HERBERTIA

VOLUME 46 **1990** **NUMBERS 1 & 2**

HERBERTIA

The journal of the International Bulb Society, is devoted to the botany and horticulture of geophytic/bulbous plants. Special emphases of the journal are the Amaryllidaceae and other petalloid monocot families rich in bulbous or cormous plants, but articles treating any aspects of dicotyledonous geophytes are welcomed as well.

VOLUME 46
NUMBERS 1 & 2
1990

EDITORIAL OFFICES, SUBSCRIPTIONS, SUBMISSION OF ARTICLES

*** NEW ADDRESS ***

INTERNATIONAL BULB SOCIETY/HERBERTIA
UCI ARBORETUM
UNIVERSITY OF CALIFORNIA AT IRVINE
IRVINE, CA 92717
UNITED STATES OF AMERICA

A non-profit, scientific and educational organization incorporated in California in 1943. Dues and donations to the Society are tax-deductible under provisions of Section 501 (c)3 of the Internal Revenue Code. Dues for the Society are currently $20 per annum, payable to the International Bulb Society, and may be sent to the above address.

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IN THIS ISSUE . . .

The Society is undergoing several major changes. The appearance of *Herbertia* is changed by the addition of ephemeral information, such as Society and bulb industry news, as well as the usual collection of articles on cultivation, collection and description of new taxa. As a result of these changes the Society no longer will issue a quarterly newsletter. These issues were compiled with the assistance of IBS directors Charles Hardman and Alan Meerow and IBS staff member Elisabeth Lassanyi.

R. Mitchel Beauchamp, Editor

Cover: *Zephyranthes reginae* Howard & Ogden.
Illustration by Joyce Ogden.

AVAILABLE PUBLICATIONS OF THE INTERNATIONAL BULB SOCIETY

DESCRIPTIVE CATALOG OF HEMEROCALLIS CLONES, 1893•1948 by Norton, Stuntz & Ballard. 100pp. $5 postpaid.

LINEAGICS by Traub, 163pp., $10 postpaid.

THE SOUTHERN AFRICAN SPECIES OF CYRTANTHUS—A REVIEW by Reid & Dyer, ca 85pp., $12 postpaid.

PERIODICALS

(A) HERBERTIA, or AMARYLLIS YEAR BOOK FULL SET.

The first series, 1934 to 1948, inclusive, is devoted exclusively to the amaryllids (Amaryllidaceae), and the workers concerned in their advancement. The second series, 1984 to present, is expanded to include all bulbous and cormous plants. A set of these volumes is indispensable to all who are interested in the amaryllids.

(B) SINGLE VOLUMES OF **HERBERTIA/PLANT LIFE.**

Single issues of **HERBERTIA** (1939–1948, 1984–1988), are available, except for volume 11 (1944) which is out of print.

PLANT LIFE between 1945–1948 includes volumes on various plant subjects, while the **AMARYLLIS YEAR BOOK** is incorporated into **PLANT LIFE** volumes between 1949–1983, which are also on various plant subjects.

Please request an order form from the society office before ordering/purchasing publications or back issues of periodicals.

ADDITIONAL SUBSCRIBER SERVICE: SEED AND BULB EXCHANGE

Member-subscribers may participate on a first come, first served basis in the IBS rare seed exchange. A moderate charge per seed packet is used to defray mailing expenses. For more information or to donate seed or bulbs, please contact —

Charles Gorenstein, Director, IBS Seed/bulb Exchange
5 Sand Oaks Road
Laguna Niguel, CA 92677 USA

The Herbert Medal

The Herbert Medal is the highest honor the International Bulb Society can bestow upon persons distinguishing themselves by meritorious achievement in advancing the knowledge of bulbous plants, especially those of the Amaryllidaceae. The medal is named for William Herbert (1778•1847), son of Henry Herbert, Earl of Carnarvon. William Herbert had a prediliction for amaryllids and achieved success in their hybridization and published his research findings in several monumental works. His contributions as a pioneer geneticist and plant breeder, and his arrangement of the Amaryllidaceae, helped set the stage upon which other workers, both amateur and professional, have been able to advance.

Awarding of the Herbert Medal is done annually and on special occasions to those individuals selected by the Board of Directors of the Society. Medalists need not be members of the Society to be recipients. Below are listed those individuals honored as Herbert Medalists:

HERBERT MEDALISTS

*Mr. Henry P. Nehring, **Florida**, Posth. 1937
*Mr. Theodore L. Mead, **Florida**, Posth. 1937
*Mr. Arthington Worsley, **England**, 1937
*Mr. Ernst H. Krelage, **Holland**, 1938
*Mr. Cecil Houdyshel, **California** 1938
*Maj. Albert Pam, **England**, 1938
*Mr. Pierre S. duPont, **Delaware**, 1938
*Mr. Jan de Graff, **Oregon**, 1938
*Mr. Fred H. Howard, **California**, 1939
*Mr. Sydney Percy-Lancaster, **India**, 1939
*Dr. J. Hutchinson, **England**, 1939
*Mr. Carl Purdy, **California**, 1939
*Dr. A.B. Stout, **New York**, 1939
*Mr. H. W. Pugsley, **England**, 1940
*Mr. W. M. James, **California**, 1941
Prof. Dr. A. Fernandes, **Portugal**, 1942
*Miss Elizabeth Lawrence, **N. Carolina**, 1943
*Dr. Henry A. Jones, **Maryland**, 1944
Mr. R. G. Huey, **Kentucky**, 1945
*Mr. Guy L. Wilson, **Northern Ireland**, 1946
*Mr. R. W. Wheeler, **Florida**, 1947
*Dr. R. A. Dyer, **South Africa**, 1948
Capt. C. O. Fairbairn, **Australia**, 1949
*Mrs. Mary G. Henry, **Pennsylvania**, 1950
*Mr. Mulford B. Foster, **Florida**, 1951
*Dr. J. C. Th. Uphof, **Florida**, 1952
*Mr. E. A. Bowles, **England**, 1953
Mr. Thomas R. Manley, **Pennsylvania**, 1954
*Dr. Robert F. Hoover, **California**, 1955
*Mr. E. O. Orpet, **California**, 1956
*Mrs. Morris W. Clint, **Texas**, 1957
*Mr. Wyndham Hayward, **Florida**, 1958
Dr. Robert G. Thornburgh, **California**, 1959
*Prof. Ira S. Nelson, **Louisiana**, 1960
Mr. Frederick B. Jones, **Texas**, 1961
Dr. Floyd F. Smith, **Maryland**, 1962
*Mr. W. D. Morton, Jr., **Louisiana**, 1963
Mr. S. Y. Caldwell, **Tennessee**, 1964
*Mr. Robert D. Goedert, **Florida**, 1965
*Mr. Leon Boshoff-Mostert, **S. Africa**, 1966
*Dr. Martin Cardenas Hermosa, **Bolivia**, 1967
Dr. Robert P. Kahn, **Maryland**, 1968
*Mr. W. Quinn Buck, **California**, 1969
Dr. Thad M. Howard, **Texas**, 1970
*Dr. C. G. Ruppel, **Argentina**, 1971
Mr. J. L. Doran, **California**, 1972
Dr. Cesar Vargas, **Peru**, 1973
Sr. Pierfelice Ravenna, **Chile**, 1974
*Dr. John M. Cage, **California**, 1975
*Mr. Floor Barnhoorn, **South Africa**, 1976
*Mrs. Emma D. Menninger, **California**, 1977
Dr. W. S. Flory, Jr., **North Carolina**, 1978
*Mr. Harry Blossfeld, **Brazil**, 1979
Mr. Charles D. Cothran, **California**, 1980
Mr. W. L. Tjaden, **England**, 1981
Walter* & Hilda Latapie, **Louisiana**, 1982
Mrs. A. C. Pickard, Alvin, **Texas**, 1983
*Mrs. Marcia C. Wilson, **Texas**, Posth. 1983
*Dr. Hamilton P. Traub, **California**, Posth. 1985
Dr. Thomas W. Whitaker, **California**, 1988
*Mr. Grant E. Mitsch, **Oregon**, 1988
Mr. L. S. Hannibal, **California**, 1988

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*Deceased

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The 4th International Symposium of Bulbous & Cormous Plants

May 17–20, 1992
THE NETHERLANDS

SPONSORED BY THE
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— Formerly American Plant Life Society —
AND
INTERNATIONAL SOCIETY FOR HORTICULTURAL SCIENCES

CALL FOR PAPERS

TOPICS

CULTIVATION
TAXONOMY
CONSERVATION
PHYLOGENY
BREEDING
ECOLOGY

FOR INFORMATION CONTACT
IBS/ISHS SYMPOSIUM 1992
UCI ARBORETUM
UNIVERSITY OF CALIFORNIA—IRVINE
IRVINE, CA 92717
FAX 091 / 714 / 856-8511

This symposium will follow the **ISHS** *Bulb Symposium in Poland May 12–15th, 1992*

FOR MORE INFORMATION CONTACT
ISHS 6TH INTERNATIONAL SYMPOSIUM ON FLOWERBULBS
RESEARCH INSTITUTE OF POMOLOGY & FLORICULTURE,
POMOLOGIGCZNA 18, P.O. BOX 105
96-100 SKIERNIEWICE, POLAND
FAX 048 / 40 / 3228

IN MEMORIAM

To the memory of ROY W. HARDMAN, father and gardening friend
Contributed by CHARLES E. HARDMAN
$50.00 to the general fund.

(Contributions intended for the "IN MEMORIAM" page may be in any amount and should be made by check or money order. If you wish to specify a certain project for your contribution such as "Scholarship Fund", "Saving Plant Species", "Improving HERBERTIA" or "Revision of 'AMARYLLIDACEAE'", please so indicate. Those "IN MEMORIA" contributions which do not specify a project, will be placed in the general fund of the International Bulb Society. Thank you for your interest and support.)

BEQUEST APPEAL

The Board of Directors of the INTERNATIONAL BULB SOCIETY is making a special appeal to those of you who would like to promote the cause of ornamental, bulbous plants. The Board asks that your last will and testament include a bequest to the INTERNATIONAL BULB SOCIETY.

There's so much more your Society could do if only the funds were available:

- more extensive field collecting trips to help save the world's disappearing plant species;
- scholarships for deserving young botanists and horticulturists;
- more color in future editions of HERBERTIA;
- publication of a revised edition of "AMARYLLIDACEAE" and other monographs.

These are just a few of the plans being made for the society's future.

The Board is asking that you become a part of these plans. Please write a bequest into your will to:

INTERNATIONAL BULB SOCIETY
c/o Dr. Harold Koopowitz
UCI Arboretum
University of California
Irvine, CA 92717
United States of America

SWAP COLUMN

EXCHANGING plants and seeds is one of the most satisfying of all the benefits which come to gardeners. Many a friendship has blossomed along with the plants and seeds exchanged. To promote such plant and seed exchanges, a page in each future edition of **Herbertia** will be devoted to a Swap Column.

If you are having trouble locating certain bulbs or plants, send in your request addressed to: Swap Column, The International Bulb Society, c/o Dr. Harold Koopowitz, University of California at Irvine, Irvine, CA 92717, United States of America. Requests should be in this form:

> Jane Smith, 124 Arrow Drive, Lake Pleasant, WA 98765 is interested in locating bulbs or seeds of *Tecophilaea cyanocrocus* var. 'Violaceae'. Please contact her at the above address. (The name, address, and request used in this example are fictitious.)

Since there are no valid requests for this edition of HERBERTIA, interested subscribers are referred to the International Bulb Society Seed Exchange. Many exciting species and hybrid plants may be obtained from the seed exchange. A complete list is available upon request. Please include a SASE (self-addressed stamped envelope) when requesting a list of available seeds. (Subscribers outside the USA may include a check for $1.00 [USA] to cover International Airmail postage.

The Seed Exchange address is listed on the page iii, and, for your convenience, it is being listed here, as well.

Charles Gorenstein
The International Bulb Society Seed Exchange
5 Sand Oaks
Laguna Niguel, CA 92677, USA

SYMPOSIUM ON NEW FLORICULTURAL CROPS

On September 15-21, 1991, the Symposium on New Floricultural Crops (both bulbous and non-bulbous) will be held at the Lord Baltimore Hotel in Baltimore, Maryland (United States). Jointly sponsored by the International Society for Horticultural Science and the United States Department of Agriculture's Florist and Nursery Crop Laboratory, it will feature, in addition to sessions on a variety of other topics, a half-day session devoted to *Zantedeschia*.

For further information contact Dr. Mark Roh, United States Department of Agriculture, Agricultural Research Service, Florist and Nursery Crops Laboratory, Beltsville, MD 20705 USA.

CONTRIBUTORS' GUIDELINES FOR *HERBERTIA*

HERBERTIA is an international journal devoted to the botany and horticulture of geophytic plants. A special emphasis of the journal is the Amaryllidaceae and other petalloid monocot families rich in bulbous or cormous plants, but articles treating any aspects of dicotyledonous geophytes are welcome as well. Contributors are asked to follow the following guidelines as closely as possible when submitting papers.

1. Articles in HERBERTIA may be refereed (peer-reviewed) or non-refereed. Articles of a scientific nature (e.g., taxonomy, plant physiology) will usually be sent to at least two appropriate members of the editorial board or outside reviewers. Authors wishing to ensure that their contributions will be peer-reviewed should indicate so in their cover letters. Refereed papers will be designated as such by the following footnote appearing at the bottom of the first page:
   "Received ______ *[date]* ______ ; Accepted for publication *[date]* ______."

2. Manuscripts must be typed or produced with legible dot matrix or laser printers on 8 ½×11 inch paper. Double spacing should be used throughout.

3. If the manuscript is prepared with a word processor, please include a diskette copy of the paper. IBM-compatible WordPerfect v. 5.1 format is preferred, but ASCII versions are also acceptable, as are any IBM-compatible computer file formats supported by the WordPerfect 5.1 conversion program, including the following:
   > Revisable-form-text (IBM DCA), Final-form-text (IBM DCA), Navy DIF Standard, WordStar 3.3, Multimate Advantage II, DisplayWrite, Microsoft Word 4.0, Spreadsheet DIF, and any WordPerfect version.

   Macintosh files may be sent, if necessary, but will require conversion.

4. Scientific papers may be prefaced with a short abstract if appropriate and so desired.

5. Descriptions of taxa must follow conventional form as to construction of descriptive paragraphs, specimen citation, and synonymy. Use the following example as a guide or consult journals such as **Systematic Botany**, **Brittonia**, or **Annals of the Missouri Botanical Garden**.

   Eucrosia aurantiaca (Baker) Pax. Die Nat. Pflanzenfam. (A. Engler and K. Prantl, eds.), 15a: 415 (1930).

   Callipsyche aurantiaca Baker. Refug. Bot. 3:t. 167 (1869). Neotype: Ecuador, El Oro, Ayabamba, 200 m, Andre 4262 (K).

   Eucrosia morleyana Rose. Addisonia 7: 3-4, pl. 226 (1922). Type: Ecuador, Chimborazo, Huigra, 4000 ft, Rose & Rose 22593 (holotype, US; isotypes, GH, NY, S).

   Eucrosia eucrosioides var. *rauhiana* (Traub) Traub. Pl. Life 22: 62 (1966). *Callipsyche eucrosioides* var. *rauhiana* Traub. Pl. Life 13: 61 (1957). Type: Ecuador, Azuay, Pasaje, 300 m, Rauh & Hirsch E15 (holotype, MO)

   Bulb large, 7.7-10cm long, 6-7.7cm in diam.; tunics tan-brown; neck (2.5)5-8cm long, 2-2.6cm thick. Leaves 2, hysteranthous; petiole 27-35cm long, 7.5-10mm thick, deeply channelled for most of its length; lamina ovate-elliptic, 29-40 (50)cm long, (12) 16-22 (29)cm wide, acute or short-acuminate, basally attenuate to the petiole, thick, coarsely undulate, hypostomatic, abaxial cuticle thickly striate and non-glaucous. Scape (5) 7-9(10)dm tall, ca. 10mm in diam. proximally, ca. 4-6mm in diam. distally; bracts 3(5)cm long, lanceolate. Flowers (7) 10-12 (13), zygomorphic, all reaching anthesis concurrently, more or less perpendicular to the axis of the scape; pedicels (11) 22-33mm long, 1-2mm in diam.; perianth (2.8) 3-4 (4.4)cm long, green in bud, yellow at anthesis, rarely orange or pink, compressed laterally giving the perianth a somewhat flattened appearance; tube sub-cylindrical, 5-7mm long, ca. 5-6mm wide, constricted at the ovary to ca. 3.8mm wide, concolorous with the tepals for most of its length, green only at the base; tepals spreading dorsally and ventrally to 23-29mm wide, recurved and sometimes stained green apically; outer tepals (20) 23-29 (36)mm long, 5-6mm wide, apiculate, lanceolate, keeled, 2 of them situated laterally, one dorsally; inner tepals 20-26 (34)mm long, obtuse, oblanceolate-spatulate, margins undulate at the middle, 2 of them ca. 9.5mm wide and situated laterally above the 2 lateral outer tepals, the third one 5-7mm wide, ventrally declinate and with the lower lateral tepals forming a pseudolabellum. Stamens subequal, 8.5-11cm long, filiform, long-declinate, ascendent in their distal ¼, green; filaments dilated and connate in their proximal 2-3mm; globose nectar glands present at the perianth throat, each 1-2mm in diam.; anthers 5.5-6mm long, oblong; pollen green, the exine mostly tectate-perforate. Style 10-11cm long, green; stigma less than 1mm wide. Ovary ellipsoid, 6.5-9mm long, 4-4.5mm wide; ovules 20 or more per locule. Capsule 2.5-3cm long, 17-22mm in diam.; pedicel 5-6cm long; seeds numerous, blackish-brown, ca. 6.5mm long, 1.5cm wide. $2n = 46$. Flowering July-September and December-January.

ECUADOR. El Oro: between Santa Rosa and La Chorita, 0-100 m, Hitchcock 21139 (GH, NY, US). Chimborazo: Río Chanchan canyon between Naranjapata and Olimpo, terrestrial in rock wall crevices, 800 m, (ex hort), Horich ISI # 214 (UC). Between Huigra and Naranjapata, 600-1200 m, Hitchcock 20638 (GH, NY, US). Cañar: valley of Río Cañar near Rosario, 960 m, Prieto CP-18 (NY, S). Azuay: Road from Jiron to Pasaje, near Uzhcurrumi, dry, steep, rocky hillside, 840 m, Plowman et al. 4600 (GH), Plowman 7634 (F), Plowman 12024 (F).km 97 on road from Cuenca to Saraguro, dry thorn scrub, ca. 1100 m [incorrectly typed on specimen label as 2400 m], Madison et al. 7517 (SEL). Inhabiting semi-desert and dry, rocky canyons and hills of the lower inter-Andean valleys (100) 300-900 (1100) m. Endemic.

6. Descriptions of new taxa must be accompanied by a short Latin diagnosis or description. Holotype or isotype specimen should be deposited in an herbarium listed in the current edition of *Index Herbariorum*.

7. Literature citations should follow the Harvard system. Author and year of publication is cited in the text with placement of parentheses depending on sentence structure:

   One author: Doe (1989) or (Doe, 1989).
   Two authors: Doe and Stein (1990) or (Doe and Stein, 1990).
   Three or more authors: Doe et al. (1978) or (Doe et al, 1978).

If there are two or more references with identical authorship and year, use lowercase letters in alphabetical order as designation: Stein (1989a) or (Stein, 1989a).

Citations must be listed in alphabetical order at the end of the paper using hanging indentations. Only the first word in titles is capitalized. Sample literature formats are as follows:

Journal article:

Stebbins, G. L. 1984. Mosaic evolution, mosaic selection and angiosperm phylogeny. **Bot. Jour. Linn. Soc.** 88: 149-164.

Book Chapter:

Hammen, T. van der. 1979. History of the flora, vegetation and climate in the Colombian Cordillera Oriental during the last five million years. Pp. 25-32 *in* H. Larsen & L. B. Holm-Nielsen (eds.). **Tropical Botany.** Academic Press, London.

Book:

Prance, G. T. (ed.) 1982. **Biological Diversity in the Tropics.** Columbia Univ. Press, New York.

8. Figures accompanying contributions may be good quality line drawings, 35 mm transparencies, or high quality black and white or color photographs. Figure captions should be included in the manuscript following the literature citations.

9. Though HERBERTIA does not at this time assess page charges, assistance is welcomed if funds are available to defray costs of publication. Contact the editor at the address below for more information.

10. Manuscripts should be sent IN DUPLICATE to:

Editorial Office
HERBERTIA
International Bulb Society
UCI Arboretum
University of California
Irvine, CA 92717
United States of America.

BULB NEWS FROM AROUND THE WORLD

FRED MEYER
27609 MOUNTAIN MEADOW ROAD
ESCONDIDO, CA 92026 USA

BREEDING PROJECTS AND RESEARCH

DR. Alan Meerow of the University of Florida, Fort Lauderdale, Florida, has recently been awarded a grant to work on creating new hybrids with *Hippeastrum* species. The funding period will be from January 1, 1990, through the end of the year. Extension for this grant may run an additional two years. Funding is being provided by American Floral Endowment.

Dr. Mark Roh of the Florist and Nursery Crop Laboratory, United States Department of Agriculture, Agricultural Research Service, Beltsville, MD 20705, and Dr. Alan Meerow are currently working on a joint project aimed towards introducing *Eucrosia spp.* and interspecific hybrids. Their work focuses on flowering control, post-harvest, forcing time, clonal selection and bulb production. They are currently using a very nice clone of *E. bicolor* ($3n$). A paper on their preliminary results will be forthcoming.

Dr. Harold Koopowitz and Fred Meyer of the University of California at Irvine, along with Dr. Robert Griesbach and Dr. Mark Roh, are currently working on a joint project for the improvement of *Ornithogalum* cultivars for cut flowers and pot plant types. The color selections will be from orange, yellow gold, peach, cream buff, and salmon to white. Some of the new hybrids have greater lasting qualities as cut flowers and pot plants. Present breeding is focusing on the third generation.

University of California at Irvine hybridizers, working with the United States Department of Agriculture in some cases, and in other cases working on their own, are developing future and very near future releases of *Gladiolus* (both pot flower and cut flower types), *Sparaxis, Ixia, Tritonia, Eucomis, Oxalis, Tulbaghia, Babiana, Lapeirousia*, and several other genera.

Several new *Gladiolus* cultivars from the hybridizing work of Dr. Avner Cohen are being tested by Sun World Company in California. These hybrids represent the result of selected standard varieties crossed with *Gladiolus tristis*. The breeding work has been aimed at producing a cool-growing *Gladiolus*. From what this writer has seen, the potential of these hybrids is great. The distributor will be Agrexco, New Jersey.

Paul Winski, formerly of the University of Connecticut, has moved to Mojonier Co. in Encinitas, California. Mr. Winski's work at Mojonier will be in tissue culturing of *Alstroemeria*.

COLLECTING TRIPS

A successful springtime bulb collection trip into Chile was accomplished by Dr. Harold Koopowitz, University of California at Irvine; Dr. Koos Kostor, Lisse Bulb Research Center (LBO); and Dr. Mark Bridgen, University of Connecticut. Led by Dr. Adrianna Hoffman, the collectors explored the vast area in central to north-central Chile searching for bulbs and seeds of bulbous plants. Collecting was done only where local plant populations could handle a *very* slight reduction in the overall population. This collecting procedure is the only way one should collect from wild populations.

A return trip is expected for the mountains and southern half of Chile. Reports on the 1989 trip will be given during 1990, with talks and slide shows.

WORKSHOPS AND PAPERS

During 1991 – date not yet announced – there will be a workshop held on *Lillium* and new crops. This workshop will be held through the coordination of Dr. Mark Roh.

The Fifth International Symposium on flower bulbs was held in Seattle, Washington, July 10 through 14, 1989. Proceedings of the excellent papers presented will be made available in the future by the International Society for Horticultural Science.

A paper is being prepared on controlling the flowering of *Urginea maritima* clones for cut flower production. This work is being done by Peter McCrohan and Dr. Howard Scott Gentry in conjunction with Fred Meyer. The paper will be published in **Herbertia**.

COOPERATION AND COORDINATION BETWEEN THE INTERNATIONAL SOCIETY FOR HORTICULTURAL SCIENCE AND THE INTERNATIONAL BULB SOCIETY

On Saturday, February 25, 1989, a discussion meeting was held during the American Plant Life Society's International Symposium on Bulbous, Cormous and Tuberous Plants at Irvine, California. Participants in this meeting were R. J. Bogers (Lisse), G. Chastagner (Puyallup), A. Haley (Rehovoth), A. Kofranek (Davis), H. Koopowitz (Irvine), F. Meyer (Escondido), A. Pilgaard (Odense), A. Rees (Littlehampton), M. Roh (Washington, D.C.), and K. Sato (Sunto-gun). The subject of discussion was the future cooperation and coordination between the ISHS International Symposium on Flowerbulbs and the APLS Symposium.

The APLS Symposium concentrates on taxonomy, systematics, ecology, conservation and the development of new crops; besides specialied scientists, amateurs and commercial breeders are highly interested in this symposium. The ISHS symposium comprises the whole field of both fundamental and applied bulb research; the vast majority of the participants is formed by scientists. It was concluded that, although the two symposia appeal for a considerable part to different groups of people, a combination of both could be of mutual interest.

It was agreed that future APLS symposia preferably should be organized about halfway between the ISHS symposia; if the ISHS symposium is to be held in the USA, the two could be combined or at least they could be organied consecutively in the same place. Moreover, the name of the APLS symposium should be changed in order to stress the particular field it covers. Both symposia should be announced in APLS as well as in ISHS publications.

In addition, the suggestion was made to include representatives of the APLS in the new ISHS Working Group on Flowerulbs within the Section Ornamentals. Part of the task of the Working Group could be to draft proposals to ISHS and APLS about times and places of future symposia, to decide about main topics for sessions and workshops at the symposia and to appoint people both to (co-organize these sessions and workshops and to maintain contacts between those interested in a particular topic.

R. J. Bogers was found willing to act as the first chairman of the working group, with H. Koopowitz as the contact person for the APLS. The other participants in the meeting agreed to become members of the working group. At the ISHS symposium in Seattle, the further membership of the working group was discussed.

INTERNATIONAL SOCIETY FOR HORTICULTURAL SCIENCE WORKING GROUP ON FLOWERBULBS

FRED MEYER
27609 MOUNTAIN MEADOW ROAD
ESCONDIDO, CA 92026 USA

THE following is a brief report of a meeting held on July 13, 1989, during the Fifth International Flowerbulb Symposium at Seattle, Washington. The meeting was sponsored by the International Society for Horticultural Science. The group meeting was the Working Group on Flowerbulbs from the Section Ornamentals of the ISHS. Present at the meeting were most symposium participants.

The Working Group On Flowerbulbs was founded in the beginning of 1989 at the request of the ISHS head office. ISHS members actively working in flowerbulb research may join this group.

ACTIVITIES OF THE WORKING GROUP:

1. To set up and maintain a database of flowerbulb research (e.g., scientists, research topics, crops, etc.);

   The Bulb Research Centre. Lisse, The Netherlands, will send a questionnaire to all participants of the 4th and 5th symposia. A start will be made with a listing of current research.

2. To advise the ISHS Council on the dates and places of the coming ISHS Flowerbulb Symposia;

   The offer of the Polish delegation to organize the 6th Symposium in Skierniewice, June, 1993, was accepted. Contact person is Prof. Dr. R. M. Rudnicki. If for some reason it turns out to be impossible to have the 6th Symposium in Poland, Israel is willing to organize the 6th Symposium. In the latter case, ISHS should inform the Israeli representatives not later than during the summer of 1991.

   If the 6th Symposium takes place in Poland, Israel is willing to organize the 7th Symposium in the spring of 1997.

3. To decide about main topics for sessions and workshops at the symposia, and to appoint people both to (co-)organize these sessions and workshops and to maintain contacts between those interested in a particular topic;

   Dr. R. J. Bogers will contact the ISHS office, the organizers of the next symposium and representatives of various countries to discuss this matter.

4. To coordinate the contents, time and place of the ISHS International Flowerbulb Symposium and other bulb symposia, such as the American Plant Life Society's International Symposium on Bulbous, Cormous and Tuberous Plants.

   During the International Bulb Society's Symposium at Irvine, February, 1989, it was concluded that this Symposium concentrates on taxonomy, ecology, conservation and the development of new crops; besides specialized scientists, amateurs and commercial breeders are highly interested in the IBS Symposium.

The ISHS Symposium comprises the whole field of both fundamental and applied bulb research; the vast majority of the participants is formed by scientists, but interested firms also attend.

The overlap between topics that would be of interest to attenders of both groups' symposia, could be in the fields of breeding and taxonomy. Harold Koopowitz, Fred Meyer and R. J. Rogers will discuss this matter with other interested people.

The Working Group agreed with the suggestion to have the net IBSA Symposium in The Netherlands in the spring of 1992, to coincide with the Floriade World Horticultural Exhibition and the 75th anniversary of the Bulb Research Centre, Lisse. This Symposium could include a joint APLS/ISHS session on germ plasm and the use of wild species in plant breeding.

Mark Roh will organize a lily workshop in Korea in 1994.

COMMERCIAL BULB CONSERVATION

FAITH T.C. CAMPBELL
NATURAL RESOURCES DEFENSE COUNCIL
1350 NEW YORK AVENUE, N.W., WASHINGTON, D.C. 20005 USA

THE Natural Resources Defense Council (NRDC), TRAFFIC, and the British conservation organization Fauna and Flora [!] Preservation Society entered negotiations with the Dutch bulb industry last September in an effort to resolve bulb trade issues, particularly correct identification of bulbs which had been collected from the wild vs. propagated, and phasing out wild-source material. A second round of negotiations in late March resulted in agreement that the industry will start applying identifying labels to packages of *most* wild-collected bulbs *in time for the fall, 1990 selling season*. Recognizing the difficulty of dealers' proving origins of all bulbs, it was agreed to use a list of bulb genera to be considered of wild origin for the initial year. Bulb catalogs will, unfortunately, not contain this information until some future year because they have already been printed for 1990. In the future dealers will be obliged to check on the origin of the specific bulbs they are selling. Propagated "minor" bulbs will be labelled by 1992; all bulbs by 1995. Verification will be by the Dutch phytosanitary service. The Dutch and FFPS will press for all countries in the European Community to adopt this system and will also press their American counterparts to do the same.

As of Friday, 5 May, 1990, the labeling system was described by the lead Dutch negotiator as "in place but unofficial." He expects formal adoption by the Dutch Commodity Board when it next meets in several weeks. Assuming that the industry fully accepts the recommendations of its leaders, we can look forward to much greater certainty in purchasing species bulbs. Meanwhile, United States dealers imported nearly 106,000 wild Turkish *Cyclamen* through the Netherlands in 1989. 40% were imported by Langeveld Bulb Co.; over 30% by M. Van Waveren & Sons., Inc. of Mount Airy, North Carolina. A third major importer was Foster & Gallagher, Inc. of Peoria, Illinois.

BULB LABELING AGREEMENT

FAITH T.C. CAMPBELL
NATURAL RESOURCES DEFENSE COUNCIL
1350 NEW YORK AVENUE, N.W., WASHINGTON, D.C. 20005 USA

THE Dutch bulb industry has officially adopted the labeling program described in the Natural Resources Defense Council's May memorandum. There is one change: there will *not* be an identifying logo on the packages of propagated bulbs. When fully implemented in 1992, the agreement will enable you to purchase propagated species bulbs with confidence—and thus support growers rather than diggers.

The Dutch Commodity Board for Ornamental Horticultural Products now requires all Dutch growers and exporters:

- * beginning with the July, 1990 selling season, to put the phrase "bulbs from wild sources" on the package of all bulbs harvested from the wild. [In order to allow implementation of the agreement immediately, until 1992 such a label will be placed on all imported bulbs belonging to certain genera which all parties agreed are solely or primarily from wild-collected plants. The regulations do not yet require a distinguishing label for propagated specimens of these species, but many exporters will probably apply the label "bulbs grown from cultivated stock" beginning the summer of 1990.]
- * beginning in 1992 to label all minor bulbs as to origin. Wild-collected ones will be labelled as described above; propagated ones will bear the phrase, "bulbs grown from cultivated stock."
- * beginning in 1995 to label major bulb varieties -- tulips, daffodils, hyacinths, etc.— "bulbs grown from cultivated stock."

The Dutch industry will also voluntarily monitor trade in *Galanthus* bulbs to detect whether particularly rare species are included in shipments from Turkey. Finally, the industry supports a proposal by Fauna and Flora Preservation Society intended to stimulate propagation of native bulb species in Turkey (the source of most wild-collected bulbs now in trade).

Please note that until 1992 *both* propagated Dutch stocks of these species and wild-collected bulbs sold by nurseries not subject to the Dutch regulations may continue to appear without warning labels. Furthermore, the Dutch have insisted on using a term, "cultivated", which has been misused here by some nurseries. Please be careful if you are buying species bulbs, particularly those belonging to species listed here. Be certain that your seller is Dutch (and is not just using a Dutch-sounding name) and is complying with the regulations. Smith and Hawken and some other American nurseries have promised not to sell wild-collected bulbs.

A new flyer summarizing the substance of the agreement *and* information on several bulb groups is available from Dr. Campbell who can provide a few copies, but requestors must photocopy the number you need for mass distribution.

DUTCH BULB INDUSTRY, "WILD BULBS" CONSERVATION MEASURES

CAROL SUTTON, CANADA
AND
SALLY FERGUSON, USA
NETHERLANDS FLOWERBULB INFORMATION CENTER

THE Dutch flower bulb industry and international environmental organizations have reached an historic agreement designed to preserve threatened or endangered species harvested from the wild and to inform consumers of the origin of bulbs offered for sale by the Dutch worldwide.

The agreement was announced by Henk Westerhof, secretary general of the Dutch Bulb Exporters' Association, Hillegom, Holland. It culminates several months of negotiation between the Dutch bulb industry and leading U.S. and British environmental organizations.

Mr. Westerhof emphasized that the agreement covers only the three-phase arrangement for labeling of bulbs, but the Dutch are taking an additional step on their own initiative by setting up a monitoring system for *Galanthus* imported into Holland during 1990. He said the Dutch bulb industry is pleased with the cooperative relationship that has developed with the environmental organizations.

The Dutch group composed of researchers, growers, plant health authorities and exporters met with officials of the Natural Resources Defense Council, the World Wildlife Fund (TRAFFIC USA), and the Flora and Fauna Preservation Society of England. The agreement applies only to flower bulbs exported by Dutch bulb companies.

THREE STAGE LABELING SCHEDULE TO COMMENCE THIS SUMMER

Citing a "willingness to work together" on the problem that arose in connection with trade in certain *Galanthus* and certain minor bulbs, principally those harvested from the wild in Turkey, Mr Westerhof said the agreement entails the following three-stage labeling schedule to commence this summer:

1) Beginning with the July, 1990 selling season, flower bulbs harvested from the wild will be marked "Bulbs from Wild Source" on the packaging. In fact, Mr. Westerhof said, all Dutch exporters are now required to mark packages in accordance with the agreement. The labeling ensures that consumers are fully informed of bulb origin.
2) Beginning in 1992, cultivated minor bulb plants will bear labels of origin and will be marked "Bulbs Grown From Cultivated Stock."
3) Beginning in 1995 , major bulb varieties – tulip, daffodil, hyacinth, etc. – also will be marked "Bulbs Grown from Cultivated Stock."

ALL DUTCH BULB COMPANIES WILL LABEL AS AGREED

The agreement, which was confirmed May 22 by the Dutch commodity Board for Ornamental Horticultural Products in The Hague, has the full support of the Dutch bulb grower and exporter organizations. The Commodity Board is the chief regulatory body of the industry and its rules must be followed by all Dutch growers and exporters.

Mr. Westerhof said that although only one-half of one percent of all the bulbs traded through the Netherlands come from wild sources, the Dutch organizations view the issue of threatened or endangered species very seriously and will take additional steps to ensure the survival of the various species through cultivation.

In this light, the Dutch flower bulb industry has agreed to support the propagation project proposed by the British Flora and Fauna Preservation Society which is intended to stimulate cultivation of certain minor bulb plants in Turkey.

At present, 95 percent of the nearly 10 billion flower bulbs sold annually by Dutch exporters are propagated and grown within the borders of Holland; 4.5 percent are purchased from growers in other countries; and 0.5 percent of bulbs sold by the Dutch are collected from the wild, mainly from Turkey.

DUTCH LAUNCH VOLUNTARY MONITORING PROGRAM FOR GALANTHI

Galanthus (snow drop) was placed on Schedule II of the Convention of International Trade in Endangered Species (CITES) in January, 1990. This means that trade in galanthi can continue, but under strict governmental control. CITES is a 100-nation international convention designed to govern trade in endangered species of all kinds.

To supplement the CITES arrangement, the Dutch bulb industry has taken the initiative to have the Netherlands Plant Health Inspection Service take samples of all consignments of galanthi imported into Holland during 1990. The samples will be planted at the bulb industry research center in Lisse, Holland to be tested for purity and quality. The results will be discussed with the conservation organizations to determine whether further measures to protect the species are needed.

In order to play a more active role in dealing with questions concerning threatened or endangered species, the Dutch bulb industry has applied to the Plants Committee of the CITES for "observer" status. Mr. Westerhof said such status would enable the industry to make positive contributions to CITES deliberations in the future.

The complete list of bulbs affected by the new labeling system is attached. Further information may be obtained by contacting Mr. Westerhof in Hillegom, Holland at telephone number: 011 31 252018544 (EDT plus six hours).

LIST OF BULBS TO BE LABELED UNDER STAGE ONE OF THE BULB ORIGIN LABELING PROGRAM EFFECTIVE WITH THE 1990 SELLING SEASON COMMENCING JULY, 1990

Note: Some of the bulbs listed below are also cultivated in Holland, as well as grown in the wild elsewhere. Thus, conscientious consumers should not necessarily avoid the bulbs listed here.

Rather, as of this year, *all Dutch companies* will mark packages of these bulbs to indicate whether they are "grown from wild sources."

Those bulbs grown in Holland from cultivated stock will not be labeled "grown from cultivated stock" until 1992, under terms of the agreement.

Of further note, *not all of the bulbs listed below are traded by Dutch companies.* Other countries may trade in these bulbs, but they are not bound to the labeling agreement mounted by the Dutch bulb industry and U.S. and British environmental groups.

— *Anemone blanda*
— *Arisaema* spp.
— *Cardiocrinum giganteum*
— *Cyclamen*, except *Cyclamen persicum*
— *Cypripedium* spp.
— *Dracunculus* spp.
— *Eranthis cilica*
— *Eranthis hyemalis*
— *Galanthus*, except *Galanthus nivalis*
— *Iris acutiloba*
— *Iris siberica* ssp. *elegantissima*
— *Iris kopetdaghensis*
— *Iris paradoxa*
— *Iris persica*
— *Iris tuberosa*
— *Leucojum aestivum*
— *Leucojum vernum*
— *Narcissus asturiensis*
— *Narcissus bulbocodium* ssp. *conspicuus*
— *Narcissus bulbocodium* ssp. *tenuifolius*
— *Narcissus cyclamineus*
— *Narcissus juncifolius*
— *Narcissus rupicola*
— *Narcissus scaberulus*
— *Narcissus triandrus albus*
— *Narcissus triandrus concolor*
— *Pancratium maritimum*
— *Sternbergia*, all species
— *Trillium* spp.
— *Urginea maritima*
– *Uvularia*

HISTORY OF NERINES IN NEW ZEALAND

IN 1954, Mr. Richmond E. Harrison, world renowned bulb and perennials authority and published author on that subject, brought to New Zealand a collection of the Rothchilds' Hybrid Nerines. Mr. Harrison, with his manager, Mr. Wallis Hart, began a breeding program in Palmerston North, New Zealand, releasing some of the hybrids in the mid-1970's. Relatively small numbers of bulbs were sent around the world.

In 1976, Mr. Maurice D. Hollows, a prominent New Zealand flower grower who supplied a large part of the domestic chrysanthemum market, trialled several hundred *Nerine* bulbs as cut flowers.

Detailed research into the nature and characteristics of the nerine as a bulb and a cut flower was undertaken by the Plant Physiology Division of New Zealand Department of Scientific and Industrial Research (D.S.I.R.). That research included work on bud initiation, temperature and light factors, propagation techniques and growth regulators.

For five years the Molecular Genetics Group of Grasslands Division of D.S.I.R. has researched ways of improving existing nerine hybrids and species through somacloning and recombinant D.N.A. technology. This research has been successful in creating new, exciting clones.

During the 1980's, extensive world travel by Mr. Maurice Hollows was undertaken to examine the market potential of nerines. Working with Mr. Hollows was the Hon. J. A. Walding, former Minister of Overseas Trade in the New Zealand government, and a prominent businessman and exporter. The commercial considerations of growing and marketing nerines received careful attention.

Also during this period, a close association developed with Mr. Tony Norris of the United Kingdom, the only known commercial producer of hybrid nerines. In 1987, Mr. Hollows negotiated the purchase of Tony Norris' nerine bulb stock and contracted Mr. Norris as a consultant and breeder.

The company Nerine Nurseries was formed in 1986. Today, Nerine Nurseries Limited is positioned to project nerines as a major cut flower and pot plant on to the world market. A continuing commitment to intensive research, high health production and marketing will ensure the success of the nerine and the on-going development of new and exciting cultivars.

SISTER SOCIETIES' NEWS

HIPPEASTRUMS
WESTERN AUSTRALIA REPORT, 1989

MRS. J. TOUDUT, SOCIETY SECRETARY

THE flowering season in Western Australia spreads over several weeks as in the western coastal States of the U.S.A. Each district in the county has its district show in turn, starting in the northern areas in early September, progressing southwards as the season gets warmer. The close is usually mid-November on the south coast. In the Metropolitan area the Royal Show, an eight day show of all horticultural classes, is conducted by the Royal Agricultural Society of Western Australia (Inc.). They call on the Western Australian Horticultural Council for volunteers to run the show during the course of the eight days. These volunteers come from the Societies affiliated with the Council such as the West Australia Gladiolus, Dahlia & Hippeastrum Society. The show is divided into three separate schedules which run for 2-3 days each consecutively. The 1989 dates were Saturday, 30th September to Saturday, 7th October.

During this period a closely grouped display of Hippeastrums was maintained daily, consisting of 30, 7-inch pots. Being of many colours and tones it was a real eye-catcher. Altogether 80 pots were shown over the 8 days. In addition, entries for competition were staged. The Royal Show Hippeastrum Championship calls for 4 pots (not necessarily distinct) and 3 entries were received. The winner was R.J. and L.J. Larsson.

The weather leading up to and during the show was most difficult to cope with as 5 inches of rain were recorded the previous 45 days to the show. On 20 of those days no rain fell, although the thermometer was low, 15°C to 18°C, and the sky was overcast nearly all the time. The low temperatures caused the flowers to open up two at once, then two more some 5-10 days later. This condition made it very difficult to produce a scape with 4 florets fully expanded.

Twelve days following the Royal Agricultural Show, the West Australia Gladiolus, Dahlia and Hippeastrum Society (Inc.) held the State Hippeastrum Championship and the State Gladiolus Championship. The venue being the Main Entrance Hall at "The Booragoon Garden Centre" shopping centre. Once again the weather played havoc with flowers and entries were very light on, but due to a surplus of blooms not quite up to judging requirements a very good colourful mass display was presented. The state champions were:

Hippeastrums—R.J. and L.J. Larsson	4 pots of Hippeastrums.
Gladiolus—H.J. Shaw	6 large flowered, cut Gladioli.

In addition, the management of Garden City sponsored championships for Gladioli, Hippeastrums, Iris and informal floral art.

No mention has been made of Dahlias as they are in a rest stage. The State Dahlia Championship is held at the Garden City venue in late March or early April, depending on the fall of Easter.

Members of our Society travelled to Country Centres, Brunswick and Busselton with displays of Hippeastrums, while at Albany the Albany Agricultural Society sponsored championships for Gladiolus and Hippeastrums and the West Australian Gladiolus, Dahlia and Hippeastrum Society (Inc.) also donated a trophy to the winner of the Gladiolus and Hippeastrum championships. The Great Southern Championship for Dahlias is held in March sponsored by the Royal Agricultural Society and conducted by the Albany Agricultural Society. This district is growing especially good flowers and competition is very keen.

I have only covered the activities of our own Society and Genera. There are lots of smaller district shows that all cater for Hippeastrums and Gladioli; they are the District Agriculture Shows mentioned at the beginning of this report.

All in all I can say that the future of Amaryllids, and particularly Hippeastrums, is assured in Western Australia. What we would like to see is more information on Hippeastrums in every publication of the Plant Life Society and Herbertia.

COASTAL BEND AMARYLLIS SOCIETY SHOW NEWS

MRS. BILL M. MILLER, SECRETARY
2805 AUSTIN STREET
CORPUS CHRISTI, TX 78404

The Coastal Bend Amaryllis Society held an exhibit at Sunrise Mall in Corpus Christi, Texas on April 14, 1990. There were 16 entries. The number of amaryllis exhibited was not as plentiful as in the past, possibly due to the freeze that contributed to premature blooming. The Corpus Christi Daylily Society exhibited with us and featured two baskets of early blooming daylilies.

SHOW AWARDS ANNOUNCED BY MEN'S AMARYLLIS CLUB

L.W. MAZZENO, JR.
944 BEVERLY GARDENS DR.
METAIRIE, LA 70002
(504) 833-3595

AGAIN the annual flower show sponsored by the Men's Amaryllis Club of Greater New Orleans, Inc., was a huge success witnessed by thousands of viewers. It was their 30th annual show and it took place at the Lakeside Shopping Center Mall, Metairie, Louisiana, on Saturday, April 21st, 1990.

Silver trophies were won by the following:

The Walter R. Latapie Sr. Memorial Trophy and "Best-in-Show" rosette was won by Tim A. Calamari, Jr. of Metairie with a 'Pamela'. The James E. Mahan Memorial Trophy for best registered and named hybrid was won by Tim A. Calamari, Jr. with a 'Pamela'. The George Merz, Jr. Trophy for best unnamed and unregistered hybrid in Section II was won by Ed Schellhaas of Kenner. The Robert Diermayer Memorial Trophy for best registered and named specimen in cut flowers, Section VII, was won by Vic Pannell of Metairie.

The John McMeekin Trophy for best registered and named specimen in cut flowers, Section VII, was won by Al Diermayer with a 'Martine'. The Evon Kruse Trophy for best unregistered and unnamed specimen in cut flowers, Section VIII, was won by Tim A. Calamari with a seedling. The Oscar J. Robert, Sr. Trophy for the best potted three-floret hybrid was won by Al Diermayer with a 'Dazzler'. The Gautier Family Trophy for the best registered 2-floret specimen was won by Vic Pannell with an 'Apple Blossom'. The Mark Pannell Memorial Trophy for the best unregistered, 2-floret specimen was won by Elmer Kinabrew of Kenner.

The Laurence Mazzeno, Jr. Trophy for best potted miniature hybrid, Division 8, was won by Tim A. Calamari, Jr. of Metairie with a 'Pamela'. The Vincent J. Peuler Trophy for best large, red specimen in show, was won by Al Diermayer with an 'Athos'. The Jerome E. Peuler Trophy for best single floret in Section IX, named and registered, was won by Holly Bowers of Metairie with a 'Pamela'. The Elmer Kinabrew Trophy for best single floret in Section IX, unnamed and unregistered, was won by Lester Laine of Metairie. The David L. Heikamp Trophy for best double flowered, single floret specimen in Section IX was won by Hilda Latapie of New Orleans. The MAGNO Club Trophy for most first place ribbons in cut specimens was won by Tim A. Calamari, Jr. The Tim A. Calamari, Jr. Trophy for most blue ribbons won by a member of the Men's Amaryllis Club of Greater New Orleans, Inc., was won by Al Diermayer.

Besides all of the above, blue ribbons were also won by Vincent Peuler and Ms. Hunter, both of New Orleans; and L.W. Mazzeno, Jr., Corinne Godbury, and Cathy Gautier, all of Metairie. Lester Laine of Metairie also won the single floret trophy for best runner up in the doubles category.

SOUTHERN CALIFORNIA HEMEROCALLIS AND AMARYLLIS SOCIETY'S MAY 16, 1990, AMARYLLIS SHOW BULB SALE

CHARLES HARDMAN
4435 CENTER STREET, BALDWIN PARK, CA 91706-2337 USA

THE bulb sale at the April Amaryllis show marked another success for the Southern California Hemerocallis and Amaryllis Society (SCHAS). In spite of the fact that top-quality bulbs were offered at bargain basement prices and that the Los Angeles State and County Arboretum (where the show and sale are held) retains a portion of the proceeds, the Society still turned a handsome profit on the sale.

Time was when people would come to SCHAS's springtime Amaryllis shows, admire the gorgeous flowers and ask, "Where can I buy bulbs like these?" Show hosts would tell them, "You'll have to wait until autumn. That's when the nurseries will have them for sale again." By autumn their enthusiasm would be gone and the Society had lost dozens of opportunities per Amaryllis show to promote one of our favorite flowers.

Now, with a huge bulb sale, SCHAS was able to satisfy show attendees' quite natural desires to grow some of the world's most beautiful flowers. This helps convert Amaryllis admirers into Amaryllis growers, and promotes the Society's goals while earning money for our scholarship and computer funds. At the April, 1990, show *every* bulb sold, including not only the hybrid Amaryllis, but also a few *Habranthus* and *Crinums*. Many more bulbs could have been sold, had they been available.

Meanwhile, the SCHAS June daylily sale is coming up. If the daylily plants and sample blooms are available and we do well selling them, a considerable amount should be earned toward the Society's operating expenses for the next year. And then there is the giant autumn bulb sale scheduled for mid-November featuring top-quality Amaryllis, daffodil, and pre-cooled tulip and hyacinth bulbs (and maybe a few daylilies) — all at bargain prices. It is an opportunity for salegoers to buy their 1991 Amaryllis show winners.

There were a number of prizes awarded at our 1990 Amaryllis Show — including two rosettes on the top awards table — which were awarded to Amaryllis flowers produced by bulbs sold at our November, 1989, giant autumn bulb sale. There is no reason why one can't grow winning Amaryllis flowers. It's fun and the Amaryllis bulbs do most of the work.

INFORMATION SOUGHT ON THREE MEMBERS OF THE AMARYLLIDACEAE

EILEEN E. MILLER
323 EGRET PLACE, STUART, FL 34996 USA
(407) 287-6747

HIPPEASTRUM DUTCH HYBRIDS

The American Plant Life Society Newsletter (Quarter IV 1986), reported that a second large Amaryllis exhibition was held at Beloeil Castle in Hainault, Belgium, displaying about 1500 flowers from the collection of Leo Berbee & Sons, Lisse, The Netherlands, with 10,000 people in attendance. The 1987 Park Seed Co. flowers and vegetables catalog introduced a new Park exclusive: Amaryllis 'Apricot Sensation', which was "chosen by Europe's top bulbsmen to be presented at the annual reception honoring the cream of new Amaryllis that the Prince and Princess de Ligne of Belgium give each year at Beloeil, their palace in the Belgian countryside".

Amaryllis Incorporated in Baton Rouge, Louisiana, sent a beautiful 36 page 19th Edition Catalog booklet of **Ludwig Amaryllis**, Ludwig & Co. N.V., P.O. Box 18, Hillegom-Holland. The entire catalog is in color, with 25 color pages of individual Dutch hybrid varieties shown. Also available from Amaryllis Incorporated was a large color poster illustrating 25 individual Hadeco hybrid varieties of amaryllis (*Hippeastrum*).

Eileen Miller would like to establish a personal collection of bulbs, evenly distributed among early-, mid- and late flowering varieties to grow in Florida. Any means of collecting complete information on modern available Dutch hybrid varieties, either through published color sources or organized visits or invitations to Europe would be helpful. Any information in this regard may be sent to the above address.

CLIVIA MINIATA (KAFFIR LILY)

The book **Bulbs: How to Select, Grow and Enjoy** (G. Scott/HP Books 1982) includes photographs of yellow flowered *Clivia miniata* and reports that " hybrids have flowers varying between yellow and dark orange-red". **Herbertia** (Vol. 40, 1984) includes a color photograph of a yellow flowered *Clivia miniata* var. *flava*. **Ortho's Complete Guide to Successful Houseplants** (1984) reports that " French and Belgian hybrids bloom in yellow to deep red-orange." **Garden Bulbs in Color** (J.H. McFarland 1938) reports of *Clivia miniata* that "more than sixty hybrids are known, varying in color from cream to orange." The spring, 1986-87 catalog for International Growers Exchange, Inc. (Livonia, MI) included the following four entries in the "Rare and Unusual Bulbs From the World's Most Famous Nurseries" section: (1) *Clivia caulescens*, salmon with yellow—$17.50 each, (2) *Clivia×cyrtanthifolia*, red & yellow—$17.50, (3) *Clivia miniata×Hippeastrum* , pink—$75.00 each and (4) *Clivia miniata* hybrids, crosses—$25.00 each. Any information regarding a source for yellow, cream, white or pink varieties of *Clivia miniata* by way of a post card sent to me would be appreciated.

CYRTANTHUS SPECIOSA (SCARBOROUGH-LILY)

Of *Cyrtanthus* (*Vallota*) *speciosa* the book **Bulbs: How to Select, Grow and Enjoy** (G. Scott/HP Books 1982) reports that "white and pink varieties are sometimes available." Sunset's **How to Grow Bulbs** (1971) says of *Vallota speciosa* that "a white-flowered form is less often seen." Peggy Schultz, in **Amaryllis and How to Grow Them** (1954), includes the following entry in her description of *Vallota speciosa*: "var. *alba*: white flowers. The small, amaryllis-like flowers are borne in groups of three to ten." Any information regarding a source for white or pink varieties of *Cyrtanthus speciosa* provided will be very much appreciated.

CONSERVATION AND BULBOUS PLANTS

HAROLD KOOPOWITZ
ARBORETUM, UNIVERSITY OF CALIFORNIA, IRVINE, CA 92717
UNITED STATES OF AMERICA

DURING the last few years there has been a growing awareness of the possibility of over-collecting of wild bulbous plants for the horticultural trade. This has resulted in the placement of some Turkish bulbous plants on the CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) appendix 1. Despite the fact that collecting for commercial use has seriously impacted some wild populations, the major threat remains the conversion of wild bulb fields to agriculture. This is particularly true on the Iberian peninsula, as well as other regions.

It is my opinion that much of the hype about the collection and sale of wild flower bulbs was built more on ignorance rather than fact. When flower species on sale in the bulb market were first tallied it was clear that no distinction was made between domesticated and propagated species and wild species. It seemed much more dramatic to lump the two together, despite the fact that many of the tulip species in the trade were selections that had been painstakingly built up and propagated for decades. Rumors still occur that pictures purported to show piles of bulbs of *wild stocks* of *Galanthus* bulbs were in fact pictures taken from farmed stock. Was there really a misrepresentation of the true situation by idealistic conservationists or an honest mistake?

One should also be aware that there is a sentiment among the growing conservation movement that wild species should not be cultivated or kept in private hands. They neglect the fact that all domesticated plants have their roots in wild species and that the species are the basic building blocks for creating new kinds of flowers. They also forget that it is in private collections where much of the germplasm of rare varieties and species is maintained. In the future we most probably will have cause to be grateful for such genetic treasures.

What are the alternatives to complete bans on trade in wild, bulbous species? Perhaps these should be considered before taking precipitous actions in the future. a) Sustainable harvests from the wild. This is probably the most desirable because it produces incentives to leave areas relatively untouched. If all trade is halted it becomes more likely that land will be converted to other agricultural uses. This kind of policy requires regulation and would be similar to some trade regulations in the fishing industry. b.) Trade in farmed species. This is often considered the best approach by conservationists but does not always work. When the international ban on trade in wild species of the slipper orchid *Paphiopedilum* came into effect several countries also banned artificially propagated species. Consequently in Australia trade in *Paphopoedilum delenatii*, which has not been collected in the wild for over 50 years, was also banned despite the fact that there are hundreds of thousands of artificially propagated plants in cultivation, all of which were derived from a single specimen collected decades ago. We must be careful that this situation does not happen to bulbous species, as well.

Many bulbous plants are endangered but often they prove easy to cultivate and propagate. Examples of such species are *Gladiolus aureus*, *G. watermeyeri*, *G. citrinus*, *Morea loubeseri*, *M. atropunctata*, and *Ixia maculata*, which have been saved from the brink of extinction by being brought into cultivation.

ALLIUM TARDIFLORUM KOLLMANN & SHMIDA A NEW AUTUMN-FLOWERING SPECIES

FANIA KOLLMANN AND AVI SHMIDA
DEPARTMENT OF BOTANY
THE HEBREW UNIVERSITY OF JERUSALEM
GIVAT RAM, 91904 JERUSALEM, ISRAEL
AND
O. COHEN
THE SOCIETY FOR THE PROTECTION OF NATURE IN ISRAEL
ROTEM
JERUSALEM, ISRAEL

ALLIUM tardiflorum, the only autumn-lowering *Allium* species in Israel, is described. It is endemic to Mount Carmel. The main habitats of this species are northern and western steep slopes in clearings of *Pinus halepensis* forest. The relationships of *A. tardiflorum* with other autumn-flowering Mediterranean species of sections *Scorodon* and *Codonoprasum* are discussed. As in other species of section *Codonoprasum* in Israel, the bud of the inflorescence in *A. tardiflorum* is formed in April, but the opening of the spathe-valves and flowering are delayed to September-October. This peculiar phenology of autumnal flowering is discussed in relation to strategies of other geophytes. Some possibility of self-pollination in this species is suggested.

The phenomenon of the autumn-flowering of geophytes in Israel and all the Mediterranean area was presented by Dafni *et al.* (1981). In the summer-arid Mediterranean climate there are only a few plants flowering in autumn (September-November, Shmida & Dafni), among them 26 geophytes which, in fact, represent about 70% of all species flowering during autumn. Their food-storing organs enable the geophytes to delay their flowering until autumn, thus providing them with a relative ecological advantage over other plants: the low competition for pollinators and greater efficiency in transportation of pollen within the same species (Shmida & Dafni).

Studies of bulbs of cultivated geophytes show that the trigger to the growth of the bud and its flowering are temperature changes (Rees 1985 a & b; Boeken & Gutterman 1986), but initiation of flowering may also be dependent on day length (Evenari & Gutterman 1987; Gutterman & Boeken 1988).

The vast majority of *Allium* species in Israel flower in spring or early summer. A delay in flowering time with increase in altitude (up to 2800m) was observed in *Allium* species on Mount Hermon (Shmida & Kollmann 1977). There are, however, differences in flowering time in different sections of the genus in Israel. Generally, species of sections *Molium* (except *A. carmeli*) and *Melanocrommyum* are first to flower (February-April); next come species of section *Codonoprasum* (April-May), whereas species of section *Allium* are the latest to flower (May-June.) An exceptionally late flowering (September-October) *Allium* species of section *Codonoprasum* was found in some localities on Mount Carmel (Israel) at 350-500m (Map 1). It is the only *Allium* species in Israel flowering in autumn. This taxon is described and discussed in the following.

Allium tardiflorum Kollmann & Shmida, species nova (Figures 1-5). Bulbus ovoideus 1.5 - 2(-3)×1-1.5 (-2)cm. Tunicae exteriores membranaceae, nigricantes vel brunneo-nigrae, in lacinias solutae, secus caulis basin adscendentes et in collum productae. Tunicae interiores et vaginae foliorum inferiorum purpureae. Scapus 40-60 (-70)cm altus, ad 75% oius longitudinis foliatus. Folia 3-4, 10-30cm×1-2mm, fistulosa, teretia, cum parte inferiore supre subapplanata. Spatha persistens, valvis binis, saepe dia non separatis, valva longior, 7-16(-20)cm longa. Umbella (2 – 3-4cm diam., floribus (7-15-20(-30). Pedicelli 1-2cm, subaequales. Perigonium campanulatum, segmenta 6-7mm longa, obovata ad oblonga, apice obtusa, interiores exterioribus latiora, virenti-vinaceae, nervo medio lato, purpureo et parte superiore striis purpureis, post anthesis omnino atrovinaceae vel purpurea. Filamenta simplicia, perigonio breviora, saepe basi purpurescentia. Ovarium ellipsoideum, apice rotundatum, stipitatum. Stylus inclusus, capsula ca. 5mm diam. Semina 3.5-4.5mm plana.

Holotype: Mt. Carmel, Nesher quarry, on chalky, disturbed soil, 6.10.1987, *Cohen* (HUJ).

Selected specimens: Carmel, Al Khureiba, 400m, 1.10.1979, *Lahav & Gertman*; Nahal Yagur (Nahal Svach), 9.10.1979, *Lahav & Gertman*; Yagur, end 9.1980, Lahav; Upper Nahal Nesher, 6.1.1988, *Cohen*.

A. tardiflorum was found in five localities in the northern and central parts of Mount Carmel (Map 1). There it occurs in different habitats and soil types such as soil pockets in hard limestone rocks or soft, chalky rocks mixed with gravel, in *Quercus calliprinos* and *Pistacia palestina* associations. However, the main habitats of this species are clearings (ca. 7-20m in diameter) in *Pinus halepensis* forest. Along the upper part of Nahal Nesher a large population of about 2000 individuals of *A.tardiflorum* was found in associations of *Pinus halepensis* and *Hypericum serpyllifolium*. In these clearings *Bromus syriacus* and *Carex divulsa* ssp. *leersii* predominate. They are accompanied by *Genista sphacellata*, species of *Orchis* and *Ophrys* and other companions usually found in maquis.

The substrate on which this species occurs is chalk of the Upper Cenoman (Khureibe formation). On this bedrock, dark rendzina, rich in organic matter, is formed, and provides apparently optimal conditions for growth of this species. *A. tardiflorum* occurs mainly on western and northern steep slopes (but it grows also on eastern and northern slopes) in half-shaded places. It is absent from understory with a 100% covering of woody plants.

Several late-flowering (September-October) *Allium* species occur in the southeast Mediterranean: *A. chamaespathum* of section *Allium* and 3 species of sections *Scorodon* and *Condonoprasum*. These are *A. autumnale* Davis (1960), endemic to Cyprus, *A. callimischon* Link ssp. *callimischon* from southern Greece (Peloponnesus), *A. callimischon* ssp. *haemostictum* Stearn (1898) from Crete and southwestern Anatolia, and *A. tardans* Greuter & Zahariadi (1975), confined to Crete and Karpathos* in different sections. We have examined one of the specimens (No. 18017) collected by Davis in Karpathos and agree with its identification (Davis 1953) as *A. paniculatum*. This plant has a many-flowered, dense umbel (in *A. tardans* it is rather few-flowered and lax.) The bases of spathe-valves are ovate, whereas in *A. tardans* they are narrowly triangular. In addition, it flowered on the 20th of July, whereas *A. tardans* flowers in September-October. Thus, *Allium* taxa flowering in autumn may have developed independently and in different areas of the eastern Mediterranean.

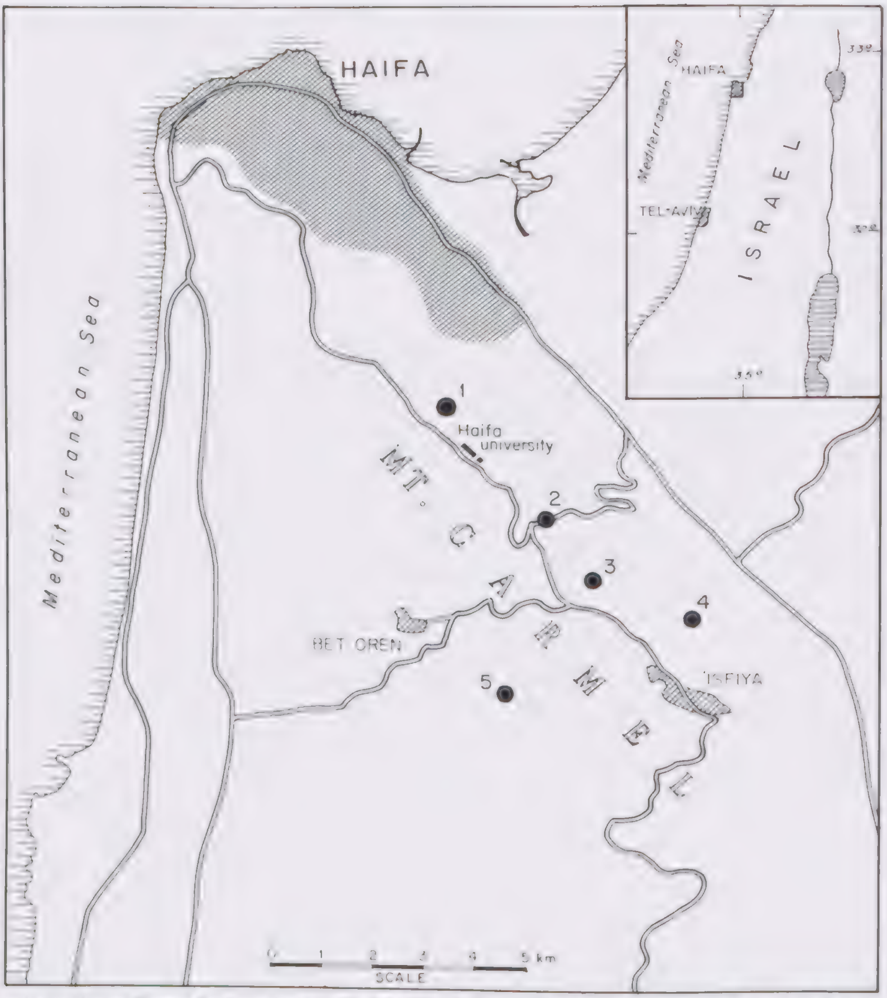
A. autumnale, *A. callimischon* and *A. tardans* are characterized by leaves sheathing the stem nearly up to the umbel; in the late-flowering *Allium*pecies in Israel the leaves are sheathing the stem to (½-) -¾ of its length. *A. autumnale* and *A. callimischon* have a 1-valved spathe, usually shorter than umbel (Figure 1); in *A. tardans* and *A. tardiflorum* the spathe is usually 2-valved, but in *A. tardiflorum* the valves remain attached to one another, separating relatively late (Figures 1 & 2).

Thus, *A. tardiflorum* is most closely related to *A. tardans* (Table 1). It differs from the latter by the color of perianth segments, greenish-wine colored in *A. tardiflorum*, pink or brownish pink in *A. tardans*, as well as by the length of spathe valves, the longer valve reaching 7-16 (-20)cm in *A. tardiflorum*, whereas in *A. tardans* the longer valve is only 2.5-4cm long. The two differ also by the height of stem, 40-60 (-70)cm in *A. tardiflorum* as against 8-30cm in *A. tardans*. In *A. tardans* the median bulb tunics are described as reddish-brown, whereas in *A. tardiflorum* the inner bulb tunics and the lower leaf sheaths are intensely purple. The two species differ also by number of flowers in the umbel and by length of perianth segments. Another difference is the shape of midvein in perianth segments: in *A. tardans* it is narrow-linear, whereas in *A. tardiflorum* it is evidently broadened (Figure 3).

The late-flowering *Allium* taxon in Israel could, therefore, not be referred to any of the three species mentioned above. On the other hand, in height of stem, length of spathe valves and included stamens, *A. tardiflorum* is possibly close to *A. paniculatum*. However, it differs from *A. paniculatum*y the purple color of inner bulb tunics and of lower leaf sheaths; the pedicels are subequal, 1-2cm long, while in *A. paniculatum* they are very unequal, 1-7cm long; the ovary in *A. paniculatum* is twice as long as broad and narrowed at apex, whereas in *A. tardiflorum* it is broader and rounded or truncate at apex. Our plants were previously identified as *A. paniculatum* subspecies *fuscum* (Waldst. & Kit.) Arcangeli (Kollmann 1986). The latter has, however, brownish-green and not greenish-wine colored perianth segments and it flowers in Europe earlier (July-August).

Biological and phenological observations were carried out on populations *A. tardiflorum* in their natural habitats. In addition, four plants of this species from a natural population of Mount Carmel (Nahal Nesher) were transplanted to the Judean Mountains (Tzur Hadassah) at the end of the flowering time (15.10.1987). They were grown for observation without irrigation.

In the following course of development of the plant is described. Flowering starts in the middle of September, maximum flowering taking place at the beginning of October. The inflorescence in *A. tardiflorum* opens successively from top to bottom, comprising at one time open flowers, withered flowers and buds (Figures 2 & 3). As in other *Allium* species, proterandry predominates. At anthesis the filaments elongate and bend towards the center of the flower. After the pollen is shed the filaments straighten again and acquire their primary position near the perianth segments; then about 99% of them are without anthers, which apparently fall down after having shed the pollen. The style elongates slowly and reaches its full length mostly after five of the stamens have reached maturity. Very often one stamen (80%), rarely two (20%), still remain in the center of the flower (Figure 3). This may indicate that at the end of the flowering time there is some overlapping of the dehiscence of the anthers of the same flower may occur. The phenomenon of some autogamy at the end of the flowering time was observed also in other *Allium* species, such as *A. pulchellum* and *A. rotundum* (Kirchner, Loew and Schröter 1934, *A. triquetrum* (Vet Brat 1965) and *A. ampeloprasum* (von Bothmer 1974). No pollinators were observed during 12 hours of careful observation. The scarcity of pollinators may correspond with the adaptation towards selfing.



Map 1. Mount Carmel Region, south of Haifa, showing distribution of *Allium tardiflorum* in Israel. 1. Nahal Ben-Dor; 2. Nesher Road; 3. Nahal Nesher; 4. Nahal Yagur; 5. Har 'Argan.

Figure 2. Inflorescence and spathe of *Allium tardiflorum*

Figure 1. Habit of *Allium tardiflorum*

Figure 3. Part of inflorescence (ca. ×7.5)

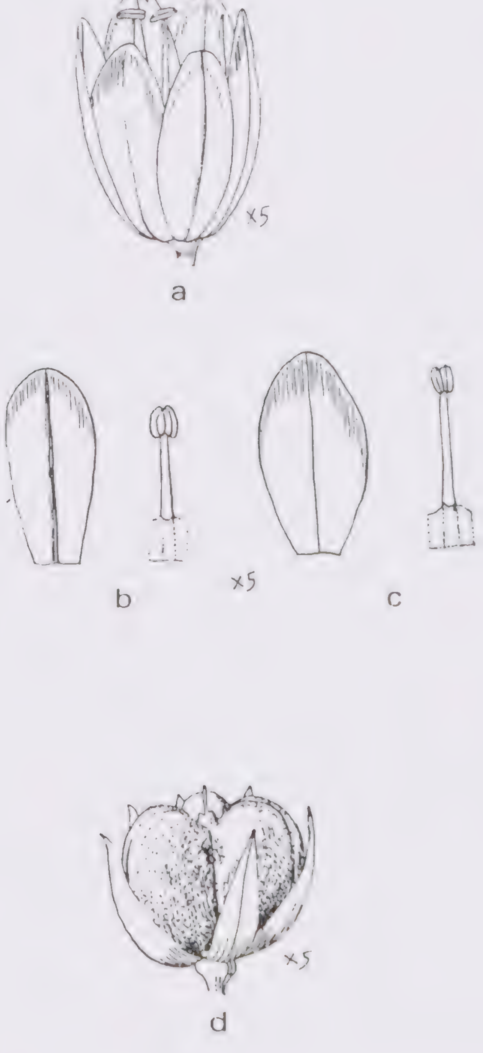


Figure 5. Flower and floral parts
- a. Flower
- b. Outer perianth-segment and stamen
- c. Inner perianth-segment and stamen
- d. Capsule with perianth.

Figure 4. Bulb with lower part of stem

Table 1. Autumn-flowering species of *Allium* (Sections *Scorodon* and *Codonoprasum*)

Species:	*A. autumnale*	*A. callimischon*	*A. tardans*	*A. tardiflorum*
Locality	Cyprus	S. Greece, Crete, S. Anatolia	Crete, Karpathos	Israel, Mt. Carmel
Height of stem (cm)	12-60	9-38	(8-)10-30	40-60 (-70)
Height of leaves on the stem	up to umbel	almost up to umbel	⅚ or ⅞ of stem	(½-)⅔-¾ of stem
Spathe	1-valved, deflexed or patent, not embracing pedicels, shorter than umbel	1-valved, tubular at base, embracing the pedicels, shorter than umbel	2-(rarely 1-) valved, lower valve longer than umbel	2-valved; valves separating rather late, both valves much longer than umbel
Number of flowers in umbel	8-15	8-25	6-15	8-30
Length of perianth segments (mm)	4-5½	5-7	5-6	6-7
Color of perianth segments	brown or pinkish-brown with a greenish median stripe, obscurely lineate	white with brown or reddish midvein	pink or brownish-pink with a narrow-linear green midvein and numerous parallel lines in the upper part	greenish-wine colored with a broad purple midvein and purple parallel lines in the upper part

Not all flowers produce capsules. At the end of the flowering time the percentage of flowers producing capsules is variable (from 20-60 (-70)%.) After fruiting the seeds are dispersed by winds and showers, but the old stem with the empty capsules breaks off in February-March of the following year. Then the leaves wither up gradually, and in April of the following year. The scape and the bud of the new inflorescence, wrapped in the spathe valves, appear in April. The scape then elongates and reaches its maximum length in mid-May. Scape and inflorescence bud remain seemingly unchanged till September when flowering starts.

As mentioned above, all the other species of section *Codonoprasum* flower in April-May. In our late-flowering species of Mt. Carmel the scape with the inflorescence appears also in April, but the opening of the spathe valves and flowering are delayed to September-October.

Most of the autumn-flowering geophytes in Israel belong to the genera *Urginea, Scilla, Crocus, Colchicum* and *Sternbergia*. (Shmida & Dafni 1990). Part of them flower after decay of spring foliage, others before the appearance of leaves with the first rains. In all these plants the inflorescence bud is subterranean during summer; it arises from the ground in autumn.

Thus, in comparison with these geophytes flowering in autumn, the development of inflorescence in *A. tardiflorum* is different. As mentioned above the inflorescence bud, initiated within the bulb, is lifted in spring or early summer by the elongation of the scape and together with the scape stays erect without flowering during all the summer till autumn. A relatively long time between flower bud formation and flowering of certain trees and shrubs in areas with Mediterranean-type climate was observed by Orshan and his collaborators (1989). Thus, *A. tardiflorum* represents an interesting example in phenology of mediterranean geophytes.

ACKNOWLEDGEMENTS

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Figures 4 & 5 from **Flora Palaestina** vol.4 (1986) courtesy of Professor N. Feinbrun-Dothan.

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SUMMER CULTURE NOTES FOR WINTER-GROWING BULBS

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IN Southern California most winter-growing bulbs must be stored in a warm, dry place during summer. Exceptions that will tolerate summer water are *Sparaxis* and *Babiana*.

BULBS IN CONTAINERS

Winter-growing bulbs adapted to Mediterranean-type climates can be planted in containers and handled in several ways during the summer. In one way they may be lifted from the growing medium, then dried and stored. An alternative is to store them in the container while remaining in their growing medium. For those bulbs that are to remain in their containers, the foliage should be left to die back normally. After the soil has dried, store the bulbs in their pots in a dry, shaded area.

TO LIFT, STORE AND DIVIDE

Before lifting the bulbs, wait until the leaves have died down completely. In the meantime, water as the bulbs require, allowing the foliage to die back at its own rate. After the top growth dies down completely, remove the bulbs from the growing mix. Gently clean off soil, then air-dry in an airy, shaded place for several days.

Store the bulbs until they are replanted early in the autumn. To store the bulbs, place them in a cardboard box. (Do not line the box with plastic.) Add a pet flea collar, stretching it first to activate the insecticidal ingredients. Then close the box and seal it with tape. Tape the box securely, but not air-tight. Store in a warm, dry, airy place.

BULBS IN THE GROUND

Most winter-growing bulbs planted in the garden will do best if they're lifted and stored dry, unless special arrangements have been made to ensure that the bulbs will remain dry while in the ground. The exceptions to the requirement for a dry summer are various species and cultivars of the South African genera *Sparaxis* and *Babiana*.

STORAGE CONDITIONS

At the University of California Arboretum in Irvine, California, the native southern African bulbs are stored in a temperature-controlled room which is maintained at around 80° F. When winter-growing bulbs are stored in a cool area during the summer, they will sprout prematurely. One of the triggers that starts their growth is cool weather.

RE-POT IN SEPTEMBER

Re-pot the lifted bulbs from early September through October. Don't water them, however, until the weather cools down. Watering too early invites rot. To re-pot bulbs that were stored in their pots, lift the bulbs in early September. Either replant them immediately, or store them in paper bags for a week or two. For any bulbs that have already sprouted, pot and water immediately.

URGINEA MARITIMA "RED SQUILL" AS A CUT FLOWER

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I once worked on a farm in New Jersey which was the epitome of organization. We were equipped with the proper tools for any job, from construction of a barn to planting a straight row of corn to scalding a hog to remove the hair completely. Yet the owner of the farm had an incongruous plaque in front of his desk at which he sat daily. It read, "there is no planning in the world that can make up for dumb luck." Such is the case for red squill (*Urginea maritima*, Liliaceae) as a cut flower.

Red squill was an accepted rodenticide in this country prior to World War II. The bulb, native to the Mediterranean countries, was dug from the wild and processed into either chips or powder and exported to this country to be mixed with bait for rat poison. The toxicity of the wild bulbs varied greatly and, hence, they fell out of favor in the rodenticide industry. In 1960, Dr. Howard S. Gentry received several bulbs that were selected for possible high toxicity. After 30 years of personal work, with the assistance of Dr. A.J. Vertiscar, a chemist, a potentially highly toxic rodenticide was developed. Not only was the product toxic to rodents, it was also selective *only* to rodents, a property other rodenticides could not purport. This high toxicity squill was put into limited production.

As luck would have it – luck for the rats, that is, and for myself as a flower grower – the value of squill as a cut flower exceeds its value as a rodenticide. With the floricultural advice of Fred Meyer and the marketing assistance of Thom Meyer, both of Escondido, California, we have carved a small niche in the specialty cut flower market. We currently have eight acres of red squill in production.

Growing red squill as a cut flower is a long-term project. From a section of a mother bulb to the first cut flower usually requires six (6) years. To propagate, 5-6 inch diameter bulbs are dug out of the field in May or June. These bulbs are cut into 10-16 longitudinal sections which must include a portion of the root pad. The sections are placed into dry soil in a nursery about 2 inches apart and covered with 3-4 inches of soil through out the dry Southern California summer. By October small bulblets start to form between the bulb scales of the sections. Usually one bulblet forms per section, with an occasional double. A good average is 110 bulblets per 100 sections. By December small leaves appear from the bulblet about the size of a single garden chive. After two years in the nursery, 1-2 inch bulbs are produced. These bulbs are dug from the nursery while summer dormant and planted in the field. We use 34 inch rows with a spacing of 15 inches between bulbs, or 12,000 bulbs per acre. The first flowers will not appear for 3-4 years after field planting.

As mentioned previously, squill is a summer-dormant, winter-growing, perennial, bulbous plant. The first leaves appear soon after flowering in October, before the winter rains start. Vegetative growth continues with the winter rains. The most vigorous growth is in February and March if soil moisture is adequate. Our ability to irrigate is limited. One to two inches of water per month from November to March is enough to grow squill. If no rain occurs for four consecutive weeks in the winter months, irrigation is applied. By March the plants are 24 to 32 inches fall and the canopy of the field completely

Figure 1. Sectioning bulbs.

Figures 2 & 3. *Urginea martima* in cultivation.

Figures 4–6. Cut stalks of *Urginea martima.*

touching. Senescence begins in May and by mid-June the plant is completely dormant. A summer dry period is essential. Squill could not grow in areas of heavy summer rains.

By far the most curious aspect of squill is its flowering habit. While most of the native chaparral flora is dormant in August, squill is flowering. The flower itself is as unusual as the time of year in which it occurs. In early August, the immature flower starts to appear. By day 2-3 the spike is the size of your pinky finger; three weeks later a 3½-4 foot flower stalk has appeared. This process continues through September. The flower height is about half stem and half inflorescence. The inflorescence is a series of white florets, gradually opening from the bottom first. The ideal time to cut the flower is when 3-6 whorls of florets have opened. The cut flower will keep 10-14 days.

This is the sixth year I will market squill as a cut flower. During the first four years, production was limited. By the fifth year, it became obvious that methods were needed to lengthen the normal 4-5 week season for harvesting flowers. Since most of the squill is clonally propagated, the easiest and most logical method for lengthening the season is to plant equal numbers of early, mid-season and late-flowering clones.

Fred Meyer advised me of the conditions required to cause flower bud initiation and development. He received this information from talking to Dr. Abraham Halevy of the Hebrew University of Jerusalem. Dr. Halevy told Mr. Meyer that flowering will occur when there is a differential in day and night soil temperatures. So we applied a very light application of water, using low volume sprinklers to cool the soil at night. Irrigation began in late July through early August, once in the evening and again in early morning. As a result, temperatures were lowered 5°-8°F at night over the control. During the 1989 season this process caused flowering 14-17 days earlier. Expanded experiments will be done in 1990. The goal of a 12-week flowering season may be a reality.

THE GENUS *CYRTANTHUS*

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THE genus *Cyrtanthus* in the family Amaryllidaceae is among the showiest and most diverse of the Amaryllidaceae of South Africa and is found from the western Cape Province through the eastern Cape, into the provinces of Natal and Transvaal, the country of Lesotho, and into east Africa as far north as Kenya. Both evergreen and deciduous forms occur, the majority being deciduous, if only for a short time. Flowers vary from small, tubular forms to large, open trumpets. Flower colors include white, yellow, pinks to reds, but no blue or violet.

The southeastern Cape Province is the center of distribution where approximately 25 species have been recorded. This region receives rainfall throughout the year. As expected, most of the evergreen species are from this region. The most well-known is the Vallota Lily, *C. purpureus* the parent of many of today's hybrids. It has large scarlet flowers on tall stems and has been cultivated for more than 100 years. Another evergreen species is the Knysna Lily, *C. obliquus*, which has robust, pendular flowers in shades of yellow to red with green markings and large, thick leaves.

Species from Natal and Transvaal are mainly deciduous. These receive rainfall during the summer and rest during the winter. Because they must be dry during the winter, few are in cultivation or have been used in hybridization projects. Crosses are being made, however, with these species and those more tolerant of winter rainfall.

C. mackenii (the Ifafa-lily) and its hybrids are probably the most successful in cultivation. Native to the summer-rainfall region of southern Natal, it occurs in very damp places, often along stream banks, keeping it moist and nearly evergreen throughout the year. It's therefore quite adaptable to the watering habits of the average garden enthusiast. *C.* 'Orange Gem' and other cultivars have *C. mackenii* in their background.

In terms of cultural requirements, no general rule applies to all *Cyrtanthus* species. When growing them, try to mimic their natural habitats. The majority available are typically spring-summer growers, thus requiring water and fertilizer during this time. Most of these species and their hybrids rest during the fall and early winter months, including the species and hybrids of *C. sanguineus* and *C. tuckii*. Even *C. mackenii* hybrids such as 'Orange Gem' can do with a little rest during the fall months.

Requirements for soil and light can't be generalized either, but fortunately do have some relationships. Forest species such as *C. elatus* (*C. purpureus*) and its hybrids do best with shaded conditions and a rich, well-drained soil, where those from grasslands, such as *C. loddigesianus*, *C. fergusoniae* and *C. mackenii*, do well with more light to full sun conditions and a heavier, sandier soil.

Insect and other pest problems are basically confined to mites and mealybugs. While aphids do occur and should be removed, they never seem to be a significant problem. Mealybug is a significant problem and shouldn't be taken lightly. Infestations can affect growth and flowering as well as kill the bulb. Deal with mealybugs immediately, because they spread rapidly. Flower thrips can be troublesome on *C. mackenii* cultivars such as 'Orange Gem'. Damage is characterized by deformed, crooked or streaked blooms. It is best to spray in the bud stage before damage occurs.

BRUNSVIGIA JOSEPHINAE

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AT the end of July in 1988, Charles Hardman invited me to visit him at his house in Baldwin Park, a suburb of Los Angeles. The purpose of the visit was to see two blooming bulbs of what is commonly called *Brunsvigia josephinae*. It was the first time they had bloomed and it had taken 14 years to flower from seed. The seed was obtained from Fred Boutine, who was the botanist at the Huntington Botanical Gardens in San Marino, California, in 1974.

Crinum expert Emma Swets of Riverside, California, in an article published in *Plant Life* several years ago, also reported that she had bloomed *B. josephinae* from seed and that it had taken 14 years. This is much better than in England. A. Worsley (1932. The Genus Amaryllis, **Journal of the Royal Horticultural Society** LVII (1-:10) states that *Brunsvigia josephinae* takes about 30 years to flower from seed in England. According to Les Larson, the bulbs of *B. josephinae* are not true *B. josephinae* but rather a hybrid. She states that the true species will not bloom out of its natural habitat. Les grows her bulbs in Fremantle near Perth in Western Australia where she reports that they seem to do much better than in Southern California.

Bill Drysdale, also of Riverside, knew Emma Swets quite well. He reports that all of her *B. josephinae* inexplicably rotted one winter even though the weather was not particularly different from that of other winters. The bulbs grown by Charles Hardman and Emma Swets were grown in the ground without protection.

The spike on Charles Hardman's largest flower was 32 inches (81.3cm) from where it exited the bulb to the top of the spike where the pedicels begin. It was 51 ½ inches (130.8cm) from where the spike exited the bulb to the top of the flower "ball". The spike was 2 inches wide at the base with edges on each side. There were approximately 75 florets in the flower "ball". The spike on the second bulb was about two thirds the size of the larger bulb with many fewer florets in the flower "ball". The flowers were identical on both bulbs. They were a dark red and identical to the *B. josephinae* grown in the ground by Leonard Doran in Burbank, California. It was not the same as the lovely set of the *B. grandiflora* (also sometimes called *B. slateriana*) growing under the trees as the base of the bulb hill in the Huntington Botanical Garden. They have a different color and are smaller. For interested readers two long, fine articles on *Brunsvigia* by Dyer can be found in *Plant Life* in 1948 and 1949.

Baldwin Park, Burbank, and San Marino are in Los Angeles county in Southern California, while Riverside in nearby but less coastal Riverside County. The area has a Mediterranean climate with hot, dry summers and winter rainfall. Temperatures occasionally fall below freezing.

Figure 1. Charles Hardman with his bulbs of *Brunsvigia josephinae* in his back yard in Baldwin Park, CA.

Figures 2–4. *Brunsvigia josephinae*

AMARYLLIS BELLADONNA HYBRIDS

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I hope the numerous people I once corresponded with will take note that I am growing and hybridizing the *Amaryllis belladonna* group again. And I sincerely hope they take the opportunity to contact me. My correspondence file on the subject is no longer in existence, so I am often unable to re-establish contact. Likewise, most of my seedlings previously created were given to another grower who lost most of them. So here's how things stand at present.

The collection of up to 100 adult clones from Les Hannibal is still intact. Also remaining is a clump of the 'Mont-aux-sources' type of *Nerine bowdenii* which I had hoped to use in crosses as a source of cold hardiness. With a resumption of interest, a few *Brunsvigia* species have been added to the prospective gene pool. And a few Nerines and Brunsvigias have been acquired in an effort to broaden the character of the *A. belladonna* group. I wish to improve the cold hardiness from crosses with *Nerine bowdenii* and to use rarer, hardy Nerines if they can be obtained. A number are mentioned in the older Tony Norris catalogs, but with that source being no more, I am still at a loss as to a source of supply.

Brunsvigia species will be used in crosses to increase the number of florets or to affect the season of bloom. If a tendency to summer leafing could be bred in, this could make the "belladonnas" more adaptable to wet-summer climates, and, from my standpoint, possibly to help them cope with frost since there might be less foliage present during the winter season. Destruction of leaves is a problem in areas that get winter frosts. So it would be desirable to modify their growth habits along these lines if that can be done.

Hoping to begin outcrossing during the 1988 flowering season, I made a number of calls in an attempt to locate someone in my area with flowering-size Brunsvigias. To my frustration, I was too late for Mike Willetts' *B. marginata*, but Wayne Roderick in Orinda had a splendid, full-sized *B. josephinae* from which he allowed me to collect pollen. This was an impressive specimen carrying 87 florets, so there was plenty of pollen.

I began putting this pollen on all the "belladonnas" that opened from then on, approximately ⅔ of the crop. The pods proved to be much smaller than those from the earlier florets, which had been allowed to self. However, upon ripening, the number of seeds proved fairly similar, often with 30 or more in a pod. The crucial difference was that the vast majority of the seeds were very small, being uniformly about ⅛ to 3/16 inch in diameter with, occasionally, one to three seeds of normal size (¼ to ⅜ inch in diameter) mixed in.

Which of these seeds, if any, are true crosses and which, if any, are parthenogenetic or apomictic, remains to be seen. My hope is that differences between members of the crossed batch and those which are selfed will show in different foliage characteristics long before the flowers finally make their appearance many years hence.

I'm eager to hear from others with an interest in these lines of work, or from people who have collections of the wild material that is needed for this work.

One thing that has been made clear from my past endeavors is that the *belladonna* hybrids benefit greatly from irrigation during dry periods of the year. The difference in root development, bulb increase, and reliability of flowering is truly remarkable with irrigation. At least this has proven to be true in my climate, with normal summer daytime temperatures in the 70's or 80's (F) and nighttime lows in the 50's (F). Soil here (central, coastal California) is a bit on the heavy side in that it can bake hard if dry, but it is not claylike. Perhaps in heavier soils, or with hotter summer temperatures, there would be harm from summer waterings, but in my somewhat coastal conditions, it has been essential for yearly bloom.

I would like particularly to hear from anyone with first generation crosses of *Amaryllis belladonna* with Nerines or Brunsvigias. Does anyone in Australia have any of the original Bidwell crosses? These are reputed to be quite sterile. On the other hand, they have been claimed to be the ancestors of the present-day *belladonna* hybrids, perhaps from chance crosses of a few good pollen grains onto *A. belladonna* itself.

One thing which needs to be determined is which other genera can be crossed into the *belladonna* group. Is it only *Nerine* and *Brunsvigia* and *Crinum*? Or are there others as well? What about *Lycoris*? Certainly the hardiness and colors of *Lycoris* would prove useful if the genus could be worked into the *A. belladonna* line. More needs to be written on the bigeneric crosses in the Amaryllids and on which genuine crosses have been successful.

In closing, I would once again like to encourage readers to contact me on the above subject.

THE GENUS *CALOCHORTUS*

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THE genus *Calochortus* is no stranger to Californians. Its members are commonly called "Mariposa Lilies" (the Spanish word "mariposa" meaning butterfly.) One species, *C. venustus*, was even eaten by native Americans as a source of starch. Formerly in the family Liliaceae and now in the segregate family, Calochortaceae, the genus can be distinguished easily from the true lilies in that the inner and outer tepals are strongly different from each other. The species are found in the western parts of North America (California, Oregon, Washington, Utah), Canada (British Columbia), and Mexico. They occur in grassland, chaparral, and semi-desert vegetation, less commonly in woodlands.

Calochortus plants are erect, often slender herbs with a truncated bulb. Generally, there are two thick, nutrient-storing leaves present, which are flat and usually linear. Sometimes there may be only one basal leaf apart from the inflorescence bracts, which is much larger than those present on the stem (cauline leaves).

The inflorescence is a branched or unbranched raceme. The flower has six tepals which are free (unattached and conspicuously different in the two whorls. Those of the outer whorl are either lanceolate and sepaloid (green) or of the same color as the inner tepals. The inner three tepals are generally broad and frequently fringed on the margins and sometimes bearded on the inner face. *Calochortus* tepals are usually yellow, rose, or crimson and are frequently marked with conspicuous spots, streaks or other patterns. Six (3 + 3) stamens are present. The ovary is tricarpellary (three lobed).

The genus *Calochortus*, perhaps one of California's most easily recognizable wildflowers, contains some 60 species. When the early Spanish explorers came across some of the brightly colored species with their large tepals, they aptly named them Mariposas—their name for butterflies. The name gradually became Mariposa Lilies, or Mariposa Tulips. In Greek, the genus *Calochortus* translates into "beautiful grass".

Calochortus can be divided into three groups: the "Star Tulips", the "Globe Tulips" and the "Butterfly Tulips". In the "Star Tulips" the flowers are open, star-like and erect, their seed pods nodding. Often referred to as "Cat's Ears", the tepals are hairy on the inside. All species are found more in the northern part of California and into Oregon and Washington.

The "Globe Tulips", aptly named for being globe-like, have their tepals turned inward, their seed pods nodding. The "Fairy Lantern", *C. albus*, found locally in Southern California foothills, is typically white and covered on the inside with fine, silky hairs. The inflorescence is usually branched, with several flowers hanging lantern fashion.

The "Butterfly Tulips", or "Mariposas", have stiffer, taller stems and large, cup-shaped flowers and erect seedpods. Southern California is home to over a dozen species, some of which are the most beautiful in the genus. The Catalina Mariposa, *C. catalinae*, occurs from Catalina Island and along the coast from Santa Barbara County to Orange County. It is endangered, mainly due to development of its habitat. Its color is lilac with a deep purple blotch at the base of the petals. Other prominent Southern California species are *C. splendens, C. venustus; C. clavatus*, the "Golden Butterfly" and the largest flowered Mariposa; and *C. plummerae*, the "Hairy Mariposa".

Most *Calochortus* are fairly easy to grow, especially the Southern California species. Remember that they are Mediterranean climate bulbs needing a dry rest period during the summer months. Certain species, like *C. albus*, require some shading. Filtered sunlight such as that provided by "shade cloth" is ideal. Some specialty nurseries carry seed and a few bulbs.

The University of California Irvine Arboretum has begun a conservation collection of California native bulbs, of which the genus *Calochortus* is playing a major role. We will be propagating our rare and endangered bulbs both for our own conservation needs and for dissemination to the public to relieve pressure on the wild populations from overzealous collectors, commercial distributors and an ever-shrinking habitat.

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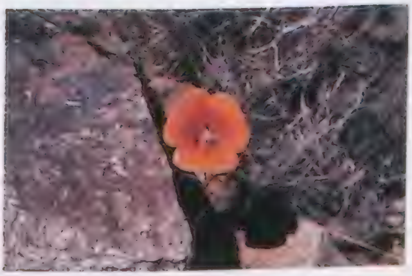

Left to right from the top:
Figure 1. *Calochortus albus.*
Figure 2. *Calochortus amabilis.*
Figure 3. *Calochortus clavatus*
Figure 4. *Calochortus kennedyi.*
Figure 5. *Calochortus venustus.*

All photographs by Charles Hardman.

E.P. ZIMMERMAN, *CLIVIA* HYBRIDIST

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E.P. Zimmerman, charter member of this society, came to the U.S. from Germany in 1907, and settled in Carlsbad, California in 1927; with the frost-free climate he could continue the *Clivia* breeding he had begun in Germany. His father and grandfather both had worked with *Clivia*, but there is no indication that their efforts contributed to the development of what came to be called the "Zimmerman strain". He was proud to say that three generations of his family had worked for 75 years on *Clivia*. He began his program in this country at age 40 on a 40-acre plot of ground sloping toward the ocean. He claimed to have 5,000 *Clivia* in pots which were plunged into the ground under lath. He aimed for 10,000 plants to provide blooms for the cut flower market. Whether he ever did sell to the flower market is not known to me. *Clivia* petals are a bit brittle, but he did send 500 stalks to the San Francisco World's Fair, for which he received a gold medal.

He offered *Clivia* plants in six color varieties and 36 types of flowers. He sent thousands of seeds to Europe stating that he sent 10,000 alone to Denmark and two firms in Germany. He had several acres devoted to *Watsonia* and annually sent two tons to the San Francisco flower market. An amusing incident offered involving K.C. Stanford, who had owned the South African nursery Bloem Erf, an establishment specializing in the commercial production of seed from South Africa plants. During the 1930's she visited California and came to visit Zimmerman. Upon reaching his acreage she is reported to have exclaimed, "Man alive, I have never seen so many *Watsonias* in my life!" "And then," he added, "she wanted to sell me seeds."

He made a specialty of *Cyrtanthus (Vallota) purpurea*, of which he had 5,000 under lath, although here in Riverside, California they grew in full sun until the *Narcissus* fly wiped them out. Mr. Zimmerman had a large bed of *Pancritum maritima* and also bulbs of *Hymenocallis (Ismene) amancaes*. He also crossed the fragrant *Gladiolus tristis* with the large flowered type in order to add fragrance to the latter.

E.P. Zimmerman sold *Crinum powellii* var. *alba*, of which he was fond, comparing them to Easter lilies. He is noted for his hybrid *Crinum* × 'Zimmerman' (*Crinum powelii alba* × *C. asiaticum*). This formed a large, conspicuous planting on his bulb farm. He also had an enormous planting of *Brunsvigia rosea* of which he claimed to have 150,000, but of these only 20,000 were of flowering size (**Herbertia** vol. 10). He stated in a letter that he crossed them "with *Crinum*, *Hippeastrum* (Amaryllis), *Nerine*, etc." He also grew iris and *Hemerocallis*.

More than 30 years ago I visited his nursery and selected several potted plants. These he refused to sell to me saying that I was knowledgeable about quality and had to content myself with several he selected. This reasoning was unique in my experience.

COLLECTING IRIDACEAE IN CENTRAL AND SOUTH AMERICA

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THE large monocotyledonous family Iridaceae is well known for its wide variety of garden plants. Among the reasons for its horticultural success, apart from the fact that many species are hardy and have showy flowers, are that most are self-compatible, so breed true, and their seed germinates readily. To European eyes the best known representatives are the Old World genera, such as *Crocus, Gladiolus, Ixia, Freesia, Schizostylis, Romulea, Homeria* and many species of *Iris*. Few of the Central and South American species are familiar, notable exceptions being *Tigridia pavonia, Rigidella orthantha* (= *Tigridia orthantha*) and some species of *Sisyrinchium*. Yet there are many beautiful species in these regions. Although some of them have potential as either garden or greenhouse plants, many are, unfortunately, inaccessible to most people, and require specialized growing conditions, such as deep pots plunged into a sand-gravel mixture on modified greenhouse benches (Castillo 1986).

Over the last few years we have collected Iridaceae from upland sites in Mexico, Peru and Brazil, for systematic (largely anatomical and cytological) research (*e.g.* Kenton *et al.* 1986; Kenton and Rudall 1987; Rudall, 1984, 1989; Rudall *et al.* 1986; Rudall and Wheeler 1988). Central and South American Iridaceae fall into three distinct groups: Sisyrinchieae, of which *Sisyrinchium* is the main genus; Mariceae, which comprises three genera (*Trimezia, Pseudotrimezia* and *Neomarica*); and Tigridieae, with about 20 genera, including *Tigridia* and *Cypella* (Goldblatt, in press). *Sisyrinchium* is a remarkably widespread genus in America, but the others are often confined to particular regions. Many species of *Trimezia, Neomarica* and *Pseudotrimezia* grow in very restricted habitats in upland areas of Brazil, such as the mountains surrounding the beautiful town of Diamantina, in the state of Minas Gerais (Figure 1). *Trimezia* species (Figure 2) often have large flowers, either yellow or blue, with strikingly variegated inner tepals, whereas the closely related genus *Pseudotrimezia* (Figure 3), which is restricted to Minas Gerais, has smaller, less specialized, yellow flowers. Flowers of both genera tend to open in the late afternoon, suggesting that they are specific to particular pollinators. Indeed, the variegated tepals of *Trimezia* and many Tigridieae may well be insect mimics. *Rigidella ortlantla* (Figure 18), with its long red flowers, is hummingbird pollinated. The dark, pretty, but unpleasantly scented flowers of *Tigridia multiflora* and *T. durangense* (Figure 12) are indicative of fly pollination, and the white flowers of *Cipura campanulata* (Figure 15), which open in the late evening, are probably moth pollinated.

Tigridieae are bulbous plants, with characteristic pleated (plicate) leaves. Genera of Tigridieae have diversified to fill a wide variety of niches, from aquatic to desert. Some grow at high altitudes (up to about 4000m), such as *Hesperoxiplion peruvianum* (= *Cypella peruviana*) and *H. herrerae* (Figure 17) in the Peruvian Andes, which we collected at various sites near the Inca capital, Cuzco (Figure 4), including along the railway line below Machu Picchu, between Aguas Calientes and Quillabamba (Figure 5). This was

Figure 1. Mountainside near Diamantina (Brazil).

Figure 4. Machu Pichu, the lost city of the Incas.

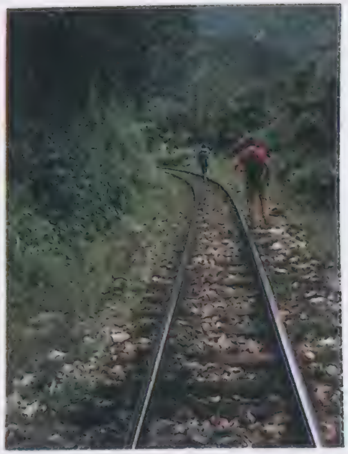

Figure 5. Collecting along the railway line below Machu Picchu.

Figure 2. *Trimezia juncifolia.*

Figure 3. *Pseudotrimezia sp.*

Figure 6. Wet meadow at Llano de las Flores, Oaxaca, Mexico.

Fig. 8.

Fig. 7.

Figure 7 (left) and Figure 8 (above). Temascaltepec woodland, Mexico, with blue *Cardiostigma mexicanum* and red *Calochortus hintonii*.

Figure 18. *Rigidella orthantha*.

Figure 17. *Hesperoxiphion herrerae*.

more hazardous than it sounds, as we occasionally had to leap into bushes to avoid trains, and walk along narrow railway sleepers across intermittent river gorges!

Mexico, also, is very rich in Tigridieae. The familiar *Tigridia pavonia* (Tiger Flower) is widespread throughout Mexico. It was cultivated by the Aztecs almost 1000 years ago for its large showy flowers and its natural distribution is now unknown. Other species of *Tigridia* generally have smaller flowers, but are nonetheless equally striking (Figures 8-18). Habitats of Tigridieae range from semi-desert (e.g. *Fosteria oaxacana*) to bogs (*T. seleriana*), and from the hot, humid plains (*Eleutlerine bulbosa*) to the high-altitude "llano", or wet meadow. The llano (Figure 6) is especially interesting as it supports many different herbaceous species. The frogs provide an auditory novelty, too. Our trip to the Llano de las Flores (Meadow of Flowers) in Oaxaca was memorable for the complete change of climate as we ascended to 3000m, from humid forest to cooler woods, full of orchids and *Rigidella orthantha*, and finally, bleak misty wetlands, where noses had to be firmly glued to the ground in order not to miss anything in the luxuriant grass and sedges.

The topography and geology of Mexico, broken up in the center by the trans-Mexican volcanic belt, and to the east, west, and south by the three Sierra Madres, encourages the development of many microspecies of *Tigridia*: for example, *T. multiflora* and *T. galanthoides* are two rather similar species with deep red, unpleasant-smelling flowers. Three more, T. alpestris, T. huahuapanensis and *T. durangense*, are very similar in appearance, but confined to specific regions.

Temascaltepec and the Valle de Bravo are very rich floristically, especially in the open pine-oak woods, whose understory supports many herbaceous species: orchids, bulbs such as *Bessera* and species of *Allium; Manfreda, Ranunculus, Salvia, Penstemon* and *Cosmea*, as well as several Iridaceae, including species of *Sisyrinchium* and Tigridieae. An unforgettable sight for us in this region were the blue, saucer-shaped flowers of *Cardiostigma mexicanum* (Figures 7 and 8) which looked from a distance like Canterbury Bells, intermingled with the delicate, nodding heads of *Tigridia meleagris*, and also a red-flowered *Calochortus, C. hintonii* (Liliaceae). *Tigridia meleagris* (Figure 16) is a delightful species, about 30cm tall, its pendant lowers pinkish-purple domes mottled inside with yellow and brown, and with a silvery, glandular surface to the inner tepals. The sad fact is that in Temascaltepec, as in many other regions of Mexico, the pine trees are being depleted rapidly for timber. What remains are sparse stands of evergreen oaks, or oaks and *Arbutus*, which do not alone provide sufficient stability to prevent extensive erosion during the rainy season. In the felled areas, the red soil is exposed in great, naked gullies, and the species diversity plummets by comparison to the richer pine-oak areas.

Although their bulbous habit makes them relatively easy to transport, collecting Tigridieae can be a troublesome process, as the bulbs may be up to two feet deep in hard clay soils, and invariably wedged under an immovable rock, so each one can take some time to dig up. Furthermore, such bizarre behavior makes you an object of great curiosity to the local people! As with all plants, there are strict collecting and exporting restrictions which must be observed. Genetic research, in particular, necessitates collecting living material, but we took great care to limit our collections to a few bulbs or seeds, and not to plunder wild populations. We were extremely fortunate to have the active assistance of university botanists in each of the countries we visited.

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Figure 9. *Tigridia sp.*

Figure 10. *Tigridia alpestris.*

Figure 11. *Tigridia venusta.*

Figure 12. *Tigridia durangense.*

Figure 13. *Fosteria oaxacana*.

Figure 14. *Tigridia ehrenbergii*.

Figure 15. *Cipura campanulata*.

Figure 16. *Tigridia meleagris*.

CRINUM BULBISPERMUM: AN INTERESTING GEOPHYTE WITH HORTICULTURE POTENTIAL

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THE genus *Crinum* was first described by Linnaeus in his **Species Plantarum** in 1753. The following year, he listed four species in the fifth edition of his **Genera Plantarum**. There are twenty-one recognied species of these versatile geophytes in South Africa and Namibia. *Crinum* species are found in the tropics in Africa, Asia, and the Americas. They also extend into the temperate regions of both hemispheres, occurring in Japan and Australia. There are approximately one hundred fifty species worldwide. More than one-half of this number come from Africa. *Crinum bulbispermum* is recorded in all four provinces in South Africa. It grows along river and stream banks or in moist hollows. It grows in black pot clay or sandy soils. Bulb sizes vary between 7 and 13cm in diameter. Leaves are glaucous green, sheathing at the base to form a false stem up to 25cm high. Leaves are up to 11cm broad, flaccid and arcuate, all with a narrow cartilaginous border scattered with small cartilaginous teeth or hairs. The plants are deciduous. Their leaves die during the winter. Peduncles are from 45cm to 85cm long, up to 30cm broad and 20cm thick. Umbels are 6 to 16 flowered. Pedicels vary in length. Normally, the perianth has a long, round tube up to 12cm in length. Petals are white with a dark red keel, or sometimes entirely red. Stamens are white, anthers grey in color, and the style is dark pink in the upper portion. The fruits are subglobose and green. The seeds appear smooth and turgid. In the Orange Free State it is commonly known as the Orange River Lily. It is the provincial flower of the Orange Free State. *Crinum buibispermum* makes an ideal garden subject. The plant seems at home in a variety of soils: loam, sand, clay and even loose gravel. This attractive geophyte flowers for three to four weeks in mid-October (southern hemisphere). The seeds develop quickly after flowering, taking only two to three weeks to mature. *Crinum bulbispermum* is accustomed to hot summers—up to 40°C—and cold, dry winters—down to -8°C. Plants of this species appear to thrive in semi-arid conditions, especially along dry water courses. In some cases, they may stand up to their necks in centimeters of water for weeks on end. The bulbs can also withstand years of severe drought. In nature, they grow in full sun.

CULTIVATION

Crinum bulbispermum is easy to cultivate. Once the seed sack has burst open, the mature seeds can be gathered. The ripened seeds are green/white in color. These seeds can be sown either directly in the ground or in seed trays (the seed trays should be at least 12cm deep to allow for root development). Sow the seeds as soon as possible, as their viability is short-lived. The seeds should be sown between 400mm to 500mm in depth. Germination in warm weather (± 30°C) is quick. Ensure that the soil is kept moist. The young bulbs' leaves look similar to germinating onions during their first year. The bulbs will develop quickly after their first year and they should flower during their fourth or fifth year. One of the advantages of sowing seed *in situ* is that there is no further need to transplant. However, should you desire, the plants can be translocated easily when the bulbs are dormant in winter.

INSECT PESTS

In Southern Africa, the only real pest is the yellow and black striped Amaryllis worm. Eggs that are deposited on the leaves hatch quickly under warm conditions. The young larvae soon begin chewing their way through the insides of the leaves. Left unchecked, they could penetrate and destroy the bulb. A mild contact insecticide should remedy the problem.

CRIUM BULBISPERMUM USED IN LANDSCAPES

Crinum bulbispermum can be used very effectively in the landscape design. The plants are suitable subjects for a city park, botanic garden or the home garden.

Planted in a pot they make ideal container plants. Always remember to give them a sunny location and feed with a foliar feed in the last month of winter. These plants probably look their best when planted in mass. When in full flower, a well-grown clump makes a spectacular sight. The Orange River Lilies can be used to their full advantage in water or swamp gardens. They also look good planted in beds. *Crinum bulbispermum* is not only an attractive and versatile plant, it is also an exciting subject to grow.

GLADIOLUS BREEDING FOR THE TROPICS

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SUMMARY

GLADIOLUS cultivars suitable for cultivation under the tropical/sub-tropical conditions as of the North Indian plains have been developed by exploiting *Gladiolus natalensis* Eck. Reinew ex Hook. f. ($2n$=75) (*G. psittacinus* Hook. f.) introduced from Zululand and Mozambique and *Gladiolus tristis* Linn. ($2n$=30) obtained from South Africa in the breeding programme. These two species were crossed with other garden cultivars having broad spectrum of colours resulting in many hybrids showing desirable characters such as vigour, disease resistance and high rate of multiplications. The promising gladiolus cultivars are namely 'Archana', 'Arun', Hans', 'Indrani', 'Manhar', 'Manisha', 'Manmohan', 'Manohar', 'Mohini', 'Mridula', 'Mukta', 'Pitambar', 'Sanyukta', and 'Triloki', which have been released for promoting floriculture trade in India.

In India *Gladiolus* cultivation was mainly confined to the temperate and mild climatic regions due to favourable climatic and edaphic conditions. The main centres of commercial cultivation were, so far, Srinagar, Simla, Chaubattia, Supi, Kalimpong, Darjeeling, Shillong, Jorhat, Pune, Bangalore and Ootacamund.

The exotic *Gladiolus* cultivars in commerce, such as American and Dutch hybrids, namely 'Aldebaran', 'Deciso', 'Eruovision', 'Friendship', 'Nichole', 'Peter Pears', 'Red Beauty', 'White Goddess', and 'Zeus' though quite elegant, are not adapted to the conditions of the North Indian plains, mainly due to high temperature, coupled with high humidity, disease susceptibility during growth and storage period and low multiplication rate of corms/cormels (Sharma *et al.* 1988). Fortunately, six ecotypes of *G. natalensis* (Eck.). Reinew ex Hook. f. ($2n$ = 75) (*G. psittacinus* Hook. f.), popularly known as *G. psittacinus* hybrids, have been found quite promising as genetic material for evolving *Gladiolus* cultivars suitable for plains.

These ecotypes are supposed to have come from Zululand and Mozambique and are cultivated in milder temperate regions of the world. They are very well adapted to the North Indian plains, multiply fast by cormels, over-summer well in storage and are resistant to many diseases.

These types flower later than the others planted at the same time. They grow 75cm to 140cm tall and bear up to 18 florets per spike. Flowers are characterised by hooded, upper perianth segments. Another species, *G. tristis* Linn. ($2n$=30), obtained from South Africa has a high multiplication rate, approximately 100-150 cormels per corm. These two species were crossed with other garden cultivars having broad spectrum of colours, resulting in many hybrids showing vigour, disease resistance and high multiplication rate along with new colour combinations. These hybrids were evaluated and promising ones released for cultivation under tropical/sub-tropical climatic conditions as prevalent in the North Indian plains.

Two aneuploid cultivars i.e., 'Archana' ($2n$=66) and 'Arun' ($2n$=67), were evolved through hybridization between *G. psittacinus* Sylvia ($2n$=75) as the female parent with 'Friendship' ($2n$=60) and G. 'Fancy' ($2n$=60) as the male parents, respectively.

'Archana'

Parents: *G. psittacinus* 'Sylvia'×*G.* 'Friendship'

Vegetative Characters: Mean plant height 1.50m, produces 1-2 corms per plant; mean corm diameter 6.5cm, mean corm weight 112.0g; cormels number 10-54; cormel diameter 0.3-1.2 cm; mean cormel weight 650 mg.

Floral Characters: Mid-season, requiring 60-90 days for flowering, mean spike length 80 cm, branched; florets Begonia 619/1, (Anon. 1938), suffused with Begonia 619, with a central white streak on petals, throat blotched with Primrose Yellow 601/3, reverse side same; florets 16-18 per spike, ruffled, 11cm across.

'Arun'

Parents: *G. psittachinus* 'Sylvia'×*G.* 'Fancy'

Vegetative Characters: Mean plant height 1.2m; produces 1-2 corms per plant; mean corm diameter 7.5cm; mean corm weight 150g; cormels number 20-60; cormel diameter 0.6-2.20cm; mean cormel weight 952 mg.

Floral Characters: Mid-season, requires 60-90 days for flowering, mean spike length 80cm, branched; florets Vermilion 18/2 splashed and streaked towards margins with Vermilion 18/1; inner lower two petals having a streak in the middle, half Primrose Yellow 601/1 and half Cardinal Red 822/3, reverse side same; florets 16-18 per spike, 10cm across.

The following 12 new triploid ($2n=45$) *Gladiolus* cultivars have been evolved through hybridization involving *Gladiolus* 'Friendship' ($2n=60$) as female parent and *G. tristis* Linn. ($2n=30$) as the male parent.

'Hans'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.35m; produces a single corm per plant; mean corm diameter 5.60cm; mean corm weight 60g; cormels number 50-120; cormel diameter 0.3-0.7cm; mean cormel weight 68 mg.

Floral Characters: Mid-season, requires 80-90 days to flower; mean spike length 70cm, branched, florets White, outer lower one and inner lower two petals having conspicuous Sap Green 62/2 central streak, reverse side White having Sap Green central streak on all the petals; florets 16-18 per spike, overlapping 12cm across.

'Indrani'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.12m; produces 1-2 corms per plant; mean corm diameter 5.54 cm; mean corm weight 75g; cormels number 100-200; cormels diameter 0.3-0.7 cm; mean cormel weight 68mg.

Floral Character: Mid-season, requires 80-90 days to flower; mean spike length 80cm; spike branched; florets Crimson 22/2, towards edges 22/1, outer lower one and inner lower two petals White towards tips, all the petals having a central White streak; reverse side Crimson 22 and 22/2 having white splashes; florets 16-18 per spike, overlapping, 10cm across.

'Manhar'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.20m; produces single corm per plant; mean corm diameter 6.0cm, mean corm weight 84.0g; cormels number 20-30; cormel diameter 0.1-1.0 cm; mean cormel weight 195mg.

Floral Characters: Mid-season, requires 60-90 days to flower; mean spike length 60cm; spike one sided, florets Primrose Yellow 601/3, the tips of outer three petals splashed Tyrian Rose 24/1, throat Primrose Yellow 601/1, reverse side Primrose Yellow 601/3 having splashes of Tyrian Rose 24/1 on outer three petals in an irregular fashion; florets 14-18 per spike, overlapping, 10cm across.

'Manisha'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.20m; produces single corm per plant; mean corm diameter 6.4cm; mean corm weight 88.0g; cormels number 80-90; cormel diameter 1-9mm; mean cormel weight 163mg.

Floral Character: Mid-season, requires 60-90 days for flowering; mean spike length 60cm, spike one-sided; florets white, outer three petals splashed with Tyrian Rose 24/3 more towards margins, throat Primrose Yellow 601/2, reverse side white irregularly splashed with Tyrian Rose 24/3; florets 14-16 per spike, overlapping, 11cm across.

'Manmohan'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.18m; produces single corm per plant; mean corm diameter 6.5 cm, mean corm weight 90.0g; cormels number 40-50; cormel 1-2mm; mean cormel weight 73mg.

Floral Characters: Mid-season, requires 60-90 days to flower, spike one-sided; mean spike length 80cm; florets Primrose Yellow 601/3 having irregular splashes of Orchid Purple 31/1 at the tips of outer three petals, throat Primrose Yellow 601/1, reverse side. Primrose Yellow 601/3 having splashes of Orchid Purple in irregular fashion; florets 14-16 per spike, overlapping, 10cm across.

'Manohar'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.36m; produces a single corm per plant; mean corm diameter 6.0cm; mean corm weight 65.0g; cormels number 30-40; cormel diameter 1-2mm; mean cormel weight 50mg.

Floral Characters: Mid-season, requires 60-90 days to flower; spike one-sided; mean spike length 80cm; florets Orchid Purple 31/2 and at tips 31/1, throat Primrose Yellow 601/3, all the petals having a central streak of Primrose Yellow 601/2, reverse side splashed with Orchid Purple 31/1 and Primrose Yellow 601/2; florets 14-16 per spike, overlapping, 11cm across.

'Mohini'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.1m; produces 3-4 corms per plant; mean corm diameter 4.0 cm; mean corm weight 25.0g; cormels number 60-90; cormel diameter 2-6mm; mean cormel weight 75mg.

Floral Characters: Mid-season, requires 60-90 days to flower; spike one-sided, mean spike length 60cm; florets white, outer three and inner upper one heavily splashed with Tyrian Rose 24/2 and 24/3, lower inner two sparsely splashed with the same colour, throat Primrose Yellow 601/3, reverse white splashed with Tyrian Rose 24/2 and 24/3 in an irregular fashion; florets 12-14 per spike; overlapping, 10cm across.

'Mridula'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.10m; produces 1-2 corms per plant; mean corm diameter 4.36cm; mean corm weight 62020g; cormels number 200-400; cormel diameter 3-5mm; mean cormel weight 96mg.

Floral Characters: Mid-season, requires 80-90 days to flower; mean spike length 70cm; florets Mallow Purple 630/2 and 630/3 having specks of Mallow Purple 630/1, towards edges and tips 630, inner lower two and outer lower one White suffused with Primrose Yellow 601/3, speckled at margins with Mallow Purple 630/2, all petals having a white central streak; reverse same; florets 14-16 per spike, overlapping, 11.5cm across.

'Mukta'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.37m; produces single corm per plant; mean corm diameter 6.2cm; mean corm weight 92.0g; cormels number 60-70; cormel diameter 1-2mm; mean cormel weight 65mg.

Floral Character: Mid-season, requires 60-90 days to flower; mean spike length 70cm; spike one-sided; florets Sulphur Yellow 1/3, throat Sulphur Yellow 1/2, reverse side Sulphur Yellow 1/3 with splashes of Orchid Purple 31/2 in irregular fashion; florets 12-15 per spike, loosely arranged, 10cm across.

'Pitambar'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.10m; produces 1-2 corms per plant; mean corm diameter 5.0cm; mean corm weight 71.40g; cormels number 150-500; cormel diameter 2-5mm; mean cormel weight 80mg.

Floral Characters: Mid-season, requires 80-90 days to flower; mean spike length 64cm; spike branched, florets Uranium Green 63/3, towards edge 63/2, throat having a streak of Orchid Purple 31/2, reverse same; florets 15-16 per spike, overlapping, 9cm across.

'Sanyukta'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.40m; produces 2-3 corms per plant; mean corm diameter 5.0cm; mean corm weight 60.6g. cormels number 100-600; cormel diameter 0.3-0.8cm; mean cormel weight 118mg.

Floral Characters: Mid-season, requires 60-90 days to flower, spike one-sided, branched, mean spike length 80cm; florets outer three petals Rose Opal 022; inner three petals Rose Opal 022/2, throat Primrose Yellow 601/3, reverse side Rose Opal 022/2, splashed with Primrose Yellow 601/3, more on the lower than on the upper side; florets 18-20 per spike, overlapping, 10cm across.

'Triloki'

Parents: *G.* 'Friendship'×*G. tristis*

Vegetative Characters: Mean plant height 1.2m; produces 1-2 corms per plant; mean corm diameter 4.6cm; mean corm weight 30g; mean cormel number 360; cormel diameter 0.2-1.0cm; mean cormel weight 173mg.

Floral Characters: Mid-season, requires 90-120 days to flower; spike one-sided, mean spike length 75cm; florets China Rose 024 in upper half portion and Primrose Yellow 601/2 in the lower half, having splashes of China Rose 024 along the margins, reverse side same; florets 14-15 per spike, 10cm across.

With the release of "tropicalised" *Gladiolus* cultivars from the National Botanical Reseaech Institute, it has been possible to cultivate *Gladiolus* commercially under the prevailing conditions in the North Indian plains from October to March. Further these tropicalised cultivars can be stored at room temperature from April to September.

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NARCISSI GROWN IN KASHMIR

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SUMMARY

FORTY-FOUR *Narcissus* varieties were collected from the Kashmir valley and its adjoining areas. 'Chinese Sacred Lily' is the most commonly grown variety, followed by 'Telamonius Plenus', 'Emperor', 'Sir Watkin', 'Grand Soleil d'Or' and 'Elvira'. The majority of the varieties presently grown in Kashmir represent introductions of the late nineteenth or early twentieth centuries. Chromosome numbers were found to be in multiples of 7, 10 and 11, or their combinations.

Cultivation of *Narcissi* (here referred to as both *Narcissus* and daffodils) in India has remained confined largely to Kashmir. On a small scale, however, they are also grown in other Himalayan states such as Himachal Pradesh, Sikkim, and the hill areas of Utar Pradash and West Bengal.

The first *Narcissi* probably were brought into Kashmir by the Moguls who are credited with having introduced several exotic ornamentals into India. Ain-i Akbari (Abu L-Fazl, 1596-97), an historical treatise of the Mogul period, mentions "nargis" (Persian and Hindustani name for *Narcissus*) under the list of aromatic plants blooming in the spring. Baker (1875) and Burbidge (1889) recorded the existence of *N. tazetta* in Kashmir. Introduction of popular, western cultivars took place at the hands of the British during the late nineteenth and the early twentieth centuries.

Explorations made by the present authors revealed that, while there are a number of cultivars grown in the valley, the identities of most of these are not known. Even the few cultivars offered by the nurseries turned out to be mixtures. And in many cases, the given names did not agree with the authentic descriptions available in literature. As a first step towards utilizing this resource, it was felt necessary to collect and document the varieties available in the valley and its surroundings. Cytological studies were carried out to reveal their chromosome constitution, and, if possible, the species involved in their origin.

MATERIALS AND METHODS

The bulk of the material was collected from public and private gardens, parks and nurseries in Kashmir (Table 1). Due to an old Muslim custom of planting flowering perennials in graveyards, these areas also were explored. In addition, collections were made from Jammu, Kishtwar and Badarwah, subtropical and temperate areas surrounding the valley. The plants were tagged while in flower, and the bulbs were uprooted after the leaves had started yellowing. Materials thus collected were given accession numbers and grown in pots for subsequent flowering.

Identification of varieties was made from relevant botanical and horticultural literature including the Royal Horticultural Society Classified List of Daffodil Names, and the American Daffodil Society Daffodil Data Bank. Confirmation of cultivar names was also obtained from experts in The Netherlands and the United States.

Cytological studies were made from young root tips prefixed and squashed according to schedules described earlier (Karihaloo and Koul 1985; a,b).

VARIETIES

Forty-four *Narcissus* varieties were isolated and identified from the collected materials (Table 1). 'Chinese Sacred Lily', 'Telamonius Plenus', 'Emperor', 'Sir Watkin', 'Grand Soleil d'Or' and 'Elvira' were found to be the most commonly grown varieties. Of these, 'Chinese Sacred Lily' is the single, most widely distributed variety. It is grown throughout the Kashmir Valley, and also in Poonch, Kishtwar, and to some extent in Jammu. It is the first *Narcissus* to bloom and, in fact, the first flower to appear in spring. Locally called 'Yemberzal', 'Chinese Sacred Lily' has found a place in some religious festivals in addition to being used as a bedding plant and cut flower.

The identity of this plant as being the 'Chinese Sacred Lily' of China and Japan was confirmed from morphological and cytological studies (Karihaloo and Koul 1983; Karihaloo 1985).

There are two opinions about the mode of entry of this variety into Kashmir. Baker (1875) and Burbridge (1889) included Kashmir, along with China and Japan, among the regions where it exists naturally. Royle (1839), Fernandes (1951), Ohwi (1965) and Stewart (1972), on the other hand, regarded *N. tazetta* as an introduced species into Kashmir, Iran, China and Japan where, subsequently, it has run wild. The present authors agree with the latter contention (Karihaloo and Koul 1983).

Most of the *Narcissus* varieties presently grown in Kashmir represent old introductions. Table 1 shows that the majority of the 31 varieties for which records are available were registered by the Royal Horticultural Society, London, in the late nineteenth or early twentieth centuries. Obviously the commercial value of these varieties is limited to multiplication for local use.

Chromosome numbers of *Narcissus* are in multiples of 7, 10, and 11. The last two numbers are restricted to the section *Hermione*, to which *N. tazetta* belongs. All the rest have $x=7$. The present varieties are diploid, triploid or tetraploid of these basic numbers, or their combinations. The 29 chromosomes of 'Beersheba' represent an aneuploid number ($4x+1$). B-chromosomes have been recorded in 'Empress' and 'Elvira'. The chromosome counts are here recorded for 17 varieties, while new numbers are reported for 7 (Table 1).

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Table 1. ***Narcissi*** **collected from Kashmir and its adjoining areas.**

	Variety & year of registration	Species	Present chromosome count	Earlier chromosome count*	Place of collection**
Hort. Div. 1					
1.	'Emperor' (1865)	*N. pseudo-narcissus*	21	21 (Nagao 1933)	2,5,6,9
2.	'Empress' (1865)	"	21 & 1B	22 (Nagao 1929) 21 & 1B (Wylie—1952)	2,5,6,9
3.	'Golden Spur' (1889)	"	21	14 (Janaki, Ammal & Wyllie—1949) 21 (de Mol 1922) 30 (Nagao 1929)	2
4.	'Magnificence' (1914)		21	——	2
5.	'Beersheba' (1923)	"	29	28 (Janaki, Ammal & Wyllie 1949)	2
Hort Div. 2					
6.	'C.J. Backhouse' (1884)	*N. pseudo-narcissus* × *N. poeticus*	14	14 (Brandham & Kirton 1987)	5
7.	'Gloria Mundi' (1887)	"	14	21 (Nagao 1929)	1
8.	'Mrs. Langry' (1890)	"	14	14 (Janaki, Ammal & Wyllie 1949)	7
9.	'Lucifer' (1890)	"	14	14 (del Mol 1925)	2
10.	'Homespun' (1907)	"	14	——	7
11.	'Croesus'	"	14	21 (Brandham & Kirton 1987)	2
12.	'Kingdom' (1913)	"	14	——	2
13.	'Sir Watkin' (1884)	"	21	21 (Nagao 1929)	5,7
14.	'Whitewell' (1910)	"	21	——	7
15.	'Flower Record' (1943)	"	21	28 (Fernandes & de Almeida—1971)	2
16.	'Golden Pedestal' (1922)	"	28	——	7
17.	'Fortune' (1923)	"	28	28 (Janaki, Ammal & Wyllie 1949)	2

18.	'Carlton' (1927)	"	28	28 (Fernandes & de Almeida—1971)	2
19.	'Brunswick' (1931)	"	28	28 (Janaki, Ammal & Wyllie 1949)	2
20.	'Scarlet Elegance' (1938)	"	28	——	7
Hort. Div. 3					
21.	'White Lady' (1898)	"	14	21 (Brandham & Kirton 1987)	7
22.	'Sunrise' (1907)	"	14	14 (Brandham & Kirton 1987)	1
23.	'Queen of the North' (1908)	"	14	——	2
24.	'Barrii Conspicuus' (1886)	"	21	——	7
25.	'Harpagon' (1913)	"	21	——	9
26.	'Frijlink'	"	21	——	2
Hort. Div. 4					
27.	'Dubloon' (1907)	"	14	——	2
28.	'Telamonius Plenus'	*N. pseudonarcissus*	14,28	14 (de Mol 1922) 27 (Fernandes & de Almeida—1971)	2,7
29.	Double form of Chinese Sacred Lily	*N. tazetta*	30	——	1,3
Hort. Div. 5					
30.	'Liberty Bells' (1950)	*N. triandrus* hybrid	21	——	2
Hort. Div. 7					
31.	'Orange Queen'	*N. pseudonarcissus*×*N. jonquilla*	14	14 (Janaki, Ammal & Wyllie 1949)	2
Hort. Div. 8					
32.	'Canary Bird' (1958)	*N. tazetta*	20	——	2,7
33.	'Grand Soleil d'Or' (1890)	"	30	20 (Sikka 1940) 30 (Nagao 1930)	2,7

34.	'Scilly White' (1889)	"	32	21 (Kurita—1954) 32 (Fernandes & de Almeida 1971)	7
35.	'Alsace'	*N. tazetta*×*N. poeticus*	17	17 (Fernandes—1950)	2
36.	'Irene'	"	24	17 (Fernandes—1950)	2
37.	'Garden Beauty'	"	24	——	7
38.	'Elvira' (1904)	"	24 24+1B	24 (Nagao 1933)	7
Hort. Div. 9					
39.	'Red Rim' (1923)	*N. poeticus*	14	14 (Fernandes & de Almeida 1971)	2,6
Hort. Div. 10					
40.	'Pheasant's Eye'	*N. poeticus*	21	——	7
41.	*jonquilla*	*N. jonquilla*	14	14 (Nagao 1929)	2
42.	*papyraceus*	*N. tazetta*	22	22 (Fernandes—1937)	2
43.	Chinese Sacred Lily	"	30	30 (Nagao 1930)	1,2,3,4, 5,6,7,8, 9,10,11,12
44.	Collection 78 (unidentified straw flower)	"	21	——	7

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* Only one report, the first, per chromosome count has been included.

** 1. Church garden, the Bund, Srinagar; 2. Private Garden of Mr. Prakash Shivpora, Srinagar; 3. Kashmir Univ. Campus and Botanical Garden, Srinagar; 4. Nishat Garden, Kashmir; 5. Shalimar Garden, Kashmir; 6. Harwan Garden, Kashmire; 7. M/s P. Kohli & Co., Srinagar; 8. Prakash Seed Farm, Srinagar; 9. Emporium Garden, Srinagar; 10. Poonch; 11. Kishtawar; 11. Jammu; 12. Badarwah.

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INTERNATIONAL BULB SOCIETY
UNIVERSITY OF CALIFORNIA AT IRVINE ARBORETUM
IRVINE, CA 92717 USA

1990 *HIPPEASTRUM* SOCIETY NEWS

MRS. J. Tondut, secretary of the West Australian Gladiolus, Dahlia and Hippeastrum Society, Inc., reports on their 1990 State Hippeastrum Championship Show held at Garden City, Booragoon, Western Australia. It "was most successful, although (there were not) as many pots as usual, owing to the very cold weather we had prior to the show. We had three entries in the State Championship, which was won by Mr. Joe Larsson. There were 70 pots in the show and 60 on display. There were 18 florets. There were some lovely blooms which were very much enjoyed by the general public." The Society's president this year is Mr. W. Davey. Correspondence with the society may be directed to Mrs. Tondut at 42 Kathleen Street, North Cottesloe, 6011, Western Australia.

Ed Beckham of the Men's Amaryllis Club of Greater New Orleans, Inc., notified **Herbertia** that their editor and show chair, Al Diermayer, died in early November, 1990, after battling an illness that required surgery. His leadership of the Club will be missed. Editorship of their newsletter is now the responsibility of Associate Editor L.W. "Buddy" Mazzeno, Jr., 944 Beverly Gardens Drive, Metairie, LA 70002 USA, while David Heikamp (717 Guiffrias, Metairie, LA 70001), Assistant Show Chair, accepts membership applications/dues ($7.50 per year.) Club president is Ed F. Schellhaas ((???) 443-2098).

The 1991 board of directors of the Southern California Hemerocallis and Amaryllis Society (SCHAS) was elected on 17 November, 1990 and includes the following:

president — Ralph Sisson, 9543 Cedros Ave., Panorama City, CA 91107-1257 USA
vice president — Ruby Lassanyi, 640 Santa Maria Road, Arcadia, CA 91007-2625 USA
treasurer — Laura Ellen Speck, 300 East Norman Ave., Arcadia, CA 91006-4732 USA
corresponding secretary — Elisabeth Lassanyi, 640 Santa Maria Road, Arcadia, CA 91007-2625 USA
recording secretary — Bruce La Rue, 2738 Vissicher Place, Altadena, CA 91001-5158 USA
advisor — Bob Zimmerman, 4465 Briney Point Road, La Verne, CA 91750-2302 USA

Membership dues for 1991 are $10 (US) per year, $12 per year for 2 people at the same mailing address; three-year memberships are also available. Membership dues may be sent to the treasurer or corresponding secretary. A bulb sale is scheduled for 15-18 February, 1991, their annual *Hippeastrum* and bulb show and sale will be the 20-21 April, 1991, and their *Hemerocallis* show/sale is scheduled for the first Saturday in June.

SPECIES *LYCORIS* COLLECTION

The owner of what may have been the largest known collection of species and hybrid *Lycoris*, Phil Adams, presented a magnificent slide show and talk on the *Lycoris* and on *Hemerocallis* hybrids at the November, 1990, meeting of the Southern California

Hemerocallis and Amaryllis Society (SCHAS). At the meeting he announced the dispersal of his *Lycoris* collection and donated several rare and unusual species (including *L. aurea*, *L. jacksonii*, and a fertile, diploid *L. radiata*) and species hybrid plants to SCHAS for auction. His collection has been split three ways with part given to a private botanical garden (Huntington Gardens of San Marino, California), part being retained by Phil, and part being sold to Herbert Kelly, Jr., who will make individual bulbs and small collections of *Lycoris* available for sale through his nursery, Kelly's Plant World. Inquiries regarding the availability and price of bulbs should contact Herb Kelly at 10266 East Princeton, Sanger, CA 93657 USA, or at (209) 292-3505.

RESEARCH GRANTS AWARDED

The American Floral Endowment has announced its research project grant selections for 1991, among which are the following:

Dr. Alan W. Meerow of the University of Florida, IFAS, will be granted $10,000 for his second year of research on breeding new *Hippeastrum* cultivars using diploid species.

Dr. Robert Langhans, Cornell University, Dr. Mark Bridgen, University of Connecticut, and Dr. Richard Craig, Pennsylvania State University, will be granted $20,000 to create a production program for virus-free *Alstroemeria*.

Dr. Terril A. Nell of the University of Florida and Dr. August A. DeHertogh of North Carolina State University will conduct their third year of research on post greenhouse evaluations of forced bulbous plants with an $11,000 grant.

Dr. Susan S. Han, University of Massachusetts, Amherst, will be studying the induction of year-round flowering of *Tritelia laxa* 'Queen Fabiola' with ethylene treatment using a $7,300 grant.

Dr. Douglas A. Hopper of Colorado State University will use a $10,650 grant to research use of thermodynamic balance for promoting *Alstroemeria* production.

BOOK REVIEW: *BULBS*. JOHN E. BRYAN

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BOOK Review: **Bulbs**. John E. Bryan. 750 pp. in 2 volumes, 754 color photos, 110 botanical paintings in color, 8 ½×11", hardbound. $120.00. Timber Press, Portland, OR. 1989.

John Bryan, formerly director of Strybing Arboretum in San Francisco, has taken on a Herculean task: the production of a sumptuous horticultural monograph on bulbous (true and "bulblike") plants. Sumptuous it is indeed, filled with color photographs as well as reproductions of color plates from the nineteenth century heyday of botanical illustration. To a large extent, Mr. Bryan has succeeded. To date, garden geophytes as a group have never before been treated so lavishly in book form. Nonetheless, as might be expected in a work of this scope, the volumes are riddled with several irksome weaknesses that as a whole detract from their strengths.

The first seven chapters (about sixty pages) of volume one are devoted to the history, botany, and horticulture of bulbous plants. Much of this information is not new to the printed page, and largely duplicates the basic outline of Martyn Rix's earlier slim volume **Growing Bulbs**. The basics of bulbous plant propagation are covered adequately, though including illustrations of such vegetative techniques as bulb scale propagation would have been useful. Particularly fine attention has been given to the utilization of bulbs in the landscape. This chapter is very nicely illustrated with color photographs, and draws upon Mr. Bryan's long career as a professional horticulturist. An informative guide for forcing bulbs out of season is also provided. However, nowhere does Mr. Bryan make a statement concerning the over-zealous collection of bulb species from the wild, a commercial practice that is currently receiving great scrutiny and outcry from many quarters. Given that **Bulbs** is likely to become a standard reference for many years, this omission is all the more unfortunate.

At the rear of the second volume, a number of appendices have been compiled in which the reader will find short descriptions of families containing bulbous plants, a cross-listing of common names, and tables of species organized by flower color, hardiness, season of bloom, as well as special use (e.g., cutflowers). These touches affirm the strength of **Bulbs** as a comprehensive reference. A short glossary and bibliography precede the index.

The bulk of the volumes' many pages is taken up with an encyclopedic treatment of bulbous, cormous, tuberous and rhizomatous plants. This section is organized alphabetically by genus. For each genus enumerated, Mr. Bryan provides historical, etymological, geographical, and descriptive details, followed by sections on culture, propagation, pests and diseases, uses, comments and an annotated list of species. The depth of information varies from genus to genus. The encyclopedic section is well organized and easy to use. The color photographs vary in quality. However, it was from within these pages that I came away wondering if Mr. Bryan had been quite meticulous enough.

The chief weakness of **Bulbs**, is Mr. Bryan's insistence on treating species with which he has no experience. As a consequence, species that have never been seen again after their initial description over a century ago are lovingly described as if the author flowered them in his greenhouse in the recent past. Indeed, if Mr. Bryan has in his possession living specimens of such amaryllids as *Plagiolirion horsmannii* or *Eucrosia mirabilis* (unfortunately listed by the old name *Callipsyche*), I will take the next plane out to the West Coast. For the cultural requirements of *Lepidochiton quitoensis* (*Hymenocallis quitoensis*), the reader is referred to *Pamianthe*, despite the fact that the former is a ephemeral xerophyte with a long season of dormancy, while the latter is an evergreen epiphyte! By a similar token, Mr. Bryan's taxonomy on a number of plants is outdated or simply in error, despite his claim of relying "upon the many experts of the various genera." This seems especially true in his treatments of South American bulbs. Conversation with specialists in other bulb groups has revealed similar shortcomings elsewhere. Sadly, there is also no mention of the International Bulb Society (formerly American Plant Life Society), despite this organization's 56 year history.

John Bryan's **Bulbs** is an expensive addition to the gardener's library. The person with only a casual interest in bulbs would be better served by the more modestly priced **The Bulb Book** by Martyn Rix and Roger Phillips. Enthusiasts and collectors will enjoy the scope and detail of **Bulbs**, despite its occasional failure to live up to its claims of authoritativeness.

"CONSIDER THE LILIES OF THE FIELD . . ."

DR. R.J. SHAW
AND
DR. M.C. WILLIAMS
UTAH STATE UNIVERSITY

THE lily family (Liliaceae) is one of the largest families of flowering plants, and is one of the most important groups of horticultural plants since it includes the true lilies and numerous cultivated lily-like genera. The onion is the lily of most economic importance.

Most of the Liliaceae are herbs, and a large percentage of these have swollen storage organs, such as bulbs, corms, rhizomes, or thick, fleshy roots. In Utah, these storage organs have not only been a source of food but have poisoned livestock and humans. This article examines distribution of lilies in Utah and will indicate whether their storage organs are edible or poisonous.

The flowers of lilies are regular and bisexual and usually have six perianth segments (sepals and petals). There are usually six stamens always arranged opposite the perianth segments. Many of the Liliaceae are pollinated by insects attracted by the nectar secreted by the ovary or nectar glands at the base of the petals.

Within Utah's native flora there are 15 genera of lilies and at least nine other ornamental genera. An exciting array of bulbous and rhizomatous plants exist among the approximately 45 native and cultivated liliaceous species found in Utah.

Among the naturally occurring lilies, perhaps the sego lily (*Calochortus nuttalli*) has the most intriguing history and beauty. It was very important to the Indians, who ate raw bulbs or roasted them in the embers of a fire. Some Indian tribes pounded the dried bulbs into a flour and used it in a porridge or mush. The bulbs could be stored for long periods of time. Mormon settlers also supplemented their meager food supply with these bulbous delicacies in the fall of 1848 when the crops were damaged by hordes of crickets (Harrington 1972). The Utah state legislature later recognized this species of the sagebrush foothills as the state flower.

Fewer sego lilies are found today than were found 138 years ago, mainly because of urban sprawl into foothill habitats. The species is not endangered, but is difficult to find. The plants and their habitats should be preserved whenever possible.

The bulbs of the common camass (*Camassia quamash*) also were an important food for Native Americans who fought many intertribal wars over rights to certain meadows where camass were abundant (Harrington 1972.) The Indians sometimes boiled the bulbs to form a syrup, but usually baked them in pits lined with stones. Camass bulbs seem to lack starch but are high in sugar content. We found the raw bulbs were crisp and palatable, but the boiled bulbs were somewhat gummy. The bulbs of the deathcamas are about the same size as the common camass bulbs and, apparently, were mistakenly consumed, often with fatal results. It is possible to distinguish between the two species by their flowers and habitats. Common camass has blue to violet flowers and grows in mesic meadows, whereas the deathcamas has whitish to cream-colored flowers and occupies drier sites on the foothills, often with sagebrush.

The glacier lilies (*Erythronium grandiflorum*) of canyons and subalpine regions served only as an occasional food for the Indian tribes of Utah, perhaps because the deep-seated bulbs were difficult to dig. The bulbs are eaten raw or boiled and even the leaves can be a potherb. These beautiful lilies can be abundant in some areas, but indiscriminate gathering should be avoided in order to protect the remaining wildflower habitats in Utah. These bulbs can be used in emergency and are eaten by bears and small mammals.

Fritillarias, also known as yellowbells and leopard lilies, are harbingers of spring found in areas ranging from valleys to subalpine regions. They were also eaten by natives. The two species, *Fritillaria pudica* and *Fritillaria atropurpurea*, reproduce asexually by bulblets that form around the main bulb. Both bulbs and fruiting capsules are edible, but should be eaten only in an emergency to protect these beautiful, scarce plants. Fritillarias can be found in grasslands, sagebrush deserts, and coniferous montane forests.

In terms of the number of species, the genus *Allium* is the most important. These wild onions and garlics have been eaten since ancient times in the Old World and the New World (Elias 1972.) Eleven indigenous species in Utah are found in areas ranging from desert locations to high mountain forests. Explorers and pioneers, like the Indians, ate various onions, either raw or cooked and with other foods for flavor. Wild mammals frequently dig these bulbs. Milk from cows that eat the foliage is onion-flavored.

Four groups or genera of the naturally occurring lilies arise from rhizomes (underground stems.) The genera *Smilacina* (false solomon seal), *Disporum* (fairy bells), *Streptopus* (twisted stalk) and *Veratrum* (false-hellebore) all have large expanded leaves well distributed along the stems; the usually numerous flowers are white to greenish white. False solomonseal, fairy bells and twisted stalk are edible (Weiner 1972), but, as will be explained later, false hellebore should not be eaten.

The aromatic rhizomes of the two false solomon seal species are starchy and slightly bitter. Some enthusiasts recommended soaking the rhizomes overnight in lye followed by parboiling to improve the flavor. The berries are edible but purgative if too many are eaten. Indians ate the sweet yellow or orange-red berries of fairy bells. The red, juicy berries on the twisted stalk may be eaten raw or added to soups and stews, but consumption of too many berries can be cathartic. All of these rhizome-bearing lilies are found in rich, moist soil and wooded areas.

The distinctive indigenous lilies known as wild hyacinths bear flowers with perianth segments joined in a definite basal tube that is usually more than ½ inch long. The stems arise from corms. They are less common than wild onion and their edible storage organs can be eaten raw or boiled. The wild hyacinths belong to the genera *Tritelia, Dichelostemma* and *Androstephium*. *Tritelia* can be found in northern Utah, while the latter two genera are limited to dry sites in southern Utah.

A series of European lilies have escaped cultivation and may show up in sanitary landfills, grassy meadows, and weedy lots in Utah. These species are grape hyacinths, star-of-Bethlehem, garden hyacinth, tulips, lily-of-the-valley and asparagus. Many are poisonous.

POISONOUS LILIES

The delicate beauty of lilies often belies the fact that many are poisonous. Three members of the lily family found in Utah are highly toxic (Kingsbury 1964): star-of-Bethlehem or snowdrop (*Ornithogalum umbellatum*), California false hellebore (*Veratrum californicum*), and deathcamas (*Zigadenus* spp.).

Star-of-Bethlehem, introduced from the Mediterranean area as a garden plant, escaped cultivation to become naturalized in many parts of the country. The bulbs contain a highly toxic alkaloid that primarily affects cattle and sheep. More than 1,000 sheep in Maryland died after they ate the onion-like bulbs. Children in other countries have been poisoned by bulbs of related species.

California false hellebore is a large, erect plant that grows on moist, open meadows at elevations of 5,000 to 11,000 feet (James, et al. 1980). The plant contains several toxic and teratogenic alkaloids. Sheep are poisoned after eating 6 to 12 ounces of the green plant. The most serious problem associated with *Veratrum* poisoning is the congenital malformations in lambs if the ewes eat the plant on the 14th day of gestation. The lambs are born with a variety of malformations ranging from the "monkey-face" deformity, in which the face resembles a monkey, to severe deformities resulting in missing or rudimentary eyes, brain, nose, or limbs. The lamb might be born cyclopic with one large eye in the center of the head. These malformed lambs are unable to walk or nurse and die soon after birth. The ewe may also abort or fail to lamb at the end of the normal gestation period.

Until the early 1960's, the malformation found in lambs was attributed to genetic problems in breeding stock or a toxic substance in the flora, soil, or water from affected areas. Workers at the U.S. Department of Agriculture's Poisonous Plant Research Laboratory at Logan, Utah, investigated the problem and established that ingestion of California false hellebore was the sole cause of monkey-face lamb disease (Keeler 1984). They further demonstrated that three steroidal alkaloids extracted from the plant, jervine, cyclopamine, and cycloposine, induced the disease.

This information provided a practical solution to the problem: keep the pregnant ewes away from the plant until at least two weeks after the rams are removed. Incidence of monkey-face lamb disease has dropped from 25-30% on false hellebore infested ranges to less than 1%, and incidence could be reduced to zero if proper management practices were always observed. The entire deathcamas plant contains toxic alkaloids (Kingsbury 1964).

The most troublesome species in Utah are meadow deathcamas (*Zigadenus venosus*) and foothill deathcamas (*Z. paniculatus*). *Zigadenus elegans*, the third species found in Utah, is less toxic. Deathcamas grow in the spring and early summer and many livestock, particularly sheep, are poisoned every year. Cattle are occasionally poisoned. Poisoned animals salivate excessively, develop nausea, tremble, become weak and usually are comatose before death.

Humans may mistake the plants for wild onions or the edible common camass. The Poison Control Center in Salt Lake City, Utah, reported six cases of human poisoning from deathcamas in one year, one case involving consumption of "wild onion soup" made from deathcamas. The victims were saved by the quick action of the Poison Control Center and a family physician.

Five other members of the lily family found in Utah have been reported to be poisonous. Two of these lilies are edible and have poisoned animals only under unusual circumstances.

Lily-of-the-valley (*Convallaria majalis*) is a common cultivated ornamental flower that contains a cardiac glycoside and also acts as a purgative and emetic. All parts of the plant are poisonous.

Bulbs of the common garden hyacinth (*Hyacinthus orientalis*) and narcissus or daffodil (*Narcissus* spp.) caused purgation in cattle when fed as an emergency feed during World War II in the Netherlands. Humans have been poisoned by eating the bulbs of daffodils. Cultivated onions (*Allium cepa*) and wild onion (*Allium canadense*) have also been poisonous, even though both are edible and the cultivated onion is a common food. Most common foods, including onions can be toxic if too much/many are consumed. The threshold of toxicity is so high that it would be virtually impossible to eat enough to produce toxic signs. Cattle and horses on fields of culled onions or that consume very large amounts of wild onion have been poisoned. They become anemic and suffer severe gastroenteritis. The poisonous compound is thought to be an alkaloid.

Other cultivated and native lilies of Utah have not been classified as edible or poisonous. Never chew or swallow any part of a lily unless you can positively identify the plant as one known to be edible. Any other lily might cause poisoning and death.

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THE PHYTOGEOGRAPHY OF THE GENUS *ALSTROEMERIA*

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ABSTRACT

THE genus *Astroemeria* is widespread in subtropical and temperate South America, with 2 centers of distribution in Chile and eastern Brazil, respectively. Many of the species of this genus are poorly defined because of the frequent incidence of spontaneous interspecific hybrids. The genus appears to have been influenced by the recent orogeny of the Andean Cordillera, the desertification caused by this orogeny and the development of the cold Humboldt Current. The glaciations of the Pleistocene may also have affected the distribution of *Alstroemeria*. The genus probably evolved between the temperate Nothofagus forest and the tropical rain forest to the north. Within these confines, speciation has filled a wide variety of ecological niches with one or more species of *Alstroemeria*. These forest types may be the dynamic that has limited the distribution of the genus.

INTRODUCTION

The genus *Alstroemeria* was discovered in 1714 when Feuillee noticed and first described a species of *Alstroemeria* growing along a stream running through the city of Conceptión in Chile. He classified this plant as a species of *Hemerocallis*, possibly because the fleshy storage roots reminded him of the day lily that had by that time been imported to Europe from the Orient. He described three species and named the one he found in Conception *H. ligtu*, after the common name the natives gave the plant and the starchy food made from its storage roots (Coats 1968). He also named *H. pelegrina* from the Spanish word for "exquisite", referring to the striking color and form of the flowers and *H. salsilla*, a climbing plant with the common name "salsilla". All three species made their way to Linnaeus, who formally described them in the second edition of *Species Plantarum*. He noted the lack of floral similarity with *Hemerocallis*, and named it *Alstroemeria pelegrina* in honor of his friend and student, Claes Alstroemer (1736-1794) of Sweden. *Alstroemeria pelegrina* thus became the type for the genus. Linnaeus also proposed the transfer of the other two species, but refused to speculate on the true identity of *A. ligtu* since he had not seen the plant himself. *Alstroemeria salsilla* was later transferred to the genus *Bomarea*.

The genus *Alstroemeria* is composed of perennials with storage roots containing starch. Nearly all members of the genus have leaves that are resupinate (turned upside down) due to the twisting of the leaf base. Flowers are arranged in simple or compound umbel-like inflorescences with individual flowers highly spotted and somewhat zygomorphic (Baker 1888). The ovary forms a three-celled capsule with three well-defined locules.

The genus is distributed in a wide variety of habitats, from swampy localities to desert areas, and from shady lowland tropical woods to high Andean alpine areas. Although species of *Alstroemeria* are restricted to South America, the closely related genus *Bomarea* ranges as far north as central Mexico (Uphof 1952). The genus has in the past been grouped in the Amaryllidaceae (Baker 1888) and the Liliaceae (Buxbaum 1954). It is now placed with *Bomarea* (Neuendorf, 1977), *Leontochir*, and *Schickendantzia* (Uphof 1940) in the Alstroemeriaceae. A recent report suggests the cytological relationship between *Bomarea*, *Leontochir* and *Alstroemeria* (Bayer 1988). The economic importance of the genus has been the use of its starchy roots since the time of the Incas, and more recently as a garden flower and commercially produced cut flower (Bullock 1952, Healy and Wilkins, 1982 & 1986).

SPECIES AND DISTRIBUTION

Alstroemeria species are found in Peru, Chile, Brazil, Venezuela, Paraguay, Bolivia and Argentina. The center of distribution appears to be in central Chile (Bayer, 1987). Some species, such as *A. pelegrina*, *A. ligtu* and *A. aurea* (syn. *A. aurantiaca*) are widely distributed, while others, such as *A. patagonica*, are endemic to small areas (Uphof 1952).

The species of *Alstroemeria* appear to fall into two major distributional areas: the Brazilian group, which occur mostly in eastern Amazonas and the Brazilian Highlands (with one species, *A. amazonica*, extending to adjacent Venezuela) in Goias, Minas Gerais, Piaui, Para, Sao Paulo and Rio Grande do Sul states; and the Chilean group, which occur in central and northern Chile, coastal Peru, and across the Andes into areas of Bolivia and Argentina south to Patagonia (Baker 1888, Baker 1987). The phytogeographical distribution of these two groups appears to coincide with high elevation or coastal areas such as the Brazilian Highlands and the Andes. Physiological research has revealed that flowering in some *Alstroemeria* cultivars is highly dependent on a period of cool soil temperature (Stinson 1942d, 1952; Healy and Wilkins 1982, 1986). Cool temperatures are also required for the germination of seeds of many species of *Alstroemeria* (Hannibal 1942). Such conditions are more often found at high elevations and in coastal areas. High soil temperatures inhibit flowering and reproduction making it impossible for survival and dispersal. The distribution of *Alstroemeria* (Table 1; Figure 1) may thus be limited by soil temperature regimes in South America.

The problem of distinguishing species of *Alstroemeria* is not easily solved because populations vary greatly in morphological characteristics and interspecific hybridization takes place spontaneously and with high frequency (Hannibal 1941; Tsuchiya *et al.* 1987). Dichogamy, the temporal separation of dehiscence of the anthers and receptivity of the stigma, promotes outcrossing in many species of *Alstroemeria* (Traub 1943). There may be a separation as large as three days between the senescence of the last anther and the receptivity of the stigma in species like *A. pulchra*, *A. ligtu* ssp. *simsii* (syn. *A. haemantha*) and *A. pulchella* (syn. *A. psittacina*). This makes outcrossing with other individuals in a population or even with sympatric species a very likely occurrence. There are also few cytological barriers to interspecific crossing in *Alstroemeria*. Of the species studied, most have $2n=16$ (Taylor 1926). *Alstroemeria ligtu is reported to be a tetraploid, with* $2n = 32$ chromosomes (Tsuchiya *et al.* 1987), and is the only reported exception. Even in *A. nemorosa*, where dichogamy has not been reported, there is evidence of some barrier to self-compatibility (Stinson 1942b). Flowers may be visited by bees, flies, hummingbirds (Stinson 1942c; Traub 1966) or butterflies (pers. obs., E. Bayer 1988). Dichogamy and the pollinating agents were particularly well described by Urban (1928). He noted that the pollinization phenomena in *Alstroemeria* are similar to those of *Tropaeolum speciosum*. In his study of *A. aurea* (syn. *A. aurantiaca*), he conjectured that the visible markings and striping of the flowers are pollen guides. The bases of the two top inner tepals are rolled to form small tubes from which a clear drop of sugary nectar is exuded. The stamens rest on the surface of the other inner tepal. The anthers are drawn upward into the center of the flower by curving caused by differential growth of the filament. The anthers each dehisce in turn and senesce rapidly. After the last anther has senesced, the style grows and curves upwardly to reach the center of the flower, and the three stigma arms recurve when they reach receptivity. Bees apparently are unable to reach the nectar, but gather the pollen in copious amounts. A bumblebee, *Bombus dahlbormi*, also gathers the pollen, which sticks to its abdomen and can be transferred to another flower. Hummingbirds are able to reach the nectar and can also transfer pollen.

The presence of interspecific sterility or fertility gives us a point from which to speculate about the relationships of the various *Alstroemeria* species. Few of the possible crosses have been attempted. Some of the species of the Chilean group have been hybridized to produce modern greenhouse and garden cultivars. These species are *A. violacea*, *A. pelegrina*, *A. ligtu*, *A. aurea* (syn. *A. aurantiaca*) and *A. ligtu* ssp. *simsii* (syn. *A. haemantha*). *Alstroemeria pulchella* of the Brazilian group, probably figures in the parentage of some hybrids as well (Tsuchiya *et al.* 1987). Stinson (1942b) reported success in his attempt to cross *A. pulchella* with *A. chilensis* and *A. pelegrina* var. *alba*, but attempts to cross *A. aurea* with *A. chilensis* were unsuccessful. *Alstroemeria pulchra* would not cross with any other species.

Traub (1943) reported success in crossing *A. pulchra* with *A. ligtu* ssp. *simsii*, but was failed in his attempt to cross *A. pulchella* with *A. ligtu* ssp. *simsii*. Goemans (1962) stated that hybrids between two species were usually fertile, but that further hybridization with a third species often produced sterile offspring. Foster (1952) stated that the eastern species of *Alstroemeria* will not hybridize with western species. This observation might suggest the separation of the genus into Brazilian and Chilean subgenera. Although mapping the distributional patterns of *Alstroemeria* species can give clues to the temporal and spatial relationships between species, past geological and climatological events have been the real controlling factors in the evolution of *Alstroemeria*.

EVOLUTION OF *ALSTROEMERIA*

Unfortunately, there is no documented fossil evidence of the prehistoric evolution of *Alstroemeria*. The evolution of this genus is therefore largely based on conjecture. Hutchinson (1959) adhered to the idea put forth by Baker (1888) of the relationship of the genus *Alstroemeria* to the Amaryllidaceae, but proposed Alstroemeriaceae on the basis of distinctions in flower characteristics. Buxbaum (1951) used morphological characteristics of the rhizome of *A. aurea* (syn. *A. aurantiaca*) to place the genus in the Liliaceae. He likened the sympodial nature of the rhizomes to the form of stoloniferous bulbs of *Lilium canadense* and *L. superbum*. In his view, the Alstroemeriaceae is directly related to the Wurmbeoidea of the Liliaceae through the Lloydieae of the Lilioideae.

The early separation and continued isolation of South America, beginning in the Tertiary, have led to the development of the unique flora observed today (Cleef 1979; Simpson, 1975). Undoubtedly one of the biggest floristic invasions of South America took place with the unification of the continent with North America in the Pliocene (Darlington 1965) while the horizontal distribution of species occurred during the Last Glacial period (Hammen 1974).

The southernmost tip of the continent may have been warmer-than-glacial even when some other parts of southern South America were glaciated in the late Carboniferous and early Permian. Since then the tip has usually been warmer than present, with a high-rainfall, oceanic climate, at least along the western edge of the land. The far-southern area of high rainfall has probably always been isolated from the wet tropics by a barrier of relatively arid country, although the barrier has fluctuated. The rise of the Andes during the Tertiary formed a temperate corridor across the tropics which lessened the climatic isolation of southernmost South America. Finally the climate of the tip became cooler in the late Tertiary and glacial in the Pleistocene, and is still cold-temperate at sea level and glacial on the mountains (Darlington 1965).

The beginning of the orogeny of the Andean Cordillera in the middle Cretaceous with strong uplift in the upper Pliocene and Pleistocene drastically changed the distribution of the climate types on the continent. The extreme rain shadow deserts of northern Chile and coastal Peru began to form in the lower Cretaceous. Later orogeny in the south led to the development of the Patagonian steppe and the grasslands of the Gran Chaco and the Pampas. In the Pleistocene, the Andean vegetation was actively advancing in the coastal deserts, and considerable speciation took place in the Pliocene, when there was a great increase in the height and extent of the Andean Cordillera (Solbrig 1976).

Glaciation has had a profound effect on the South American continent, beginning in the Permo-Carboniferous with a widespread glaciation that was centered in present-day northern Argentina but did not effect the southern tip of South America. There is no evidence of further glaciation until the Pleistocene, a time of repeated but less extensive glaciation on the southern tip of South America. During these glaciations, arid regions separated the tropical rain forest from the more temperate *Nothofagus* forest as they do today, but conditions were generally wetter than they are at present (Solbrig 1976).

There is considerable debate about the actual origin of the flora of South America. The discovery of fossil *Glossopteris* on the continent is evidence that it was once inhabited by the Gondwanaland flora, and isolation of South America led to the development of its unique flora. There has been much speculation about the center of the evolution of the modern flora of South America. Some claim that Antarctica was once ice-free with a tropical or subtropical climate and served as the center of evolution (Darlington 1965). Fossil remains of such plants as tree ferns in Antarctica support this theory (Doumani and Long 1962). But the unquestionable lack of floristic affinity with other southern hemisphere landmasses sheds doubt on the idea of a common Antarctic origin. In the case of the Alstroemeriaceae, there is no floristic affinity with any other southern hemisphere land mass. The extreme range of the family is represented by the presence of *Bomarea* species in central Mexico, and *Bomarea* is closely related to *Alstroemeria*, differing in the addition of one pair of chromosomes (Whyte 1929), a twining habit in most species, actinomorphic flowers and a sarcotesta on the seed. The invasion of *Bomarea* into North America could be as recent as the joining of North and South America in the Pliocene (Darlington 1965). Few South American dominant species are shared with India, South Africa or Australia, suggesting separate evolutionary paths for these regions for long periods of time or successive invasion from the north. The presence of certain species of tree ferns in marine temperate climates, sometimes very near glaciers in New Zealand, would suggest that the fossil findings in Antarctica are not necessarily tropical. The great effect of the joining of North and South America should be emphasized, and invasion from the north has probably been rapid. *Quercus* has recently invaded, and is advancing southward along the Andes (Darlington 1965).

It is interesting to note that many of the members of the genus *Alstroemeria* are found in areas that can be considered desert or semidesert. Sarmiento (1975), in his examination of the floristic affinities of the dry areas of South America, discussed statistical similarities of the flora of central Chile with the supposed center of distribution of *Alstroemeria*

(Uphof 1952). The highest affinity was with the Monte formation of central Argentina and the Sierra formation of central Peru. This agrees with the idea of a persistent dryland floral formation separating the tropical rain forest and temperate forest areas of South America. Given the center of distribution stated by Uphof (1952), *Alstroemeria* most likely evolved in an arid or semiarid climate.

We know that glaciation had a profound effect on the flora of the Andes in the tropics (Hammen 1974), when the tree line descended to about 2000 m, about 1200-1500 m lower than today. Undoubtedly, vegetational types moved north and south along the Andes as well with the advance of the temperate forest northward into the arid regions during glacial periods, and the advance of the dryland formations southward during the interglacial periods, perhaps as far south as Tierra del Fuego, with the Andes serving as a refugium for the temperate forest vegetation (Darlington 1965). Thus, although the Andes would be a formidable barrier to genetic exchange in glacial times, the possibility for interglacial genetic exchange could be substantial. Steyermark (1979) noted that during the glacial period of Pleistocene, temperatures cooled and the vegetational belts developed into lower altitudes which encouraged horizontal expansion of flora which prediously was isolated in highland valleys. This may provide a geological explanation of the trans-Andean distribution of species like *Alstroemeria aurea*. Although a geological explanation of the trans-Andean distribution may be the most probable, trans-Andean trade between the indigenous coastal cultures and the Amazonian and east Andean peoples can not be ruled out.

Adaptive radiation is seen in the evolution of *Alstroemeria*. The commonly accepted center of distribution (Uphof 1952; Gulmon and Mooney 1980) is in the Mediterranean climate region of central Chile, marked by extreme seasonality of precipitation and the infrequency of freezing weather with cool, moist winters and hot, dry summers. Species such as *A. patagonica* are adapted to much harsher conditions on the steppes of southern Patagonia, where the climate is summer-wet with prolonged periods of severe freezing weather and little precipitation in the winter (Ravenna 1967). There are alpine representatives in the genus, such as *A. parvula*. *Alstroemeria campaniflora* is adapted to marshy places in the tropics. *Alstroemeria polyphylla* and *A. graminea* are adapted to some of the driest conditions found on the planet in the Atacama Desert (Uphof 1952). *Alstroemeria pulchra* has rhizomes that run along the surface of the ground, like crabgrass (Stinson 1942a). It appears that the genus *Alstroemeria* had enough plasticity during the orogeny of the Andes and the increase in the development of extreme arid conditions in South America to adapt and speciate in response to newly created environments. *Alstroemeria* seems to show the same type of adaptive evolution described by Gentry (1979) in Bignoniaceae. The distribution of *Alstroemeria* species may demonstrate, at least in part, the same 'reverse refugia' phenomonen that was postulated for dry forest Bignonianceae (Gentry, 1979).

SUMMARY

Because of the lack of information regarding the evolution of the species of *Alstroemeria*, it is difficult to draw conclusions about the effect of past events on the genus. It is probable that the genus evolved in the persistent arid region between the temperate *Nothofagus* forest in southern South America and the tropical rain forest of the Amazon Basin. The herbaceous nature of this genus might render the species unlikely to compete with dense forest vegetation in these formations. Soil temperature may also be a factor limiting the distribution of *Alstroemeria* species. The distribution of the modern species is centered in central Chile with a satellite distribution in central and eastern Brazil.

Table 1. Distribution of recorded species of *Alstroemeria*. Distribution is a compilation of distributions stated in the works of Baker (1888); Bayer (1987); Brydon (1940a, b); Foster (1945); Goodspeed (1940); Gulmon and Mooney (1980); Ravenna (1967, 1988); Robinson (1963); Thompson et al. (1979); Uphof (1940, 1952); and Veblen (1982). The distributional pattern noted here is not complete and only reflects the distributional patterns stated by the above authors. The species recorded in Chile are a compilation of Bayer's (1987) recent monograph of Chilean *Alstroemeria* and those species Ravenna (1988) described after publication of Bayer's monograph. Numbers correspond to numbers in Figure 1.

1.	*A. plantaginea*	high hills of Minas Gerais, Bahia and Goias in central Brazil
2.	*A. isabellina*	mountain marshes and rough pastures, near Portalegre, Rio Grande State, central and southern Brazil
3.	*A. radula*	primitive forests of the Serra do Itatiaya, at 1300m to 1850m, Brazil
4.	*A. cunea*	central Brazil
5.	*A. gardneri*	province of Goias, central Brazil
6.	*A. malmeana*	moist fields, near Santo Angelo, Rio Grande do Sul, Brazil
7.	*A. brasiliensis*	Goias and Minas Gerais, central Brazil
8.	*A. chapadensis*	Chapada Mountains, Brazil
9.	*A. campaniflora*	swamps and marshy places along mountains between Sao Paulo and Santos, Brazil
10.	*A. hasslerana*	Tobaty, Paraguay
11.	*A. piauhyensis*	shady woods near Veiras, Piauhy province, Brazil
12.	*A. damaziana*	near Ouro Prieto, Brazil
13.	*A. regnelliana*	Las Caldas, Minas Gerais, Brazil
14.	*A. insignis*	Alto de Serra, Sao Paulo, Brazil
15.	*A. amazonica*	northwest Pará State, Brazil; Estado Bolivar, Venezuela
16.	*A. inodora*	Solta, Brazil, in rock crevices
17.	*A. scaberula*	brushy places near Douro, Goias province, Brazil
18.	*A. butantanensis*	Sao Paulo, Brazil
19.	*A. platyphylla*	Goias, central Brazil
20.	*A. stenopetala*	Serra de Manuel Gomez, central Brazil
21.	*A. schenkiana*	San Joao das Antes, central Brazil
22.	*A. longistyla*	near Barbacena, Minas Gerais, Brazil
23.	*A. burchellii*	Goias, Brazil
24.	*A. caryophyllea*	southern Brazil, Esperito Santo State, acid soil in shade
25.	*A. monticola*	Serra dos Lagos, Bahia, Brazil
26.	*A. foliosa*	Minas Gerais, central Brazil

27.	*A. longistaminea*	Bahia, Brazil
28.	*A. nemerosa*	widespread in central and southern Brazil
29.	*A. sellowiana*	southern Brazil
30.	*A. zamioides*	Goias, Brazil
31.	*A. pulchella*	Northern Brazil
32.	*A. bakeri*	Catamarca, Argentina
33.	*A. epulauquensis*	Laqunas Epulauquen province Neuguen, Argentina
34.	*A. lacrima-solis*	pampa del Rio Salado, province Neuguen, Argentina; province Rio Negro, Argentina
35.	*A. pygmaea**	black soil at 2900m, Pasco, Peru, in prairies; Gregory Bay, eastern Patagonica, the Andes of Bolivia
36.	*A. fiebrigiana*	rocky slopes, at 3700m, Escayache, near Tariija, southern Bolivia
37.	*A. chorillensis*	Lima, Peru, and mountains of Peru
38.	*A. pavoniana*	Peruvian Andes
39.	*A. apertiflora*	Villarrica and Casguazu, Paraguay
40.	*A. pseudospathulata*	Andes, Chile and Mendoza
41.	*A. patagonica*	Santa Cruz, Chile, Neuquen and Laguna Blanca, Argentina, in arid steppes; to the top of Mount Frias and along the shingle beach of Lake Argentina, fiords near forest clad foothills, Argentina
42.	*A. garaventae*	near Limache, Chile
43.	*A. umbellata*	Santiago province, Chile
44.	*A. polyphylla*	mountains in Atacama province; Quebrada de Sorna, Chile
45.	*A. andina* ssp.. *andina*	Atacama and Coquimbo province, Chile and in mountains near Santiago
46.	*A. andina* ssp.. *venustula*	Coquimbo province, Chile
47.	*A. modesta*	Copiapo, Atacama and Coquimbo province, Chile
48.	*A. graminea*	Antofagasta and Atacama province, Chile
49.	*A. werdermannii*	Atacama province, Chile
50.	*A. aurea*	Island of Chiloe, off Chile, edges of virgin forests and open places, south to Puerto Aisen, north to Valparaiso, Chile; near Antuco Volcano, Argentina
51.	*A. exserens*	Maipu; Colchagua and Maul province, Chile
52.	*A. presliana* ssp.. *presliana*	mountains in Ñuble and Bio Bio province, Chile
53.	*A. presliana* ssp.. *australis*	areas around Malleco province, Chile
54.	*A. ligtu* ssp.. *ligtu*	around the cities of Concepción, Constitución; Maule, Bio Bio, and Ñuble province, Chile
55.	*A. ligtu* ssp.. *simsii*	Valparaiso, Chile; northern Brazil; Ovalle to Valdivia Chile
56.	*A. ligtu* ssp.. *incarnata*	Conception, Chile, Pulmari, Argentina; central Chile

57. *A. pelegrina*	Coquimbo province, Chile, on the coast, between xerophytic shrubbery, south to Amorgos near Corral; mountains of Peru, hills near Lima
58. *A. versicolor*	Chabut, Neuquen, Colchagua, Curico and Cautin provinces, Chile, Valparaiso and Cenceptión, Valle de los Cipreses
59. *A. pallida*	Aconcagua and Santiago province, Chile
60. *A. hookeri* ssp.. *hookeri*	Mendoza, Argentina; Cordillera de la Costa, central Chile
61. *A. hookeri* ssp. *recumbens*	lomas (coastal hills) in central Peru to flat tops of head lands near the beach in sand, province Valparaiso, Chile
62. *A. hookeri* ssp. *maculata*	Coquimbo province, Chile
63. *A. hookeri* ssp. *cummingiana*	Choapa and Maipo province, Chile and in the mountains near Valparaiso
64. *A. angustifolia* ssp. *angustifolia*	areas around Valparaiso and Santiago
65. *A. angustifolia* ssp. *velutina*	Coquimbo province, Chile
66. *A. kingii*	sandy soil on slopes and flat areas in Atacama province, Chile
67. *A. diluta* ssp. *diluta*	Talca province, Chile
68. *A. diluta* ssp. *chyrsantha*	Coquimbo and Elqui province, Chile
69. *A. pulchra* ssp. *pulchra*	Coquimbo and Santiago province, Chile; around Valparaiso
70. *A. pulchra* ssp. *lavandulacea*	Concepción and Malleco province, Chile
71. *A. magenta*	coastal northern Chile to Araucania, in loose sandy to rocky soil, the Fray Jorge fog forest at the edge of the Atacama Desert among Adesmia, Porliera and Encelia
72. *A. magnifica* ssp. *magnifica*	Coquimbo province, Chile
73. *A. magnifica* ssp. *maxima*	shady places, Aconcagua, Chile
74. *A. philippii*	near Papudo, Chile in clay soil on steep slopes; Coquimbo province to Valparaiso; Carrizal desert, Chile
75. *A. leporina*	Atacama and Coquimbo province, Chile
76. *A. crispata*	Huasco and Coquimbo province, Chile
77. *A. paupercula*	desert coastal mountain, in the Atacama, Mejillones; Antofagasta and Atacama province, Chile
78. *A. schizanthiodes*	Elqui, Limari and Coquimbo province, Chile
79. *A. revoluta*	Valparaiso area; Santiago, Colchagua, Curicó, Maule, Talca, Concepción, and Bio Bio province, Chile
80. *A. zoellneri*	Aconcagua and Santiago province, Chile
81. *A. volckmannii*	Araucania province, Chile

82. *A. spathulata*	areas around Valparaiso
83. *A. nubigena*	high Andes of Santiago province, Chile
84. *A. lineariflora*	Chile
85. *A. nivalis*	near the snow line in Santiago province, Chile
86. *A. inconspicua*	Santiago province, Chile
87. *A. oxyphylla*	Maula province, Chile
88. *A. sabulosa*	beach near El Tabo, province Valparaiso, Chile
89. *A. timida*	steep mountainous oak forest near Polpaico, Chile
90. *A. yaele*	Macul, Santiago province, Chile
91. *A. venusta*	sandy area near southern Laraquette Arauco province, Chile
92. *A. nidularis*	cypress forest valley near Maule, province Talca, Chile
93. *A. bilabiata*	oak woods province Santiago, Chile; woody plateau near Cantillanae, province Cachapoal Chile
94. *A. polpaicana*	high elevation oak woods near Santiago, Chile
95. *A. spectabilis*	Maip, Quebrada del La Plata, province Aconcagua, Chile; Rinconada province Maip province Santiago, Chile
96. *A. magna*	shrubby area between Los Molles and Los Villos, province Aconcagua, Chile
97. *A. jocunda*	Laguna Lo Encañado; Santiago province, Chile
98. *A. cantillanica*	edge of the high plateau near the Nothofagus forest Cachapoal province, Chile
99. *A. poetica*	Coquimbo province, Chile
100. *A. longaviensis*	wooded valleys Linares province, Chile
101. *A. huemulina*	Ñuble province, Chile
102. *A. monantha*	Puerto Oscuro and Los Vilos Aconcaqua province, Chile
103. *A. parvula (A. umbellata?)*	high Andes of Santiago and Aconcagua, Chile

* Transfered to *Schickendantzia* Pax

Figure 1. Distribution of recorded species of *Alstroemeria*. Numbers correspond to numbers in Table 1 and represent either an individual sighting of the species or the approximate geographical midpoint of the distribution.

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A TRUE BREEDING STRAIN OF YELLOW *CLIVIA*

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IN the late 1960's I wrote to Mr. Les Hannibal and asked him if he could send me seed of the yellow *Clivia*. He told me that his plant was self-sterile, but that he would set seed on it using an ordinary orange *C. miniata* as a pollen parent and that if I raised the seed I "could recover the yellow plants in the second generation." Since then I have been extensively crossing the original six F_1 seedlings with themselves and, when possible, with F_2 yellow seedlings. So far all the deep green seedlings (without any anthocyanin pigment in their leaves) which have flowered have been yellow. Thus, the appearance of the seedlings in their first year has enabled the yellow plants to be separated, and grown rapidly. Some yellows have flowered in four years from seed, comparable to the orange seedlings' growth rate.

Since a number of yellows have flowered they have been crossed among themselves (ie: $F_2 \times F_2$) and this seed produces 100% pure green (no pigment) plants and, thus, 100% yellow flowers. This breeding procedure has indicated that the yellow factor acts as a simple recessive gene as shown by the following figures:

cross type	**percentage yellow**
F_1 (orange) × F_1 (orange)	≈ = 20%
F_1 (orange) × F_2 (yellow)	≈ = 50%
F_2 (yellow) × F_2 (yellow)	≈ = 100%

The $F_1 \times F_1$ cross regularly produces less than the expected 25% yellow, whereas the $F_1 \times F_2$ cross is very close to the expected 50% yellow. The reason for this is not apparent. I have been told that yellow flowered *Clivia* in South Africa have produced the following results from seed. Two different yellow clones when crossed produced all orange offspring. When these two clones were self-pollinated, one produced yellow seedlings, while the other produced orange seedlings. I was also told that these (and possibly other results) had led to the belief that yellow plants did not breed true for yellow in their offspring.

As stated above, the two yellows used were *different* clones that had originated separately in the wild. As indicated by the selfing results, they are also different genetically. I suggest that this is very similar to the genetics of white *Cattleya*. Most white *Cattleya* when selfed produce white offspring. However, some whites when selfed produced colored offspring varying in colour from mauve back towards white. These are called "tinged" whites and are not true albinos. They are plants in which the normal purple pigment is so dilute that the plants appear white. Other times they appear to contain "suppressor" genes which prevent the purple pigment from being formed. When selfed the plants which do not get the suppressor gene produce progeny of the normal purple color. When whites are crossed with other whites, whites are sometimes obtained; at other times all purple flowers appear. It was determined that the naturally occurring white clones could be divided into two groups. Crossing white with white *within* the two groups always produced white offspring but crossing *between* the groups always produced purple offspring. I suggest that the clivia results are along the same lines.

If you cross two yellows with the same genetic makeup you get 100% yellow seedlings. If a yellow will self (the original yellow grown in this country won't and, apparently, Les Hannibal's plant wouldn't, also), yellow seedlings will be obtained if it is a true yellow. If, however, it is a "tinged" yellow (that is a yellow because the orange pigment is so dilute or suppressed that it is not apparent), the offspring will be mainly orange. If you have two yellow clones with *different* genetic backgrounds and you cross between them, the offspring will be mainly or totally orange. This, I suggest, is the situation previously described for South African plants. Hence, to produce a true breeding strain it is better to only use one yellow plant (i.e.: one genetic type) for the F_1 because when finally one has a number of yellow plants (different F_2 seedlings), they all have the same genetic background and, thus, breed all yellow.

Under my conditions I do not find the yellow flowering plants much less vigorous than their orange siblings (F_2 generation). They are slightly less vigorous in that

(A) when small they seem to rot off more easily when transplanted. This is controlled by planting (as soon as they can be separated by leaf color) the yellow seedlings either in individual tubes or six to a 3-inch pot. Then they are annually moved on to larger pots with no disturbance. This seems to control the rotting off problem.

(B) When mature, I have found that a yellow plant carrying a full umbel of seed will often not flower the following year. In Australia the plants flower in late September (spring) and carry their seed for more than 12 months until about November the following year. I have found that cutting the seed heads with the peduncle attached when the seed capsules have fully coloured (June—July, mid-winter here) allows the plant to flower in spring as usual. I have removed capsules at the end of March (only 6-7 months old) and the seed appears fully viable. This early removal of capsules allows the seed to be planted in spring which produces better germination and faster growth than planting in November-December, which is a very hot and dry time in this area. The seed seems to germinate better under the cooler and moister conditions of spring.

So far the yellow seedlings have been quite variable in flower shape (open or bell shaped), petal width and colour (yellow to quite pale). This indicates great potential for selection and production of different types. The very pale flowers suggest that the production of white flowers is quite possible simply by dilution of the yellow colour.

THE GENUS *SPREKELIA* IN MEXICO, CENTRAL AMERICA, AND SOUTH AMERICA

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SPREKELIA formosissima has been widely grown since William Herbert's time (1837) and, though recognized as being variable, it has always been considered a monotypic genus. Baker (1888) recognized four varieties, including one having glaucous leaves. In 1965 Traub published a new species as *S. clintiae*. This, too, had glaucous leaves and appears to be the same plant that Baker knew as var. *glauca*. This made more sense, as the glaucous leaved forms are distinct from the type, not only in leaf, but in the shape, size, and color of the flower, as well as time of flowering. About this time, the author found yet another distinct taxon in Southern Mexico with very tiny bulbs, and flowers having unusually narrow perianth segments. The leaves were decidedly more narrowly linear, channelled, and of a dull green with a silvery sheen. These grew at a lower elevation than one would normally associate with *Sprekelia*. This taxon, once published, will increase the Mexican *Sprekelia* to three distinct species.

The author has collected *Sprekelia* in fourteen Mexican states, mostly at higher elevations, from Chihuahua in the north to Oaxaca in the south. They were said to be common in Alta Verapaz, Guatemala, but we are unaware of their being found in the rest of Central America. There is no reason to doubt that possibility, as I have a cultivated clone from Peru with very dark red flowers and pale yellow pollen. We might then speculate that perhaps they may be found in the Andes of Columbia, as well. If found, they may need further study to determine exactly how many species there really are. The Peruvian cultivar seems very near to the Mexican forms of *S. formosissima*, so it will take more than slight variables within the flowers to determine if these are new species or not. It is my personal opinion that *S. formosissima* is the dominant species found.

For many years *Sprekelia* was thought to be an aberrant form most nearly allied to the genus *Hippeastrum*. Traub placed *Sprekelia* in the tribe *Zephyrantheae* stating that *Sprekelia* was nearer the genus *Habranthus* than to *Hippeastrum*. This seemed to be verified when John M. Cage reported a bigeneric cross between *S. formosissima* var. *superba* and *Habranthus robustus* in the form of ×*Sprekanthus cagei* Traub. My own finding of a new *Sprekelia* miniature species in 1964 seemed to add weight to the theory that *Sprekelia* was very near *Habranthus*. My bulbs resembled *Habranthus* in leaf when collected, and the following year when they flowered (1965) the developing buds looked much like *Habranthus* until they opened, when it was obvious that they were *Sprekelia*. This remained the consensus of erudite enthusiasts of the *Amaryllidaceae* until a few years ago when some startling new reports began to trickle in from India, Holland, Japan, and the USA. In each case the reports stated that hybrids between *Sprekelia* and *Hippeastrum* had been effected by a few people. The official initial reaction was to patronize the breeders while secretly laughing at what seemed to be utter foolishness. Mr. Udai Chandra Pradhan (1970) of Darjeeling, India reported a cross between *Sprekelia* and *Hippeastrum* complete with illustration and titled "An Apparent *Sprekelia-Amaryllis* Cross." The article was without fan-fare and regarded as putative. In 1974 fuel was added to the fire when Russell Manning of Minnesota reported having successfully made a hybrid cross of *Sprekelia*×*Hippeastrum*. Unfortunately his seedlings did not persist and were eventually lost (personal communication.)

Then, in the mid-eighties, a Japanese journal, **Asahi Pictorial Encyclopedia of Horticulture** (11) page 48, showed a hybrid of *Sprekelia* and *Hippeastrum* in full color, alongside both of its parents. Also around the same time, Wayside Gardens (Hodges, South Carolina; Spring 1986) offered a bulb of *Sprekelia*×*Hippeastrum* as "*Hippeastrelia*" var. 'Mystique', complete with a well-detailed color photograph and at the handsome price of $25.00 per bulb. The encomiums tempted the author to invest in one bulb, which, on arrival, looked to be very unusual for either a *Sprekelia* or a *Hippeastrum*. For one thing the coats were blackish like *Sprekelia*, but bulbs were flattish in form. It did not look exactly like any *Sprekelia* that I had ever seen in its shape, and certainly the coal-black bulbs did not remind me of *Hippeastrum*. I began to think that, indeed, this might be a bigeneric hybrid and this was reinforced as the leaves appeared. They appeared to be intermediate, as the leaves were a dark green, long and narrow, and very glossy with bluntish tips, much too glossy and dark for *Hippeastrum*, and, perhaps, nearer *Sprekelia*. Soon three scapes appeared, two of which were two-flowered and the other of which was smaller and solitary flowered. The scapes were a dark wine-red, as were the spathes, much too highly pigmented for *Hippeastrum*, but not at all unusual for *Sprekelia*. I self-pollinated one scape, pollinated another scape with *Hippeastrum* pollen and the other with *Sprekelia* pollen. Only the *Sprekelia* pollen yielded seed. The capsule was large and the seed black, D-shaped, and crowded. Germination was good, but I lost a number of seed prior to planting by accident. As it was, I still managed to grow four seedlings to near-maturity and they are now nearing their first flowering. The seedlings are ¾ *Sprekelia* and ¼ *Hippeastrum*, but they look much more like *Sprekelia* (pollen parent) in leaf and bulb.

I discussed this ×*Hippeastrelia* with Herb Kelly of Fresno, California who also purchased a bulb, flowered it, and crossed it with a number of *Hippeastrum* and *Sprekelia* clones and was far more successful than I in getting seed from his crosses. These included not only two *Sprekelia* species, but several *Hippeastrum* species, as well. His seedlings are the same age as mine and have not yet flowered (personal communication.)

So where does this leave the long-cherished theory that *Sprekelia* is nearest *Habranthus*, but totally sterile when attempts are made to cross with *Hippeastrum*? That theory is no longer valid. Recent findings show that the bigeneric hybrids are already being widely cultivated, and that second generation hybrids are ready to bloom either in 1991 or 1992. I will not begin to try to offer any explanation as to how, or why, a few individuals in India, Japan, Holland or the USA seem to have broken the barrier that supposedly prevented a true gene exchange. We may quote William Herbert in his 1837 **Amaryllidaceae** when he said "numberless unsuccessful attempts have been made to cross it (*Sprekelia*) with other genera, especially *Hippeastrum* and Zephyranthes."

As for the bigeneric hybrid, the clone 'Mystique' certainly does live up to fanfare. The flowers are, indeed, shaped like *Sprekelia* (zygomorphic), but the petals are wider and very *Hippeastrum*-like. Aside from form, (for a *Hippeastrum*) the size and color are much too ordinary. As a *Sprekelia*, the petals are much too wide and rob it of the exquisite, orchid-like gracefulness that so typifies the genus. My thoughts were that it would be much prettier if it were a bit more graceful while retaining a multiflowered scape. Perhaps we may see this in the backcrosses?

As for *Sprekelia formosissima*, it is a most variable species, not only over its wide geographical range, but even within any given colony. A number of forms are in cultivation, but the most popular form sold has been 'Supurba'. This seems to do well if dug and stored over winter each year in the lower South. Otherwise, if left in the ground, the bulbs divide excessively and the embryonic buds are apt to abort. Far better is the clone widely distributed as 'Orient Red', which is near-everblooming where climate permits. Its flowers are large with a greenish center and whitish stripes. The color is Oriental red. It seems to be the easiest to grow and flower, especially in warmer climates. It easily hybridizes with ×*Hippeastrelia* and all other *Sprekelia*. Its seedlings seem to inherit its wonderful vigor. The cultivar from Peru has been distributed as 'Inca Queen' and flowers freely. Hybrids between 'Orient Red' and 'Inca Queen' are especially nice, with many retaining the velvety dark red color of the Peruvian parent. There has been recent activity in hybridizing the miniature forms with *S. formosissima*, and many seedlings now exist, but there have been no flowering reports at this writing. An illustration of a Guatemalan *Sprekelia* form greatly resembles a form with brick-colored flowers that I once had as 'Aztec Idol'. I have seen nothing exactly like it in Mexico, and perhaps we have a clue that it comes from Guatemala. The wide petals and open, flat-faced form suggests it. As ornamental plants, the quality of *Sprekelia* flowers varies. I prefer wider petals to the very narrow ones, and flat flowers to long-faced ones. Colors should be clear, and can vary from very dark through all shades of red, including pinks and bricks. There may be white stripes in the center of the petals. So far no albino forms have been reported, but we can always hope.

The miniature forms may be a different species. They are certainly pretty enough and should be grown with *Habranthus* and *Zephyranthes*. Unfortunately, they are not easy to grow and require very careful watering. They are also much more cold-tender.

The glaucous leaved forms, such as *S. clintiae* (syn. *S. glauca*), flower weeks later than the normal forms. Foliage is an attractive bluish green and the flowers tend to run to the more pinkish and brick orange shades. Floral shape is also different, as the segments are a bit more narrow, and lateral petals spread rather widely and then curve downward. The flowers are smaller, too. Their range seems to be limited to the states of Jalisco and Michoacan, and more so at lower elevations. They are quite rare, and more tender, but should be in every collection of *Sprekelias*. They easily hybridize with the normal forms, but there have been no reports of their flowering yet. The seedlings seem to all have typically green leaves.

The author once crossed *Sprekelia* onto *Zephyranthes*×*ruthiae* and obtained seed, but seedlings were lost the following very bitter winter and the cross was never repeated. It is apparent that occasionally one may succeed in crossing *Sprekelia* with *Habranthus*, *Zephyranthes*, and *Hippeastrum* even if the odds do not favor it. The writer has no explanation for it, but will continue to ignore those who claim that it is impossible. The existence of such a vegetable as ×*Hippeastrelia* in horticulture makes such negative pronouncements appear ludicrous. It is time that we studied *Sprekelia* more intensely and attempted to fathom how and why they may occasionally fly against didactic pontifications. They are a good example of how the improbable becomes possible. It just takes a little longer.

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Figures 1 & 2. *Sprekelia formosissima* in habitat, Durango, Mexico. Photos by Scott Ogden.

TWO NEW MEXICAN SPECIES OF *HYMENOCALLIS* SALISB. (AMARYLLIDACEAE)

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Hymenocallis araniflora T. M. Howard, sp. nov.

Hymenocallis sonorensis et *H. howardii* affinis sed differt habitatione collina intersaxis volvanica, foliis patentibus lanceolatis atroviridibus non glaucescentibus et flore praecici; a *H. nayaritiana* foliis sessilibus, scapo ancipitio et tubo perianthii longiore.

Bulb ovoid, 5-6cm long, 3-4cm wide, 1.5-2cm long, tunics brown. Leaves 3-5, 30-40cm long, 2.5-3cm wide at middle, sub-erect, spreading, medium green, lanceolate, channeled, sessile, acute. Scape glaucescent, 4-5 flowered, 12-30cm tall, 1.2cm at base, ancipitous; spathe valves 5cm long, 1cm wide, lanceolate, scarious at anthesis. Flowers slightly sweet scented; tube straight, green, 12-14cm long; segments 6-9cm long, 4.5-5cm wide, white, spreading, slightly reflexed. Staminal cup 2cm long, 2.5-3cm wide, white, sub-rotate with funnel form base, with a 2mm denticulation between filaments; free filaments 4.5cm long, green, white proximally; anthers 2cm long, versatile; pollen orange. Style 6.5cm long, green, exceeding filaments; stigma capitate. Ovary sessile, 0.7cm long, two ovules per cell. Seed 1.3 to 1.4cm long, 1cm wide, oblong-obovate, dull light green, rounded, slightly angled, with 2-4 slight longitudinal furrows, floating in water. Flowering mid-June to early July.

Type: Mexico, southern Sinaloa and adjacent Nayarit, ca. 70 miles S of intersection of Mexico Hwy 15 with Mexico Hwy 40 at microöndas de la Murgalla on a rocky volcanic hillside overlooking tropical wetlands and the Pacific Ocean. In company with *Bessera elegans*, *Cipura* sp. and *Selenecerus* sp, T.M. Howard *84-15* (MO).

Hymenocallis araniflora is sympatric with *H. sonorensis, H. nayaritiana*, and *H. howardii*, and a host of species from the state of Jalisco. It differs from both *H. sonorensis* and *H. howardii* in having bright green, spreading, lanceolate foliage, earlier flowering habits, and a rocky hillside habitat. Such harsh habitats would not favor *H. sonorensis*. *H. araniflora* also can easily be differentiated from *H. nayaritiana* by its longer, narrower, sessile leaves; ancipitous scapes; longer, straight tepal tubes; more sweetly scented flowers; and paler, smoother, larger seeds.

H. jaliscensis (M.E. Jones) Bauml (1979) has been confused with *H. nayaritiana* but it occupies a more inland, higher elevation and is somewhat geographically remote from known populations of the latter species. Living specimens from the type locale in Jalisco have yet to be confirmed. *H. araniflora* is but another new species from that area adding to the confusion as to which plant is the true *H. jaliscensis*. My own experiences with *Hymenocallis* from the Pacific side of Mexico indicate that differences in elevation, geography and habitat make for different species. Dried specimens can lead to confusion because they lack the subtle characteristics that set them apart in the living state. The identity of *H. jaliscensis* will not be settled until it can be re-collected in the type locale and studied in the living, flowering state.

The foliage of *H. araniflora* somewhat resembles that of *H. nayaritiana*, though it is not quite as broad. The flowers differ markedly, however. Apparently *H. araniflora* is endemic to the Pacific slopes of Nayarit and Sinaloa. Cultivated *Hymenocallis* are commonly known as "spider lilies" in the lower South, around the Gulf of Mexico, and it seems appropriate that one species should recognize the spider, which aptly describes the floral form of *Hymenocallis*. It is an all-encompassing name for an otherwise undistinguished spidery flower. Bulbs planted out of doors at San Antonio have survived five successive winters, including four nights when the temperature dropped to six degrees above zero Fahrenheit. They have made no offsets and often scapes abort their buds at ground level. Perhaps good irrigation is critical at this stage. Because this species seeks a rather harsh habitat in which to grow, it seems fairly safe from the encroachment of agriculture at this time.

Hymenocallis imperialis T. M. Howard,sp. nov.

Hymenocallis caribaea Herb. affinis sed bulbo grandi globoso complanato, foliis latioribus obscure viridibus et leviter glaucis, habitatione montana, flore grandiore, cupula staminala grandiore differt.

Bulb large, to 10cm in diam., with 5cm pseudostem, compressed-globose, tunics brown, slowly forming basal offsets. Leaves 6-10, 33-70cm long, 7-12cm wide above the middle, 3-6cm wide at the base, narrowly oblanceolate, acute to sub-acute, channelled, dull green with slight glaucesence. Scape 5-10 flowered, 50-75cm tall, 2.5-3cm wide at base, 2-2.5cm wide at apex, ancipitous, glaucous, 1-3 produced per bulb; spathe bracts 7-8cm long, ca 3.5cm wide, lanceolate, acute, membranous at anthesis. Flowers fragrant, white, sessile; tepal tubes straight, 10-14cm long, 6mm wide below segments, greenish; segments spreading, 9-14cm long, 1cm wide. Staminal cup 3-4cm long, 5.5cm wide, funnelform with spreading margins, margins with prominent denticulations between filaments; free filaments 3-5cm long, whitish in lower third, greenish above; anthers ca. 2cm long, versatile, straight or slightly curved; pollen orange-yellow. Style 1-1.5cm longer than the segments, often zig-zagged and angled along its free portion; stigma capitate. Ovary 2 celled. Seed large, ca. 4cm long, ca. 3cm wide, rounded, glossy, lime-green, becoming dull green with age, with 3-5 longitudinal striations, floating in water. *H. caribaea* alliance.

Type: Mexico, Hidalgo, Rancho Viejo, on rocky ledges above Pan American highway and Rio Moctezuma, 24 May 1986, Howard and Ogden *86-18* (MO).

Other collections: Howard 57-3, flowering in cultivation in Jacala, Hidalgo, Mexico, June 24, 1957. Howard 62-2, in leaf in cultivation at Tamazunchale, San Luis Potosi, late July, 1967.

Hymenocallis imperialis was first encountered in cultivation by the writer in a garden at Jacala, Hidalgo, flowering in late June, 1957. A second collection was found in cultivation at a motel in Tamazunchale, San Luis Potosi, in July of 1962. I recognized it as a species new to me but was unable to identify it in Sealy's monograph. During the early sixties, Dr. Ray Flagg sent me a similar plant that he and Walter Flory had similarly found in cultivation in Tamazunchale. Though the plants were ocassionally encountered in local gardens, none were known from the wild. It was only during a 1986 botanical expedition to Mexico, in a search for various *Zephyranthes* of this region, did I finally find a small colony of this plant growing on a mountain side above a deep canyon formed by the Rio Moctezuma. The *Hymenocallis* grew in a cloud forest at an altitude of about 3000 feet. The small village of Rancho Viejo was across the road, but no *Hymenocallis* were in cultivation. Since this is a large plant with foliage nearly a meter high and 7-12cm broad, it would not be easy to overlook.

Hymenocallis imperialis is best described as massive, yet compact. Foliage is broad, yet not overlong, considering the size of the plant. Bulbs are quite large and the flowers are larger than most species in this genus, with segments 1cm wide. The styles are unusual in that they are easily 1-1.5cm longer than the already-long segments. Because of the pressure within the closed segments prior to opening, the styles may zigzag in their free portion.

Hymenocallis imperialis is among the easiest species in cultivation, and a well-grown bulb can produce three scapes with ten to twenty flowers each in a single season. The writer has flowered it in only two years from seed. It is a fine plant for hybridizing, and 'Invicta' and 'Hispaniola' were introduced as hybrids by crossing this species with *H. traubii*. *H. imperialis* sets quite large, shiny, lime-green seed easily, and it forms offsets just as freely. It has been widely distributed during the past years under names such as 'Jacala Giant' and 'Big Fatty'. This is a fine plant for horticulture and is aptly named for the last two emperors of the Aztecs (Moctezuma and Cuauhtemoc) when the Spaniards conquered Mexico. *H. imperialis* may be the "king" among the larger *Hymenocallis* from the tropics. It is incredibly hardy to cold in our area, considering its tropical origin. *H. imperialis* is sympatric with *Zephyranthes macrosiphon* (Baker), and the pink-flowered *Bomarea acutifolia* in that part of Hidalgo, along the Pan American Highway.

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Figure 1. *Hymenocallis araniflora* T.M. Howard, sp. nov. in cultivation in San Antonio, Texas. Photo by T.M. Howard.

Figure 2. *Hymenocallis imperialis* T.M. Howard, sp. nov. in habitat on rocky ledge, Rancho Viejo, Hidalgo, Mexico. Photo by Scott Ogden.

SIX NEW SPECIES OF *ZEPHYRANTHES*

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Zephyranthes bella Howard & Ogden, sp. nov.

Zephyranthes verecunda et *Z. fosteri* affinis sed foliis filiformibus brevioribus, perianthio et scapo brevioribus.

Bulb globose, ca. 1.5cm in diam., neck ca. 3cm long, tunics brown. Leaves 2-4, filiform, lax, 5-13cm long, ca. 1mm wide or less, subacute, dark grey-green, shiny. Scape 1-6cm tall, purplish; spathe ca. 2cm long, exceeding perianth tube, purplish, tubular, fenestrate, split on one side in lower half. Perianth suberect; tube 1-1.5cm long, green; segments elliptic, ca. 2cm long, 4-5mm wide, white to pink, red at the apex, flushed pinkish to reddish on the exterior. Staminal filaments white, ca. 1cm long; anthers versatile, ca. 5mm long, erect; pollen orange-yellow. Style as long as the filaments, but subtending anthers; stigma capitate, shortly trifid, lobes ca. 1mm long. Ovary ca. 4mm long, 2mm wide, sessile.

Type: Mexico, near Zacatecas-San Luis Potosi state lines, Hwy. 80 at km 31-33. Dry, rocky hillsides, full sun, in rocky, gravelly soil, in company with *Z. lindleyana*, 14 July 1987, Howard & Ogden *87-32* (holotype: MO).

Zephyranthes bella is among the smallest Mexican *Zephyranthes* and not apt to be confused with any of its relatives except *Z. verecunda* and *Z. fosteri*, from which it differs in having filiform leaves 1mm or less wide, a perianth tube 5mm or less long, fenestrate spathe which exceeds the perianth tube, and purplish-red stem and spathe. It differs from *Z. erubescens* and *Z. lindleyana* in those particulars, and in having a sessile ovary. *Z. bella* is named for its fine appearance and daintiness. It seems to be endemic to this area, but is easily overlooked as the scapes are quite small and crocus-like, and the plants seem to favor the driest, rockiest terrain in poor, gravelly soils. Although rather attractive, it is doubtful that *Z. bella* will be of much importance as a cultivated plant because of requirements for near-desert conditions.

Zephyranthes chichimeca Howard & S. Ogden, sp. nov.

Z. longiflora et *Z. crociflora* affinis sed differt a *Z. longifolia* bulbis fasiculatibus et flore roseo et albo; a *Z. crociflora* pedicello longiore, tubo breviore, filamentis sub-erectis et versatilibus, pollene luteo, stigmate trifido antheras exedens.

Bulb clustered, ovoid, ca. 2.5cm long, ca. 1.5cm wide, neck 2.5-3cm long; tunics dark brown. Leaves 10cm or more long, ca. 1mm wide, dull green, narrowly linear, bluntly acute, erect to sub-erect, appearing with flowers. Scape 13-20cm tall, dark, dull green; spathe ca. 2.5cm long, fenestrate, olive-brown to reddish. Perianth suberect; tube ca. 1cm long, olive-green; segments ca. 2.2cm long, 1-1.5cm wide, pink to pinkish-white, broadly elliptic, bluntly apiculate. Staminal filaments ca. 1cm long, suberect, white; anthers ca. 5mm long, versatile, curved; pollen orange-yellow. Style erect, ca. 1.5cm long, exceeding filaments; stigma deeply trifid with lobes 3-4mm long. Ovary ca. 5mm long, ca. 2mm wide. Seeds black, D-shaped.

Type: Mexico, Nuevo Leon, ca 25 miles north of Matehuala, San Luis Potosi, near the state line of Nuevo Leon and San Luis Potosi, in company with *Z. longifolia*, T.M. Howard & Scott Ogden *86-44*, Jun 1986 (holotype: MO).

Additional Collections: Same location as *86-44*, Howard *62-A*, Apr 1962; Nuevo Leon, dirt road off Mex 57 between km 66 & 67, open spots in fluffy, brown soil among *Hesperaloe* and *Yucca*, Howard & Bauml *72-184*, 17 Aug 1972; Nuevo Leon, at Microondas Cruz de Elorea, 1.8 miles past the Nuevo Leon/San Luis Potosi state line, Howard & Bauml *74-134*, 20 Jul 1974; Zacatecas, Hwy 54, km 68, 10 km S of the Tropic of Cancer, Howard & Bauml *76-64*, 7 July 1976; Same locality as *62-A*, Howard & Ogden *86-44*.

Zephyranthes chichimeca is a distinctive resident of the northern *Mesa Central* of Mexico, adapted to this arid region of alkaline soils. In common with *Z. longifolia* and *Z. crociflora*, which share similar habitats, this species develops tufts of linear foliage. *Z. chichimeca* is readily distinguished from these other desert species by its pink or rose-blushed perianth, obovate to spatulate tepals, and clustering growth habit. In its wide natural range across the high desert plateau from Nuevo Leon to Zacatecas, this species generally occurs by itself in localized colonies, but overlaps the range of *Z. longifolia*, which may be expected to grow nearby. *Z. chichimeca*'s relationship to these other species of the high desert, as well as *Z. lindleyana* and *Z. erubescens*, which inhabit the plateau to the south, remains obscure.

Z. chichimeca takes its name from the Aztec word for the Amerindian peoples who inhabited this vast desert region, roaming in small nomadic bands. Although the pink flowers of this species are rather attractive and possess an icy sparkle similar to many *Nerine*, the desert culture preferred by these bulbs makes them difficult to flower under cultivation. Despite continuing disruption of the deserts of northern Mexico for agricultural use, the disturbed habitat preferred by this species does not appear to be threatened at this time. Overgrazing by goats, as was evident at the type locality, may actually contribute to an increase in suitable habitat for this species.

Zephyranthes crociflora Howard & Ogden, sp. nov.

Zephyranthes lindleyana et *Z. longifolia* similis, differt a *Z. lindleyana* foliis filiformibus, perianthio crociformi, filamentis erectis, stigmate capitato; a *Z. longifolia* tubo longioribus, perianthio albo extra rubiscenti.

Bulb clustered, globose to sub-globose, ca. 2cm long, 2-2.5cm wide, with neck 2.5-5cm long, tunics dark brown. Leaves 3-4, 7-15cm long, ca. 1mm wide, dull, dark green, narrowly linear, erect to sub-erect, appearing with the flowers. Scape 15-20cm tall, dark, dull green; spathe 3.5-4cm long, olive brown to reddish, fenestrate; pedicel 0.5-1cm long. Perianth suberect to erect, crociform; tube 2-2.5cm long, olive-green; segments 2.5-3cm long, 1.5-2cm wide, broadly elliptic, bluntly apiculate, white, flushed reddish outside. Staminal filaments erect, 3-4mm long, white, closely spaced; anthers erect, ca. 5mm long; pollen pale yellow. Style erect, as long as or longer than filaments; stigma capitate, trifid. Ovary ca. 2mm long. Mature capsule and seed not seen.

Type: Mexico, Coahuila, S end of Saltillo city limits, growing along roadsides, in fields of grey-black soil among limestone rocks, 5 Jun 1987, Howard & Ogden *87-45* (holotype: MO).

Zephyranthes crociflora (Fig. 1) is distinguished from other Mexican *Zephyranthes* in its erect, closely spaced filaments and anthers, and pale yellow pollen, reminiscent of *Cooperia drummondii* (syn. *Z. chlorosolen*). The leaves are erect to suberect and filiform, and the bulbs grow in clumps. Perianth segments are erect to suberect, forming a goblet-shaped flower with the appearance of *Crocus pulchellus* or *C. vernus.*

The relationship of *Z. crociflora* to other Mexican *Zephyranthes* is not well understood. Other rain lilies (*Z. longifolia*, *Z. lindleyana*, *Cooperia drummondii* and *C. pedunculata*) are to be found within the state of Coahuila. Natural hybridization between *Zephyranthes* species has been well documented and can make any new-found species suspect. Where natural hybridization occurs, there should be evidence of both parents growing nearby. However, no other *Zephyranthes* species was observed in the several colonies of *Z. crociflora* seen growing southeast of the city of Saltillo.

At present *Z. crociflora* is known only from a small area within the city limits of Saltillo, Coahuila, along the central highway to Mexico City. Since this road is frequently traversed by botanists, it is a testimony to the sometimes reclusive nature of some *Zephyranthes* that such a distinctive species has not been collected and described earlier. The present authors are aware of this, as on the day of our collection we had found similarly colored *Zephyranthes* earlier in the morning. *Z. crociflora* was at first dismissed as just another form of *Z. erubesens* or *Z. lindleyana* until the distinctive staminal structures were observed while making specimens of the collection. The next morning we returned to the site of *Z. crociflora* to photograph and study them in habitat.

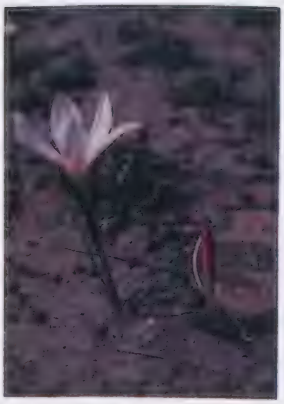
In cultivation *Z. crociflora* has proved to be easy to grow and hardy to our winters, but difficult to flower, due to its xerophytic requirements. At present its habitat seems stable, but this could change in the future as the growing city of Saltillo expands. We can only hope that *Z. crociflora* has a wider range than we know of at this time.

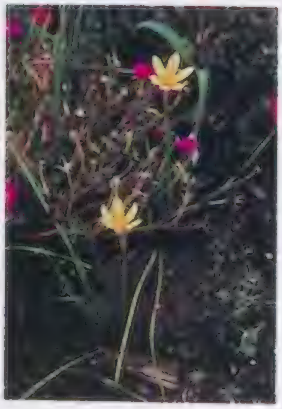
Several yellow-flowering *Zephyranthes*, and *Cooperia* (syn. subgenus, *Cooperia*), are known from North America. *Z. longifolia* is found in west Texas and north central to central Mexico. *Z. pulchella* is found in the Texas Coastal Bend, south Texas, and north eastern Mexico. *Z. refugiensis* and *C. jonesii* are endemic to the Texas Coastal Bend, while *C. smallii* is endemic to Cameron County, at the southern tip of Texas. The exact geographical limits of *Z. citrina* are poorly defined, but believed to be more or less around the coastal Yucatan peninsula. *Z.* ×*katherinae* is thought to be a natural hybrid between red flowered and yellow flowered forms occurring in the state of Hidalgo, in east-central Mexico, and endemic to that area. The following three new yellow-flowered species are all native of eastern Mexico in the states of San Luis Potosi and adjacent southern Tamaulipas.

Zephyranthes nymphaea Howard & Ogden, sp. nov.

Zephyranthes pulchella affinis a perianthio pallido, antheris longioribus et rectioribus, pollene aurantiaco, stigmate breviter trifido differt.

Bulb ovoid, 3.5 to 4cm long, 3 to 3.5cm wide, neck ca. 8cm long, tunics brown. Leaves 20-32cm long, ca. 3mm wide, linear, bright grass-green, purplish at base, slightly convex to flattened, subacute. Scape 16-23.5cm tall, reddish at base; spathe ca. 3.8cm long, purplish, tubular, split on one side in upper half; pedicel 2.3-3.4cm long, longer than perianth tube. Perianth 3.2-4cm long, light yellow in bud and at anthesis; tube green, 5-7mm long; segments linear-lanceolate, ca. 3cm long, 7 to 10mm wide, outer whorl abruptly acuminate. Staminal filaments ca. 1.3cm long; anthers ca. 10mm long; pollen orange. Stigma distinctly trifid. Ovary ca. 10mm long, 2mm wideMature seed capsule ca. 8mm long, ca. 10mm wide; seeds black, D-shaped. Flowering May to October.





Facing Page (L-R, from top):

Figures 1 & 2. *Zephyranthes bella* Howard & Ogden in habitat.
Figure 3. *Z. chichimeca* Howard & Ogden in habitat, Nuevo Leon, Mexico.
Figure 4. *Z. chichimeca* in cultivation in Texas.
Figure 5. *Z. chichimeca* in habitat, Zacatecas, Mexico. Photo by Jim Bauml.
Figures 6 & 9. *Z. primulina* Howard & Ogden in cultivation. Photos by T.M. Howard.
Figures 7 & 8. *Z. nymphaea* Howard & Ogden in cultivation.

Above (left to right, from top):

Figure 10. *Zephyranthes primulina* Howard & Ogden in cultivation. Photo by T.M. Howard
Figure 11. *Z. citrina* in cultivation. Photo by Kitty Clint.
Figure 12. *Zephyranthes reginae* Howard & Ogden ("Valles Yellow") in habitat, Hidalgo, Mexico. Photo by David Jordan.
Figure 13. *Z. reginae* ("Valles Yellow") in habitat in a wet field in Hidalgo. Photo by T.M. Howard
Figures 14 & 15. *Z. reginae* in cultivation.

All photos by Scott Ogden unless otherwise noted.

Type: Mexico, San Luis Potosi and adjacent Tamaulipas, between El Naranjo, San Luis Potosi, and Nuevo Morelos, Tamaulipas, in the El Naranjo River valley, pastures and roadsides off Hwy 80, in heavy, black clay, ex hort T. M. Howard *63-80*, 28 Jun 1963 (holotype: MO).

In its native habitat in the El Naranjo River valley, *Z. nymphaea* is sympatric with the ivory-colored *Z. subflava*. These taxa do not appear to hybridize, as they have maintained their distinctive characters in cultivation for more than twenty-five years, including many generations of seed propagation. They can easily be segregated, even when not in flower, by leaf color. Foliage of *Z. subflava* is a dull yellowish-green, while that of *Z. nymphaea* is a dark grass-green. This has been consistent in both habitat and in cultivation. References to light yellow flowers on *Z. subflava* (Spencer, 1986) stem from confusion of these two species by the collector, Mrs. Morris Clint, who sighted one, but collected the other, thinking that they were the same, and that either the lighter-colored flowers had simply "faded" with age or were altered by unfavorable soil conditions in cultivation. Eventually, she did make a collection of this taxon, *Z. nymphaea*, but in another location, where it grew as a pure stand. She never made the connection, however. It remained the only known irony in her illustrious career as a *Zephyranthes* explorer, as she was a very keen observer.

From *Z. subflava* our species differs in its light yellow, rather than ivory-colored, perianth and buds (the buds of *Z. subflava* are greenish), in its linear-lanceolate segments, and also in having larger, more erect anthers, a shorter, trifid style, brighter orange pollen, and darker green leaf color.

From *Z. pulchella*, which it otherwise resembles, *Z. nymphaea* differs in its pale-yellow perianth, larger, less curved anthers, darker pollen, less rounded stigma lobes, and a decidedly longer flowering season beginning nearly three months earlier and continuing into early autumn.

Zephyranthes nymphaea is named for the genus *Nymphaea*, the water lily, the flowers of which resemble this new species and which shares an affinity for wet places.

Zephyranthes nymphaea is sympatric with *Z. subflava* and several other distinct, unidentified taxa, including a rose-pink species found along the Valles River, and a blush-white flowered species found in the foothills of the eastern Sierra Madre range near the city of El Naranjo, in the state of San Luis Potosi. This region is particularly rich in its wide variety of distinctive *Zephyranthes* species, some of which are, undoubtedly, new to science.

Zephyranthes primulina Howard & Ogden, sp. nov.

Z. macrosiphon et *Z. reginae* affinis differt a *Z. macrosiphon* perianthio brevioribus luteo extra rubiscenti, antheris flexuosis et versatilibus, pollene croceo; a *Z. reginae* foliis carinatis et tubo perianthii longioribus.

Bulb ovoid, ca. 4cm long, ca. 3.5cm wide, tunics black. Leaves 6-8, ca. 30cm long, ca. 4mm wide, erect, dull green, reddish at the base, carinate, linear, subacute, margins slightly scabrous. Scape ca. 15.5cm tall, compressed; spathe ca. 3cm long, olivaceous, tubular, split on one side in upper half; pedicel as long as spathe. Perianth narrowly funnelform in lower third; tube ca. 2.5cm long, greenish-yellow; segments 3.5-4cm long, ca. 1.3cm wide, oblanceolate, primrose-yellow flushed pink on reverse near tip. Stamens half as long as the segments; anthers versatile and flexuous; pollen orange-yellow. Style shorter than the filaments; stigma trifid, lobes 2-3mm long. Ovary ca. 5mm long and ca. 2mm wide. Capsule ca. 1.5cm long, 1 ca.cm wide; seeds black, D-shaped.

Type: Mexico, San Luis Potosi, at lower elevations on the eastern foothills and valleys of the Sierra Madre Oriental, between Valles and Tamazunchale, near Cd. Valles, ex hort Howard from collections by T.M. Howard & Scott Ogden, Howard *86-16*, May, 1986 (MO).

Closely allied to *Z. macrosiphon*, *Z. primulina* differs in having slightly smaller, primrose-yellow flowers with more slender segments. Also, the anthers are flexuose-versatile instead of antrorse, and the pollen color is orange-yellow rather than yellow. Two other yellow-flowered species (*Z. reginae*, and *Z. nymphaea*) are sympatric with *Z. macrosiphon* and *Z. primulina*. This new taxon will be a welcome addition to horticulture, as it has proved to be of easiest culture and very free flowering. Though native to a tropical area, its cold-hardiness in southern gardens has not yet been fully tested. Other yellow-flowered *Zephyranthes* from the same region are fairly hardy with us, but *Z. macrosiphon* is very tender and does not usually survive our winters. *Z. primulina* is easily distinguished from all other known yellow-flowered Mexican *Zephyranthes* by its distinctly carinate (keeled) foliage and longer floral tubes.

An exact chromosome count has not been determined in *Z. primulina*, but many cells with somatic ($2n$) numbers in the low fifties are found. A number of cells have been found that are definitely $2n = 50$, or $2n = 52$, or $2n = 53$, all in the same preparation from the same plant. Additional numbers may be found with further study of this taxon. This includes perhaps 50 different preparations made at different times. (G. Smith, unpubl. data).

Zephyranthes reginae Howard & Ogden, sp. nov.

Zephyranthes citrina et *Z. subflava* affinis sed differt a *Z. subflava* pedicello longioribus, flore luteo extra rubescenti; a *Z. citrina* perianthio pallido et tepalis angustioribus.

Bulb ovoid, ca. 2.5cm long, 2-2.5cm wide, neck ca. 3cm long, tunics brown. Leaves 19-29cm long, ca. 4mm wide, flattened to convex, subacute, slightly reddish at base. Scape 12.5-22cm long, reddish at base; spathe ca. 2cm long, purplish, tubular, split on one side in upper half; pedicel 1.4-2.1cm long. Perianth 4.3-4.5cm long; tube 1-1.5cm long, shorter than the pedicel, narrowly funnelform in lower half; segments lanceolate, 9-12mm wide, obtuse or abruptly acuminate, light yellow on exterior streaked red in upper half. Stamens ca. 1cm long, less than half as long as the segments; anthers ca. 10mm long, anthrose, somewhat twisted; pollen orange-yellow. Style 12-14mm long, equaling filaments in length; stigma trifid, lobes ca. 2mm long. Ovary ca. 5mm long, ca. 2mm wide. Capsule ca. 8mm long, ca. 1cm wide. Seeds black, D-shaped. Flowering from May to September during the rainy season.

Type: Mexico, San Luis Potosi, tropical valleys and roadside ditches north and south of Tamazunchale, approximately midway between Valles, San Luis Potosi, and Tamazunchales, San Luis Potosi, roadside in a low, wet spot between a fence and the highway in company with *Cooperia drummondii*, T. M. Howard *53-1*, 2 Jul 1953, specimen prepared ex hort, Howard *s.n.*, 15 Aug 1986 (holotype: MO).

This plant was discovered by the senior author in flower in July, 1953. Although observed flowering several times in subsequent years at the same locality, it has since disappeared with the invasion of a dense willow thicket that heavily shades its habitat. Though endemic to this region, it may persist in other favorable places in the valleys of this lush tropical region. *Zephranthes reginae* is closely related to other yellow-flowered species of the region and it superficially resembles *Z. nymphaea* in size and color. It differs in its wider foliage, larger and more sweetly scented flowers tinged red on the exterior, shorter pedicel, longer perianth tube, twisted anthers and orange-yellow pollen (bright orange in *Z. nymphaea*). From *Z. subflava* it differs by its light yellow (versus ivory) perianth, and shorter pedicel and style. From *Z. primulina*, it differs in its narrower, unchanneled leaves, slightly narrower tepals and shorter pedicel and tube.

Though *Z. reginae* resembles *Z.*×'Ajax' (*Z. citrina*×*Z. candida*), it differs from that classic hybrid by its more flaccid foliage, red-tinged flower and paler pollen. The flowers of *Z. reginae* are larger, paler and have narrower segments (distinctively tinged red on the exterior) than *Z. citrina*, to which it bears superficial resemblance. Chromosome counts for *Z. reginae* ($2n = 28$, Flory 1968) suggest a relationship nearest to *Z. subflava* ($2n = 24$, Spencer 1986).

Zephyranthes reginae is sympatric with *Z. primulina*, *C. drummondii* (syn. *Z. chlorosolen*), *Z. macrosiphon*, and several indebtified pink-flowering species. It has been widely cultivated and distributed under the name 'Valles Yellow' and has proven to be a valuable garden subject. Its future in the wild is uncertain due to habitat destruction, but because of its ease of culture, it has a bright future in horticulture. Though of tropical origin, it is hardier to cold than most species and can stand considerable neglect. It offsets slowly, but reseeds prolifically.

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Figures 16-18. (above & left). *Zephyranthes crociflora* Howard & Ogden *in situ*, Saltillo, Coahuila, Mexico. Photos by T.M. Howard.

Figure 19. (lower left). *Zephyranthes macrosiphon* in a roadside ditch, Hidalgo, Mexico. Photo by Kitty Clint.

Figure 20. (lower right). *Z. macrosiphon* in cultivation. Photo by Scott Ogden.

Right:
Zephyranthes primulina Howard & Ogden, sp. nov.

Left: *Zephyranthes* nymphaea Howard & Ogden. Illustrations by Joyce Ogden.

A NEW SPECIES AND TRANSFER IN *HABRANTHUS*

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Habranthus vittatus T. M. Howard, sp. nov.

Planta Oaxacana bulbo tunicato sub-globoso, foliis 2-4 linearibus, erectis, glaucentibus, 20cm longis, 7mm latis; scapo cavo unifloro 20cm alto; spatha 3cm longo inferne tubulosa; tubo perianthii brevioribus quam tepala; perianthio 6.5cm longo, roseo pallido, vittatis roseis fuscis, basin roseis fuscis; stigmate profunde trifido.

Bulb sub-globose, 2.5-3cm wide, 2.5-3.5cm long, neck 2-4cm long, tunics dark brown. Leaves 18-25cm long, ca. 7mm wide, hysteranthous, erect, linear lorate, glaucous, subacute, reddish at base, channeled. Scape one-flowered, 17-21cm long, ca. 3mm wide at base, terete; spathe ca. 3cm long, magenta at base, fading to green; pedicel ca. 4.5cm long. Perianth funnelform, horizontally declinate, 5.5-6.2cm long, ca. 5.5cm across the limb; tube 5-8mm long; segments 5.8-6.5cm long, inner ca. 1.5cm wide, outer ca. 9mm wide, narrowly obovate, pale magenta rose (HCC 27/3), longitudinally striped dark magenta rose (HCC 27), fading towards apices, dark magenta-rose at bases. Staminal filaments white, fasciculate, in four lengths, declinate-ascending; anthers versatile, ca. 1.4cm long; pollen pale yellow. Style exceeding filaments; stigma deeply trifid, branches ca. 3mm long. Ovary ca. 1cm long, 3-5mm wide. Seeds black, flat, D-shaped, ca. 5mm long, ca. 4mm wide. Blooms with earliest summer rains, before the foliage.

Type: Mexico, Oaxaca, ca. 3 miles north of Huajuapan de Leon, in calcareous soil on low hillsides and limestone outcroppings, growing with thorny shrubs, Hwy 85, T. M. Howard *83-25* (holotype: MO).

It has been noted that while most *Habranthus* filaments line up (front to rear) in the order two-one-two-one, those of *H. vittatus* are in the order one-two-one-two, for reasons not understood. The leaves and bulbs are nearly indistinguishable from a *Sprekelia* species that grows in the same surroundings sympatrically. In northern Oaxaca, both the *Sprekelia* and *Habranthus* share the same general habitat and habits, with similar leaf and bulb characters, and when not in flower are very difficult to differentiate from one another. Thus, a 1981 collection was made, thinking that these were the *Sprekelia* taxon, but when they flowered it was obvious that a very distinguished, new *Habranthus* species had been found instead. The flowers are typical of other Mexican *Habranthus* in all respects, save in the color, which is a pale pink, with longitudinal magenta-rose lines and the same color in the throat and exterior. It has proved to be very cold-tender in cultivation and is best grown in pots or in frost-free areas out of doors. They flower with earliest summer rains, before the leaves appear.

Habranthus howardii (Traub) Howard, comb. nov.

Zephyranthes howardii Traub. 1963. Pl. Life 23: 50-51.

In early July, 1954, the writer found a yellow-flowered rain lily in flower at Mamulique Pass (Cuesta de Mamulique) midway between Nuevo Laredo and Monterey in the state of Nuevo Leon. It seemed somewhat similar to a plant that Fred B. Jones had found growing naturalized in someone's yard in Laredo, Texas. (See×"*Coobranthus coryii*, A Natural Bigeneric Hybrid" in this issue.) Bulbs of my collection (Howard *54-1*) were sent

Figures 1-3. *Habranthus vittatus* in cultivation. Photos by T.M. Howard.

Figure 4. Lower right: *Habranthus vittatus* in Huajuapan, Oaxaca, Mexico. Photo by M.C. Wilson.

to Dr. Hamilton P. Traub for identification. It was subsequently named as a new species, *Zephyranthes howardii* Traub (1963) and was recognized as being closely allied to *Z. concolor*. Eventually it was recognized that *Z. concolor* was actually a *Habranthus*, and one of several species of *Habranthus* to be found in Mexico. Dr. Traub fully intended to transfer *Z. howardii* to the genus *Habranthus* (pers. comm. to Marcia C. Wilson), but he was awaiting more specimens. The transfer was never accomplished before Traub's death.

Habranthus howardii is nearest *H. concolor*, but other *Habranthus* species have been reported from Mexico. Overall, *H. howardii* is somewhat smaller than *H. concolor*. As with *H. concolor*, the filaments are in four lengths, but here the length differences are rather short, differing in 1mm increments. Even so, these lengths are easily demonstrated in living material. The stigma is trifid, but less markedly so than in *H. concolor*, and the flowers are less markedly declinate but rather sub-erect. Like many Mexican *Habranthus*, *H. howardii* has not proved to be of easy culture. Finding it in flower in its habitat has always been very difficult. One must find them at just the right time after rains, and rains are often infrequent and spotty. They are apt to be found in flower anytime between April and July. Originally the taxon was found in bloom in early July, but more recently (mid-April, 1976) they were found flowering in some abundance. It was then that I had the luxury of dissecting enough flowers to study their filament lengths at leisure in order to confirm that they were, indeed, *Habranthus*. Mrs. Katherine Clint and her daughter, the late Marcia C. Wilson, made collections of the yellow flowered *Habranthus* south of Mamulique Pass and were able to verify that they were, indeed, *Habranthus*, and not *Zephyranthes*. The limited knowledge that we have of this taxon suggests that it is endemic to northeast Nuevo Leon, including Mamulique Pass and several miles south on the plateau. It is a very rare plant and difficult to maintain in cultivation under anything but xerophytic conditions. At the present, livestock overgrazing seems to be its principle threat.

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a	Z. nympheae
b	Z. pulchella
c	Z. crociflora
d	Z. chichimeca
e	Z. macrosiphon
f	Z. primulina
g	Z. reginae
h	Z. subflava
i	H. vittatus
j	H. howardii
k	XCoobranthus coryi

x*COOBRANTHUS CORYI* T.M. HOWARD. A NATURAL BIGENERIC HYBRID OF THE TRIBE *ZEPHYRANTHEAE*

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x*Coobranthus coryi* T.M. Howard, nothogen. et nothosp. nov.

Bulb ovoid to subglobose, 4cm wide, neck to 9cm long, tunics dark brown. Leaves glaucous, 2-4 at anthesis, slightly concave-convex, 5.5cm long, 7-9mm broad. Scapes one or more per bulb, erect, stout, to 4cm tall, flattened, 5-8mm wide at base and about 2mm less wide at the top; spathe bracts light green, glaucous, 5.4cm long, bifid, the lobes ⅛ as long as the tube, longer than the pedicel and ovary; pedicel 3cm or more long, elongating after anthesis. Perianth to 6cm long, tube 1.8-2cm long; segments light yellow, subsimilar, oblong-ovate, to 4cm or more long, the outer three more broadly rounded and 3-4mm wider than the inner three, bluntly apiculate; stamens inserted at the throat of perianth tube, erect-spreading, regularly arranged, the 3 longer at stigma level (3cm) alternating with 3 shorter (2.6cm); anthers versatile, sickle-shaped, 10mm long, deep yellow, darker than perianth; style white, 3cm high, stigma trifid, the lobes 2.5mm long. Spring-early summer, opening at mid-day.

TYPE: Mexico, Nuevo Leon, about midway between Nuevo Laredo and Monterey limestone escarpment of Mamulique Pass (Cuesta de Mamulique), T. M. Howard *63-6*, 21 Apr 1963 (holotype: MO). In company with *Habranthus howardii*, *Cooperia pedunculata*, low, thorny shrubs and other xerophytes. Full sun or under shrubs.

Traub (1951) united the genus *Cooperia* with the genus *Zephyranthes*, demoting *Cooperia* to a subgenus of *Zephyranthes* on the basis that they not only hybridized freely, but that their hybrid offspring were often self-fertile and intercrossed easily. In 1954 Traub created the nothogeneric name x*Sydneya* for hybrids between *Zephyranthes* and *Habranthus*. Traub (1959) reported intergeneric hybrids between *Habranthus* and *Rhodophiala* (= x*Rhodobranthus*) and in 1969 J.M. Cage reported a hybrid between *Habranthus* and *Sprekelia* (= x*Sprekanthus*) and that fertile hybrids not only existed but were commercially available between *Sprekelia* and *Hippeastrum*. These hybrid experiments no longer necessarily support the old theory that if fertile hybrids between two or more different genera occur, there is no longer a basis in keeping the genera separate. Recent hybrid experiments between *Polianthes*, *Manfreda*, and *Prochnyathes* of the *Agavaceae* show that the three genera freely yield fertile hybrids when intercrossed.

After the Traub's (1951) taxonomic change, many taxonomists considered *Cooperia* little more than non-complying members of *Zephyranthes*. However, there was never complete accord in the demotion of *Cooperia* to a subgenus. Bryan (1989) stated that, "some authorities regard (*Cooperia*) as being placed in *Zephyranthes*, but the separation is quite distinct. The flowers open at night and have a pleasant primrose-like fragrance." There are other taxonomic reasons including placement of the stamens, length of the floral tubes, and flowering habits, but these details are well-enough known so that they need not be repeated here. By the same token, x*Cooperanthes* Lancaster (1936) should be resurrected, since these are valid bigeneric hybrids between *Cooperia* and *Zephyranthes*. Experiments with trigeneric hybrids have been successful when *Habranthus howardii* was crossed with x*Cooperanthes* by the writer; the genes of *Cooperia*, *Habranthus*,

Figures 1 & 2. (above). *Habranthus howardii*. Photos by S. Ogden & T. Howard.

Figure 3. (far left). x*Coobranthus coryi* Howard 'Laredo Yellow.' Photo by Marcia Wilson.

Figure 4. (near left). x*Coobranthus coryi* Howard in cultivation. Photo by T.M. Howard.

and *Zephyranthes* were combined and the seedlings were fertile. Such hybrids are technically regarded as x*Sydneyara* in the revised sense of Traub's x*Sydneya*.

Fred B. Jones first found this taxon naturalized in a back yard at Laredo, Texas, the yard being visible from the street and flowering April 30, 1949. It attracted the attention of Mr. Jones and he was able to purchase 5 bulbs of various stages of maturity from the Mexican-American residents; he was, however, unable to learn the origin of these plants. Later they received wide distribution (as Fred Jones' cultivar 'Laredo Yellow') by Mr. Jones, Mrs. Morris Clint, Marcia Wilson and the writer.

In the spring of 1963 the writer came across a slightly different yellow-flowered rain lily while looking for *H. howardii* (syn. *Z. howardii*) at Mamulique Pass, Nuevo Leon, Mexico. It was immediately apparent that this taxon was morphologically similar to the Fred Jones plant in form, size and color. At long last, I was able to verify what we had always suspected: that Fred's plant did, indeed, originate at Mamulique Pass. Only later did we realize that it was not exactly the same as its *Habranthus* parent. And much later did it finally sink in that this plant was a hybrid of the *Habranthus* and *Cooperia pedunculata* which grew in the foothills of the Pass. What had always been obvious took time for us to interpret. There simply had never been *Habranthus* hybrids reported as occurring in nature in North America. This was further complicated by the fertility of the hybrids. We would have normally expected sterility in such hybrids. Chromosome studies of Mexican *Habranthus* by Flory & Smith (1980) indicate that some of the lesser known species can have unusually high chromosome numbers, and this includes *H. howardii* and x*Coobranthus coryi*, although these were identified by other names or collection numbers.

The bigeneric name x*Coobranthus* is proposed for hybrids between *Cooperia* and *Habranthus*. x*Coobranthus coryi* is named in honor of the late Victor L. Cory, former field botanist at Southern Methodist University, who was my mentor while I was in my formative college years as a neophyte amateur botanist at Texas A & M University. His letters and notes, generously shared, were invaluable with regards to native Texas bulbs in general, and this taxon, in particular.

BREEDING EXPERIMENTS

In 1952 Fred Jones attempted a hybrid cross between two native Texas rain lilies, *Z. pulchella* and *C. pedunculata* (Jones, 1957). Normally *C. pedunculata* is virtually useless as a seed parent because of apomixes and its built-in self-pollinating morphology. Fred was able to circumvent this by removing the perianth segments and de-anthering well before the buds were due to crack open. Even so, he only obtained two hybrid seedlings out of a number of maternal siblings. One hybrid sibling favored the *Zephyranthes* parent florally, but the other sibling favored the *Cooperia* parent. Both were self-fertile. Fred generously shared one of the seedlings (the one favoring *Cooperia*) with me, as it produced offsets fairly easily. I was surprised to find that this hybrid casually resembled his Laredo garden taxon in a number of ways, though the flowers were a bit smaller. Fred's unique x*Cooperanthes* was given the name 'Sir Fred' by the writer. Unfortunately this clone was later lost.

In the late sixties the writer crossed *H. howardii* with one of his own x*Cooperanthes* cv. 'Texas,' a large, light-yellow hybrid of his own breeding, in hopes of obtaining some really large yellow-flowered hybrids with the characters of the *Habranthus* parent. Seedlings (Howard 1976) flowered four years later, but were somewhat disappointing as they greatly resembled the pollen parent (*Habranthus*) in color, size, form, foliage and growth habits. They, too, were self-fertile, but I did not carry this breeding experiment any further as the results were not what I had in mind. Being trigeneric, they qualified for x*Sydneyara*, possibly the first authentic x*Sydneyara* in existence. Unfortunately, these seedlings were eventually lost.

In its habits, x*Coobranthus coryi* is intermediate between both of its parents. As with many of the x*Cooperanthes* hybrids, the flowers do not open until midday. (Flowers of *Zephyranthes* and *Habranthus* open in the morning, while *Cooperia* flowers open in late afternoon or evening.) Floral forms of both x*Coobranthus* and x*Cooperanthes* favor *Zephyranthes*, which may indicate a parallel dominance. Traub indicated that "x*Sydneya*" hybrids had "stamens mostly similar to those of *Habranthus* (zygomorphic), sometimes similar to *Zephyranthes* (regular); otherwise mostly intermediate between the two genera." However, the only true bigeneric hybrid (*Z. grandiflora*×*H. teretifolia*) took on *Zephyranthes* characters as Traub, himself, reported. x*Sydneya lancasterae* Traub (1954) is an illegitimate name, being a bigeneric cross between *Habranthus* and *Cooperia*, and I take the opportunity to rename it x*Coobranthus lancasteri* (Percy-Lancaster) Howard. The x*Cooperanthes* hybrids of Lancaster were widely open to question as to the true identity of his *Z. robustus*. Traub interpreted this to be *H. robustus*, but this appears to be a misidentification on the parts of both Lancaster and Traub. The plant was *Z. grandiflora*. Indeed, so-called "*Z. robustus*" are still being exported from India and marketed in the United States, but all of these are actually *Z. grandiflora*. Lancaster (1936) clearly stated that his "*robustus*" flowers were "deep rose-red, flowers large", whilst his "*Z. carinata*" (interpreted by Traub to be *Z. grandiflora*) were "lilacy-pink, flowers medium". This does not square with the known facts about *Z. grandiflora*, which has very large, rose-red flowers. We do know that Lancaster was so unsure of the identity of his "*robustus*" that he questioned whether or not it might actually be *Z. lindleyana*! Thus, we can pretty well deduce that Lancaster never had (nor used) *H. robustus* and that all such plants were really *Z. grandiflora*. Thus, no true x*Sydneyara* can be ascribed to him, and much of the Traubian concept of what constitutes a x*Sydneyara* falls by the wayside due to errors in interpretation of the Lancaster species. On the other hand, Lancaster claimed to have incorporated *H. andersonii* var. *texanus* (?) in his program ("copper and yellow, flowers small") and this might possibly be correct. However, we know that *H. andersonii* var *texanus* is apomictic (Flory 1938) when used as a seed parent, thus there is a shadow of doubt as to whether he got true hybrids using this plant by a 50% factor at the very least. Lancaster was unsure about his identification of *Z. carinata*, as he questioned it by suggesting that it might be *Z. wrightii*.

More recently, the late Alex Korsakoff obtained his cultivar 'Teddy Buehler' by crossing *Z. albiella*×*H. martinezii*. However, it must be pointed out that *Z. albiella* has a *Habranthus*-like form and an oddball chromosome number ($2n = 18$) and it is of South American origin. Offspring are sterile.

Habranthus cardinalis (synonym *Z. bifolia*) has been crossed with *H. immaculatus*, producing sterile hybrids (Clint 1964) with *Habranthus*-like form. However, its status as a *Zephyranthes* has always been in doubt, as the slightly nodding flowers have fasciculate filaments in four lengths differing in 1mm increments and a $2n = 60$ chromosome number, which is unusual for either *Habranthus* or *Zephyranthes*. Others (Hamor 1942) have previously reported that the filaments of *H. cardinalis* are in two lengths, which may be so in the dried state when shrinkage occurs. However, the writer observed that the filaments of one fresh flower were in four lengths in 1mm increments, the same as *H. howardii*, and this might explain how this detail could be easily overlooked. In the meantime its status as a *Zephyranthes* is on shaky ground. Hybrids between it and *Zephyranthes* might be interpreted as being bigeneric, whereas hybrids between it and *Habranthus* might be within the same genus, according to the concept of interpretation of the genus *Habranthus* and the genus *Zephyranthes*. Padre Julio Cicero (1976) of the Dominican Republic has obtained some very interesting fertile hybrids between *H. cardinalis* and siblings of *Z. rosea*×*Z. puertoricensis* and they, indeed, boggle the mind.

The generic limitations of *Cooperia, Habranthus*, and *Zephyranthes* are fairly well defined and understood. On the basis of these limitations, even though fertile hybrid seedlings may result, there is little rationale in reducing them to one or two genera when, by nature, they are easily segregated by their habits and morphology. Hybrids between *Habranthus* and *Zephyranthes* are x*Zephybranthus* Howard. Hybrids of *Cooperia* and *Habranthus* are x*Coobranthus* Howard. Hybrids involving all three genera are x*Sydneyara* Traub emend. Howard, and *Zephyranthes*×*Cooperia* are x*Cooperanthes* Percy-Lancaster.

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Figure 1. *Allium texanum* Howard.

Figure 2. *Allium texanum* Howard, Lawton, OK. Photo by Scott Ogden.

ALLIUM TEXANUM [AMARYLLIDACEAE (ALLIACEAE)] A NEW SPECIES FROM CENTRAL TEXAS AND ADJACENT OKLAHOMA

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Allium texanum T. M. Howard, sp. nov.

Allium canadense L. et *A. fraseri* (M. Ownby) Shinners affinis sed differt bulbo tunicato postea florens extra albido plerumque deficienti fibris reticulatibus, flore leviter parvo; a *A. canadense* bulbillis umbellatibus deficientibus; a *A. fraseri* foliis late spiralibus erectus, glaucous, umbella ampla et ovario viridulo.

Bulb ovoid, 2-3cm long, 1.5-2.5cm wide, without basal offsets, often one of a cluster, inner coats whitish, epidermal cells obscure, vertically elongate, regular or nearly so, outer coats whitish, striate, with elongate cells in regular vertical rows, persisting as a series of membranous coats. Leaves 4-8 per bulb, 40-50cm long, 0.5-1cm wide, erect, spiralled, concave-convex, flattened-carinate, margins entire, shorter than the scape, glaucous or glaucesent. Scape 50-60cm tall, 60-100 flowered, terete, usually solitary; spathe membranaceous, caudate, breaking before anthesis into usually 3, ovate to lanceolate, attenuate, 7-11-nerved bracts which may remain partially united at the base; pedicels 1.5-2cm long, nearly equal in length, mostly 3-4 times the length of the segments, elongating and becoming flexuous and rigid in fruit; perianth broadly campanulate, segments 6-7mm long, elliptic to lanceolate, obtusely acute, entire, spreading, chalky white, withering in fruit, the midribs somewhat thickened. Stamens usually shorter than the perianth, filaments subulate, dilated and united into a cup at the base, anthers oblong, pinkish or cream obtuse. Style linear, about equalling filaments in length; stigma capitate, entirely or obscurely lobed. Ovary greenish, crestless. Seeds black, shining, finely alveolate; alveoli each with a minute pustule in the center. Found in river bottoms, swales, seepages, low wet places, full sun or part shade. Flowering late spring (April to early May.)

TYPE: Bosque County, Texas, Bosque river bottom in part shade, near roadside, 31 Mar 1962, T.M. Howard *68-2* (holotype: MO).

OTHER COLLECTIONS: Texas: Blanco County, north side of the road in full sun in low swales, in flower in mid- to late April, 1978, T.M. Howard *78-1*; northeast corner of Comal County, in leaf in full sun along roadsides, early March, 1989, Howard & Ogden *89-A*. Oklahoma: Comanche County, Wichita Mountains near Fort Sill, in seepy places, in fruit, early summer, 1982, S. Ogden *82-A*.

Allium texanum T.M. Howard is described as a new species from central Texas and the Wichita mountains of adjacent Oklahoma. It is distinguished from the closely related *A. fraseri* in flowering later, having broadly spiraled, glacous foliage, taller, more robust habits, larger umbels with flowers having green ovaries, and having membranous coated bulbs or with non-persisting, poorly developed reticulated bulb coats. *A. texanum* differs from *A. canadense* in its mostly membranous-coated bulbs, floriferous, rather than bulbil-bearing, umbels, and in the individual floral form. Both species seek low, wet places with heavy soils.

The genus *Allium* is a group of more than 600 species of the Amaryllidaceae (Alliaceae) found in the northern hemisphere in temperate areas. In North America *Allium* are found in the USA, adjacent Canada, Mexico, Guatemala, and Honduras. Some authorities place *Allium* under a separate family, Alliaceae.

Ownbey (1950) reported a dozen *Allium* species from Texas. Since then several new species and subspecies have been discovered: *A. canadense* var. *parksii* V.L. Cory (unpubl.), *A. acetabulum* var *eulae* V. L. Cory (unpubl.), *A. zenobiae* Cory, and *A. howardii* Traub. Ownbey reduced several Texas onions to varieties of the bulbiliferous *A. canadense*. All were seed-bearing taxa, but all shared in having fibrous-reticulated bulb coats. These were var. *fraseri*, var. *hyacinthoides*, and var. *mobilense*. This reduction was rejected by both Cory (pers. corr.) and Shinners (1951, 1958). The author may add that these species are all seed bearers, and *A. canadense* is a specialized plant with bulbils replacing flowers in the umbel for the most part. The $2n$ number for the seed-bearing plants is 14, while that of *A. canadense* is 28. Clearly *A. canadense* is polyploid. This suggests that the seed bearing species are primitive, by comparison, not only in their behavior, but in their lower chromosome ($2n = 14$) numbers. Also, even though Ownbey's treatment of the *A. canadense* alliance was convenient (reticulated bulb coats), in actual practice, it resulted in the arbitrary separation of otherwise closely related plants (i.e.: *A. runyonii* ((M. Ownbey)) and *A. elemendorfii* ((M.E. Jones)), which differ physically only in their bulb coats) while grouping plants whose relationships may be rather distant. This weakness was admitted by Ownbey, himself, but justified by placing taxonomy as a science distinct from phylogeny and evolution.

Ownbey noted that his *A. canadense* alliance had bulbs that were either "one of a cluster, or bearing basally attached to bulblets." In truth, *A. canadense* and a few of its relatives propagate vegetatively (aside from the bulbils of *A. canadense*) by simply dividing into two bulbs of equal size. This is a most important characteristic that distinguishes this group, but in the case of coastal prairie form of *A. elmendorfii* (M.E. Jones), the bulbs form basal offsets instead of dividing. This character sets it apart from other species from Texas having reticulated bulb coats. This is a rather rare deviation from the norm. The writer has noted that at least two other bulbous plants share in similarly dividing by simple basal offset formation, or in producing underground stolons. This has been observed in populations of *Tulipa clusiana* and *Hymenocallis acutifolia*, proving that there is always an exception to every rule.

A. elmendorfii and *A. runyonii* are only separated by a little more than 30 miles in south Texas. Both grow in thin, sandy soil, and have similar flowering seasons. Foliage is the same, as are the flowers. Bulbs of *A. runyonii* have fibrous-reticulated coats. The bulblets are basal and stalked. Those of *A. elmendorfii* are similar in all respects, save that their bulb coats are white and membranous. Under magnification, the bulb coats are broadly reticulated, but the coats do not persist as do those of *A. runyonii*.

A similar parallel situation exists between *A. fraseri*, and *A. fraseri* var. *eulae* Cory except that in the latter case, some forms of var. *eulae* occur within colonies that have persisting reticulated bulb coats. In some cases the situation is nearly equal proportions. However, those with persisting reticulations have more delicate fibers than do the type forms of *A. fraseri*. Thus *A. fraseri* var. *eulae* is little more than an ecotype form of *A. fraseri*, fairly well-marked, though it be.

In the case of *A. texanum*, another similar parallel exists. The Texas forms are lacking in the persisting reticulations, but one variety from the Wichita mountains of southwestern Oklahoma may retain them. It has been noted that forms from wetter situations lose their heavy coats, whilst those from areas prone to irregular cycles of heat and drought need the heavier coats to carry them through the difficult dry years.

The status of *A. mobilense* needs further study. In this instance, there are two subspecies recognized by Dr. V.L. Cory. A bulbiliferous form from Brazos County was named as *A. canadense* var. *parksii*, but indications show that it is a bulbiliferous form of *A. mobilense* and not a form of *A. canadense*. It appears that other forms of "*canadense*" were spawned by mutating bulbil-bearing forms of related species. This may account for the many geographical variations found in the range of *A. canadense*. Also, the fact that *A. canadense* is the dominant species in the eastern half of North America only proves that its bulbil-bearing specialization gives it an advantage over its seed-bearing ancestors. In similar fashion our native *Nothoscordum bivalve* has virtually raced across the roadsides of the eastern lower quarter of the United States because of its aggressive proliferation. And all of this since the early settlers arrived in North America. The same case is noted with the coyote, armadillo, house finch, prickly pear cactus, etc. Higher populations do not necessarily indicate a more primitive occupancy. This is probably the case with *A. canadense*. It is simply an opportunist.

Allium texanum has proved to be a model garden allium in cultivation in the sun-belt. It is robust and gives a good account of itself, but the color is not particularly showy, due to the greenish ovaries. In this respect it is not too unlike flowering scapes of ordinary edible onions, particularly *A. tuberosum*. Well grown bulbs of *A. texanum* can become large enough (at 1 ½ inches) to slice, though a bit on the garlicky side in flavor. *A. texanum* is one of the two Allium species of central Texas to flower at the end of spring (May), the other being *A. zenobiae*, which is a robust form closely allied to *A. mobilense*.

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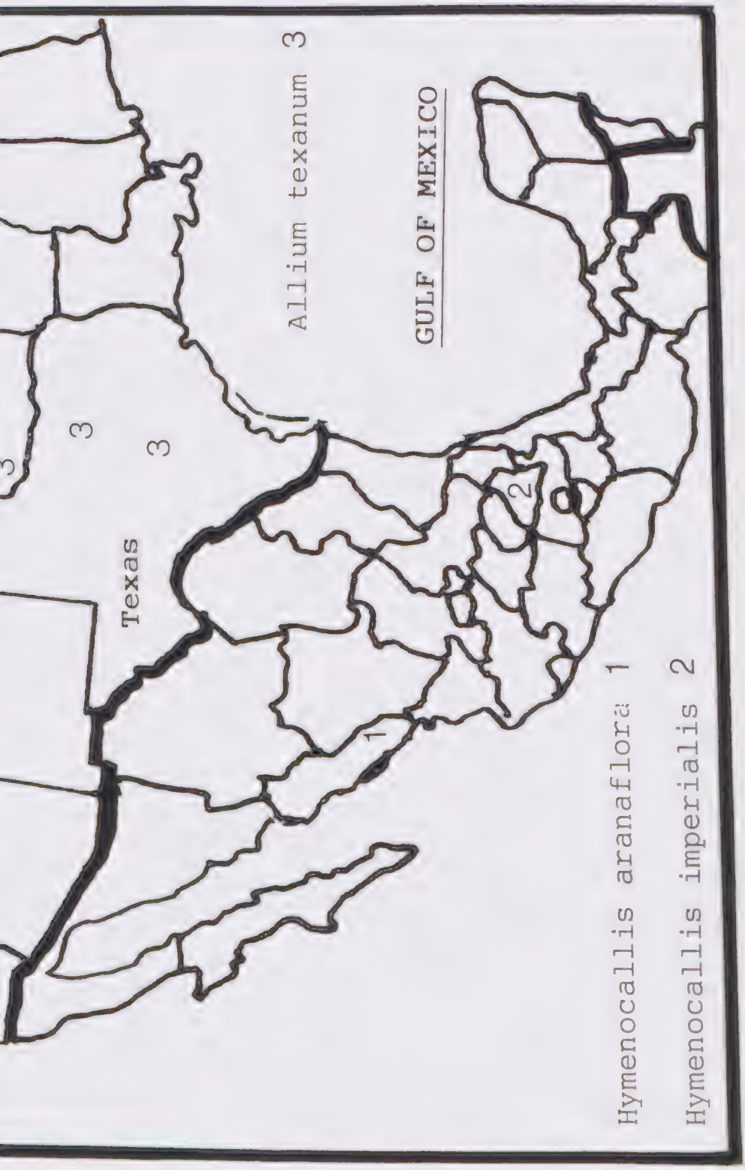

ribution of *Allium texanum* & *Hymenocallis*.

INTER- AND INTRASPECIFIC HYBRID
THE GENUS *ORNITHOGALU*

FRED MEYER*
ROBERT J. GRIESBACH**
AND
HAROLD KOOPOWITZ*

A joint breeding program between the United States Depar
ist and Nursery Crop Laboratory of Beltsville, Maryla
California At Irvine Arboretum (UCI) was started in the spr
of the genus *Ornithogalum* for this breeding program was bas
as the need for improving an existing crop, the existence of a
at UCI, and their remarkable post-harvest qualities. We wa
spectrum of the commercial cut flower types, presently only
oranges and pastels of these colors. We also needed to expand t
flowering times and the arrangement of the flowers on the ster
pot-plant cultivars and novel cut-flower types.

The taxonomy of the South African members of this genu
the large degree of variation within species. Therefore, we tre
as separate entities, referring to them as belonging to the *O*
thyrsoides-complex, the *O. dubium*-complex, *O. conicum*-cor
word "complex" denotes that the individual plants approxima
set forth for that particular species in the most recent key to th
of this genus (Obermeyer, 1978). The need for use of embryo/
niques was indicated by our previously unsuccessful attempts
intra-specific hybrids of this genus. Other parties working o
genus experienced similar problems in the production of hybrid
(Roos, 1964). Our previous attempts indicated that ovary se
pollinated flowers prior to full development of the ovule into
to use the EOR techniques, it was necessary to find out at wh
in terms of days after pollination (DAP), were required to p
suitable for employment of EOR. The proper *In vitro* medium
embryo/ovule also needed to be devised. We evaluated all the
for the desired characteristics we demanded for our hybridiz

In order to pinpoint the number of DAP required for succe
we harvested ovaries starting with 3 to 21 DAP. Between 10 ar
for optimal embryo-ovule rescue. The ovaries were surface s
bleach for 30 minutes and the ovules were aseptically removed
then cultured *in vitro*. We were able to retrieve plants from o
the optimal 10 to 14 DAP, but the percentage of viable plan
medium consisting of ½ MSO and 30g/l of sucrose and 6.5g/l c

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prior to autoclaving was used. After two to three months on this medium, the developing plants were large enough to be removed from culture and acclimated into a sterilized, soilless mix. Flowering occurred after 6 to 9 months. Using this system a generation time of less than one year was realized. This compares to the normal maturation time of 3 to 4 years from seed. The shortening of generation time might be attributed to heterosis, hybrid vigor, since hybrids between closely allied biotypes took about two years to flower.

During the growing cycle we fertilized with **Dyna-Gro** (7-9-5) twice weekly at the 125ppm nitrogen rate. **Orthene 75W** was used to control aphids and thrips. It should be noted that a good pest and virus vector management program is essential, for *Ornithogalum* is very susceptible to virus.

OBSERVATION OF THE FIRST GENERATION OF *ORNITHOGALUM* HYBRIDS

The first year of hybridization resulted in 100 different sets of pollinations (Table 2). The number of ovaries that produced viable plants from any given cross varied from 1 to as many as 25. We were able to obtain living plants in 33 of the 100 attempted sets of pollination. Table 3 represents the second year's crosses and shows a better rate than was obtained in the first year's series of crosses, 107 successful out of 200 attempted. The first year's lower percentage of successful crosses was due in part to our experimentation with media, finding the correct DAP for optimal ovary harvesting, and learning proper ovary post-harvesting techniques. These hybrids started flowering during January, 1989, and continued until late May and early June.

The crosses between highly colored species found in the *O. dubium*-complex and *O. maculatum*-complex with the *O. thyrsoides*-complex resulted in hybrids with an array of pastel colored flowers. These pastel hybrids varied between an orange sherbet color to a yellow lemon custard color. The yellow and orange pigmentation is due to carotenoids which are found in the photosynthetically inactive chromoplasts. Chromoplasts develop either directly from the colorless proplastids or arise from normal chloroplasts which lose their chlorophyll. This can be seen during flower development when the green flower buds are transformed into yellow through orange flowers at anthesis. The gross morphology of the hybrids was intermediate between both parents, although the height of the flower stem and flower size tended to approach that of the larger parent. The effects of heterosis were noticed in one remarkable cross, #30, in which the gross morphology of this hybrid was much larger than that of either parent. It must be noted that #4745, one of the parents of #30, was the most atypical biotype that we assigned to the *O. dubium*-complex. The genetic makeup in cross #30 was probably the deciding factor in the most demonstrative form of heterosis found in the F_1 generation. #519, the other parent in #30, when crossed with other biotypes of the *O. dubium*-complex resulted in vigor only as great as the most vigorous parent (e.g. #92 and #98). #92 and #98 did not flower 100% until the second year, whereas #30 flowered 100% the first year. In cross #41 we obtained the only sterile hybrid. All of the other first generation hybrids had varying degrees of fertility, which provided the opportunity to generate successive generations. The hybrid sterility found in #43 was found to have a chromosomal basis. In this case sterility was the result of defective chromosome pairing during meiosis. The *Ornithogalum* we dealt with were all autogamous, requiring emasculation to insure that self-pollinations would not occur. We also conducted the crosses in insect-proof houses to prevent external pollinators. Pseudogamy occurred in several crosses with *O. conicum*-

complex #2003. In order to get any hybrids of *O. conicum*-complex #2003, it had to be used as the pollen parent. Several crosses between widely divergent biotypes exhibited hybrid sterility. Attempts are being made to restore their fertility by the creation of allopolyploids. These procedures are being carried out *in vitro* with the exposure of callus tissue to colchicine in combination with low temperatures. Autopolyploids of several species have already been generated and that protocol will be reported in a future paper.

Several hybrids are now being multiplied *in vitro* in order to obtain a large quantity of plants for trials as cut flowers or pot plants. These trials will also determine whether *Ornithogalum* can be commercially produced as a stage IV plug. Judging from the favorable response of the many people in the floricultural industry who visited us during their flowering cycle, we would not be surprised if the pastel shades will prove more popular than the saturated colors. Some of the hybrids from within the *O. dubium*- and *O. maculatum*-complexes resulted in highly colored flowers with a dwarf habit. Some of these crosses produced 12 flower spikes from 4 to 5 bulbs in a single four inch pot.

OBSERVATION OF THE SECOND GENERATION OF *ORNITHOGALUM* HYBRIDS

Since a very high percentage of the F_1 flowered in the spring of 1989, we were able to breed a range of 2nd generation hybrids. The F_1 pastels were either sibling crossed or back crossed with the highly colored species and hybrids. This effort was aimed at the continued introgression of deep, saturated colors into tall, cut-flower type species. We expected recombination and segregation to introgress both the saturated colors into the tall types and pastel colors into the dwarf types. In addition, a new accession (4*n* ORG), a tetraploid form in the *O. dubium*-complex, was incorporated into the breeding program.

Of the over 200 pastel F_2 segregates, no plants were found to have darkly colored or pure white flowers. The F_2 population was large enough to insure that the rare single gene recessives would be observed. In fact, the color range of the F_2 generation was very similar to that found in the F_1. However, when the pastel types were crossed back onto the color saturated types, an additive shift in the color range was observed. This shift of color range only approached the highly colored type parents and was as highly colored as the darkest F_1. In crosses #258 and #285 some type of color modifier gene in the *O. thyrsoides*-biotype apparently was at work. These F_1 were a salmon pink similar to that observed in "pink" bearded iris or some "pink" daffodils.

The apparent lack of segregation in the F_2 could either be the result of multigenes, maternal inheritance, or lack of pairing between parental chromosomes. Preliminary data suggests that all three mechanisms might be operating. The inheritance of flower colors due to carotenoids involves both the standard nuclear genes and the genes found within the chromoplast. Chromoplast genes, unlike nuclear genes, are maternally inherited. The female parent passes all its chromoplast genes to her progeny, while the male parent contributes none of its chromoplasts' genes. Functional chromoplasts are a result of the interaction of many nuclear and chromoplast genes. Lack of chromosome pairing in the nucleus could also prevent segregation. Not all hybrids segregate. One example involves chromosome inversions. If one parent has a section of its chromosome inverted (ABCD) compared to the other parent (ACBD), then any recombination on that inverted segment would produce a chromosome bridge during meiosis and be lethal. In the hybrids we have observed many chromosome bridges.

We accomplished in the first two generations what we had originally set out to do. We now have both cut and pot *Ornithogalum* in a wide range of colors and forms. We did about 100 crosses in the third generation mostly just to fine tune some aspects of productivity and cropping times. Also, we have embarked on the creation of true white-flowered types. Commercially available white types are not pure white but either grey or greenish white. We are striving for clean white types with an everblooming habit.

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Figure 1 (top left). #285 (4*n* orange×Hadeco 2), a star shaped, salmon-tinged cut or pot type.

Figure 2 (lower left). #7474, an *O. thyrsoides* biotype.

Figure 3 (right). #7050, a globose *O. thyrsoides* type.

TABLE 1

Number	Color of unopened flowers	Color of open flowers	Stem height (cm)	Flower head shape	Spotting at base of petal	Remarks
				Ornithogalum thyrsoides Complex		
Hadeco 1	green	light greenish white	60	thyrsoid	none	narrow leaf, flowers not pure whites; the predominant biotype in the cut flower trade; produces many bulbils from bulb & etiolated leaf bases
Hadeco 2	olive green	light grayish white	80	cylindrical	none	flowers tend to face outward, long flower head, many star-shaped flowers open at one time, nice stems of good length,
UCI	green	whitish	100	cylindrical	little to none	long pedicels, narrow, star-shaped petals, long stems, narrow leaf
4230	whitish	clean white	100	cylindrical	both	broad, rounded petals; large, clean white flowers make an excellent overall display; old flowers like white paper; broad, slightly glaucous leaf,
7050	light green	whitish	35	globose	slight	very large flowers with nicely rounded petals, not clean white but many open at one time; broad leaf
5762	almost white	white	45	spike of spikelets	none	beautiful white flowers with all open flowers facing outward; rounded, short leaves.
7474	light green	white	45	sub-corymbose	yes	clean white, rounded flowers with & without spots at base of petals; old flowers turn light brown; leaves shiny, dark green, very broad, short, & rounded lay flat on ground
Hadeco double	light green	whitish	80	cylindrical	none	tall, vigorous plant with indeterminant doubling of flowers
				Ornithogalum conicum Complex		
2003	light green	white	100	sub-corymbose	none	evergreen with long flowering season (almost year round), excellent grower

TABLE I (Continued)

Number	Color of unopened flowers	Color of open flowers	Stem height (cm)	Flower head shape	Spotting at base of petal	Remarks
Ex Aust.	light green	white	100	sub-corymbose	none	almost identical to #2003, but goes dormant
				***Ornithogalum dubium* Complex**		
519	green	dark orange to golden yellow	30	sub-corymbose	both	largest flower of the colored biotypes, nicely rounded petals; broad, rounded leaf
608	medium green	mostly yellowish	35	sub-corymbose	none	medium to small flower with clean petals & light green ovary
4745	green	golden	20	loose cylindrical	none	small flowers, same flower stem in bloom for up to 3 months (the longest of all *Ornithogalum* biotypes in collection), approximates larger forms of *O. multifolium*; small bulbs, narrow leaf
5031	green	dark orange to golden	35	sub-corymbose	both	similar to #519 but with smaller flower
4436	medium green	a few light orange, mostly clear yellow	35	cylindrical	none	similar to #608, but much nicer; #608 has stronger color saturation
				***Ornithogalum maculatum* Complex**		
4223	green	orange	30	thyrsoid	none	orange flower, with & without brownish green tip at apex of each petal, few flowers, erect leaves; #4323 similar
4232	green	orange	30	thyrsoid	none	
4*n*	green	dark orange	30-40	sub-corymbose	none	tetraploid & diploid in same population, polyploidism induced through tissue culture; large, bright orange flowers, rounded petals, highest flower bud count of the *O. maculatum* complex
				***Ornithogalum multifolium* Complex**		
4341	green	orange	3	sub-corymbose	none	very small flowers, terete leaf; nice pot plant

TABLE 2—SUCCESSFUL *ORNITHOGALUM* HYBRIDS, 1988

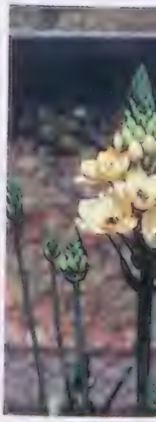
	Crosses:		Crosses:
1.	002003 sibling	48.	002003 sibling
2.	002003 × 004745	50.	004341 × 004230
3.	NDC sibling	58.	000519 × 004230
5.	002003 × 004745	60.	004341 × 004341
6.	002003 × 004223	66.	004230 sibling
7.	004341 sibling	68.	004230 sibling
11.	000519 × 004223	73.	000519 × 004230
14.	000519 × 004223	74.	000519 × *arabicum*
17.	002003 × 004745	83.	*thyrsoides* Hadeco × *arabicum*
18.	004341 × 004232	90.	000608 × 004230
19.	002003 × 004223	92.	000608 × 000519
23.	000519 × 004230	93.	005031 × 004230
29.	000519 × 004230	96.	004230 × *thyrsoides* Hadeco
30.	000519 × 004745	98.	005031 × 000519
31.	000519 × *thyrsoides*	99.	000519 × 004230
32.	000519 × 002003	100.	004230 × 000608
43.	004230 × 002003		

TABLE 3—SUCCESSFUL *ORNITHOGALUM* HYBRIDS, 1989

	Crosses:		Crosses:
102	002003 × 000519	131	30 × 4230
103	002003 × *O. arabicum*	133	30 gold × 4230
104	002003 × *O. dubium* white	134	30 yellow × 4230
106	002003 × 4230	138	23 sibling
107	002003 × *O. arabicum*	139	4230 × 30
109	002003 × NCD	141	30 dark orange
110	002003 × Sc. Per. (*Scilla peruviana*?)	142	4230 × 30 orange
112	002003 × 004223	146	4230 sibling
114	004203	149	99 × 4*n* orange
115	002003 × 85	151	30 × 23
116	*O. arabicum* seedling	152	30 × 23

e top, left to right:

4–5. #23, a tall, cut flower type with large, soft orange flowers.
. #289, tall, saturated color types.
. #96, 0608×HADECO 1, a clean, yellowish flower suitable for cut or pot use.
. #99, a soft, yellow cut flower type.
. #139, a soft, medium orange cut type.
0. #201, a coppery orange cut flower type.
1. #251, a coppery gold cut type.



Left to right, from top:

Figures 12–13. #73, a large, light yellow to orange-yellow cut flower type.

Figure 14. #91, a dwarf, pot type plant.

Figure 15. #99, a yellow-cream cut type.

Figure 16. #100, a light yellow cut type.

Figure 17. #273, a large flowered, cream cut type.

Figure 18. #281, a large, dark orange cut flower type.

Figure 19. #266, a bright yellow cut flower type.

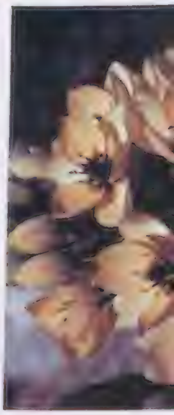


TABLE 3 — SUCCESSFUL *ORNITHOGALUM* HYBRIDS, 1989 (Continued)

153	30 orange × 4230	207	30 × 4230
155	30 × 23	208	30 × 4*n* orange
156	30 orange × 23	209	23 × 23 orange
158	30 orange × 23 orange	210	11 × 14
160	30 × 99	211	4*n* orange × 4230
163	30 × *O. thyrsoides* c.	212	30 orange × 4230
166	30 × 23	213	30 × 4230
168	30 orange 1 × 30 orange 2	214	4745 × 4230
169	11 × 4*n* orange	216	100 × 23
170	30 × 23	217	23-089-E × 4*n* orange
175	30 orange × 4*n* orange	218	23-089-B × 4*n* orange
180	30 × 23	219	4745 × 4*n* orange
183	4230 × 4*n* orange	223	30 × *O. thyrsoides* c.
184	30 × *O. arabicum*	226	4230 × 2003
185	30 × 14	231	30 × 99
186	30 × 4230	232	30 orange × 4*n* orange
187	14 × 23	233	30 × 23
188	14-089-A × 4*n* orange	234	98 × 4745
189	30 × 4*n* orange	236	4745 × 96-089-C
190	30 × *O. arabicum*	239	23 × 96-089-C
191	30 × 4*n* orange	240	73 × 4*n* orange
192	11 × 4*n* orange	244	30 orange × 23
193	31 × 23-089-B	245	11 × 14
195	30 × 4230	247	4230 sibling
196	30 × *O. thyrsoides* c.	249	30 × 4230
198	30 × 4230	250	23 × 4*n* orange
200	11 × 4*n* orange	251	30 × 23-089-B
201	30 orange × 23	253	23-089-B × 30
202	30 × 4*n* orange	254	30 × 4*n* orange
203	30 × 23	255	30 × 23
205	23 × 14 orange		

TABLE 3, *Continued*

258	4*n* orange × *O. thyrsoides* Hadeco 2
261	30 × 4230
262	14-089-A × 23-089-B
265	30 × 4230
266	100 × 30 yellow
267	4*n* orange × 96-089-C
270	4*n* orange × 30
272	4745 × 4*n* orange
273	23-089-B2 × 58
274	23-089-E × 4*n* orange
276	4*n* orange × 30
277	73-089-G × 14
278	30 orange × 30 yellow
279	30 × 23
280	30 orange × 4*n* orange
281	23 × 4*n* orange
282	23 × 4*n* orange
285	4*n* orange × *O. thyrsoides* Hadeco 2
288	30 orange × 4230
289	23 × 96-089-C
291	30 × 96-089-C
292	96-089-C × 23
294	4230 × 4*n* orange

KEY TO THE ALLIUMS OF CHINA

J.M. XU
FROM FLORA REIPUBLICAE POPULARIS SINICAE

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SUMMARY

IN order to enable many botanists and amateur growers to make use of the recently published important revision of Chinese *Allium* species by J. M. Xu in the new flora of China, the main key has been translated from Chinese. A list of all Chinese species of this genus has been provided and some comments have been made regarding the infrageneric classification used in this revision.

The Chinese *Allium* species are interesting in many respects. Morphologically and ecologically they represent a very variable assemblage, ranging from alpine plants to those inhabiting moist forests or extremely dry deserts. They comprise a rather diverse assortment of floristic elements. They include important cultivated food plants and taxa having so-called secondary gene pools which are of potential value as plant genetic resources for future breeding programs. Some of them are very decorative and have already been introduced as ornamentals into the gardens of Europe and America.

Taxonomically, the Chinese alliums have been rather poorly known. Thus the revision of the Chinese taxa of *Allium* by Jie-mei Xu is to be welcomed, as it represents a botanically important event, especially for those dealing with bulbous plant species. Of course there are serious linguistic barriers that prevent a full appreciation of this revision by the botanical community. Therefore, a translation into English should enhance knowledge of these plants considerably and may be useful for many readers.

The revision by J. M. Xu is a part of volume 14 of "Flora Reipublicae Popularis Sinicae" (edited by Wang Fa-tauan and Tang Tsin), the new Chinese flora, of which more than 50 volumes have been published. Volume 14, which appeared in 1980, contains the Allium revision on pages 170-272, and is from which the main taxonomic key (pages 174-184) is translated below. In the flora there are also special keys for the cultivated species, for taxa from Xinjiang, for taxa from other parts of Northwestern China, for taxa of Northern China, for taxa of Southwestern China and for those from Eastern, Southern and Central China. The key also contains data on the distribution of the species by

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1. Note: Shaanxi (not to be confounded with Shanxi) was formerly most often spelled Shen(h)si!

provinces or autonomous regions. For these geographical areas names are used according to the transcription officially adopted in China (with the exceptions of Neimenggu and Xizang which are better-known as Inner Mongolia and Tibet in Western countries).[1] Some species are also included in the key which have not been reported in China but which can be expected to occur in Western areas of the country. These species are unnumbered and are not listed in Table 1, which has been transferred from the list on pages 171 – 174 of the aforementioned volume of the Chinese flora. For a better understanding of the species concept accepted by J. M. Xu in his revision, some of the species names thought to be synonyms by the author have been added. The table also illustrates the infrageneric grouping which had been used. Some comments will be given later on in regard to this problem.

Altogether 99 species have been accepted for China, by J. M. Xu, among them seven occur only in cultivation and two are likewise cultivated and growing spontaneously. The species are rather unevenly distributed in the country (see Figure 1). Most of them occur in western and northern parts of China, whereas the southern, south-eastern and eastern coastal provinces are inhabited only by a few species. Xinjiang is the region with the most taxa (40 species). This indicates the relationship with the Middle Asiatic/Middle East center of diversity of *Allium*; whereas, the species concentrations in Sichuan (32) and Yunnan (19), and partly also of Tibet (21) represent mainly the indigenous Southwestern Chinese–Eastern Himalayan floristic elements. In other provinces or regions the higher numbers of species may result from the coincidence of different floristic elements (e.g., Gansu, 28, Central Asiatic/Southwestern Chinese elements; Hebei, 17, and Heilongjiang, 16, Siberian-Mongolian/Eastern Asiatic elements; Qinghai, 17, Central Asiatic/Southwestern Chinese/Middle Asiatic elements; etc.).

Most of the strictly endemic species occur in Southwestern and Northwestern China (Sichuan, Yunnan, Tibet, Qinghai, Xinjiang, Gansu), although some of them, mostly newly described ones, may be distributed also in other regions of the country.

[Ed. note: Although some of the couplets in the following key are not strictly parallel (that is, one or the other half of the couplet contains more information or slightly different information than its "sister"), all have been left as received since in most cases they provide additional descriptive data about these poorly known species.]

KEY FOR DETERMINATION OF CHINESE *ALLIUM* SPECIES

1. Leaves usually 2, opposite, rarely 1 or 3, linear to ovate, usually narrowed into a petiole; ovary attenuated into a short stipe, each locule with 1 ovule (sect. *Anguinum* G. Don)
    2. Leaf 1, elliptic-ovate, 16.5 – 22.8cm long, 11.3 – 15.7cm broad, cordate at base, petioles almost as long as leaf blade (Sichuan, Hubei) . . . 4. *A. funckiaefolium* Hand.-Mazz.
    2. Leaves 2—3, distinctly smaller
        3. Outer tepals narrower than inner ones
            4. Leaves oblanceolate-elliptic to elliptic, cuneate at base, gradually narrowed into the petiole (Heilongjiang, Jilin, Liaoning, Hebei, Shanxi, Shaanxi, Inner Mongolia, Gansu, Sichuan, Hubei, Henan, Zhejiang) . . . . 1. *A. victorialis* L.
            4. Leaves elliptic to roundish-ovate, rounded to cordate at base, abruptly narrowed into the petiole (Hebei, Shanxi, Shaanxi, Henan, Anhui) . . . 1a. *A. victorialis* L. var. *listera* (Stearn) J. M. Xu

3. Outer tepals broader than inner ones or equal in breadth

5. Scape 2—5cm, distinctly shorter than leaves, leaves sheathing 3/4 to 4/5 of the stem, oblong to narrowly oblong, with a short petiole (Yunnan, Sichuan) . . . 5. *A. nanodes* Airy-Shaw

5. Scape 10—80cm, longer than leaves or only somewhat shorter, petiole very long or leaf blade narrowing basally and petiole indistinct

6. Leaves ovate, roundish-ovate or lanceolate-oblong, rounded to cordate at base, petiole distinct

7. Tepals lanceolate-oblong, narrowly oblong to oblong, outer ones 1.4—2.0mm broad, inner ones with entire margin, very rarely with 1 tooth near apex; apex obtuse, emarginate or irregular-denticulate; leaf blade rounded to somewhat cordate at base, rarely distinctly cordate; blade and petiole usually papillose

8. Blade without white nerves; inner tepals narrower than outer ones (Yunnan, Guizhou, Sichuan, Qinghai, Gansu, Shanxi, Hubei) . . . 2. *A. ovalifolium* Hand.-Mazz.

8. Blade with white nerves, outer tepals as broad as inner ones (Sichuan) . . . 2a. *A. ovalifolium* Hand.-Mazz. var. *leuconeurum* J. M. Xu

7. Tepals linear-lanceolate, outer ones 0.5—1mm broad, inner ones with a small marginal tooth in the upper part, apex acuminate; leaf blade distinctly cordate at base, margin undulate; blade and petiole not papillose (Sichuan) . . . 3. *A. cordifolium* J. M. Xu

6. Leaves linear, linear-lanceolate, elliptic-lanceolate or elliptic-oblanceolate, narrowed towards the base, petiole indistinct; flower purple-red to pale red, rarely white (Tibet, Yunnan, Sichuan, Qinghai, Gansu, Shanxi, Henan, Anhui) . . . 6. *A. prattii* C. H. Wright ap. Forb. et Hemsl.

1. Leaves several, lorate, linear, semicylindric or cylindric, solid or fistulose, not narrowed into a petiole at base (with the exception of *A. wallichii* Kunth var. *platyphyllum* J. M. Xu with oblong-lanceolate to lanceolate leaves narrowed into a petiole); ovules 2 to several per locule of the ovary; if only 1, bulb tunic never distinctly reticulate

9. Roots thick, sometimes nearly tuberous; leaves linear, main nerve distinct; scape usually 2- or 3-angular; locules with 1 or 2 ovules (sect. *Bromatorrhiza* Ekberg)

10. Only 1 ovule per locule

11. Pedicels almost equal; umbel subglobose; filaments as long as tepals or somewhat shorter; ovary narrowed into a short stipe, stigma punctiforme

12. Plants tall, scape (10)20—60cm, longer than leaves; leaves 5—10(-28)mm broad; flowers white (Sichuan, Yunnan, Tibet, also cultivated) . . . 7. *A. hookeri* Thwaites

12. Plants usually lower, scape 3—15 (30)cm, shorter than leaves; leaves 2—5 (-10)mm broad; flowers greenish-yellow to yellowish (Sichuan, Yunnan) . . . 7a. *A. hookeri* Thwaites var. *muliense* Airy-Shaw

11\. Pedicels unequal; umbel fan-shaped; filaments 1.3 to 1.5×shorter than tepals; ovary without distinct stipe, stigma 3-lobed (Sichuan, Yunnan) . . . 8. *A. humile* Kunth var. *trifurcatum* Wang et Tang

10\. Two ovules per locule

13\. Flowers yellow, tepals connate at base into a short tube (Yunnan) . . . 11.*A. chienchuanense* J. M. Xu

13\. Flowers white, red, purple-red to dark purple, tepals free

14\. Filaments connate to ⅔ of their total lengths

15\. Tepals rounded or submarginate at tip; base of free part of the inner filaments usually broadened and shouldered (Tibet, Yunnan, Sichuan, Qinghai) . . . 13. *A. cyathophorum* Bur. et Franch.

15\. Tepals acuminate, base of free parts of inner filaments not broadened or shouldered (Sichuan, Gansu) . . . 13a. *A. cyathophorum* Bur. et Franch. var. *farreri* Stearn

14\. Filaments connate only basally

16\. Flowers white, tepals lanceolate, apex acuminate or irregularly two-lobed (Tibet, Qinghai) . . . 9. *A. fasciculatum* Rendle

16\. Flowers red, purple-red to dark purple, tepals oblong, narrowly oblong or ovate-oblong with truncate, obtuse or emarginate apex

17\. Flowers stellate-spreading, tepals becoming twisted after flowering, inner and outer ones similar, oblong-elliptic to narrowly oblong-elliptic, 5—9mm long

18\. Leaves linear, not contracted into a petiole, sheathing only the base of the scape (Tibet, Sichuan, Yunnan, Guizhou, Guangxi, Hunan) . . . 10. *A. wallichii* Kunth

18\. Leaves oblong-lanceolate to lanceolate, contracted into a petiole, sheathing ½ of the scape (Yunnan) . . . 10a. *A. wallichii* Kunth var. *platyphyllum* (Diels) J. M. Xu

17\. Flowers campanulate, tepals not twisted after flowering, inner ones somewhat longer and narrower than outer ones, ovate-oblong, outer broadly oblong, 8—12mm long (Shaanxi, Gansu, Sichuan, Yunnan, Tibet . . . 12. *A. macranthum* Baker

9\. Roots thin, fusiform; leaves without distinct main nerve, scape usually terete; each locule with 2 to several ovules

19\. Bulb cylindric, conical, ovoid-cylindric, rarely ovoid, usually clustered, rhizome distinctly developed (sect. *Rhizirideum* G. Don)

20\. Bulb tunic becoming fibrous, reticulate- or subreticulate-fibrous or loosely fibrous

21\. Flowers white, pale red, purple-red, purple, dark purple or yellow

22\. Filaments shorter than tepals or equalling or somewhat longer, but never more than 1.25 times tepal length

23. Flowers yellow, later becoming red, filaments connate to 3/5—4/5 of their length into a tube, tepals lanceolate to ovate-lanceolate, 9.5—16.8mm long; leaves broadly linear, usually longer than scape (Xinjiang) . . . 70. *A. semenovii* Regel
23. Flowers not yellow, filaments connate only at base or 1/6 to 1/2 of their length connate into a tube, but in this case flowers purple-red to white
  24. Inner filaments without basal teeth
    25. Sheaths covering ¼ to ½ of scape length
      26. Bulb tunic distinctly reticulate
        27. Pedicels unequal, 2—7 times longer than flowers, tepals 6—8mm long (Xinjiang) . . . 16. *A. deserticolum* M. Pop.
        27. Pedicels unequal, slightly longer until 2(-3) times longer than flowers, tepals 7—14mm long (not yet recorded for China) . . . *A. barszczewskii* Lipsky
      26. Bulb tunic subreticulate
        28. Leaves linear, 2—5mm broad, pedicels unequal (Xinjiang, Gansu, Ningxia, Inner Mongolia, Jilin, Heilongjiang) . . . 23. *A. strictum* Schrad.
        28. Leaves semicircular in transverse section, 0.5—1mm broad, pedicels unequal
          29. Bulb tunic yellowish-brown, base of inner filaments broadly triangular, 3 times broader than base of outer ones, gradually attenuated to the tip; ovary at base with nectariferous pores (Xinjiang) . . . 14. *A. teretifolium* Regel
          29. Bulb tunic grayish-brown, base of inner filaments broadly triangular, 2 times broader than those of outer ones, abruptly attenuated to the tip; ovary at base with nectaries covered by hood-like projections (Xinjiang) . . . 15. *A. korolkowii* Regel
    25. Sheaths covering only the base of the scape
      30. Bulb tunic reticulate or subreticulate; flowers white to pale-red

31. Inner filaments broadly triangular, base 2 times broader than that of outer ones, tepals with dark purple main nerve, apex distinctly reflexed; bulb tunic distinctly reticulate (Xinjiang, Tibet) . . . 24. *A. oreoprasum* Schrenk
31. Inner filaments narrowly triangular, their bases only slightly broader than those of outer ones, tepals without purple nerve
    32. Pedicels 2—4 times longer than tepals, with bracteoles at base, tepals longer than 4mm
        33. Leaves linear, flat, solid, flowers white, usually with green midnerve (cultivated, also spontaneous) . . . 25. *A. tuberosum* Rottl. ex Spr.
        33. Leaves 3-angular-linear, ± keeled beneath, fistular, flowers white, rarely pale-red, usually with pale-red midnerve (Heilongjiang, Hebei, Shandong, Shanxi, Shaanxi, Inner Mongolia, Ningxia, Gansu, Qinghai, Xinjiang) . . . 26. *A. ramosum* L.
    32. Pedicels equalling tepals, without bracteoles or with minute ones, tepals about 3mm long (not yet recorded for China) . . . *A. juldusicolum* Regel

30. Bulb tunic fibrous, or reticulate only at base, flowers dark purple, purple, pale-red or purple-red
    34. Inner filaments broadened at base
        35. Leaves semicylindric to cylindric, 0.5—1.5mm broad, flowers pale-to purple-red (Xinjiang, Qinghai, Gansu, Ningxia, Shanxi, Inner Mongolia, Liaoning) . . . 29. *A. mongolicum* Regel
        35. Leaves linear, 1.5—3 (-5)mm broad, flowers purple to dark purple (Sichuan, Yunnan, Tibet) . . . 43. *A. forrestii* Diels
    34. Inner filaments basally not broadened

36. Flowers funnel-shaped; stamens 1.5—1.7 times shorter than tepals, ovary attenuated to the apex, without distinct basal nectariferous pores (Sichuan, Yunnan, Tibet) . . . 42. *A. mairei* Lévl.

36. Flowers tubular, stamens slightly shorter to slightly longer than tepals; ovary not attenuated to the apex, with basal nectaries covered by narrow hood-like projections (Tibet) . . . 45. *A. changduense* J. M. Xu

24. Inner filaments toothed or denticulate at base

37. Filaments ½ of tepal length (Sichuan, Yunnan, Tibet) . . . 43. *A. forrestii* Diels

37. Filaments equalling tepals or slightly longer

38. Leaves linear, 2—5mm broad (Xinjiang, Gansu, Ningxia, Inner Mongolia, Jilin, Heilongjiang) . . . 23. *A. strictum* Schrad.

38. Leaves semicylindric, 0.25—1mm broad

39. Bulb tunic subreticulate; filaments connate into a tube for 1/6—1/2 of their lengths, this tube adnate for 1/3—1/2 to the tepals (Xinjiang, Qinghai, Gansu, Inner Mongolia, Ningxia, Shanxi, Hebei, Liaoning, Jilin, Heilongjiang) . . . 27. *A. polyrrhizum* Turcz. ex Regel

39. Bulb tunic distinctly reticulate; filaments only at base connate and adnate to tepals

40. Pedicels 2—3 times longer than tepals, bracteolate at base, flowers pale purple to purple; ovary without deep basal nectariferous pores (Ningxia, Inner Mongolia, Hebei) . . . 17. *A. eduardii* Stearn

40. Pedicels 2 times longer than tepals, ebracteolate, flowers pale red; ovary with nectaries covered by hood-like projections (Sichuan) . . . 37. *A. aciphyllum* J. M. Xu

22. Filaments longer than tepals, at least 1.25 times

41. Tepals connate basally for 1.5—2.0mm into a short tube; base of filaments also connate for 1.5—2.0mm and adnate to tepals (Yunnan) . . . 19. *A. siphonanthum* J. M. Xu

41. Tepals free, filaments only basally connate *inter se*

42. Bulb tunic distinctly reticulate, usually red; inner filaments oblong, broadened at base ⅓—½ of their total lengths, apically with 1 tooth on each side; ovary without deep basal nectariferous pores (Sichuan, Tibet, Yunnan, Shaanxi, Ningxia, Gansu, Qinghai, Xinjiang) . . . 18. *A. przewalskianum* Regel
42. Bulb tunic reticulate, never red; base of inner filaments broadened but not more than to ⅓ of their total length; ovary with deep basal nectariferous pores covered by hood-like projections
    43. Flowers white to pale yellow
        44. Leaves semicylindric, fistular, 1—5mm broad; base of inner filaments with one tooth at each side, sometimes tip of the tooth irregularly 2—4 denticulate (Inner Mongolia, Gansu) . . . 20. *A. leucocephalum* Turcz.
        44. Leaves linear, flat, 2-7mm broad; base of inner filaments with 1 tooth at each side (Xinjiang) . . . 21. *A. flavidum* Ledeb.
    43. Flowers light red, purple-red to purple
        45. Bulb tunic reticulate; pedicels bracteolate, ovary with deep nectariferous pores (Xinjiang) . . . 22. A. *lineare* L.
        45. Bulb tunic fibrous, sometimes subreticulate; pedicels ebracteolate, ovary with nectariferous pores covered by hood-like projections
            46. Base of inner filaments broadened, at each side with 1 basal tooth ((1)2—3mm long), tip of teeth irregularly 2- to several- denticulate (Sichuan, Gansu, Shaanxi, Hubei, Anhui) . . . 41. *A. plurifoliatum* Rendle
            46. Base of inner filaments edentate (Sichuan) . . . 41b. *A. plurifoliatum* Rendle var. *zhegushanense* J. M. Xu

21. Flowers purplish-blue or blue
    47. Filaments shorter than tepals
        48. Tepals narrowly oblong to narrowly ovate-oblong, 11—14 (-17)mm long, margin entire; filaments usually 4/5 of tepal length; style usually 2—3 times longer than ovary (Yunnan, Sichuan) . . . 33. A. *beesianum* W. W. Sm.
        48. Tepals ovate to ovate-oblong, 6—10mm long, at least inner ones irregularly denticulate, filaments usually ½ to ⅔ of tepal length; style shorter than ovary or equalling
            49. Tepals acuminate, inner and outer ones of equal length and breadth, margin irregularly denticulate, rarely outer ones with entire margin; leaves linear, keeled beneath, mostly reflexed when dried (Sichuan) . . . 34. *A. yuanum* Wang et Tang
            49. Tepals obtuse, inner longer and broader than outer ones, only inner ones irregularly denticulate; leaves linear, flat (Ningxia, Shaanxi, Gansu, Qinghai, Sichuan, Yunnan, Tibet) . . . 35. *A. sikkimense* Baker
    47. Filaments slightly longer than tepals
        50. Leaves semicylindric (Shaanxi, Ningxia, Gansu, Qinghai, Tibet, Sichuan, Hubei) . . . 36. *A. cyaneum* Regel
        50. Leaves linear, flat

51. Pedicels almost equal, more or less equalling the tepals until 2 times longer than tepals

52. Bulb tunic reticulate, umbel lax, few-flowered; pedicels 1.5—2 times longer than tepals; base of inner filaments one-toothed at each side (Sichuan, Hubei) . . . 38. *A. henryi* C. H. Wright

52. Bulb tunic subreticulate; umbel compact, many-flowered; pedicels equalling tepals until to 1.5 times longer than them; base of inner filaments with 1 long tooth at each side, apex of tooth sometimes denticulate (Hebei, Shanxi, Honan) . . . 41a. A. *plurifoliatum* Rendle var. *stenodon* (Nakai et Kitag.) J. M. Xu

51. Pedicels distinctly unequal, 2—4 times longer than tepals (Sichuan) . . . 39. *A. heteronema* Wang et Tang

20. Bulb tunic coriaceous, thin-coriaceous, membranous, papery, entire, splitting into strips or only at the top becoming fibrous

53. Filaments shorter than tepals, never more than 4/5 of tepal length

54. Flowers blue

55. Tepals narrowly oblong to narrowly ovate-oblong, 11—14 (17)mm long, margins smooth, filaments usually 4/5 of tepal length; style mostly 2—3 times longer than ovary (Yunnan, Sichuan) . . . 33. *A. beesianum* W. W. Sm.

55. Tepals ovate or ovate-oblong, 6—10mm long, at least margin of inner ones minutely and irregularly denticulate; filaments mostly ½—⅔ of tepal lengths; style usually shorter than ovary or subequalling

56. Tepals acuminate, inner and outer ones of equal length and breadth, margin irregularly denticulate, rarely outer ones with smooth margin; leaves linear, keeled beneath, mostly reflexed when dried (Sichuan) . . . 34. *A. yuanum* Wang et Tang

56. Tepals obtuse, inner longer and broader than outer ones, only inner tepals with irregularly denticulate margin; leaves linear, flat (Ningxia, Shaanxi, Gansu, Qinghai, Sichuan, Yunnan, Tibet) . . . 35. *A. sikkimense* Baker

54. Flowers white, pale red, purple-red, pale purple, purple, yellow or bright yellow

57. Flowers white, pale red, purple-red, pale purple or purple

58. Filaments to 3/4—4/5 urceolately connate, base of free part of inner filaments shouldered, sometimes one-toothed at each side; bulb tunic membranous, dirty gray or dark brown (Xinjiang) . . . 59. *A. weschniakowii* Regel

58. Filaments connate at base only or to ⅓—½ of their lengths

59. Bulb tunic coriaceous; pedicels bracteolate; ovary with deep nectariferous pores covered by hood-like projections

60. Bulb tunic dark brown, top becoming fibrous and somewhat subreticulate; pedicels unequal, especially when fruiting some of them 2—3 times longer than tepals (Xinjiang) . . . 15. *A. korolkowii* Regel

60. Bulb tunic light yellowish-brown, top splitting into linear fibers; pedicels equal, equalling tepals until to 2 times longer than them (Xinjiang) . . . 59. *A. setifolium* Schrenk

59. Bulb tunic membranous, papery or thin-coriaceous; pedicels ebracteolate; ovary without deep nectariferous pores
  61. Tepals 6—18mm long, inner ones with rounded apex
    62. Leaves semicylindric, 0.5—1mm broad; tepals 6—7.5mm long; filaments only ⅔—¾ of tepal length
      63. Rhizome in densely branched clusters, bulb tunic papery, top becoming fibrous; pedicels about 2 times longer than tepals, tepals ovate-oblong, 7—7.5mm long, about 3mm broad; broadened base of inner filaments continuously attenuated into the tip (Gansu) . . . 28. *A. yongdengense* J. M. Xu
      63. Rhizome loosely branched with elongated horizontal branchlets, bulb tunic membranous, splitting into linear strips; pedicels equalling tepals or 1.5 times longer; tepals elliptic to ovate, 6—7mm long, 3—4mm broad; about ½ of the length of the inner filament bases broadened and narrowly ovate (Xinjiang) . . . 30. *A. caespitosum* Siev. ex Bong. et Mey.
    62. Leaves linear, 1.5—4mm broad; tepals 13—18mm long; filaments about half as long as tepals (Tibet) . . . 44. *A. kingdonii* Stearn
  61. Tepals 2.8—5mm long, inner ones with truncate or rounded-truncate apex
    64. Leaves, scape and pedicels smooth or only leaf and pedicel edges (but never the scape) scabrid
      65. Plants low; pedicels subequal, 0.5—1.5cm long, tepals 2.8—4.2mm long (Heilongjiang, Jilin, Liaoning, Shandong, Hebei, Shanxi, Inner Mongolia, Gansu, Sichuan, Shaanxi, Ningxia, Henan, Jiangsu, Zhejiang) . . . 46. *A. tenuissimum* L.
      65. Plants taller; pedicels unequal, 1.5—3.5cm long, tepals 3.9—5mm long (Heilongjiang, Jilin, Liaoning, Shandong, Hebei, Inner Mongolia, Xinjiang) . . . 47. *A. anisopodium* Ledeb.
    64. Leaves, scape and pedicels scabrid along the edges (Heilongjiang, Jilin, Liaoning, Inner Mongolia, Hebei, Shanxi, Shaanxi, Gansu, Shandong) . . . 47a. *A. anisopodium* Ledeb. var. *zimmermannianum* Wang et Tang

57. Flower pale or bright yellow

66. Bulb cylindric, lower part scarcely thickened; leaves broadly linear, flat, slightly falcate, usually half as long as scape, rarely equalling (Qinghai, Gansu) . . . 67. *A. chrysocephalum* Regel

66. Bulb ovoid-globose to ovoid; leaves semicylindric-linear, almost equalling the scape (Qinghai, Gansu) . . . 68. *A. herderianum* Regel

53. Filaments slightly shorter, equal or longer than tepals

67. Leaves semicylindric or cylindric, 0.5—4mm broad, fistulose or solid

68. Base of inner filaments broadened, with 1 obtuse tooth at each side

69. Broadened part of inner filaments equalling 4/5 of total stamen length (Heilongjiang, Jilin, Liaoning, Hebei, Shanxi, Inner Mongolia, Xinjiang) . . . 31. *A. bidentatum* Fisch. ex Prokh.

69. Broadened part of inner filaments shorter than ½ of stamen length (Gansu, Shaanxi) . . . 32. *A. dentigerum* Prokh.

68. Base of inner filaments edentate

70. Spathe long-beaked, beak several times longer than base of spathe; bulb tunic dark brown or reddish dark brown, coriaceous, entire or splitting into strips

71. Flower purple-red or pale-red, rarely white (Xinjiang) . . . 63. *A. globosum* M. B. ex Red

71. Flowers pale yellow, tepals with green midvein (not yet recorded for China) . . . *A. petraeum* Kar. et Kir.

70. Spathe shortly beaked

72. Flowers white, pale or greenish-yellow

73. Bulb tunic dark red-brown, lustrous; scape solid, pedicels bracteolate (Heilongjiang, Jilin, Liaoning, Shandong, Hebei, Shanxi, Inner Mongolia) . . . 64. *A. condensatum* Turcz.

73. Bulb tunic light brown or brown, dull; scape fistulose, pedicels ebracteolate (Sichuan, Yunnan) . . . 65. *A. xichuanense* J. M. Xu

72. Flowers pale red, red, pale purple to purple

74. Filaments slightly shorter, equal or slightly longer than tepals

75. Ovary without nectariferous pores at the base

76. Bulbs 3—6mm thick, clustered, bulb tunic grayish-white or somewhat reddish, papery, splitting into linear strips, sometimes into fibres at the top; middle and basal part of inner filaments broadened, broadly ovate (Gansu, Shaanxi) .. 48. *A. dentigerum* Prokh.

76. Bulbs 5—10mm thick, solitary or to 2, bulb tunic light brown to blackish, finally almost coriaceous, usually entire; inner filaments narrowly triangular-conical (Heilongjiang, Xinjiang) . . . 48. *A. prostratum* Trev.

            - 75. Ovary with convex nectaries along the septa, nectary pits at ovary base open (Xinjiang) . . . 60. *A. subtilissimum* Ledeb.
        - 74. Filaments 1.5—2 times longer than tepals
            - 77. Bulb tunic dark brown, coriaceous, dull, entire or splitting into linear strips at the top; leaves semicylindric or almost cylindric, 0.5—1.0 (1.5)mm broad, margin shortly ciliate- or scabrous-dentate (Xinjiang) . . . 61. *A caricoides* Regel
            - 77. Bulb tunic red-brown, membranous to almost coriaceous when dried, lustrous; leaves semicylindric, fistulose, 2—3mm broad, smooth (Hebei, Shanxi) . . . 62. *A. longistylum* Baker
- 67. Leaves linear, lorate or linear-lanceolate
    - 78. Bulbs attached to thick horizontal, sometimes oblique rhizomes, scape mostly 2-angular
        - 79. Leaves beneath one-keeled; ovary with deep nectariferous pores covered by hood-like projections at base (Shandong) . . . 49. *A. taishanense* J. M. Xu
        - 79. Leaves not keeled, ovary without deep nectariferous pores
            - 80. Flowers white to yellow; pedicels ebracteolate (Hebei) . . . 50. *A. chiwui* Wang et Tang
            - 80. Flowers pale red, pale purple to purple-red; pedicels bracteolate
                - 81. Inner filaments with edentate bases (Heilongjiang, Jilin, Liaoning, Hebei, Henan, Shanxi, Inner Mongolia, Gansu, Xinjiang) . . . 51. *A. senescens* L.
                - 81. Inner filaments with one tooth at each side (Xinjiang) . . . 52. *A. nutans* L.
    - 78. Bulbs attached to vertical rhizomes, scape terete
        - 82. Flowers yellowish-green to pale yellow
            - 83. Plants robust, scape 60—100cm, leaves 5—20mm broad (Xinjiang) . . . 56. *A. obliquum* L.
            - 83. Plants lower, scape 20—50cm, leaves 3—8mm broad (Tibet, Sichuan, Gansu, Qinghai) . . . 66. *A. rude* J. M. Xu
        - 82. Flowers white, pale red, purple-red, purple or blue
            - 84. Leaves linear, straight
                - 85. Ovary with nectariferous pores covered by hood-like projections
                    - 86. Leaves broadly linear to linear-lanceolate, 0.5—2.3cm broad, spathe long-beaked, the tip sometimes 7cm long, flowers white (Shanxi, Henan, Shaanxi, Sichuan) . . . 40. *A. paepalanthoides* Airy-Shaw
                    - 86. Leaves linear, 0.2—0.6 (0.8)cm broad, spathe short-beaked, flowers pale red, pale purple, purple, purplish-blue or blue
                        - 87. Inner filaments at base with one, sometimes long, tooth at each side

88. Umbel more or less lax, flowers pale red, pale-purple or purple; inner filaments one-toothed at each side, tip of tooth usually irregularly 2—several-denticulate; pedicels 2—4 times longer than tepals (Sichuan, Gansu, Shaanxi, Hubei, Anhui) . . . 41. *A. plurifoliatum* Rendle

88. Umbel hemiglobose to subglobose, dense, flowers blue or purplish-blue, rarely purple; inner filaments with one long tooth at each side, sometimes tip of the teeth denticulate; pedicels equalling tepals until 1.5 times longer (Shanxi, Hebei, Henan) . . . 41a. *A. plurifoliatum* Rendle var. *stenodon* (Nakai et Kitag.) J. M. Xu

87. Inner filaments edentate at base, conical (Sichuan) . . . 41b. *A. plurifoliatum* Rendle var. *zhegushanense* J. M. Xu

85. Ovary with deep nectariferous pores at base but without hood-like projections or without nectariferous pores at all

89. Ovary with conspicuous nectariferous pores, leaves linear, 2—10 (17)mm broad

90. Bulb tunic membranous or papery, black to dark brown, dull, entire; tepals lustrous (Xinjiang, Gansu) . . . 53. *A. platyspathum* Schrenk

90. Bulb tunic coriaceous, red-brown, lustrous, splitting into strips; tepals not lustrous

91. Inner filaments edentate at base (Xinjiang) . . . 57. *A. hymenorrhizum* Ledeb.

91. Inner filaments one-toothed basally at each side (Xinjiang) . . . 57a. *A. hymenorrhizum* Ledeb. var. *dentatum* J. M. Xu

89. Ovary without distinct nectariferous pores at base; leaves narrowly linear, 0.5—1.5 (-3)mm broad; bulb tunic brown, usually splitting into narrowly linear strips (Xinjiang) . . . 58. *A. kaschianum* Regel

84. Leaves linear, usually falcate

92. Bulb tunic dark brown to yellowish-brown, coriaceous; scape 20—60cm; ovary with distinct nectariferous pores (Xinjiang, Gansu, Qinghai, Tibet) . . . 54. A. *carolinianum* DC.

92. Bulb tunic grayish-black, membranous or papery; scape 6—10cm; ovary without distinct nectariferous pores (Tibet) . . . 55. *A. phariense* Rendle

19. Bulb globose, ovoid-globose, ovoid (if cylindric to ovoid-cylindric leaves thick, cylindric, fistulose), usually solitary, rhizome indistinct

93. Leaves fistulose, cylindric, mostly thick, smooth

94. Bulb cylindric to ovoid-cylindric; pedicels ebracteolate; filaments edentate (sect. *Schoenoprasum* G. Don)

95. Filaments shorter than tepals, to ⅓—¾ of their length connate into a tube; flowers yellow, later becoming red or purple (Xinjiang, Qinghai, Gansu, Sichuan, Yunnan, Tibet) . . . 71. *A. atrosanguineum* Schrenk

95. Filaments shorter or longer than tepals, connate only at base; flowers white, pale red, pale purple, purple-red or yellow, but in this case never becoming red

96. Flowers pale red, pale purple to purple-red

97. Pedicels unequal, shorter than tepals, sometimes interior ones almost as long as tepals; filaments ⅓—½, rarely ⅔ of tepal length

98. Scape and sheaths smooth (Xinjiang) . . . 72. *A. schoenoprasum* L.

98. Scape and sheaths scabrous-dentate along the edges (Xinjiang) . . . 72a. *A. schoenoprasum* L. var. *scaberrimum* Regel

97. Pedicels subequal, 1.5—3 times longer than tepals; filaments equalling tepals or slightly shorter (Heilongjiang, Jilin, Inner Mongolia) . . . 73. *A. ledebourianum* Roem. et Schult.

96. Flowers yellow, pale yellow, whitish-yellow or white

99. Scape and leaves more or less thin, middle and lower parts not more than 5mm thick; flowers yellow to pale yellow (Qinghai, Gansu, Shaanxi, Sichuan, Hubei, Yunnan, Tibet) . . . 74. *A. chrysanthum* Regel

99. Scape and leaves robust, middle and lower parts more than 5mm thick; flowers white or whitish-yellowish-white

100. Bulb ovoid-cylindric, thick, tunic red-brown, subcoriaceous; flowers whitish-yellow; pedicels 1.5—2 times longer than tepals, somewhat thicker (Xinjiang, Heilongjiang) . . . 75. *A. altaicum* Pall.

100. Bulb cylindric, tunic usually white, rarely light red-brown, membranous; flowers white; pedicels 2—3 times longer than tepals (cultivated) . . . 76. *A. fistulosum* L.

94. Bulb depressed-globose, globose, ovoid-globose to oblong-globose, rarely cylindric with thickened base; pedicels bracteolate at base; inner filaments basally one-toothed at each side (sect. *Cepa* Prokh.)

101. Scape fistulose

102. Stem singular or only to 3, flowering scape developed, propagated by seeds

103. Bulbs depressed-globose to subglobose; umbel only with flowers, tepals white with green midvein (cultivated) . . . 77 *A. cepa* L.

103. Bulbs ovoid to ovoid-oblong; umbel with many bulbils, usually developing young leaves being still within the umbel, tepals white with pale red midvein (cultivated) . . . 77a. *A. cepa* L. var. *proliferum* Regel

102. Plants caespitose, flowering scape not developed, propagated by bulbs (cultivated) . . . 78. *A. ascalonicum* L.

101. Scape solid (Xinjiang) . . . 79. *A. galanthum* Kar. et Kir.

93. Leaves linear, triangular-linear, linear-angular, semicylindric, rarely cylindric-fistulose (but thin)

104. Ovary with 2 ovules per locule

105. Inner filaments entire or at base one-toothed or one-denticulate at each side, dents shorter than the anther-bearing cusp of the stamen (sect. *Haplostemon* Boiss.)

106. Flowers blue, mostly becoming purplish-blue when dried

107. Leaves linear, angular beneath, mostly contorted when dried; filaments edentate, slightly longer than tepals (Xinjiang) . . . 90. *A. caeruleum* Pall.

107. Leaves semicylindric, not contorted when dried; inner filaments broadened to ⅔ of their lengths, one-toothed basally at each side, stamens slightly shorter than tepals (not yet recorded for China) . . . *A. caesium* Schrenk

106. Flowers white, pale red, red, purple or purple-red

108. Filaments shorter than tepals, not more than ⅓—½ of tepal length (Xinjiang) . . . 91. *A. schoenoprasoides* Regel

108. Filaments longer than tepals or slightly shorter, but never shorter than ⅔ of tepal length

109. Flowers unisexual, dioecious, female flowers single, tepals with stamen rudiments at base; male flowers to 2, one long-, the other short-pedicelled, ovary rudiment three-locular, without ovules, rarely 1 locule with 1 sterile ovule (Heilongjiang, Jilin, Liaoning, Hebei) . . . 92. *A. monanthum* Maxim.

109. Flowers hermaphroditic

110. Bulbs narrowly ovoid or ovoid

111. Filaments shorter than tepals or subequal

112. Pedicels distinctly unequal, 2—9 times longer than tepals; spathe 1.5—4.0 times longer than umbel; flower red to dark red, bright (not yet recorded for China) . . . *A. paniculatum* L.

112. Pedicels subequal

113. Leaves sheathing not more than ⅓ of the scape; pedicels slightly longer than tepals, ebracteolate; filaments ⅔—¾ of tepal length; ovary smooth (Xinjiang) . . . 80. *A. grisellum* J. M. Xu

113. Leaves sheathing ⅓—½ of the scape; pedicels mostly 2—4 times longer than tepals, bracteolate; filaments equalling tepals or only ¾ of their length; ovary tuberculate (not yet recorded for China) . . . *A. delicatulum* Siev. ex Roem. et Schult.

111. Filaments longer than tepals

114. Inner filaments basally one-toothed or one-denticulate at each side

115. Leaves 3—5-angular, fistulose; pedicels subequal, bracteolate; inner filaments one-toothed at each side of the base (cultivated, also wild) . . . 81. *A. chinense* G. Don

115. Leaves narrowly linear; pedicels unequal, ebracteolate; base of inner filament one-denticulate at each side, tip of dents irregularly minutely denticulate (Sichuan) . . . 83. *A songpanicum* J. M. Xu

114. Inner filaments edentate

116. Leaves semicylindric, 1—2mm ± broad; flowers white to pale red, sometimes light green (Qinghai, Gansu, Ningxia, Shaanxi, Shanxi, Hebei) . . . 82. *A. yanchiense* J. M. Xu

116. Leaves triangular-linear, ± keeled beneath, 1.5—5.0mm broad; flowers red to purple (Heilongjiang, Jilin, Liaoning, Shandong, Hebei, Shanxi, Shaanxi, Henan, Jiangsu, Hubei, Taiwan) . . . 84. *A. thunbergii* G. Don

110. Bulbs subglobose, ovoid-globose or ovoid, but then ovary with deep nectariferous pores at base however not covered by hood-like projections

117. Pedicels subequalling tepals or slightly longer; ovary without conspicuous nectariferous pores (Xinjiang) . . . 87. *A. glomeratum* Prokh.

117. Pedicels 2—5 times longer than tepals; ovary with deep nectariferous pores at base

118. Bulbs ovoid to ovoid-globose, tunic mostly finally splitting into fibrous strips at the top; leaves linear

119. Leaves and sheaths scabrid along the nerves; pedicels bracteolate at base (Tibet, Qinghai, Gansu) . . . 85. *A. tanguticum* Regel

119. Leaves and sheaths smooth; pedicels ebracteolate or only with a few bracteoles (Yunnan, Sichuan) . . . 86. *A eusperma* Airy-Shaw

118. Bulbs ovoid-globose to subglobose, tunic entire; leaves semicylindric, channelled above

120. Umbel always with flowers; pedicels ebracteolate or only with a few bracteoles; inner filaments with broadened bases, usually one-toothed at each side (Xinjiang) . . . *A. pallasii* Murr.

120. Umbels with flowers and sometimes also with bulbils or only with bulbils; pedicels bracteolate; inner filaments edentate (whole country besides Xinjiang and Qinghai) . . . 89. *A. macrostemon* Bge.

105. Base of inner filament broadened, one-toothed at each side, top of teeth long, thread-like, longer than anther-bearing cusp of the stamen (sect. *Porrum* G. Don)

121. Umbel only with flowers; stamens longer than tepals, propagated by seeds (cultivated) . . . 93. *A. porrum* L.

121. Umbel with bulbils and sometimes with several flowers; filaments shorter than tepals; propagated by bulbs (cultivated) . . . 94. *A. sativum* L.

104. Ovary with four to many ovules per locule

122. Tepals free (sect. *Molium* G. Don)

123. Filaments ½ of tepal length; leaves linear to linear-lanceolate, 5—25mm broad, sheathing the lower part of the scape (not yet recorded for China) . . . *A. winklerianum* Regel

123. Filaments longer than tepals or slightly shorter, but not shorter than ⅔ of tepal length

124. Leaves lorate, 2—12cm broad, scape robust, 80—150cm (not yet recorded for China) . . . *A. aflatunense* B. Fedtsch.

124. Leaves linear to broadly linear, not more than 3cm broad

125. Flowers white, tepals with green midvein, erect after flowering (Xinjiang) . . . 95. *A. sinkiangense* Wang et Y. C. Tang

125. Flowers red-purple, tepals soon reflexed and contorted

126. Pedicels 2—6 times longer than tepals; tepals elliptic, ca. 2mm broad; ovary with 4 ovules per locule, with deep basal nectariferous pores (Xinjiang) . . . 96. *A. decipiens* Fisch. ex Roem. et Schult.

126. Pedicels 2—3 times longer than tepals; tepals linear to linear-lanceolate, 1—1.2mm broad; ovary with 4—6 ovules per locule, with basal nectary fissures (Xinjiang) . . . 97. *A. fetisowii* Regel

122. Middle and lower parts of the tepals connate into a tube (sect. *Caloscordum* Baker)

127. Plants more or less small, scape 15—30 (40)cm; pedicels 0.8—4 (7)cm long; tepals 5—7(8)mm long; ovary with (3)4 ovules per locule, rarely 1 or 2 locules with 5—6 ovules (Sichuan, Hubei, Gansu, Shaanxi, Shanxi, Henan, Hebei) . . . 98. *A. tubiflorum* Rendle

127. Plants taller; scape (15)20—52cm; pedicels (4.5)7—11cm long; tepals 7—10mm long; ovary with 6(-8) ovules per locule, rarely only with 5 ovules (Heilongjiang, Jilin, Liaoning, Hebei) . . . 99. *A. neriniflorum* Baker

Annotations to the Infrageneric Groups of *Allium* in China

Sect. *Bromatorrhiza*

Ekberg (1969) described the new subgenus *Bromatorrhiza* Ekb. as consisting of sect. *Bromatorrhiza* (type: *A. wallichii* Kth.) and sect. *Coleoblasta* Ekb. with *A. mairei* Lévl. as a type species. The latter section was obviously not accepted by J. M. Xu, because *A. mairei* is listed under sect. *Rhizirideum*.

Sect. *Rhizirideum*

The Chinese species of this group represent a rather heterogenous assemblage; in other classifications of the genus the Rhizirideums are more subdivided (e.g., Kamelin 1973). *A. weschniakowii* Regel and *A. semenowii* Regel are nowadays transferred (together with *A. atrosanguineum* Schrenk of the following section) to the recently described sect. *Annuloprason* Egor. (Grubov and Egorova 1977).

Sect. *Schoenoprasum*

Usually *A. fistulosum* Pall. and *A. altaicum* Pall. are included within sect. *Cepa* Prokh. or separated as its own sect. *Phyllodolon* (Salisb.) Prokh. (Hanelt 1985).

Sect. *Cepa*

For nomenclatural problems regarding *A. ascalonicum* auct. non L., see Stearn (1960). Recently the shallots have been mostly included as a special cultivar group within *A. cepa*.

Sect. *Haplostemon*

The concept of this section apparently follows the broad circumscription adopted by Vvedenskij in the **Flora of the USSR** (1935). Most recent authors (e.g., Stearn 1978) distribute the species into sect. *Scorodon* Koch and sect. *Codonoprasum* Rchb. The Chinese taxa belong exclusively to sect. *Scorodon* with the exception of *A. paniculatum* L. which is listed in the key but not in Table 1 since it is not yet recorded for China. This species belongs to sect. *Codonoprasum*. Obviously, some of the Chinese species are misplaced under this section and they had to be transferred to sect. *Rhizirideum*. This is true for *A. thunbergii* G. Don, *A. chinense* G. Don and the newly described *A. yanchiense* J. M. Xu. Their exact taxonomic relations, however, still await resolution.

Sect. *Porrum*

The correct name of this section is sect. *Allium*, it includes the type of the genus (*A. sativum*).

Sect. *Molium*

As with sect. *Haplostemon*, the author has adopted the broad concept of Vvedenskij (1935) for this section, but the three Chinese species would be placed by most recent authors into sect. *Melanocrommyum* Webb et Berth., *sensu lato* (or in subgenus *Melanocrommyum* ((Webb et Berth.)) Rouy).

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TABLE 1

List of Chinese taxa of the genus *Allium* including some of the cited synonyms and arranged according to the classification adopted by J.M. Xu in his revision for **Flora Reipublicae Popularis Sinicae** vol. 14 (1980).

Sect. Anguinum G. Don
1. *A. victorialis L.*
(*A. latissimum* Prokh., *A. ochotense* Prokh., *A. microdictyon* Prokh.)
1a. *A. victorialis* L. var. listeria (Stearn) J. M. Xu
(*A. listeria* Stearn)
2. *A. ovalifolium* Hand.-Mzt.
(*A. prattii* C. H. Wright var. latifolium Wang et Tang)
2a. *A. ovalifolium* Hand.-Mzt. var. leuconeurum J. M. Xu
3. *A. cordifolium* J. M. Xu
4. *A. funckiaefolium* Hand.-Mzt.
5. *A. nanodes* Airy-Shaw
6. *A. prattii* C.H. Wright apud Forb. et Hemsl.

Sect. Bromatorrhiza Ekberg
7. *A. hookeri* Thwaites
(*A. tsoongii* Wang et Tang)
7a. *A. hookeri* Thwaites var. muliense Airy-Shaw
8. *A. humile* Kunth var. trifurcatum Wang et Tang
9. *A. fasciculatum* Rendle
10. *A. wallichii* Kunth
(*A. polyastrum* Diels, *A. bulleyanum* Diels)
10a. *A. wallichii* Kunth var. platyphyllum (Diels) J. M. Xu
(*A. polyastrum* Diels var. platyphyllum Diels, *A. platyphyllum* (Diels) Wang et Tang, *A. lancifolium* Stearn)
11. *A. chienchuanense* J. M. Xu
12. *A. macranthum* Baker
(*A. oviflorum* Regel)
13. *A. cyathophorum* Bur. et Franch.
13a. *A. cyathophorum* Bur. et Franch. var. farreri Stearn

Sect. Rhiziridium G. Don
14. *A. teretifolium* Regel
(*A. grimmii* Regel)
15. *A. korolkowii* Regel
16. *A. deserticolum* M. Pop.
17. *A. eduardii* Stearn
(*A. fischeri* Regel)
18. *A. przewalskianum* Regel
(*A. junceum* Jacq. ex Bak. non Sm., *A. stoliczkii* Regel, *A. jacquemonti* Regel non Kth.)
19. *A. siphonanthum* J. M. Xu
20. *A. leucocephalum* Turcz.
(*A. flavovirens* Regel)
21. *A. flavidum* Ledeb.
22. *A. lineare* L.
23. *A. strictum* Schrader
(*A. schrenkii* Regel, *A. bogdoicolum* Regel)

Figure 1. *Allium macranthum* Bak., TAX 289; top, left. Number 12 in table 1.
Figure 2. *Allium mairei* Lévl., TAX 559; top row, center. Number 42, table 1.
Figure 3. *Allium tenuissimum* L., TAX 1197; top row, right. Number 42, table 1.
Figure 4. *Allium anisopodium* Lebed., TAX 2354; middle row, left. Number 47, table 1.
Figure 5. *Allium obliquum* L., TAX 201; middle, center. Number 56, table 1.
Figure 6. *Allium neriniflorum* Bak., TAX 2379; middle row, right. #99, table 1.
Figure 7. *Allium neriniflorum* Bak., TAX 221; bottom, right. #99, table 1.
Figure 8. *Allium thunbergii* G.Don., TAX 1958; bottom, left. Number 84, table 1.

All photographs by P. Hanelt.

Figure 8. Map of China and Taiwan indicating the number of known taxa of *Allium* in each province or autonomous region.

24. *A. oreoprasum* Schrenk
25. *A. tuberosum* Rottl. ex Spreng.
26. *A. ramosum* L.
    (*A. odorum* L., *A. potaninii* Regel)
27. *A. polyrhizum* Turcz. ex Regel
    (*A. subangulatum* Regel)
28. *A. yongdengense* J. M. Xu
29. *A. mongolicum* Regel
30. *A. caespitosum* Siev. ex Bong. et Mey.
31. *A. bidentatum* Fisch. ex Prokh.
    (*A. omiostema* Airy-Shaw, *A. salsum* Skv. et Bar.)
32. *A. dentigerum* Prokh.
33. *A. beesianum* W. W. Sm.
34. *A. yuanum* Wang et Tang
35. *A. sikkimense* Baker
    (*A. kansuense* Regel, *A. tibeticum* Rendle)
36. *A. cyaneum* Regel
    (*A. hugonianum* Rendle, *A. tui* Wang et Tang, *A. szechuanicum* Wang et Tang)
37. *A. aciphyllum* J. M. Xu
38. *A. henryi* C. H. Wright
39. *A. heteronema* Wang et Tang
40. *A. paepalanthoides* Airy-Shaw
    (*A. albostellerianum* Wang et Tang)
41. *A. plurifoliatum* Rendle

41a. *A. plurifoliatum* Rendle var. stenodon (Nakai et Kitag.) J. M. Xu
(*A. stenodon* Nakai et Kitag.)
41b. *A. plurifoliatum* Rendle var. zhegushanense J. M. Xu

42. *A. mairei* Lévl.
    (*A. rhynchogynum* Diels, *A. yunnanense* Diels, *A. amabile* Stapf, *A. pyrrhorhizum* Airy-Shaw)
43. *A. forrestii* Diels
44. *A. kinzdonii* Stearn
45. *A. changduense* J. M. Xu
46. *A. tenuissimum* L.
    (*A. elegantulum* Kitag., *A. pseudotenuissimum* Skv.)
47. *A. anisopodium* Ledeb.
    (*A. tchefouense* O. Deb.)

47a. *A. anisopodium* Ledeb. var. zimmermannianum (Gilg) Wang et Tang
(*A. zimmermannianum* Gilg)

48. *A. prostratum* Trevir.
    (*A. satoanum* Kitag.)
49. *A. taishanense* J. M. Xu
50. *A. chiwui* Wang et Tang
51. *A. senescens* L.
    (*A. baicalense* Willd., *A. spirale* Willd., *A. saxicola* Kitag., *A. kungii* Nak. p.p.)
52. *A. nutans* L.
53. *A. platyspathum* Schrenk
    (*A. amblyophyllum* Kar. et Kir., *A. alataviense* Regel
54. *A. carolinianum* DC.
    (*A. blandum* Wall., *A. polyphyllum* Kar. et Kir., *A. thomsoni* Baker, *A. aitchisoni* Boiss.)
55. *A. phariense* Rendle
56. *A. obliquum* L.

57. *A. hymenorrhizum* Ledeb.
57a. *A. hymenorrhizum* Ledeb. var dentatum J. M. Xu
58. *A. kaschianum* Regel
59. *A. setifolium* Schrenk
60. *A. subtilissimum* Ledeb.
61. *A. caricoides* Regel
(*A. hoeltzeri* Regel)
62. *A. longistylum* Baker
(*A. jeholense* Franch., *A. hopeiense* Nak.)
63. *A. globosum* MB. ex Redouté
64. *A. condensatum* Turcz.
65. *A. xichuanense* J. M. Xu
66. *A. rude* J. M. Xu
67. *A. chrysocephalum* Regel
68. *A. herderianum* Regel
69. *A. weschniakowii* Regel
70. *A. semenovii* Regel
(*A. tristylum* Regel)

Sect. Schoenoprasum G. Don

71. *A. atrosanguineum* Schrenk
(*A. monadelphum* Turcz. ex Kar. et Kir., *A. chalcophengos* Airy-Shaw)
72. *A. schoenoprasum* L.
(*A. raddeanum* Regel)
72a. *A. schoenoprasum* L. var. scaberrimum Regel
(*A. karelinii* P. Pol.)
73. *A. ledbourianum* Roem. et Schult.
(*A. maximowiczii* Regel)
74. *A. chrysanthum* Regel
75. *A. altaicum* Pall.
76. *A. fistulosum* L.
(*A. wakegi* Araki)

Sect. Cepa Prokh.

77. *A. cepa* L.
77a. *A. cepa* L. var. proliferum Regel
78. *A. ascalonicum* L.
79. *A. galanthum* Kar. et Kir.

Sect. Haplostemon Boiss.

80. *A. grisellum* J. M. Xu
81. *A. chinense* G. Don
(*A. bakeri* Regel)
82. *A. yanchiense* J. M. Xu
83. *A. songpanicum* J. M. Xu
84. *A. thunbergii* G. Don
(*A. sacculiferum* Maxim., *A. japonicum* Regel, *A. taquetii* Lévl., *A. pseudojaponicum* Makino, *A. ophiopogon* Lévl., *A. morrisonense* Hay., *A. pseudocyaneum* Gruning, *A. komarovianum* Vved.)
85. *A. tanguticum* Regel

86. *A. eusperma* Airy-Shaw
87. *A. glomeratum* Prokh.
88. *A. pallasii* Murr.
(*A. lepidum* Ledeb., *A. caricifolium* Kar. et Kir., *A. albertii* Regel, *A. semiretschenskianum* Regel)
89. *A. macrostemon* Bunge
(*A. nereidum* Hance, *A. grayi* Regel, *A. nipponicum* Franch. et Sav., *A. uratense* Franch., *A. chanetii* Lévl., *A. ouensanense* Nakai)
90. *A. caeruleum* Pall.
(*A. coerulenscens* G. Don, *A. azureum* Ledeb.)
91. *A. schoenoprasoides* Regel
(*A. sairamense* Regel, *A. kesselringi* Regel)
92. *A. monanthum* Maxim.

Sect. Porrum G. Don
93. *A. porrum* L.
94. *A. sativum* L.
(*A. pekinense* Prokh.)

Sect. Molium G. Don
95. *A. sinkiangense* Wang et Y. C. Tang
96. *A. decipiens* Fisch. ex Roem et Schult.
(*A. tulipifolium* Ledeb., *A. roborowskianum* Regel)
97. *A. fetisowii* Regel
(*A. simile* Regel, *A. tschimganicum* B. Fedtsch.)

Sect. Caloscordum (Herb.) Baker
98. *A. tubiflorum* Rendle
99. *A. neriniflorum* Baker

CALIFORNIA CALLA BREEDING

(PRESENTED AT THE 1989 INTERNATIONAL SYMPOSIUM ON BULBOUS AND CORMOUS PLANTS HELD IN IRVINE, CALIFORNIA)

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Zantedeschia (Callas) have been grown commercially on the central coast of California for over 60 years. Our own firm, formerly Brown Bulb Ranch, now Golden State Bulb Growers, first started growing callas in the late 1920's. The varieties of spring callas grown then are the same species varieties from which nearly all the hybrid callas available today originated. They are: *Zantedeschia elliotiana* (yellow calla), *Z. rehmannii* (pink calla), and *Z. albo-maculata* (miniature white calla).

The original plant breeding work done with these species callas was that of individual selection in open pollinated blocks. This was done to keep the varieties uniform and of high quality. From that point, the true lines were bulked up through mass selection out of expanded seed-grown blocks.

There was no formal calla hybridizing work done here in California until the mid 1940's when the production and popularity of spring callas began to increase. The bulk of the production was in San Mateo, Santa Cruz and Monterey counties. The main suppliers and breeders of callas in those years were names like Garibaldi, Reinalt, Antonelli, Enwright and Brown.

The first genuine hybridizing efforts of crossing the existing line of callas, resulted in a myriad of bright new colors, and in turn, bright new hopes for the future of spring callas.

These new hybrids ran the gamut of colors from purple to red, to rose, to orange, to apricot. The plant not only varied in flower color, but in plant height, leaf shape, leaf pigmentation, flower size and floriferousness.

The reasons for this varied and diverse selection of material is not difficult to deduce. The hybridizing of callas was not to be a simple proposition. The color genes in *Z. rehmannii* and *Z. elliotiana* were not simple arrangements but complicated combinations which caused much diversity when combined. F_2, F_3 and subsequent generations were even less thrilling to calla breeders as diversity in color and plant form persisted. The goal of new homogeneous seed strains of many different colors was not to be readily realized. As a result, the new hybrid varieties of calla would have to be sold as mixed hybrids for years to come.

The popularity of callas peaked in the late 1950's. By the early 1960's both the production and demand for callas decreased. The main reasons for this were the inability of many growers to control the bacterial soft rot *Erwinia carotovora*, and the poor collection of seed. The lack of seed encouraged growers to propagate asexually by offset. The use of asexually reproduced material that previously had exposure to contaminants such as *Erwinia*, caused severe rot problems. The resulting product was of poor quality and discouraged consumers.

The decrease in popularity of the spring, or colored callas, also affected the breeding work. If it were not enough that callas were easily infected by *Erwinia*, that seed was difficult to collect in volume, and that three years were required to advance a single generation in a breeding program, now there would be little revenue to support any sustained hybridizing work.

Calla production went into a dark age through the 1960's and 1970's and only began to increase again by the early part of this decade. This also caused a stagnation in the breeding of the plant with the notable exception of the development of a hybrid yellow calla.

The hybrid yellow was a result of crossing and back crossing *Z. elliotiana* with *Z. albomaculata*. This hybrid is more disease resistant, more compact in plant habit, more floriferous, and slightly lighter in flower color than *Z. elliotiana*. It was a breakthrough in calla hybridizing and still remains the only true hybrid line available today.

In the 1980's with the more advanced cultural techniques of preventing and suppressing disease infestation, along with the development of tissue culture brought to light by the New Zealand calla growers, callas began a renaissance period which we are experiencing today. Now the possibilities for callas seem to be endless with their adaptability to pot and cut flower culture showing great potential.

The efforts underway today begin with the reconstruction and segregation of the fragmented work done over the last 40 years. The quality of material available to breeders here is unsurpassed by any other available throughout the world. The work to be done now is to take the hybrid and species calla material on hand and focus the current selecting and breeding work on the priorities developed by the commercial pot and cut flower producers here and abroad.

The demands of the marketplace for quality varieties of hybrid callas both asexually and sexually produced must be met in order to insure the longevity of the calla as a top pot and cut flower item. Initial hybrid line or clonal selections now available may lack a number of the qualities desired and demanded by the marketplace. The novelty of new colors of calla in segregated groups may capture the attention of growers for the short term, but new varieties must be able to deliver more of the fully encompassing qualities desired by commercial growers and consumer alike. This is the challenge ahead of us.

What are the characteristics of a good pot plant? More specifically, what are the qualities of a good bulb type pot plant? Here are a few characteristics that I would list: plant height, floriferousness or number of flowers, flower size, ease of culture, disease resistance, ability to force the plant to flower at the right time, and cost of producing that potted plant.

What are the qualities necessary for a good cut flower? How about: stem length, stem strength, number of blooms per plant, vase life, flower size, ease of culture, disease resistance, ability to force, and cost of producing blooms?

First I would like to address what is being done in hybridizing efforts for pot varieties and then follow by what we are doing in our efforts to produce top cut-type callas.

Generally speaking, the more compact the habit of a potted plant, the better it is accepted. The pink calla, *Z. rehmannii*, grows between 8 inches in the open field and up to 14 inches in a shade house or greenhouse. This is about 2-4 inches shorter than *Z. albo-maculata*, the miniature white, and 6-8 inches smaller than *Z. elliotiana*. Consequently, it is the pink callas and *Z. rehmannii* hybrids that hold the most potential for pot culture when it comes to plant height and habit.

The hybrids of the pink calla range in color from blush pink, to hot pink, to lavender, to purple, to rose, to red. It is these colors that we can expect to see more of in the calla pot market. In addition, the leaves should be more lanceolate, more abundant, and with less speckling than hybrids with more *Z. elliotiana* or *Z. albo-maculata* blood.

Floriferousness is also more apparent in *Z. rehmannii*. This trait can be easily recognized by the storage structure itself as it is considerably more composed of multiple eyes rather than a single more centralized and dominant eye as in *Z. elliotiana* and *Z. albo-maculata*.

Flower size is valued by pot growers whether it be small or large. The *Z. rehmannii* flower is the smallest of the callas, followed closely by the miniature white *Z. albo-maculata*. The yellow calla has the largest blooms of the spring callas.

Ease of culture and disease resistance I will discuss together since they are closely related. Spring callas are not completely free of disease problems. They are susceptible to water molds and Rhizoctonia, as many plants are. But, in addition, viruses, storage rots, and bacterial soft rot can complicate your life when you are a calla grower.

The biggest of these bugaboos is certainly the bacterial soft rot, *Erwinia carotovora*. This friendly fellow has a certain affinity for callas. Through inoculation of carefully selected specimens, we are slowly tracking down those types of hybrids and specie callas that are tolerant and planning our future crosses to isolate and then transfer those traits to other hybrid selections. We know that *Z. elliotiana* is the most susceptible calla, *Z. rehmannii* less so, and *Z. albo-maculata* being the most tolerant.

The ability to force calla pot plants to flower on a scheduled time line is currently being studied by a number of researchers. The potential to do this seems good, but more studies are needed. The link to genetic heritage of individual clones, or hybrid lines, may be remote, and in fact environmental treatments may be more useful. However, the stability of a line, whether hybrid or of species origin, does seem to make a difference in uniformity when trying to force a variety. The more stable a variety, the better it seems to react to a given environmental treatment.

The last characteristic that I feel is very important to growers, and maybe the most important trait, is the cost to produce that plant. Currently, it is not a cheap crop to produce and it doesn't appear to be getting any less expensive with the introduction of tissue culture into the production cycle. From a hybridizing viewpoint, we must produce varieties, whether they be clonal or of seed origin that are less expensive to produce than the current lines and clone varieties available.

The production period for callas is, on average, 2½ years in order to achieve a pot-size calla suitable to growers. This is not an inexpensive procedure. They require excessively clean conditions, proper handling of dormant material, and vigorous attention to all types of stresses during their growing cycle. In order to decrease the cost of production, we must find and develop varieties that grow more vigorously and develop more quickly into saleable material. Some of this work can be done by breeding, but some of the work will also rest with those of us who are also responsible for developing more advanced production techniques. Both of these efforts are under way, and the future holds promise for a more economical calla with the combination of results from plant breeders and producers. Fortunately, our company, Golden State Bulb Growers, is not only a producer of callas, but has an involved breeding program as well; and we feel confident that we can achieve a balanced program that can deliver the desired product.

The calla as a cut flower is exceptional and holds potential to be second to none. Many of the qualities necessary for a top cut flower are also those of a good pot plant. The qualities of floriferousness (or number of flowers), plant height, disease resistance, size of bloom, forcing, and cost of production have already been addressed. The characteristics of stem length, stem strength, and vase life I will focus on now.

Stem length is greatest in the yellow calla. The *Z. pentlandii* calla, which I have not yet mentioned, generally produces flowers on stems from 18-28 inches from 3-year-old rhizomes in open field. *Z. pentlandii* is currently being used to a greater extent in breeding cut varieties. *Z. elliotiana* will produce stems from 16-24 inches tall from the same size rhizomes. The species *Z. elliotiana* seems to be more consistent in stem length along with flower size as well as leaf shape and pigmentation than *Z. pentlandii*. Stem strength is also cornered by the yellow calla. *Z. albo-maculata* is second in both length and strength, with *Z. rehmannii* a distant third.

Vase life seems to be very similar among all calla varieties. There are reports of *Z. pentlandii* lasting considerably longer than the rest of the calla species, but we are unable to substantiate that. Most callas will last from 2-3 weeks in a vase after being cut if cared for properly. They tend to turn green slowly when maturing, but are not unsightly. The ability to breed callas that last longer appears to be limited, but again, environmental treatments may be developed to exceed the current parameters.

The likely result of the breeding possibilities for callas should bring about colors of cut flowers that tend towards the yellow end of the spectrum. Most of the taller cut flowers should be in the range of apricot, orange, salmon, cream, and fire red. However, there should be suitable specimens with somewhat shorter stems from light pink, lavender, rose, and red.

The existing callas available to growers and consumers today are quite good and should provide good pot and cut flower selections. We are currently continuing mass selection for line development and recurrent selection for true F_1 hybrid development and improvement of open pollinated populations.

VOLUNTEER SUPPORT

The Winter-Spring 1989 issue of the *Flamingo Garden Bulletin* had a photo and note concerning one of that garden's volunteers, Billie Davis, who is also a long-time IBS member. Mrs. Davis maintains the amaryllid collection at this Florida institution. She has volunteered there for the past several years to help collect, test, groom and propagate not only *Hippeastrum* species and cultivars, but also *Crinum, Cyrtanthus, Lycoris, Zephyranthes* and other genera.

Efforts by supporters, such as Billie Davis, are very important to volunteer, non-profit organizations. Her energies in sharing the joy and beauty of bulbous plants benefit not only Flamingo Garden, but also IBS. It was a joy to see Billie Davis at the Irvine symposium, although we had little time to chat.

For those interested in seeing the displays, Flamingo Garden is located at 3750 Flamingo Road, Davie, Florida 33330, near Ft. Lauderdale. An annual membership is $20. The Garden is also anxious to receive any amaryllid plant material. If you have items which you believe might do well there, contact the Curator of Plant Collections, Dr. David Bar-Zvi, or write to Mrs. Davis, 741 SW 71 Terrace, Pembroke Pines, Florida 33023.