliad Society 10th Annual Bromeliad Show and Sale. Barnwell Garden and Art Center, 501 Clyde Fant Parkway, Shreveport, LA. Saturday and Sunday, 1–5 p.m. Harvey C. Beltz 381-635-4980.
5 - 6 May	La Ballona Valley Bromeliad Society 1990 annual Bromeliad Show and Sale. Veterans Memorial Auditorium, Overland Ave. at Culver Blvd., Culver City, CA. Saturday, noon to 4:30 p.m.; Sunday, 10 a.m. to 4 p.m. Admission is free. Potting demonstration both days at 2 p.m. Charlyne J. Stewart (213) 391-4118.
17 - 19 May	Bromeliad Society of South Florida 13th Annual Show and Sale. Fairchild Tropical Garden, 10901 Old Cutler Rd., Miami, FL 33156. Saturday and Sunday, 9 a.m. - 4 p.m. Milt Lesser 305-865-0020.
19 - 20 May	Baton Rouge Bromeliad Society 15th Annual Show and Sale "Stars on Earth," Baton Rouge Garden Center, 7950 Independence Blvd., Baton Rouge, LA. Saturday, 1–6 p.m.; Sunday, 9 a.m. –5 p.m. Michael Young 504-355-5408.
6 - 10 June	Ninth World Conference, "Bromeliads in Space," Wyndham Greenspoint, 12400 Greenspoint Dr., Houston, Texas. Betty Head, 7818 Braes Meadow, Houston, TX 77071. telephone 713-774-7778.
8 June	Cryptanthus Society Board Meeting, 2:30 p.m.; rare plant auction, 5–6 p.m. Both events Wyndham Greenspoint, Houston, TX (see World Conference above).