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NEW TRENDS IN AMARYLLIS (*HIPPEASTRUM*) BREEDING[1]

ALAN W. MEEROW
University of Florida, IFAS
Department of Ornamental Horticulture
Ft. Lauderdale Research and Education Center
3205 College Avenue
Ft. Lauderdale, FL 33314

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Abstract. **Relatively few of the ca. 60 species of amaryllis (*Hippeastrum* Herbert) have been developed into the several races of largely tetraploid hybrids popular for forcing indoors and useful for garden cultivation in USDA zones 9 and 10. Subsequent breeding efforts have largely been concentrated among the various hybrid populations themselves. Many new species have been described in the last 30-40 years, some of which exhibit novel floral form and coloration patterns. A breeding program has begun using such species as *H. fragrantissimum (Amaryllis fragrantissima* Cardenas), *H. lapacense (A. lapacensis* Cardenas), *H. cardenasianum (A. cardenasiana* Traub & Doran), *H. papilio (A. papilio* Ravenna), and *Hippeastrum reticulatum* Herbert var. *striatifolium* Herbert, several of which deserve wider cultivation on their own merits. Though some of the primary hybrids may yield superior progeny, it is expected that the major selection program will be concentrated in the F-2 (if obtainable), and backcross generations. Superior progeny can be rapidly increased through tissue culture. Tetraploidization of plantlets can be induced with colchicine in the hopes of increasing flower size and/or number, and overcoming self-incompatibility. Selections will be tested for landscape performance as well as forcing potential.**

Hippeastrum Herbert, the amaryllis, has yielded a number of large-flowered, tetraploid hybrids over the course of a 200-year breeding history (36). Bulbs are produced for indoor forcing and, to a lesser extent, garden use in mild winter zones. The initial center of amaryllis breeding was Holland, with the Ludwig strains preeminent among Dutch amaryllis (27). South Africa has also now become an important breeding center and exporter of amaryllis (3, 11, 23). Florida was at one time a substantial producer of hybrid amaryllis bulbs and also hosted the breeding efforts of Henry Nehrling (35) and Theodore Mead (4, 25). The Mead hybrids in particular, originating from Nehrling's germplasm, have figured in a number of modern hybrids when crossed with Ludwig or other Dutch stock (4). Though the Mead hybrids may not have matched the Dutch material in flower size and number of scapes produced, they were reliable and vigorous performers under Florida garden conditions (4, 24), a characteristic hardly on the priority list of Dutch and South African breeders. As amaryllis production in Florida faded, the result of a combination of biotic (disease) and economic (competition, quality control) factors, much of this germplasm has been lost.

The Current State of Amaryllis Breeding

Hippeastrum consists of ca. 60 entirely American species (37). The species are concentrated in two main areas of diversity, one in eastern Brazil, and the other in the central southern Andes of Peru, Bolivia and Argentina, on the eastern slopes and adjacent foothills. Relatively little of this genetic diversity is represented in modern amaryllis hybrids. Primary hybrids were produced from a relatively small number of species, among which *H. vittatum* Herbert, *H. leopoldii* Dombrain, *H. pardinum* (Hook. f.) Lemaire, *H. reginae* Herbert, *H. puniceum* (Lamarck) Voss and *H. aulicum* Herbert figure heavily (4, 13, 33, 34). *Hippeastrum* 'Johnsonii,' generally acknowledged as the first amaryllis hybrid, was a primary hybrid of *H. vittatum* and *H. reginae* (34.) The emphasis in commercial breeding efforts has always been on large flower size, traits attributable specifically to genes originating in *H. leopoldii* and *H. pardinum* (4, 33). Commercial breeding efforts subsequent to the initial flurry of primary hybridization has largely been concentrated among the hybrids themselves, leading to a greater complexity of parentage (much without documentation) and dilution of many of the unique characteristics of the original component species (4, 5, 13, 33).

The overwhelming majority of *Hippeastrum* species are diploid, with somatic chromosome number of $2n = 22$ (2 22, 29). Virtually all of the complex hybrid material presently in cultivation is tetraploid (4, 5, 7, 33), a result of both selection for tetraploid progeny (often associated with plant and flower size increases in hybrid amaryllis) and incorporation of a few natural tetraploid species in early hybridization efforts. The concentration of recent commercial breeding efforts among the various populations of tetraploids may exist for several reasons: 1) desirable characteristics of flower size, scape number, and plant vigor are already stabilized in the hybrid races; 2) sterile triploid progeny when diploid species are crossed with tetraploid hybrids (5, 7); 3) many of the diploid species are not readily available; and 4) self-incompatibility, which occurs in most diploid species and diploid hybrids, generally breaks down in the tetraploid hybrids (4, 7, 13, 33, 38),

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[1]Following the decision of the Nomenclature Committee of the International Association for Plant Taxonomy, *Hippeastrum* Herbert is recogized as properly applied to the neotropical genus discussed in this paper, and *Amaryllis* L. as a monotypic genus of South Africa. As formal transfers into *Hippeastrum* of many species described as *Amaryllis* have yet to be made, the valid name and authority is given in parentheses wherever necessary.

thereby allowing breeders to obtain a segregating F-2 generation.

The result of these constraints, whether voluntary or involuntary, on commercial amaryllis breeding has been a sameness to many of the modern hybrids. The flowers, while large, tend to be of the wide, flat, "dinner-plate" type with little variety of form and limited variation in color (21), despite the call from students of the species for renewed programs of interspecific hybridization (4, 7, 12, 13, 21, 33).

The pursuit of novelty in amaryllis hybrids has largely been the province of amateur breeders and collectors, most of whom have little inclination to commercially exploit their hobby or have failed in their attempts to do so (14). The efforts of J. L. Doran (21, 39) and C. D. Cothran (17) of California in particular are well known to amaryllis enthusiasts. Limited commercial availability of some of their offerings was halted by the untimely death of Marcia Wilson of Brownsville, Texas. Breeding efforts by amateurs have largely been ignored by European breeders with the possible exception of attempts to develop a large-flowered yellow hybrid (9, 17, 18, 19, 20, 24). There has also been some commercial interest in double-flowered varieties (8). Dr. William O. Bell of Gainesville, Florida continues breeding efforts among diploid species. To my knowledge, only a single commercial floriculturist, Fred Meyer of Escondido, California, is actively pursuing a species-oriented amaryllis breeding program with commercial intent.

Species With Breeding Potential

Amaryllis hybrids could be improved in a number of ways (4, 7, 13, 33). These include novel attributes of flower form (e.g.: trumpet or long-tubed perianth, novel pigmentation patterns), re-introduction of fragrance, evergreen foliage, repeat bloom, as well as along more strictly cultural criteria [resistance to hippeastrum mosiac virus and red scorch (*Stagonsopora curtisii*)].

Using a number of interesting species, I have begun a breeding program directed towards some of these goals. Most of these species are also deserving of cultivation on their own merits, particularly in light of their rarity and destruction of their tropical habitats (4, 33). Attempts to increase their supply via tissue culture are underway as well. The species currently being used or under consideration are listed.

Hippeastrum papilio (Fig. 1). First described in 1970 (31), *H. papilio* is arguably the most significant amaryllis introduction in this century. The species is evergreen, and he foliage, while not as attractive as other evergreen amaryllids such as *Clivia miniata* L., is quite handsome relative to most other *Hippeastrum*. The flowers, which last for at least a week on the plant, are laterally compressed and attractively patterned with red. One of four clones in collections at the Ft. Lauderdale Research Center flowers twice per year under daily overhead irrigation without any manipulation. The species has definite interiorscape potential and is reportedly self-compatible (7).

Hippeastrum fragrantissimum. Described by Martin Cardenas in 1960 (15), this Bolivian species is a long-tubed, white-flowered, and very fragrant amaryllis.

Hippeastrum lapacense (Fig. 2). Another Bolivian species described by Cardenas in 1972 (16), *H. lapacense* is notable for the stunning pattern of crimson stippling on the interior of the tepals.

Fig. 1. *Hippeastrum papilio.*

Hippeastrum cardenasianum (Fig. 3). Closely related to *H. pardinum* and *H. lapacense*, this Bolivian species has pink flowers lightly stippled with darker pink.

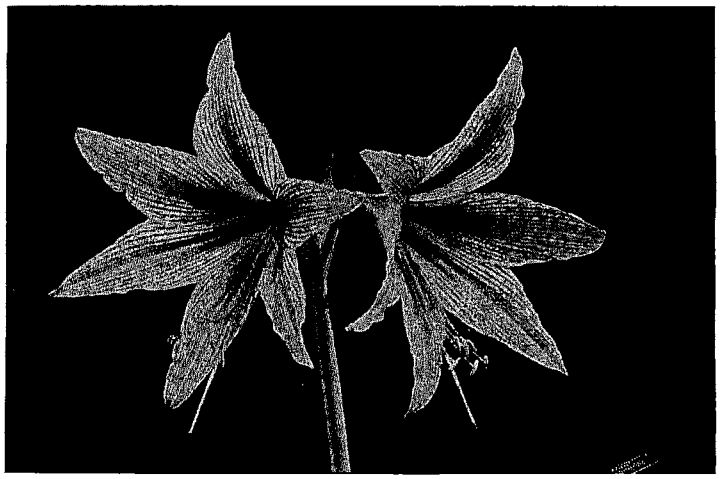

Fig. 2. *Hippeastrum lapacense.*

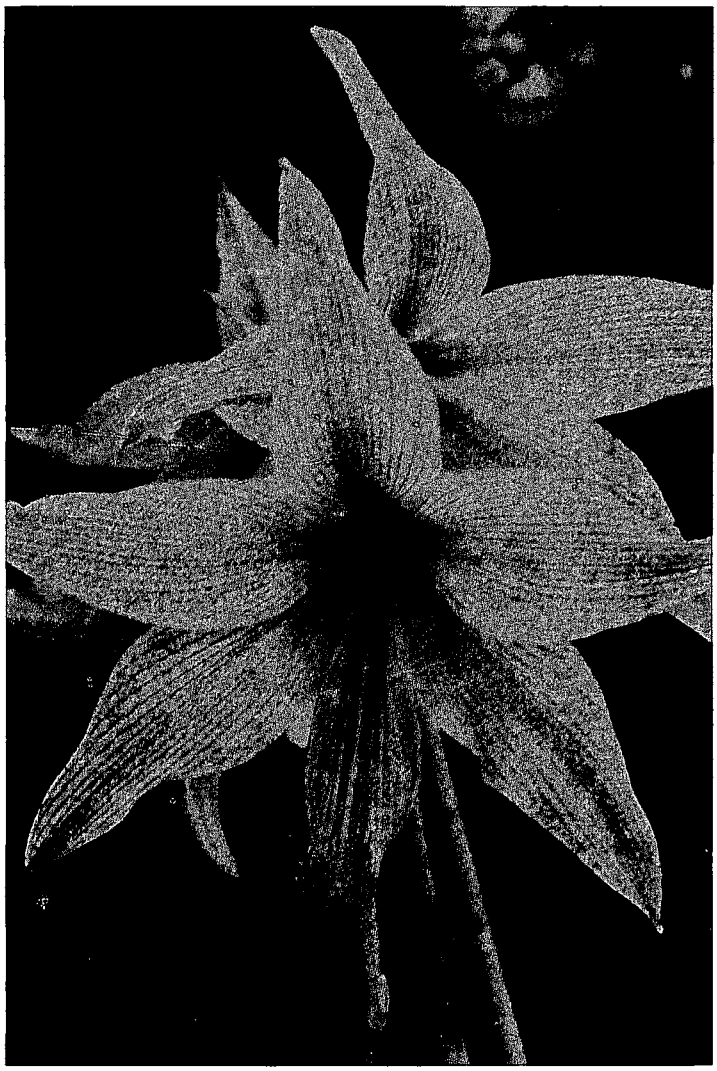

Fig. 3. *Hippeastrum cardenasianum*

Hippeastrum reticulatum var. *striatifolium* (Fig. 4). This variety of the Brazilian species *H. reticulatum* is notable for the distinct white midrib on the leaves. The lavender flowers are trumpet-shaped, nodding and appear in late summer to early fall in south Florida, suggesting that there may be a photoperiodic response involved in scape emergence. The plants can be maintained with leaves yearround, and have excellent potential as a flowering pot crop. It is one of the few species that can be successfully self-pollinated. The white striping of the leaves segregates in a 3:1 ratio among selfed progeny and the striping carries over into F-1 hybrids with other species (7).

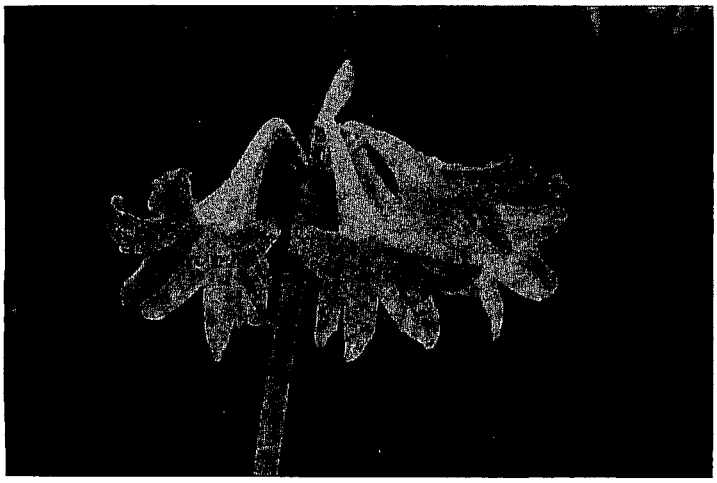

Fig. 4. *Hippeastrum reticulatum* var. *striatifolium.*

The Breeding Program, Goals and Progress to Date

The initial focus of my breeding program is on *Hippeastrum papilio.* The intent is to develop a race of evergreen hybrids with the species' attractive floral form and keeping qualities, but with an increase in floret number and variation in pigmentation. Reciprocal F-1 progeny have been successfully produced with *H. lapacense, H. cardenasianum,* and an unidentified Bolivian species with a trumpet-shaped perianth. Reciprocal crosses between *H. lapacense* and *H. cardenasianum* have also been accomplished. If the seedlings are maintained in an actively growing state, flowering size bulbs should be achieved between 2 and 3 years of age.

Primary hybrids between amaryllis species often yield disappointing results (33), and the self-incompatibility of diploid hybrids prevents access to a segregating F-2 (38). Line-breeding successive generations from sibling crosses of the F-1 progeny is usually necessary to bring forth interesting variations (33). Hopefully, the reported self-compatibility of *H. papilio* will carry through into the F-1 generation, thereby allowing F-2 progeny to be developed. Back crosses to the parents will also be undertaken.

Attempts to tetraploidize some of the progeny in order to overcome self-incompatibility (33) are also planned. There is some evidence that tetraploidy can be induced with colchicine in plantlets of *Hippeastrum* produced under aseptic conditions (5). In many amaryllis interspecific hybrid crosses, a few natural tetraploid progeny are sometimes produced (4). Among the seedlings currently being grown at the Ft. Lauderdale Research and Education Center, several show greater than average leaf width and vigor, two indications of possible tetraploid genotypes (6). This can easily be confirmed with root-tip squash chromosome counts (28). In future crosses, I intend to treat half of the seed harvested with colchicine before planting in an attempt to induce tetraploidy in some of the progeny. Irradiation of seed or tissue cultured plantlets is another means of inducing both tetraploidy and mutative morphological changes (26).

Superior selections from the breeding program can be increased through tissue culture (1, 10, 30, 32) and tested both for pot crop and landscape potential. Hopefully, the results will warrant renewed interest in amaryllis as a crop in Florida.

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EFFECT OF TEMPERATURE AND DESICCATION ON THE GERMINATION OF *THRINAX MORRISII*

WILLIAM J. CARPENTER
AND EDWARD F. GILMAN
University of Florida, IFAS
Ornamental Horticulture Department

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Abstract. **Temperature was found to control the germination of *Thrinax morrisii* H. Wendl the key thatch palm. At constant temperatures the seeds have a narrow temperature range, with 69% germination at 35°C and 29, 21 and 30% at 40°, 30° and 25° respectively. Maximum germination of 86 and 81% resulted from alternating temperatures at 12-hour intervals between 25°-35° and 30°-40°. Temperatures at 35° promoted 50% of final germination in 51 days while alternating and other constant temperatures required 59 to 74 days. Seeds retained viability in storage under high levels of moisture and temperature stress. No changes in total germination or days to 50% of final germination occurred until seed moisture contents declined below 7%. Seeds stored 3 weeks at 5° to −10° had no reduction in total germination or rate of germination. These results indicate that long-term storage of seeds at low moisture contents and temperatures should be possible.**

Thrinax morrisii H. Wendl., the key thatch palm, is a slender fan palm native of southern Florida and the West Indies (Fig. 1). It is one of Florida's native palms frequently used in landscapes and, until recently, has been moved from natural to urban locations for this purpose. It is included on the list of Florida's threatened indigenous plants (11). Recent legislation protecting palm habitats has created interest in nursery propagation by seed. Limited seed germination research has been conducted using this genera. Rees (9) reported 63% germination of *Coccothrinax argentata* in 30 days and Basu and Mukherjee (1) germinated *Thrinax parvifolia* seed in 99 days, but failed to report the germination percentage. Research with other palm species has resulted in general recommendations for seed germination. Seed soaking for 24 to 72 hours prior to propagation has been found to shorten the days required for germination (7,8). Failure to remove the fleshy pericarp from palm seeds has delayed and caused irregular germination (2,10). Maintaining relatively high germination medium temperatures from 25° to 35° C has promoted seed germination (3,7). The purpose of this research was to determine the effects of temperature and seed desiccation on the germination of *Thrinax morrisii*.