HERBERTIA

Journal of the International Bulb Society

VOLUME 60
2005–2006

International Bulb Society
P.O. Box 336
Sanger, CA 93657 USA
http://www.bulbsociety.org

David J. Lehmiller • Editor
Alan W. Meerow • Associate Editor
Victor W. Lambou • Associate Editor

ISSN 1559-8772

The International Bulb Society, Inc., is a non-profit organization. Said corporation is organized exclusively for educational and scientific purposes, and especially to promote, encourage and foster the horticulture, development and improvement of bulbous or geophytic plants and public interest therein. These purposes are expressly limited so that IBS qualifies as an exempt organization under Section 501 (c) (3) of the Internal Revenue Code of 1954 or the corresponding provision of any future Internal Revenue Law of the United States of America.

INTERNATIONAL BULB SOCIETY

Directors

Herbert Kelly Jr.	President, Director SX/BX, Director Awards
Kathy Andersen	Secretary
Pamela Kelly	Treasurer
David Lehmiller	Director Membership, Co-Director Publications
Tony Palmer	Co-Director, Publications

International Representatives

Rachel Saunders	South Africa
Andre Gaboriau	France
John Grimshaw	UK
Tony Palmer	New Zealand
Alberto Grossi	Italy

BENEFITS OF MEMBERSHIP

As a member of the **INTERNATIONAL BULB SOCIETY** you will receive the following yearly benefits:

The annual journal of the Society: **HERBERTIA.** The most comprehensive journal on bulbous plants in the world.

The Society's full color magazine/bulletin: **BULBS.** A great source of down to earth information on how to grow bulbs.

Participation in the SX/BX program. Periodic internet offerings of rare bulbs and bulb seed.

Participation in our exciting electronic E-mail Forum (IBSMEMBERS). A great forum to learn, ask questions and discuss issues with some of the greatest bulb experts in the world. Plus, when you join the Bulb Forum, you become eligible to participate in the SX/BX (Seed and Bulb Exchange). Contact Herbert Kelly Jr. at herb76@aol.com.

Participation in occasional rare bulb sales. This will permit members to obtain rare and desirable species not available anywhere else.

Participation in our new MEMBERS ONLY section on the web site, where special offers and opportunities will be made only to members of the Society.

MEMBERSHIP DUES ARE AS FOLLOWS:

For USA:	**Outside USA** (surface/air):
1 year $40	1 year $50
2 years $75	2 years $95
3 years $110	3 years $140

Check, money order, international postal money order, or credit card**
Make payable to: IBS (in US funds only) and mail to: Dave Lehmiller, Membership Director,
18173 Hwy 326 North, Sour Lake, TX, 77659, USA. Email to: IBSMEM@aol.com
**If paying by credit card, enclose your card number (MasterCard or VISA only) and expiration date.
Or you may apply online via secure server: www.bulbsociety.org

TAX-DEDUCTIBLE DONATIONS (deductible in U.S.) may be made to the IBS as well. The following funds can be targeted for such donations: Research and Grants, Color for Publications, Conservation, General Fund. A donation in any given year (NOT including dues) entitles the donor to be recognized in BULBS Magazine.

ADVERTISERS: If you would like to advertise your products or services in HERBERTIA, please contact David Lehmiller. Email to: IBSMEM@aol.com. (Please use ADS FOR HERBERTIA as your subject heading.) Or call at 1-409-673-2507.

Ad Rates	***Black & White***	***Color***
1/4 page	$75	$100
1/2 page	$100	$150
Full page	$150	$250

EDITOR'S COMMENTS

Two of the Society's recent Herbert Medalists, Dr. August De Hertogh (2000) and Dr. Marcel Le Nard (2003), are well known to many IBS members through a book they co-edited: The Physiology of Flower Bulbs, published by Elsevier Science Publishers B.V. in 1993. Could it be more than a mere coincidence that the 2006 Herbert Medalist, Dr. Abraham H. Halevy, co-authored a chapter in the latter book? Dr. Halevy has published a few books of his own. His "bibliography" is most impressive.

The 2006 Traub Awardee, Mrs. Pamela J. Kelly, provides us with only a modest account of her life and her service to the Society. But for those of us who have been on the Board of Directors and the Awards Committee for a period of time, we know that she "saved" the Society from ruin. Fortunately for the Society, she discovered regulations regarding the State of California and the Internal Revenue Service that were unknown to the rest of the Board of Directors, and she filed the pertinent reports and salvaged the Society's non-profit, tax-exempt status.

Regarding the content of this volume, Fritsch et al provides us with an account on *Allium* and their medicinal properties, possibly the first article in Herbertia devoted to medicinal bulbs and the identity of their active ingredients. Charles Craib, a long time IBS member and contributor to Herbertia, continues with his field accounts on rare and unusual geophytes from Southern Africa. Many of Craib's investigational reports represent the only thorough field reports in the literature on the subject plants. And then we have three *Crinum* accounts – what would an issue of Herbertia be without articles on this taxon?

And finally, I wish to acknowledge and to thank Alan Meerow and Victor Lambou for their contributions in editing and organizing this publication.

—David J. Lehmiller, Editor

HERBERTIA VOLUME 59, 2004–5

THE HERBERT MEDAL

The Herbert Medal is the highest honor that the International Bulb Society can bestow upon a person for meritorious achievement in advancing the knowledge of bulbous plants. The medal is named for William Herbert (1778-1847), son of Henry Herbert, Earl of Carnarvon. William Herbert had a predilection for amaryllids and achieved success in their hybridization. He 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.

The Herbert Medal may be awarded annually or on special occasions by the Board of Directors of the Society. Candidates for the Medal are recommended to the Board of Directors by the Awards and Recognition Committee. Medalists need not be members of the Society to be considered for the Herbert Medal. The award includes honorary life membership in the Society.

PAST HERBERT MEDALISTS

1937 Mr. Henry P. Nehrling, Florida
1937 Mr. Theodore J. Mead, Florida
1937 Mr. Arthington Worsley, England
1938 Mr. Ermst 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
1939 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
1940 Mr. H. W. Pugsley, England
1941 Mr. W. M. James, California
1942 Prof. Dr. A. Fernandes, Portugal
1943 Miss E. Lawrence, North Carolina
1944 Dr. Henry A. Jones, Maryland
1945 Mr. R. G. Huey, Kentucky
1946 Mr. Guy L. Wilson, Northern Ireland
1947 Mr. R. W. Wheeler, Florida
1948 Dr. R. A. Dyer, South Africa
1949 Capt. C. O. Fairbairn, Australia
1950 Mrs. Mary G/ Henry, Pennsylvania
1951 Mr. Mulford B. Foster, Florida
1952 Dr. J. C. Th. Uphof, Florida
1953 Mr. E. A. Bowles, England
1954 Mr. Thomas R. Manley, Pennsylvania
1955 Dr. Robert F. Hoover, California
1956 Mr. E. O. Orpte, California
1957 Mrs. Morris W. Clint, Texas
1958 Mr. Wyndham Hayward, Florida
1959 Dr. Robert G. Thornburgh, California
1960 Prof. Ira S. Nelson, Louisiana
1961 Mr. Frederick B. Jones, Texas
1962 Dr. Floyd F. Smith, Maryland
1963 Mr. W. D. Morton, Jr., Louisiana
1964 Mr. S. Y. Caldwell, Tennessee
1965 Mr. Robert D. Goedert, Florida
1966 Mr. L. Boshoff-Mostert, South Africa
1967 Dr. M. Cardenas Hermosa, Bolivia
1968 Dr. Robert P. Kahn, Maryland
1969 Mr. W. Quinn Buck, California
1970 Dr. Thaddeus M. Howard, Texas
1971 Dr. C. G. Ruppel, Argentina
1972 Mr. J. L. Doran, California
1973 Dr. Cesar Vargas, Peru
1974 Sr. Pierfelice Ravenna, Chile
1975 Dr. John M. Cage, California
1976 Mr. Floor Barnhoorn, South Africa
1977 Mrs. Emma D. Menninger, California
1978 Dr. W. S. Flory, Jr., North Carolina

PAST HERBERT MEDALISTS (cont'd)

1979 Mr. Harry Blossfeld, Brazil

1980 Mr. Charles D. Cothran, California

1981 Mr. W. L. Tjaden, England

1982 Walter & Hilda Latapie, Louisiana

1983 Mrs. A. C. Pickard, Texas

1984 Mrs. Marcia C. Wilson, Texas

1985 Dr. Hamilton P. Traub, California

1988 Dr. Thomas W. Whitaker, California

1988 Mr. Grant E. Mitsch, Oregon

1988 Mr. L. S. Hannibal, California

1990 Dr. H. Shuichi Hirao, Japan

1991 Dr. Kenneth E. Mann, California

1992 Mr. Brian Mathew, England

1996 Dr. Maurice Broussard, France

1997 Sir Peter Smithers, Switzerland

1997 Dr. Dierdre Snijman, South Africa

1998 Dr. Alan W. Meerow, Florida

1999 Mr. Fred Meyer, California

1999 Dr. Peter Goldblatt, Oregon

2000 Dr. A.A.De Hertogh, North Carolina

2000 Dr. David J. Lehmiller, Texas

2001 Mr. Graham Duncan, South Africa

2002 Dr. Marcel Le Nard, France

2003 Dr. Harold Koopowitz, California

2004 Mr. Floris Barnhoorn, South Africa

2005 Mr. Herbert Kelly Jr., California

2006 HERBERT MEDALIST

DR. ABRAHAM H. HALEVY

ABRAHAM H. HALEVY

AUTOBIOGRAPHY

I was born in 1927 in Tel-Aviv, Israel and had my primary and secondary education in this town. After graduating from high school, I joined an agricultural kibbutz (a collective community) where I worked for three years with several horticultural crops. I then joined the Israel Defense Forces and fought (and was injured) during Israel's War of Independence. After the war I studied biology and horticulture at the Hebrew University of Jerusalem and obtained with distinction my M.Sc. (1955) and Ph.D. (1958) in Plant Physiology and Horticulture. The Hebrew University authorities offered me a fellowship if I would conduct my postdoctoral work in citriculture and later join the Citrus Department of the University. At that time, citrus was Israel's most important horticultural crop for export, floriculture was not taught at the Faculty of Agriculture of the Hebrew University, and there was virtually no serious floriculture in Israel. I declined the offer to work on established crops such as citrus and decided to try to establish an ornamental industry including teaching and research at the University.

I therefore, in 1958 applied for and was accepted as a Research Fellow in the Ornamental Crops Department of the USDA in Beltsville, MD, where I worked for one and a half years with great scientists such as Harry Borthwick, Sterling Hendricks, Neil Stuart, Marc Cathey, Sam Asen and others. When I returned to Israel and the Hebrew University at the end of 1959, I had to teach plant physiology and citriculture, but I also started offering "voluntary" courses in floriculture and commenced my research program on floral crops. In 1964 the University approved floriculture as a legitimate line of teaching and research. I founded the Department of Ornamental Horticulture at the Hebrew University and served as Head of the Department for twenty-two years. Actually, this was the beginning of the floriculture industry in Israel that developed from almost nil in the early 60's to an annual export value of over US$350M today. Our graduates, being the major researchers, extension officers, growers and exporters, were mainly those who built this industry.

In 1964/5 I was a Visiting Professor at Michigan State University, East Lansing, and during the 70's, 80's and until 1993, I served as a Visiting Professor on sixteen occasions in the Department of Environmental Horticulture of the University of California, Davis.

Although I have been officially retired for almost ten years, I continue maintaining my laboratory and research greenhouses, as well as guiding graduate students and following my research almost as before. During my scientific career I published over 350 scientific papers in reviewed international journals, which about 120 of them are on bulbous crops (see enclosed "List of Publications on Bulbous Plants"). I also published 5 books, among them the 6- volume treatise "Handbook of Flowering" (1985-1989), which is still the most comprehensive book on flowering. I founded the International Working Group on Flowering (1985) and issued and edited its scientific journal for four years. My main three lines of research activities focused on: (a) physiology of flowering and developing practical methods for control of flowering; (b) postharvest physiology of flowers, and (c) introduction and development of new florist crops. Initially I worked mainly on geophytes: gladiolus, iris, ornithogalum, tulip, native geophytes, but still the study on the physiology and culture of bulbous plants constituted an important part of my work.

Over the years I received several awards: In 1983 I was nominated a Fellow of the American Society of Horticulture. In 1999 I was elected a member of the Norwegian Royal Academy of Science and Letters. Volume 8 of "Horticultural Reviews" (1986) was dedicated to me. In 2002 I was awarded the "Israel Prize", the highest prize for contributions to science and society in Israel. In 2003 I received an Honorary Doctor of Science from the University of Waterloo, Canada. And last, but not least, the Herbert Medal of the International Bulb Society.

BIBLIOGRAPHY

BOOKS:

1. Handbook of Flowering (6 volumes). Vol. I-IV (1985), Vol. V (1986), Vol VI (1989). CRC Press, Boca Raton, Florida.
2. Processes and Control of Plant Senescence (1986). Elsevier Sci. Pub. Amsterdam.
3. Developmental Processes in Plants (1982). Hapoalim Press, Tel-Aviv (Hebrew).
4. Physiology' of Plant Senescence (1987). Hapoalim Press. Tel-Aviv (Hebrew).
5. Proceedings of the International Symposium on Flower Bulbs 1997. (Convener and Editor), 2 Volumes, Acta Horticulturae 430, ISHS.

MAJOR REVIEW ARTICLES:

1. Halevy, A.H. and S. Mayak. 1979. Senescence and postharvest physiology of cut flowers. Part 1. Hort. Rev. 1:204-236.
2. Halevy, A.H. and S. Mayak. 1981. Senescence and postharvest physiology of cut flowers. Part 2. Hort. Rev. 3:59-143.
3. Halevy, A.H. 1985. Pollination-induced corolla senescence, Acta Hortic. L81:25-32.
4. Halevy, A.H. 1986. Recent advances in the use of growth substances in ornamental horticulture. In "Plant Growth Substances 1985". (ED.M. Bopp) Springer Verlag, Berlin, Heidelberg, 391-398.
5. Halevy, A.H. 1987. Assimilate allocation and flower development. In "Manipulation of Flowering". (Ed. J.G. Atherton) Butterworths, London, 364-378.
6. Halevy, A.H. 1990. Recent advances in control of flowering in horticultural crops. Adv. Hort. Sci. 1:39-43.
7. Halevy, A.H. 1990. Recent advances in control of flowering and growth habit of geophytes. Acta Hort. 266:35-42.
8. Halevy, A.H. 1992. Ethylene treatment as a factor promoting flowering. Israel Agresearch 6:57-65.
9. Halevy, A.H. 1995. The use of plant bioregulators in ornamental crops. Acta Hort. 394:37-42.
10. Halevy, A.H. 1996. Rose In: Photoassimilate Distribution in Plants and Crops. Ed. E. Zamski and A.A. Schaffer, Marcel Dekker, Inc. N.Y. 883-892.

LIST OF SCIENTIFIC PUBLICATIONS ON BULBOUS PLANTS:

1. Halevy A.H. and S. Asen. 1959. Identification of the anthocyanins in petals of tulip varieties Smiling Queen and Pride of Haarlem. Plant Physiol. 34:494-499.
2. Halevy A.H. 1959. Forcing of Wedgwood iris. Fl. Rev. March 19. 124:35-36
3. Halevy A.H. 1960. Diurnal fluctuations in water balance factors of gladiolus leaves. Bull. Res. Counc. Israel. 8:239-246.
4. Halevy A.H. 1960. The influence of progressive increase in soil moisture tension on growth and water balance of gladiolus leaves and the developments of physiological indicators for irrigation. Proc. Amer. Soc. Hort. Sci. 76:620-630.
5. Halevy A.H. 1961. Notes on the anatomy of contractile roots, leaves and stomata of gladiolus. The Gladiolus Year Book 36:53-58.
6. Halevy A.H. and S.P. Monselise. 1961. Influence of flower removal on yields of corms and cormels and successive flower quality of gladiolus var. Sans Souci. The Gladiolus Year Book 36:71-76.

7. Halevy A.H. 1962. Anthocyanins in petals of tulip var. President Eisenhower. Biochem. J. 83:637-639.
8. Monselise S.P. and A.H. Halevy. 1962. Effects ofgibberellin and Amo-1618 on growth, dry-matter accumulation, chlorophyll content and per oxidase activity of citrus seedlings. Amer. J. Bot. 49:405-412.
9. Halevy A.H. 1962. Irrigation experiments on gladioli. In: Advances in Horticutral Science and their Application, Vol. II:484-492. Perganon Press Oxford.
10. Shillo R. and A.H. Halevy. 1963. The effect of low temperatures on the flowering of gladioli. Isr. J. Agr. 13:141-145.
11. Halevy A.H., J. Shoub, D. Rakati, 0. Plessner and S.P. Monselise. 1963. Effects of storage temperature on development, respiration, carbohydrate content, catalase and peroxidase activity of Wedgewood iris plants. Proc. Amer. Soc. Hort. Sci. 83:786-797.
12. Halevy A.H. 1962. Metabolic changes in Wedgewood iris as influenced by storage temperature of bulbs. Proc. 16th Internatl. Hort. Congress, pp. 220-228.
13. Halevy A.H. 1962. Effect of hardening and chemical treatments on drought resistance of gladiolus plants. Proc. 16th Internatl. Hort. Congress, pp. 252-258.
14. Halevy A.H., S.P. Monselise and Z. Plaut. 1964. Effects of gibberellin on translocation and on dry matter and water content in several plant species. Physiol. Plant. 17:49-62.
15. Halevy A.H., J. Shoub and D. Rakati-Aayalon. 1964. The effects of storage temperature and growing conditions on intermediate size bulbs of Wedgewood iris. Isr. J. Agr. 14:11-17.
16. Halevy A.H. and J. Shoub. 1964. The effect of cold storage and treatment with gibberellic acid on flowering and bulb yields of Dutch iris. J. Hort. Sci. 39:120-129.
17. Maatsch Von R., A. Herklotz, J. Shoub and A.H. Halevy. 1964. Uber den Einflub der Lagertemperature auf die Entwicklung von Ornithogalum arabicum L. Gartenbauwiss. 29:419-424.
18. Halevy A.H. and J. Shoub. 1964. Changes in metabolic activity and com position of Wedgewood iris bulbs during maturation of bulbs. Proc. Amer. Soc. Hort. Sci. 85:605-610.
19. Halevy A.H. and J. Shoub. 1964. The effects of gamma-irradiation and storage temperature on the growth, flowering and bulb yield of Wedgewood iris. Radiation Botany 5:29-37.
20. Shillo R. and A.H. Halevy. 1964. Experiments in the irrigation of gladioli according to absorption of viscous fluid through stomata. Isr. J. Agr Res. 14:89-95.

21. Halaban R., E. Galun and A.H Halevy. 1965. Experimental morphogenesis of stem tips of Ornithogalum arabicum L. cultured in vitro. Phytomorphology 15:379-387.
22. Halevy A.H. and Y. Mor 1969. Promotion of flowering in Freesia plants var. Princess Marijke. Acta Hort. 15:133-137.
23. Jacoby B. and A.H. Halevy. 1970. Participation of light and temperature fluctuations in the induction of contractile roots of gladiolus. Bot. Gaz. 133:74-77.
24. Ziv M., A.H. Halevy and R. Shillo 1970 Organs and plantlets regeneration of Gladiolus through tissue culture. Ann. Bot. 34:671-676.
25. Halevy A.H. and R. Shillo. 1970. Promotion of growth and flowering and increase in content of endogenous gibberellins in gladiolus plants treated with the growth retardant CCC. Physiol. Plant. 23:820-827.
26. Halevy A.H., R. Shillo and S. Simchon. 1970. Effect of 2-chloroethane-phosphonic acid (Ethrel) on health, dormancy, and corm yield of gladioli. J. Hort. Sci. 45:427-434.
27. Mayak S and A.H. Halevy. 1971. Water stress as the cause for failure of flower bud opening in iris. J. Amer. Soc. Hort. Sci. 96:482-483.
28. Shoub J., A.H. Halevy, R. Maatsch, A. Herklotz, J. Bakker and G. Papendracht. 1971. Control of flowering in Ornithogalum arabicum L. Hort. Res. 11:40-51.
29. Halevy A.H., J. Mor and J. Valershtein. 1971. Endogenous gibberellin level in Ornithogalum arabicum and its relationship to storage temperatures of bulbs and to flower development. Acta Hort. 23:82-89.
30. Simchon S., Y. Silberstein, A.H. Halevy and Y. Henis. 1972. The mode of action of ethephon in increasing health of gladiolus corns. J. Hort. Sci. 47:369-374.
31. Biran I., I. Gur and A.H. Halevy. 1972. The relationship between exogenous growth inhibitors and endogenous levels of ethylene, and tuberization of dahlias. Physiol. Plant. 27:226-230.
32. Simchon S., R. Shillo and A.H Halevy. 1972. Studies on dormancy of gladiolus corms. 1. Refinement of the triphenyl tetrazolium chloride method for estimating the dormancy of gladiolus corms. J. Hort. Sci. 47:505-508.
33. Halevy A.H. 1972. Phytohormones in flowering regulation of self-inductive plants. Internatl. Hort. Cong. Tel-Aviv 5:187-198.
34. Biran I. and A.H. Halevy. 1973. The relationship between rooting of dahlia cutting and the presence and type of bud. Physiol. Plant. 28:244-247.
35. Biran I. and A.H. Halevy. 1973. Stock plant shading and rooting of dahlia cuttings. Sci. Hortic. 1:125-131.

36. Biran I. and A.H Halevy. 1973. Endogenous levels of growth regulators and their relationship to the rooting of dahlia cuttings. Physiol. Plant. 28:436-442. 37. Ziv M., R. Kanterovitz and A.H. Halevy. 1973. Vegetative propagation of Alstroemeria in vitro. Sci. Hortic. 1:271-277.
38. Mayak S., B. Bravdo, A. Gvilli and A.H. Halevy. 1973. Improvement of opening of cut gladioli flowers by pretreatment with high sugar concentrations. Sci. Hortic. 1:357-365.
39. Biran I., B. Leshem, I. Gur and A.H. Halevy. 1974. Further studies on the relationship between growth regulators and tuberization of dahlias. Physiol. Plant. 31:23-28.
40. Halevy A.H 1975. Light energy flux and distribution of assimilates as factors controlling the flowering of flower crops. Proc. XIXth Inter Hort. Cong. Warszawa 2:125-134.
41. Halevy A.H., S. Simchon and R. Shillo. 1974. Changes in "free" and two forms of "bound" gibberellins in the various stages of dormancy of gladiolus corms. Plant Growth Substances 1973. Hirokawa Pub. Co. Inc. Tokyo, pp. 64-74.
42. Shillo R. and A.H. Halevy. 1975. Winter blindness of Gladiolus: Interaction of light and temperature, Acta Hort. 47:277-285.
43. Halevy A.H. and I. Biran. 1975. Hormonal regulation of tuberization in dahlia. Acta Hort. 47: 319-329.
44. Shillo R. and A.H. Halevy. 1976. The effect of various environmental factors on flowering of gladiolus. I. Light intensity. Sci. Hortic. 4:131-137.
45. Shillo R. and A.H. Halevy. 1976. The effect of various environmental factors on flowering of gladiolus. II. Length of the day. Sci. Hortic. 4:139-146.
46. Shillo R. and A.H. Halevy. 1976. The effect of various environmental factors on flowering of gladiolus. III. Temperature and moisture. Sci. Hortic. 4:147-155.47. Shillo R. and A.H. Halevy. 1976. The effect of various environmental factors on flowering of gladiolus. IV. Interaction of environmental factors. General discussion. Sci. Hortic. 4:157-162.
48. Shillo R. and A.H. Halevy. 1976. Inflorescence development of flowering and blasted gladiolus plants in relation to development of other plant parts. Sci. Hortic. 4:79-86.
49. Halevy A.H., A.M Kofranek and J. Kubota. 1976. Effect of enviromental conditions on flowering of Strelitzia reginae Ait. HortScience 11:584.
50. Kofranek A.M. and A.H. Halevy. 1976. Sucrose pulsing of gladiolus stems before storage to increase spike quality. HortScience 11:572-573.

51. Halevy A.H., A.M. Kofi-anek and S.T. Besmer. 1978. Postharvest handling methods for bird-of-paradise flowers (Strelitzia reginae Ait.). J. Amer. Soc. Hot. Sci. 103:165-169.
52. Halevy A.H. and S Mayak 1979 Senescence and postharvest physiology of cut flowers (Ed. J. Janick). Part I, Hortic. Rev., Vol. 1, pp. 204-236. AVI Pub. Co., West Point, Conn.
53. Robinson M., I. Harav, A.H. Halevy and Z. Plaut. 1980. Distribution of assimilates from various source leaves during the development of Gladiolus grandiflorus. Ann. Bot. 45:113-122.
54. Van De Venter H.A., J.G.C. Small and A.H. Halevy. 1980. Some charac teristics of leaf and inflorescence production of Strelitzia reginae Ait. in Port Elizabeth. J.S. Afr. Bot. 46:305-311.
55. Halevy A.H. and S. Mayak 1981 Senescence and postharvest physiology of cut flowers. Part 2 Hortic. Rev. (Ed. J. Janick, AVI Pub. Co.) 3:59-143.
56. Shillo R. G. Valis and A.H. Halevy. 1981. Promotion of flowering by photoperiodic lighting in winter-grown gladiolus planted at high densities. Sci. Hortic. 14:367-375.
57. Shillo R. and A.H. Halevy. 1981. Flower and corm development in gladiolus as affected by photoperiod. Sci. Hortic. 15:187-196.
58. Besemer S.T., R.B. McNairn and A.H. Halevy. 1981. Studies of bird-of-paradise clonal selections. Part 1. General characteristics. Flower & Nursery Rept. Univ. of California. Fall 1981:3-6.
59. Besemer S.T., R.B. McNairn and A.H. Halevy. 1981. Studies of bird-of-paradise clonal selections. Part II. Flower production. Flower & Nursery Rept. Univ. of California. Winter 1981:1-3.
60. Tirosh T., S. Mayak and A.H. Halevy. 1983. Interrelated effects of short-term treatment with nutritive solution and shipment conditions on the quality of iris flowers. Sci. Hortic. 19:161-166.
61. Robinson M., A.H. Halevy, D. Galili and Z. Plaut. 1983. Distribution of assimilates in Gladiolus grandiflorus as affected by water deficit. Ann. Bot. 51:461-468.
62. Ziv M. and A.H. Halevy. 1983. Control of oxidative browning and in vitro propagation of Strelitzia reginae. HortScience 18:434-436.
63. Mor Y., A.H. Halevy, A.M. Kofranek and M.S. Reid. 1984. Postharvest handling of Lily of the Nile flowers. J. Amer. Soc. Hort. Sci. 109:494-497.
64. Halevy A.H., C.S Whitehead, and A.M. Kofranek 1984. Does pollination induce corolla abscission of cyclamen flowers by promoting ethylene production? Plant Physiol. 75:1090-1093.

65. Halevy A.H. 1984. Light and autonomous induction. In: Light and the Flowering Process (Ed. D. Vince Prue, B. Thomas & K.E. Cockshull), Academic Press, London, pp. 65-73.
66. Faragher J.D., S. Mayak, T. Tirosh and A.H. Halevy. 1984. Cold storage of rose flowers: effects of cold storage and water loss on opening and vase life of "Mercedes" roses. Sci. Hoi-tic. 24:369-378.
67. Halevy A.H., H.C. Kohl and A.M. Kofranek. 1984. Senescence and postharvest handling of cyclamen flowers. HortScience 19:848-850.
68. Halevy A.H., A.M. Kofranek and S.T. Besemer. 1984. Photoperiodic response of miniature gladiolus cultivars. HortScience 19:858-860.
69. Goh C.J., A.H. Halevy, R. Engel and A.M. Kofranek. 1985. Ethylene evo lution and sensitivity in cut orchid flowers. Sci. Hortic. 26:57-67.
70. Lavee A., A. Borochov and A.H. Halevy. 1985. Effects of growing and storage temperatures on growth and tuber yield of Caladium. Sci Hortic. 26:175-182.
71. Halevy A.H. 1985. Gladiolus. In: Handbook of Flowering (Ed. A.H. Halevy), CRC Press, Boca Raton, Florida 1985, Vol. III, pp. 63-70.
72. Wilkins H.F. and A.H. Halevy 1985. Paeonia. In: Handbook of Flowering (Ed. A.H. Halevy). CRC Press, Boca Raton, Florida 1985, Vol. IV, pp. 2-4. 73. Criley R.A. and A.H. Halevy. 1985. Strelitzia reginae. In: Handbook of Flowering (Ed. A.H. Halevy), CRC Press, Boca Raton, Florida 1985, Vol. IV, pp. 396-402.
74. Wilkins H.F. and A.H. Halevy. 1985. Triteleia laxa. In: Handbook of Flowering (Ed. A.H. Halevy). CRC Press, Boca Raton, Florida 1985. Vol IV, pp. 415-417.
75. Halevy A.H. 1986. The induction of contractile roots in Gladiolus grandiflorus. Planta 167:94-100.
76. Byrne T.G. and A.H. Halevy. 1986. Forcing herbaceous peonies. J. Amer. Soc. Hort. Sci. 111:379.383.
77. Halevy A.H. 1986. Recent advances in the use of growth substances in ornamental horticulture. In: Plant Growth Substances 1985 (Ed. M. Bopp). Springer-Verlag Berlin Heidelberg, pp. 391-398.
78. Halevy A.H. 1987. Assimilate allocation and flower development. In: Manipulation of Flowering (Ed. J.G. Atherton) (Proc. 39th Univ. of Nottigham Easter School in Agr. Sci., March 84). Butterworths, London, 1987, pp. 364-378.
79. Halevy A.H. 1986. Factors affecting the induction of contractile roots in Gladiolus. Acta Hort. 189:323-330.
80. Borochov A., A. Lavee and A.H. Halevy. 1986. Low temperature effects on Caladium tubers. Acta Hort. 177:347-352.

81. Halevy A.H., R.A. Criley, S.T. Besemer, H.A. van de Venter, M.E. McKay and O. Kawabata. 1987. A comparison of flowering behavior of Strelitzia reginae at four locations as affected by air temperature. Acta Hort. 205:89-96.
82. Han S., A.H. Halevy, R.M. Sachs and M.S. Reid. 1989. Effect of ethylene on growth and flowering of Brodiaea. Calif. Flower and Nursey Report, Spring issue, pp. 5-6.
83. Han, S. A.H. Halevy, R.M. Sachs and M.S. Reid. 1989. Effect of ethylene on growth and flowering of Triteleia laxa. Acta Hort. 261:209-214.
84. Han, S., A.H. Halevy and M.S. Reid. 1989. The role of ethylene in petal senescence of Triteleia laxa 'Queen Fabiola'. Acta Hort. 261:185-189.
85. Han, S.H., A.H. Halevy, R.M. Sachs and M.S. Reid. 1990. Enhancement of growth and flowering of Trieteleia laxa by ethylene. J. Amer. Soc. Hort. Sci. 115:482-486.
86. Halevy A.H. 1990. Recent advances in control of flowering in horticultural crops. Adv. Hort. Sci. 1:39-43.
87. Halevy A.H. 1990. Recent advances in control of flowering and growth habit of geophytes. Acta Hort. 266:35-42.
88. Han, S.H., A.H. Halevy and M.S. Reid. 1990. Postharvest handling of Brodiaea flowers. HortSci. 25:1268-1270.
89. Han S., A.H. Halevy, R.M. Sachs and M.S Reid. 1991. Flowering and corm yield of Brodiaea in response to temperature, photoperiod, corm size, and planting depth. J. Amer. Soc. Hort. Sci. 116:19-22.
90. Han S., A.H. Halevy and M.S. Reid. 1991. The role of ethylene and polli nation in petal senescence and ovary growth of Brodiaea. J. Amer. Soc. Hort. Sci. 116:68-72.
91. Barzilay, A., J. Ben-Jaacov, A. Ion and A.H. Halevy. 1992. Minigladiolus as a flowering pot plant. Sci. Hort. 49:117-124.
92. Han S. and A.H. Halevy. 1993. Triteleia. In: The Physiology of Flower Bulbs (Eds. A. De Hertogh and M. Le Nard). Elsevier, Amsterdam, pp.611-616.
93. Halevy A.H. 1992. Ethylene treatment as a factor promoting flowering. Israel Agresearch. 6:57-65.
94. O'Neill S.D., J.A. Nadeau, X.S. Zhang, A.Q. Bui and A.H. Halevy. 1993. Interorgan regulation of ethylene biosynthetic genes by pollination. The Plant Cell. 5:419-432.
95. Han S.S., A.H. Halevy, R.M Sachs and M.S. Reid. 1994. Morphology of flower initiation of Brodiaea. Scient. Hort. 56:235-243.
96. Porat R., A. Borochov and A.H. Halevy. 1994. Pollination-induced senescence in Phalaenopsis petals. Relationship of ethylene sensitivity

to activity of GTP-binding proteins and protein phosphorylation. Physiol. Plant. 90:679-684.

97. Porat R., A. Borochov and A.H. Halevy. 1994. Pollination-induced changes in ethylene production and sensitivity to ethylene in cut Dendrobium orchid flowers. Sci. Hort. 58: 215-221.

98. Porat R., A. Borochov, A.H. Halevy and S.D. O'Neill. 1994. Pollination-induced senescence of Phalaenopsis petals. Plant Growth Regul. 15:129-136.

99. Imanishi H., A.H. Halevy, A.M. Kofranek, S. Han, and M.S. Reid. 1994. Respiratory and carbohydrate changes during ethylene-mediated flower induction in Dutch iris. Sci. Hort. 59:275-284.

100. Porat R., A.H Halevy, M. Serek and A. Borochov. 1995. An increased ethylene sensitivity following pollination is the initial event triggering an increase in ethylene production and enhanced senescence of Phalaenopsis orchid flowers. Physiol. Plant. 93:778-784.

101. Porat R. N. Reiss, R. Atzron, A.H. Halevy and A. Borochov. 1995. Examination of the possible involvement of lipoxygeoase and jas monates in pollination-induced senescence of Phalaenopsis and Dendrobium orchid flowers. Physiol. Plant. 94:205-210.

102. Ilan, A., M. Ziv, A.H. Halevy. 1955. Propagation and corm development of Brodiaea in liquid clutures. Sci. Hort. 63:101-112.

103. Halevy A.H. 1995. The role of sensitivity to ethylene in pollination induced corolla senescence syndrome. Australaian Postharvest Horticulture Conference, pp. 75-80.

104. Halevy A.H., R. Porat, H. Spiegelstein, A. Borochov, L. Botha and C.S. Whitehead. 1996. Short-chain saturated fatty acids in the regulation of pollination-induced ethylene sensitivity of Phalaenopsis flowers. Physiol. Plant. 97:469-474.

105. Whitehead C.S., M.L. Botha and A.H. Halevy. 1997. Effect of octanoic acid on ethylene sensitivity of Dutch iris bulbs. Acta Hort. 430:89-94.

106. Philosoph-Hadas S., S. Meir, I. Rosenberger and A.H. Halevy. 1997. Regulation of the gravitropic response of cut Ornithogalum 'Nova' spikes during storage and transport in horizontal position. Acta Hort 430:397-398.

107. Botha M.L., S.C. Whitehad and A.H. Halevy. 1998. Ettect of octanoic acid on ethylene-mediated flower induction in Dutch iris. Plant Growth Regul. 25:27-51.

108. Halevy A.H. 1999. Ornamentals: Where diversity is king - the Israeli experience. In: Perspectives on New Crops and New Uses (Ed. J. Janick. ASHS Press, Alexandria VA. 404-406.

109. Halevy A.H. 2000. Introduction of native Israeli plants as new cut flowers. Acta Hort. 541:79-82.
110. Halevy A.H. 2000. Introduction and development of new floriculture crops - the Israeli experience In: Advances in Floriculture Research (Ed. E. Stromme), pp. 15-20.
111. Halevy, A.H., M. Levi, M. Cohen and V. Naor 2002. Evaluation of methods of flowering advancement of herbaceous peonies. HortScience 37:885-889.
112. Halevy A.H. 2003. The use of native Israeli flora for introduction of new ornamental crops. Acta Hort. Vol 598:55-58.
113. Kamenetsky R., A. Barzilay, A. Erez and A.H. Halevy. 2003. Temperature requirements for floral development of herbaceous peony cv. Sarah Bernhardt. Sci. Hortic. 97:309-320.
114. Halevy A.H. 2003. Advances in developing methods for the control of flowering of cut flower crops in mild climate – the Israeli experience. Acta Hortic. 614:77-80.
115. Philisoph-Hadas, S., H. Friedman, A. Lers, B. Kochanek, A.H. Halevy and S. Meir. 2004. Life is short: in vivo and in vitro characterization of the proteolytic activity in Iris Oncocylus cut flowers towards retardation of their rapid senescence. Acta Hortic. (in press).
116. Halevy, A.H. 2004. Exploring Israeli flora for new floriculture crops. Acta Hortic. (in press).
117. Halevy, A.H., A. Barzilay and R. Kamenetsky. 2004. Flowering advancement of herbaceous peony. Acta Hortic. (in press).
118. Friedman, H., S. Meir, I. Rosenberg, A.H. Halevy and S. Philisoph-Hadas. 2004. Calcium antagonists inhibit bending and differential ethylene production of gravistimulated Ornithogalum ‘Nova’ flower spikes. Postharvest Physiol. Tech. (in press).

THE HAMILTON P. TRAUB AWARD FOR DISTINGUISHED SERVICE

This award was established in 2000 by the IBS Board of Directors to recognize meritorious service to the Society. It is named after Dr. Hamilton P. Traub, founder of the American Plant Life Society, antecedent of IBS, and editor of its journal for a half century.

HAMILTON P. TRAUB AWARD
2004
Presented to
DAVID J. LEHMILLER

BY THE INTERNATIONAL
BULB SOCIETY
FOR OUTSTANDING SERVICE
TO THE SOCIETY

PAST RECIPIENTS

2000	Mr. Charles E. Hardman
2001	Mr. Marvin C. Ellenbacker
2002	Mr. Michael G. Vassar
2003	Dr. Alan W. Meerow
2004	Dr. David J. Lehmiller
2005	Dr. Charles Gorenstein

2006 TRAUB AWARD

MISS PAMELA J. KELLY

MISS PAMELA KELLY

AUTOBIOGRAPHY

I was born in San Francisco and lived in California and Oregon while growing up. My father worked for the U.S. Forest Service, and he was transferred about every 1-2 years until we settled in Fresno, California. Here I finished school, married Herbert Kelly Jr. and raised 3 children, Timothy, Susan and Catherine. We now have 4 grandchildren;

I was the Office/Credit Manager for JM McDonalds Department Store, before working as an Accounts Receivable for the local PBS TV station.

IBS SERVICE:

1. 1978-1983: American Plant Life Society, helped create an index of Plant Life and Herbertia for Dr. Hamilton Traub.
2. 2002: Assisted in organizing the IBS Symposium at the Huntington Library, Art Collections and Botanical Gardens.
3. 2002-Present: IBS Treasurer.

MORE THAN A PRETTY FACE - ORNAMENTAL "DRUMSTICK ONIONS" OF *ALLIUM* SUBG. *MELANOCROMMYUM* ARE ALSO POTENTIAL MEDICINAL PLANTS

Reinhard M. Fritsch, Maia Gurushidze
Leibniz-Institut Für Pflanzengenetik Und
Kulturpflanzenforschung, Corrensstr. 3, D-06466
Gatersleben, Germany

Jarmila Jedelská, Michael Keusgen
Philipps-Universität Marburg, Institut Für
Pharmazeutische Chemie, Marbacher Weg 6, D-35032,
Marburg Germany

SUMMARY

Many members of *Allium* subg. *Melanocrommyum* are cultivated as ornamentals in European and North American gardens. Most of these species occur naturally in Southwest and Central Asia where they are collected in nature and used as vegetable, spice, and medicinal plants by the local people.

Eighteen species reportedly used as medicinal plants were morphologically and taxonomically characterized. Most of these species were chemically analyzed and also screened for radical scavenger activity. Our data verified relatively large amounts of cysteine sulphoxides (the main, medicinally-active sulphur compounds of garlic and common onion) to be present in ten species. However, some highly valued species also showing a very high radical scavenger activity contained only traces of cysteine sulphoxides; these species contained significant amounts of the newly detected sulphur pyrrole. This latter compound was apparently responsible for the high radical scavenger activity. Unexpectedly, three species showed high scavenger activity but did not contain remarkable amounts of either cysteine sulphoxides or sulphur pyrroles. These data underlined that another bioactive principle might be present, and more species of subg. *Melanocrommyum* than hitherto used may represent valuable medicinal plants.

1. INTRODUCTION

Allium is one of the largest genera of the monocots (currently at least 780 species) and extremely diverse. The newest taxonomic classification (Friesen at al., 2006) accepts 15 subgenera, and subg. *Melanocrommyum* (Webb et

Berth.) Rouy is one of the largest containing about 140 species. Many members of this and other subgenera have a striking appearance, having been introduced as ornamentals into the gardens beginning in the 19th century. A steadily growing number of named cultivars (selections as well as hybrids) are offered by the traders of ornamental bulbs. Some widely cultivated, spicy *Allium* species like chive, Chinese chive, rakkyo, Great-Headed garlic, as well as some more rarely cultivated ones also possess ornamental properties. They are mostly rather small plants but bear conspicuous head-like inflorescences during anthesis.

In the scientific literature, medicinal applications by the local population of their home countries have been reported for several *Allium* species, which are cultivated as ornamentals in Europe and North America (for details see Keusgen et al., 2006, Fritsch et al., 2006).

Most members of the genus *Allium* have specific tasteful properties thus making them powerful spice plants. Spicy onions are well known to contain one or more cysteine sulphoxides as precursors of the main active principles and show a remarkable correlation: the most intensely tasting and smelling species contain most of these compounds, mostly alliin and isoalliin, and they are also those with the strongest health-supporting and medicinal effects (Keusgen, 2002; Fritsch and Keusgen, 2006). Other substances like steroid saponins and different sugars (mono-, di- and polysaccharides) are also present in remarkable amounts (Sokolov, 1994; Keusgen, 2002) and contribute to taste, odor as well as medicinal activity of these species. Therefore, the term "nutraceutical", which means food with a supporting medicinal (healing or protective) effect, fits *Allium* species perfectly.

Surprisingly, only very few ornamental *Allium* species of the subg. *Melanocrommyum* possess an onion or garlic-like taste and odour. Screening on cysteine sulphoxides usually shows low to very low relative contents also in spicy smelling species (Fritsch and Keusgen, 2006). Only a few exceptions occur. This also holds true for those species, which are reportedly collected for general tonic properties or for specific medicinal applications. Thus, another active principle should also be present.

2. MATERIAL AND METHODS

Original information was gained during joint research missions with Tajik, Uzbek, and Iranian cooperation partners from 2003 till 2006. In the areas of interest, at first *Allium* plants were collected in nature, and then shown to the native people, which were interviewed in their native languages asking about the local name, possible use, and mode of application of these plants. Afterwards, the presented plant material was planted in the national Tajik, Uzbek, or Iranian *Allium* collections, where also herbarium voucher specimens were taken if possible (for more details and addresses of these collections see Keusgen et al., 2006, Fritsch et al., 2006). A part of the original material was taken to Marburg University, Germany, where the content of cysteine sulphoxides was determined and bio-activity was tested. Because drying of bulbs causes indeterminable losses of cysteine sulphoxides, fresh plant parts were extracted with methanol or with ethyl acetate. In contrast, leaf material could be dried by moderate heat (up to 60 °C) within 14 hours. Radical scavenger activity was spectrophotometrically measured (at 517 nm or 540 nm) in a 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution as substrate with butylated hydroxytoluene (BHT) as reference using microtiter plates (details see Jedelská et al., 2004). The contents of the above mentioned four cysteine sulphoxides were separately measured in form of ortho-phthaldialdehyde (OPA) derivatives at 335 nm by HPLC-separation using Sperimarge 80-ODS2 RP column (5 µm particle size; 250 x 4 mm with integrated guard column) operating at a flow rate of 1.0 ml/min (details see Fritsch and Keusgen, 2006).

Duplicates of some accessions were also transferred to the Taxonomic *Allium* Reference Collection of the Leibniz-Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany, to be re-determined if necessary. Here leaves of all available accessions per species were tested as to whether they exude a red sap as described above.

We compared our results against data from literature as far as available. However, it was impossible to study all original publications (mostly in Russian with difficult access). Therefore, some data were cited from review papers only (e.g. Sokolov, 1994). Unfortunately, nearly all cited references do not mention the offspring of investigated materials, and no information could be gained about presence and housing of voucher specimens, photographs, or other data characterising the material in a taxonomic sense. This was a strong drawback considering the complicated *Allium* taxonomy and significantly differing principles of classification and naming of taxa. In the case of contradictorily data from literature, we had the impression that incorrect botanical determinations may be the reason but cannot give proof.

Fig. 1. *Allium akaka*, bulb from Khalkhal, northern Iran.

Fig. 2. (Left) *Allium motor*; bulbs from Chimgan Mountain Range, Uzbekistan.

Fig. 3. (Right) *Allium severtzovioides*, bulbs in Ugam Mountain Range, Uzbekistan.

3. RESULTS

3.1 Taxonomic characterization and reported medicinal use of different species.

a) Sect. *Acanthoprason* Wendelbo

About 20 species of rather small plants but with dense fasciculate or semi- to sub-globose dense inflorescences belong to this mainly Southwest-Asian section. Most characteristic are the tepals which are longitudinally enrolling after anthesis and may become stiff and prickly when completely dry. The leaves are generally much longer than the scape.

Allium akaka S. G. Gmel. ex Schult. et Schult. f. *s. l.* "Valak" (Persian)

This name is taxonomically still somewhat unclear, but most often it is applied for stout broad-leaved plants (Fig. 1) distributed in the mountains of northern Iran and the adjacent Turkish and Transcaucasian territories. This taxon grows on sunny rocks and stony slopes.

Young to flowering plants are eaten as vegetable and are applied against rheumatism and other pains. Inflorescences pickled in vinegar are used as a special spice "torshi". Thus *A. akaka* is a typical "nutraceutical" being used as a vegetable and spice with medicinal properties. The plants and the inflorescences are offered in such large amounts at the markets as observed in Tehran (Fritsch et al., 2006) that populations of this species are probably endangered by over-collecting already.

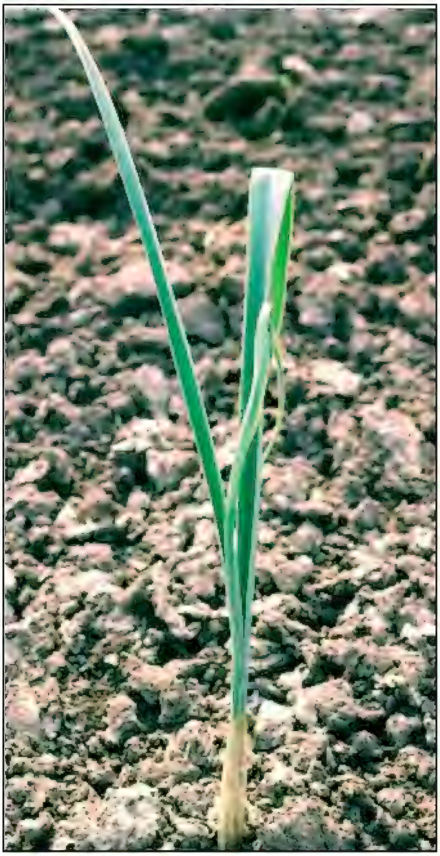

Fig. 4. *Allium costatovaginatum*, bulb from Chatkal Mountain Range, Uzbekistan, showing the ribbed sheath leaf.

Fig. 5. *Allium suworowii,* a population growing near Panj River, Tajikistan.

Fig. 6. *Allium chitralicum*, bulb from Yazgulem Mountain Range, Tajikistan.

b) Sect. *Acmopetala* R.M.Fritsch

This variable section contains mainly tall "drumstick-onions" with globular dense flower heads and leaves much shorter than the scape. Often the tepals are long tapering and the mid-vein is ending below the tip.

Allium motor Kamelin et Levichev "Motor, moy - modor " (Uzbekistan; the term 'motor' means "health")

The natural area of distribution of this tall species (Fig. 2) is rather small comprising only the Chatkal mountain range in Uzbekistan and adjacent Kyrgyz and Kazakh territories. Here it grows on shady slopes among bushes and is easily recognized by a smooth, thin, and quickly decaying sheath leaf.

The leaves are much collected in April and May. They are freshly used as stuffing for a special variant of the national pie dish 'somsa' which is highly esteemed for a specific activity as tonic. However, application is problematic for persons having high blood pressure (Umarov, 1992, Keusgen et al., 2004, Keusgen et al., 2006). The use of "motor" became known from people living in the Kirgiz territory of Chatkal mountain range during the 1970's, first in

Fig. 7. *Allium komarowii*, bulbs from Turkestan Mountain Range, Tajikistan.

the Parkent area of Uzbekistan (Umarov, 1992). Today also this species is much collected for consumption and has become rare in some areas.

Because leaves of other *Allium* species look similar, people collecting "motor" must know the two 'signs of authenticity' of the true species: a reddish liquid coming out of the damaged tissue of freshly plucked leaves, and a special soft structure of the leaf tissue which is tested by chewing a piece of leaf.

Allium severtzovioides R.M. Fritsch "Tosh - motor" (Uzbekistan)

This species is closely related and very similar to *A. motor* occurring in the same geographical region. However, plants of *A. severtzovioides* grow larger and prefer more sunny slopes (Fig. 3). It can easily be differentiated from *A. motor* by an elongated, strong, and very coarse sheath leaf.

Fresh leaves and bulbs without stems are locally applied against stomach and duodenum diseases (Keusgen et al., 2006) and as a mild tonic (Umarov, 1992). The fresh leaves of "tosh - motor" do not show reddish liquid, and the tissue is remarkably harder (the local name can be translated as 'hard motor').

Allium costatovaginatum Kamelin et Levichev.

The same local name as for the previous species and use was mentioned for this related species (Umarov, 1992). These are smaller plants having a strong sheath leaf bearing a few conspicuous ribs (Fig. 4); they occupy dry stony slopes of the Chatkal mountain range.

Fig. 8. *Allium jesdianum* s. str., bulbs from Deh Balla, Iran.

Fig. 9. *Allium jesdianum* s. lat., bulb in Shahu Massiv, northwestern Iran.

Fig. 10. *Allium rosenorum*, bulbs from Hissar Mountain Range, Tajikistan.

Allium suworowii Regel "Niyazi ansul, piozi anzur, yovvoji pioz " (Uzbekistan,Tajikistan)

This variable species occurs in all Central Asian republics. The plants often reach more than 1 m height and grow on open slopes (Fig. 5) and in grassy disturbed areas along roads and other ruderal areas. Most characteristic are fibrous, elongated, and spirally coiled bulb tunics, an intense unpleasant odour of all plant parts, and glossy (like polished) ovaries.

In Uzbekistan and Tajikistan young bulbs are pickled and used as spicy vegetable (Dadabaeva, 1972, Khassanov and Umarov, 1989) and also in folk medicine against internal and lung diseases, early forms of tuberculosis, and bronchitis (Sakhobiddinov, 1948, Vvedensky, 1963, Khalmatov, 1964, Sokolov, 1994). In the Darvaz mountain range of Tajikistan, decoctions of flowers and seeds are applied against headache and cold (Keusgen et al., 2006).

Fig. 11. *Allium rosenbachianum* subsp. *kwakense*, bulbs from Botanic Garden Dushanbe, Tajikistan.

c) Sect. *Brevicaule* R.M. Fritsch

This small section contains only three rather small species showing variable leaf and flower characters, and these taxa may not represent a natural group.

Allium chitralicum Wang et Tang s. str. (*A. pauli* Vved., *A. badakhshanicum* Wendelbo) "Siri kuhi" (Tajikistan)

Contrary to most other species mentioned in this paper, the plants are rarely higher than 20 cm, possess one or two leaves somewhat longer than the scape, and a small spherical head of white flowers (Fig. 6). They are growing on moist slopes of higher mountain areas in northern Afghanistan, adjacent Tajikistan, and north-western Pakistan. It is a rare species not much collected for use.

Fig. 12. *Allium sarawschanicum*, bulbs from Hissar Mountain Range, Tajikistan.

Fig. 13. *Allium stipitatum*, bulbs in an abandoned vineyard near Hamadan, Iran.

Fig. 14. *Allium nigrum*, pink flowering form from Botanical Garden Leipzig, Germany.

Medical usage is only known from Tajikistan where smashed bulbs are used against a sense of fear. The whole plant is also used as vegetable for the national dish 'atolla' (Keusgen et al., 2006).

d) Sect. *Compactoprason* R.M. Fritsch

Tall species especially imposing by extraordinary dense globular flower heads belong to this section. The anthesis may last 20-30 days. The leaves of the well known ornamentals *A. giganteum* Regel and *A. macleanii* Baker are consumed as vegetables, but medicinal use was not reported.

Allium komarowii Lipsky "Gushi gurgak, khujrak-motor" (Tajikistan)

This species combines broad thick glaucous leaves like the below mentioned *A. karataviense* with a dense globe of scarlet flowers on a rather tall

Fig. 15a. (Top) *Allium karataviense*. Population on a rubble slope near Panj River, Tajikistan.
Fig. 15b. (Bottom) Bulb with red flowers from Angren Valley, Uzbekistan.

Fig. 16. *Allium koelzii*, bulb in Zagros Mountain Range near Kermanshah, Iran.

Fig. 17. *Allium hissaricum*, bulbs from Hissar Mountain Range, Tajikistan.

scape (Fig. 7). However, it is not such a striking ornamental like *A. giganteum* and *A. macleanii.* It occurs in the Turkestan and Hissar mountain ranges of northern Tajikistan and adjacent regions of Uzbekistan and Kyrgyzstan.

Allium komarowii is believed to have a rather strong medical power. Leaves and bulbs are used fresh, or cut in pieces and cooked and applied against anaemia and bad circulation, and beyond it as anabolic drug for horses (Keusgen et al., 2006). Cysteine sulphoxide content of the bulb is low but high in the leaves (Table 1). This species contains also the above mentioned red dye (Table 2).

e) Sect. *Megaloprason* Wendelbo s. str.

This section also comprises tall species, but the globular pink to purple flower-heads are only moderately dense and show a much shorter duration of anthesis. Species showing prominently ribbed scapes in the living state occur only in this section of subg. *Melanocrommyum.* The flowers of several species like *A. rosenbachianum* of gardens and *A. stipitatum* are conspicuously colored and are well-known ornamentals, but the flower heads of other ones are rather inconspicuous. Generally, the flower characters of all members of this section show a very similar variation pattern and cannot be used for simple differentiation between the taxa.

Allium jesdianum Boiss. et Buhse, in the wide sense. "Sorkhe, suroneh" (Persian)

This species name is also taxonomically under discussion. In this paper it is solely applied to Iranian populations. Plants from the type location (shady places among trees in the mountains of the Shir Kuh massif west of Yazd) show thin membranous bulb tunics, dull lanceolate leaves, a basally ribbed, dull green flower scape topped by a globular head of purplish-pink flowers (Fig. 8) with lanceolate-triangular tepals. Local people interviewed denied any use for these plants (Fritsch, 1996).

At the markets of Kermanshah province rather large amounts of fresh leaves of a medicinal plant named "sorkhe" we sold. These plants made the general impression as belonging to *A. jesdianum* but differed by shining (not dull) leaves, smooth (not basally ribbed) scapes, and thick and soft (not thin and membranous) bulb tunics. The sellers told us that the plants have come from "the mountains around". Later we were so lucky to find a few flowering plants in the wild on moderately steep and stony slopes among large perennials (Fig. 9) which confirmed identical flower characters like *A. jesdianum.* The leaves also secreted a red liquid at the leaf bases and wounded parts from which the Persian names could be deduced ("sur" means "red"). These fresh leaves are used as general tonic and against rheumatism, as fresh salad, and mixed with yoghurt (Fritsch et al., 2006).

About 100 km more northward, in Kordestan province, we found very similar plants but with dull leaves and papery bulb tunics, which were growing in moist meadows and in ploughed fields. Flowers and inflorescences were again identical. The local people regarded these plants as weeds and denied any use.

In the Binalud mountain range not far from Mashhad in NE Iran we collected another variant of *A. jesdianum* showing noticeably lax and dull yellowish-green leaves, completely smooth scapes, and thin membranous bulb tunics. These plants were growing in the shadow of limestone rocks, near waterfalls, and along creeks. Local people again denied any use for these plants.

The described differences would be sufficient to recognize these morphologically and ecologically separable taxa as intraspecific entities. But currently it seems too early to describe them because investigations are still under progress to elucidate the areas of distribution, and also to search for transitional forms, which might exist among the different morphotypes.

Allium rosenorum R.M. Fritsch (*A. rosenbachianum* of Russian authors and of gardens, *A. jesdianum* of some authors) "Siekhalaf, siralaf, shipioz, jorji" (Tajikistan)

This much merged species is closely related to *A. jesdianum* differing by thicker and narrower leaves showing a more reflexed posture (Fig. 10), and a strongly ribbed scape also in fresh condition. The flower characters are similar to *A. jesdianum* and *A. rosenbachianum.* Thus herbarium specimens in anthesis but without well prepared leaves cannot be determined with certainty.

In the Vakhsh and Hissar mountain ranges of Tajikistan, young fresh or dried leaves are used for the national soup dishes 'atolla' and 'oshi siralaf' which are much esteemed for strong tonic properties (Keusgen et al., 2006). Kochkareva and Chukavina (1985) reported use as spice in that area, but the people interviewed by Keusgen et al. (2006) always denied any use as spice. Fresh leaves boiled in water did not present any spicy or otherwise remarkable taste characteristics (experiments made by R. M. F.).

Several years ago during taxonomic field-work in Tajikistan, R. M. F. was informed by local people that application of the fresh leaves of "siralaf" to wounds promotes quick healing. This experience was confirmed during a specific test: this species showed remarkable antibiotic activity against six gram-positive bacterial strains (Jedelská et al., 2005). The plants of this species also contain the afore-mentioned red dye, which is regarded as a 'sign of authenticity' when the leaves are collected in April and May. However, too intensive collection, if not plundering, has strongly diminished formerly rich populations in the mountains near Dushanbe, Tajikistan.

According to our information, dishes made from the leaves are explicitly consumed because of the tonic property. Contrary to the term 'motor' discussed above, the local names of this and the next species are not related to application.

Allium rosenbachianum Regel subsp. *rosenbachianum* and subsp. *kwakense* R.M. Fritsch "Gushi buzak" (Tajikistan)

This inconspicuous species grows in the shade under shrubs and trees and sometimes on moist terraces of north-facing steep limestone slopes in the eastern part of Central Tajikistan. The completely smooth and shining scapes are smaller than those of *A. rosenorum*, and the lanceolate and mostly shining leaves are still wider than those of *A. jesdianum.* Additionally, the yellowish-green and completely smooth leaves of *A. rosenbachianum* taper to a narrower base that is stalk-like in the typical subspecies and only somewhat narrowed in subsp. *kwakense* (Fig. 11). Both subspecies also differ in leaf posture. The flower characters are rather similar to *A. jesdianum* and *A. rosenorum,* but a specific characteristic of *A. rosenbachianum* is the inconspicuously silvery-pinkish flower color.

Fresh and dried young leaves are also used for the national soup dish 'atolla' which is much esteemed as an appetizer and general tonic in Central Tajikistan (Keusgen et al., 2006). The use of leaves as a condiment was also reported by Kochkareva and Chukavina (1985). The leaves of "gushi buzak" are equally estimated by the local population like "siralaf" leaves despite the fact that they do not contain red sap. In the mountains along Panj River in Tajikistan demand is already higher than supply, and the natural populations are strongly over-collected.

Allium sarawschanicum Regel

Although the inflorescences of this species (Fig. 12) are similar to those of *A. jesdianum*, flower color is more conspicuous, and the presence of six radial and upward directed outgrowths on the top of the ovary is most characteristic. Scapes and also leaves are similar to *A. rosenbachianum*, but the leaves of *A. sarawschanicum* differ by the triangular and not lanceolate, tapering tip. The distribution is restricted to Hissar and Zaravshan mountain ranges of Uzbekistan and Tajikistan, and to Kopetdag mountain range in Turkmenistan and Iran.

Medicinal use against skin diseases was reported only once in Uzbekistan (Sokolov, 1994). Currently, local people in Uzbekistan and Tajikistan deny any use of this species (Keusgen et al., 2004), and an error in identification seems possible.

Allium stipitatum Regel "Mu - sir" (Persian), "Pioz - anzur" (Tajikistan and Uzbekistan)

The taxonomic circumscription of this variable species is not yet clarified. Plants collected near the type location in Hissar mountain range of Tajikistan showed up to 8 cm wide leaves with a more or less dense indumentum of white hairs or at least teeth along the margins and at the veins of the lower side. Scapes are 80-120 cm high and smooth and shining; they become ribbed only when dry. The inflorescences are initially semi-globose and later depressed-globose bearing between 50-400 striking, star-like flowers having rose-pinkish to scarlet (rarely white or lilac) narrowly lanceolate tepals up to 12 mm long. The depressed-globose ovary is shortly stalked (thus the specific epithet) with an always rough (tuberculate) surface. Under cultivation, Iranian *A. hirtifolium* Boiss. plants (Fig. 13) were morphologically indistinguishable from *A. stipitatum*. Thus both names refer to one botanical species which occurs over wide parts of Central Asia to the Zagros mountain range of Iran. This species prefers loamy slopes and terraces with good soil, often in the shadow of shrubs and trees.

In several geographic regions (e.g. in western Tienshan, Khozratishoh, and Kopetdag mountain ranges), there are populations having a more slender stature, narrower and only slightly toothed or even smooth leaves, a smaller umbel, and more intensely-coloured tepals that in late anthesis are spirally enrolled. They are often separated as *Allium altissimum* Regel. Unfortunately the exact type location of this species is unknown, and the true identity could not be studied yet with modern taxonomic methods.

Tall *A. stipitatum* plants having more or less smooth broad leaves are often mis-named *Allium aflatunense* B. Fedtsch. However, the true latter species occurs only in the mountains surrounding the north-eastern edge of Fergan depression in Central Asia and is characterized by a generally stouter stature, lower scapes, a much denser umbel and broader tepals. *Allium aflatunense* of Dutch bulb trade is still another taxon (*A. hollandicum* R.M. Fritsch) characterized by a basally ribbed scape only 40-60 cm high in anthesis, narrower leaves, and broader but shorter tepals.

In Central Asia, sour pickling of the young bulbs as spice is the dominant use (Keusgen et al., 2006) and was also reported from Bakhtiar province of Iran (Fritsch, 1996). Medicinal application against skin diseases was only once mentioned (Sokolov, 1994), and medicinal use without further specification in Turkmenistan (Kurbanov, 2005, additionally under the name *A. altissimum*). In other provinces of Iran medicinal use is much more in focus. In Hamadan province fresh bulbs are sold at the markets to be used (possibly also after drying) against pains of backbone, legs, and feet (Fritsch et al., 2006). Somewhat surprising was the report of *A. stipitatum* as poisonous plant used as repellent for mice, rats, and cockroaches (Kurbanov, 2005).

It is a controversial item of discussion among the political authorities in Tajikistan and Uzbekistan as to whether intense collecting of the bulbs for making conserves has strongly diminished the natural populations. In some regions we have seen that it is a very common plant.

f) Sect.*Melanocrommyum* Webb et Berth. s. str.

This is the largest and at the same time most diverse section consisting of several subgroups differing by the length relations of leaves and scapes (leaves shorter or equal or longer than scape) and by inflorescence shape (fasciculate or umbellate or subglobose).

Allium nigrum L.

Most characteristic and the source of the species name are the ovaries which are blackish-green (in the Levante strongly red flushed) when in full anthesis but green when younger or after anthesis (Fig. 14). The lanceolate leaves are bent to the side and later reflexed. The smooth scape may become about 80 cm long and bears an umbellate and dense inflorescence with nearly star-like flowers. It is well known as an ornamental in European gardens and was introduced about a century ago.

Only a single record could be found about the medicinal use of this plant against carcinomas (see Dr. Duke's Phytochemical and Ethnobotanical Databases http://www.ars-grin.gov/cgi-bin/duke/ethnobot.pl?ethnobot.taxon=Allium%20nigrum)

g) Sect. *Miniprason* R.M.Fritsch

Only a single species belongs to this section.

Allium karataviense Regel "Chychka-kulak" (Uzbekistan)

This species was introduced in the European gardens about 120 years ago as a striking ornamental for rock gardens. The plants have 1-4 elliptic, rather wide, thick, bluish-green leaves and bear a rather dense flower head on a thick scape reaching scarcely more than 25 cm length in full sun. The star-like flowers show canaliculate, somewhat bent-up tepals of mostly rose-pinkish, sometimes deep pink to magenta color (Fig. 15). The natural area of distribution reaches from the Karatau mountain range of Kazakhstan to the Kugitang massif in eastern Turkmenistan and the Hindukush mountain range in Afghanistan.

In North Tajikistan, Uzbekistan, and probably other parts of Central Asia the plants are used against light diseases, pneumonia and lung problems (Sakhobiddinov, 1948, Sokolov, 1994, Khalmatov, 1964). Application promotes quick healing of wounds (Dadabaeva, 1972) but was not specified by other authors like Khassanov and Umarov (1989).

h) Sect. *Pseudoprason* (Wendelbo) K. Persson et Wendelbo

This section also contains only a single species.

Allium koelzii (Wendelbo) K. Persson et Wendelbo

This name refers to medium tall plants (Fig. 16) growing in West Iran in the central parts of the Zagros mountain range mostly in small populations. The ovate, yellowish-green and shining leaves may reach 10 cm width and more than 20 cm length. The straight, smooth scape is 60-80 cm long and bears a moderately dense flower head of milky-white, rather inconspicuous flowers. The ovate, concave tepals are only about 5 mm long and bear often three (sometimes up to 7) strip-like and narrowly parallel arranged mid-veins.

In Kermanshah province it was once was reported that the bulb is cooked and used against skin diseases. This very specific use of the bulbs may have been confused by the informant with that of *A. stipitatum* (Fritsch et al., 2006).

i) Sect. *Regeloprason* Wendelbo

Smooth scapes of moderate length and variable leaf characters are diagnostic for the 12 or so species of this section. Most characteristic are the narrowly campanulate to funnel-shaped flowers with a basal union of all tepals (for about ¼ of the whole length) and filaments (up to half of the whole length).

Allium hissaricum Vved. "Sir" (Tajikistan)

Leathery bulb tunics, only one or two narrowly linear-lanceolate leaves, and an umbel-like inflorescence bearing lilac to pinkish-carmine, pleasantly smelling flowers are specific characters of this species (Fig. 17). It grows on grassy slopes of the Hissar, Gozimailik, and Vakhsh mountain ranges in Central Tajikistan. Fresh or dried leaves are applied against headache and fever (Keusgen et al., 2006).

3.2 Cysteine sulphoxide contents.

In the genus *Allium*, generally an onion or garlic-like taste and odour points to a high content of cysteine sulphoxides. Bulbs may contain more than 1% of these compounds relative to fresh weight, with amounts of 0.2-0.8% in different garlic accessions, and 0.2-0.3% in common onion (bulbs with a water contents of 60-80%; storage over several months increases content of cysteine sulphoxides). These amounts were regarded as very high and high, and species of subg. *Melanocrommyum* with medicinal use as mentioned in this publication sometimes contain high amounts of cysteine sulphoxides (Table 1). This was unexpected because other species most often showed only traces (below 0.1%) of these compounds, and rarely medium to low contents (Fritsch and Keusgen, 2006).

The different specific taste and odour is strongly influenced by the presence or absence of alliin, isoalliin, methiin, and propiin, and by the relations between these four main substances if two or more of them are present. They are stored in the cytoplasm. Decomposition of these sulphoxides into volatile, intensely smelling and tasting sulphur compounds (for more details see Keusgen, 2002) is caused by the enzyme alliinase, which is located in the vacuole. Therefore this process can only start after mechanical or thermal injury of the cells. The resulting compounds possess antimicrobial, antifungal, and anticancer activities, lower lipid and blood glucose levels, and show different minor protective effects (Keusgen, 2002). Because the decomposition products of the different cysteine sulphoxides have similar medicinal properties; only the total contents are of interest (Table 1). This study is not complete yet, and therefore data for *A. costatovaginatum, A. nigrum,* and *A. koelzii* are still missing.

TABLE 1. Total contents of cysteine sulphoxides of different species, related to the fresh weight of bulbs (B) and dry weight of leaves (L). Each accession number was analysed four times.

Name of the taxon	total contents [%] (average)	Number of determinations	Origin of the accessions
A. akaka s. lat.	B: 0.63	1	Iran
A. motor	B: 0.21 L: 0.07	1	Uzbekistan
A. severtzovioides	B: 0.10	1	Uzbekistan
A. suworowii	B: 0.68 L: 0.06	4	Tajikistan and IPK
A. chitralicum	B: 0.09 L: 0.94	1	Tajikistan
A. komarowii	B: 0.08 L: 0.81	2	Uzbekistan, Tajikistan
A. jesdianum	B: 0.36	3	Iran and IPK
A. rosenorum	B: 0.03 L: 0.04	2	Tajikistan and IPK
A. rosenbachianum	B: 0.05 L: 0.08	1	Tajikistan
A. sarawschanicum	B: 0.03	1	IPK
A. stipitatum	B: 0.96	1	IPK
A. altissimum	B: 0.15	1	IPK
A. aflatunense	B: 0.63	2	Uzbekistan and IPK
A. karataviense	L: 0.31	1	Uzbekistan
A. hissaricum	B: 0.88 L: 0.05	1	Tajikistan

3.3 Presence of sulphur pyrroles.

The red stain present in several species mentioned above is chemically a sulphur pyrrole, a newly discovered natural substance (Jedelská et al., 2004). It was possible to isolate and to characterize this compound, which was only detectable in freshly wounded tissue, *e.g.* from *A. giganteum.* The chemical structure was determined as dithiodipyrrole (Fig. 18). It was assumed that the formation of the red dye is catalyzed by enzymes. An enzyme having catechol oxidase activity and consisting of two subunits with molecular weights of 24 kDa and 31 kDa could be isolated and partially purified (Vogt et al., 2005). Incubation with a low-molecular weight extract of the same plant resulted in the formation of the red dye. The purified substance showed a strong antioxidative effect (see below), but its contribution to the health benefit of the entire plant was not clear until now.

During our fieldwork we became aware that this kind of red stain could only be observed in members of subg. *Melanocrommyum*, but not in all species. A few species did always show it (see above), other never did show it like *A. severtzovioides*, and still others showed variable color intensity, *e.g. A. karataviense.* Therefore this character was screened in the *Allium* reference collection in Gatersleben (IPK) in order to study the amount of variation and possible relations to taxonomy. This study is not finished yet, and preliminary results are given in Table 2.

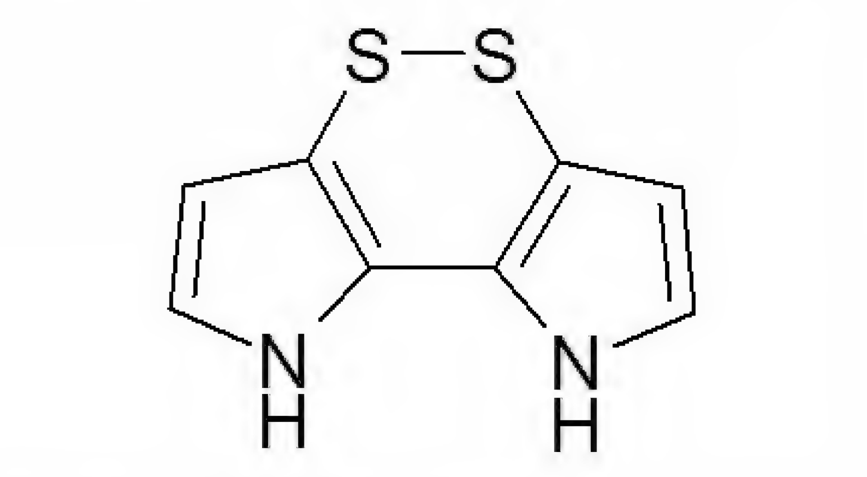

Fig. 18. Structure of the dithiodipyrrole isolated from *Allium giganteum.*

TABLE 2. Screening for presence of a red exudate in the *Allium* reference collection in Gatersleben (members of subg. *Melanocrommyum* only).

Name of the taxon	Color intensity*	Number of accessions screened	Origin of the accessions
A. akaka	0	2	Iran
A. motor	2, 3	5, 3	Uzbekistan
A. severtzovioides	0	10	Uzbekistan, Tajikistan, Kazakhstan
A. costatovaginatum	0	3	Uzbekistan
A. suworowii	0	6	Tajikistan, Kazakhstan, Uzbekistan
A. chitralicum	0	1	Tajikistan
A. komarowii	3	6	Tajikistan, Uzbekistan
A. jesdianum	3	13	Iran, Uzbekistan, Tajikistan, botanical gardens
A. rosenorum	2, 3	1, 25	Tajikistan
A. rosenbachianum	0, 1	4, 1	Tajikistan
A. sarawschanicum	0	13	Iran, Uzbekistan, Tajikistan
A. stipitatum	0	36	Iran, Tajikistan, Uzbekistan, Kirgizstan, Kazakhstan, bot. gardens
A. altissimum	0	1	Kazkhstan
A. aflatunense	0	13	Tajikistan, Uzbekistan, Kirgizstan, Kazakhstan,
A. nigrum	0, 1	1, 1	Turkey, botanical garden
A. karataviense	0, 1, 2, 3	10, 3, 1, 2	Tajikistan, botanical garden, Uzbekistan, Kirgizstan, Kazakhstan
A. hissaricum	0	2	Tajikistan

* 0 = colorless, 1 = slightly reddish, 2 = red, 3 = dark red sap

3.4 Radical scavenger activity.

In humans, free radicals like oxygen radicals can induce several diseases, such as vascular diseases and cancer. These free radicals can be trapped by different natural compounds, mostly types of polyphenols. The potential to trap free radicals is described by the "radical scavenger activity", which can be investigated for pure compounds or extracts. For these tests, butylated hydroxytoluene (BHT) was used as reference compound (radical scavenger activity of 100%). It can be assumed that plant materials exhibiting a high radical scavenger activity are potential medicinal plants. Daily intake may prevent cardiovascular diseases and cancer. Radical scavenger activities larger than 40% are significant. Radical scavenger activity of dithiodipyrrole (see above) was found to be approximately 100%, meaning that this compound is a very strong radical scavenger.

Currently results for 39 wild *Allium* species and garlic (Jedelská et al., 2004, and unpublished data) are available which showed a significant activity for 24 species and garlic. Ten of eleven species, which showed even a higher activity than the reference compound, belong to subg. *Melanocrommyum*, and eight of the latter ones developed red sap when wounded. However, no correlation to cysteine sulphoxide contents was found in this material.

TABLE 3. Radical scavenger activity of members of subg. *Melanocrommyum* (Jedelská et al., 2004, and unpublished results).

Name of the taxon	relative activity* [%]	Number of determinations	Origin of the accessions
A. motor	110	1	Uzbekistan
A. suworowii	4	1	Uzbekistan
A. komarowii	110, 116	2	Uzbekistan, Tajikistan
A. jesdianum	109, 109, 113	3	Iran, IPK
A. rosenorum	109, 123	2	Tajikistan
A. rosenbachianum	34	1	Tajikistan
A. stipitatum	16, 16	2	Tajikistan
A. aflatunense	17	1	IPK
A. karataviense	53	1	Uzbekistan
A. hissaricum	45	1	Tajikistan

butylated hydroxytoluene (BHT) = 100%; garlic 45 … 84%.

4. DISCUSSION

First we would like to explain that nearly all of the data presented originated from people who were neither qualified physicians nor well trained local healers. We strongly warn against basing any healing aims or self medications on this information. We intensely tried to present all data as exactly as possible but cannot guarantee for exactness in the sense of law.

The majority of the medicinally applied species mentioned above contain more cysteine sulphoxides in the bulbs than common onion, and several even more than garlic. Therefore, these compounds may well represent the main medicinally active principle in species like *A. suworowii* and *A. stipitatum*, the bulbs of which are only applied externally. Unexpectedly, in *A. chitralicum* and *A. komarowii*, we detected remarkable high contents in the leaves but only traces in the bulbs. Also in these cases the high cysteine sulphoxide contents in the leaves could be important. Most other species showed a much lower cysteine sulphoxide in the leaves compared to the bulbs (Table 1). Unfortunately, we cannot discuss these relations in detail. Many species possess only remains of leaves in the flowering stage, and during our field-work we were not able to collect dried leaves of all species dealt with in this paper. On the other hand, only leaves from *A. karataviense* could be analysed, because the bulb was in bad condition during harvesting time.

High medicinal activity and very high radical scavenger activity (Table 3) of another group of species (*A. motor, A. komarowii, A. jesdianum, A. rosenorum*, and possibly also *A. karataviense*) is clearly related to the presence of sulphur pyrroles (see Table 2). These species are highly valued for their medicinal and tonic properties. We must therefore conclude that sulphur pyrroles are powerful pharmaceutical agents.

Finally, we should not overlook the fact that *A. severtzovioides* and *A. rosenbachianum* did not contain significant amounts of cysteine sulphoxides and showed no or only slight sulphur pyrrol activity, but they are still regarded as medicinal species. *Allium rosenbachianum* showed also rather low scavenger activity (Table 3, *A. severtzovioides* was not tested yet). Therefore we must conclude that further substances contribute to the proposed medicinal effects of these species, *e.g.* saponins, polyphenols, and sugars.

Allium akaka, A nigrum, and *A. koelzii* became known to us as medicinal plants only very recently, and chemical data are not yet available for discussion. The inclusion of *A. sarawschanicum* was most probably caused by a mis-identification.

Certainly more species than detailed described and discussed above could be prospective medicinal plants and neutraceuticals. First choice in this respect would be several species showing high (> 100 %: *A. alaicum* Vved., *A. chelotum* Wendelbo, *A. giganteum* Regel, *A. macleanii* Bak., *A. winklerianum* Regel) or at least significant radical scavenger activity (> 40 %: *A. bucharicum* Regel, *A. cristophii* Trautv., *A. ellisii* Bak. (Jedelská et al., 2004, and unpublished data). However, some of them are rare species which could only gain importance as medicinal plants when taken under cultivation. Other ones like *A. giganteum* and *A. macleanii* are eaten as vegetables by the local population in Tajikistan and Iran. Probably the specific knowledge of their health-supporting and medicinal impact was lost in the past. Sokolov (1994) mentioned also *A. decipiens* Schult. et Schult. f. and *A. fetisowii* Regel to possess a medicinal potential because of bactericidal and fungicidal activity.

ACKNOWLEDGEMENTS

The authors are greatly indebted to organizers and local scientists supporting the field-work in Iran, Tajikistan and Uzbekistan, especially to Dr. Mehrdad Abbasi, Prof. Dr. Hikmat Hisoriev, and Dr. Furkat Khassanov. Funding by VolkswagenStiftung (Hannover, Germany) under the general funding theme "Zwischen Europa und Orient-Mittelasien/Kaukasus im Fokus der Wissenschaft" is gratefully acknowledged.

REFERENCES

Dadabaeva, O.D. 1972. Slovar nauchnykh i mestnykh nazvanij lekarstvennykh rastenij severnogo Tadzhikistana. Dushanbe.

Friesen, N., Fritsch, R.M. and F.R. Blattner. 2006. Phylogeny and new intrageneric classification of *Allium* L. (Alliaceae) based on nuclear rDNA ITS sequences. Aliso 22:372-395.

Fritsch, R.M. 1996. The Iranian species of *Allium* subgen. *Melanocrommyum* sect. *Megaloprason* (Alliaceae). Nordic Journal of Botany 16:9-17

Fritsch R.M. and Keusgen, M. 2006. Occurrence and taxonomic relations of cysteine sulphoxides in the genus *Allium* L. (Alliaceae). Phytochemistry 67:1127-1135.

Fritsch, R.M., Abbasi, M. and M. Keusgen. 2006. Useful wild *Allium* L. species in northern Iran. Rostaniha 7 Suppl 2:189-206.

Jedelská, J., Fritsch, R.M., and M. Keusgen. 2004. Schwefelpyrrole — eine neue Naturstoffklasse in arzneilich genutzten, zentralasiatischen *Allium*-Arten. Pp. 66-70 in Thüringer Landesanstalt für Landwirtschaft Jena (ed.). Tagungsband Fachtagung für Arznei-und Gewürzpflanzen, 7. bis 9. September 2004 in Jena. Dornburg.

Jedelská, J., Fritsch, R.M., and M. Keusgen. 2005. Antibiotic activity of some wild *Allium* L. species. P. 193 in Anonymous (ed.). Final program and book of abstracts, 53rd Annual GA congress, Florence, Italy, August 21st-25th, [poster] P. 165.

Keusgen, M. 2002. Health and Alliums. Pp. 357-378 in H. D. Rabinowitch and L. Currah (eds.). Advances in *Allium* science. CABI Publishing, Wallingford UK.

Keusgen, M., Fritsch, R.M., Hisoriev, H., Kurbonova, P.A. and F.O. Khassanov. 2004. Wildwachsende zentralasiatische *Allium*-Arten, die als Gewürz oder Arzneimittel verwendet werden. Programm Abstracts und Postertexte, Fachtagung für Arznei-und Gewürzpflanzen, 7. bis 9. September 2004 in Jena. P. 101.

Keusgen, M., Fritsch, R.M., Hisoriev, H., Kurbonova, P.A. and F.O. Khassanov. 2006. Wild *Allium* species (Alliaceae) used in folk medicine of Tajikistan and Uzbekistan. Journal of Ethnobiology and Ethnomedicine 2: [paper] 18. http://www.ethnobiomed.com/content/pdf/1746-4269-2-18.pdf

Khalmatov, K.K. 1964. Dikorastushchie lekarstvennye rasteniya Uzbekistana. Izdat. Meditsina Uzb. SSR, Tashkent.

Khassanov, F.O. and Umarov, T.A. 1989. Dikorastushie pishchevye vidi roda *Allium* L. zapadnogo Tyanshanya. Uzbekskij Biologicheskij Zhurnal 6:24-25.

Kochkareva, T.F. and Chukavina, A.P. 1985. Dikorastushchie pishchevye rasteniya Khovalingskogo rajona (Tsentral'nyj Tadzhikistan). Rastitel'nye resursy 21(2):140-149.

Kurbanov, J. 2005. Dikorastushchie luki Turkmenistana. Problemy osvoeniya pustyn (Problems of Desert Development) No. 3:23-28.

Sakhobiddinov, S.S. 1948. Dikorastushchie lekarstvennye rasteniya Srednej Azii. Tashkent.

Sokolov, P.D. 1994. Rastitel'nye resursy Rossii i sopredel'nykh gosudarstv: Tsvetkovye rastenija, ikh khimicheskij sostav, ispol'zovanie. Tom 8.

Semejstva Butomaceae - Typhaceae. Nauka, Sankt Peterburg.

Umarov, T.A. 1992. Dikorastushchie pishchevye rastenija gornoj chasti Tashkentskoj Oblasti. Avtoreferat [Summary] of thesis. Tashkent.

Vvedensky, A.I. 1963. Semejstva Amaryllidaceae Rod 166 (1) Luk, Piez (tadzh.)-Allium L. Pp. 290-370 in Ovczinnikov, P. (ed.). Flora Tadzhikskoj SSR, Volume 2. Izdatel'stvo Akademii Nauk SSSR Moskva-Leningrad.

NAMAQUANULA BRUYNSII IN ITS HABITAT ON THE TIRAS MOUNTAINS OF SOUTH-WESTERN NAMIBIA, WITH AN ACCOUNT OF CULTIVATING AND PROPAGATING THIS SPECIES

Charles Craib
Box 67142, 2021 Bryanton, South Africa
E-mail: www.penroc.co.za

Photography by Connall Oosterbroek

FIELD ACCOUNT

The Tiras Mountains in south-western Namibia and the Rooirand to the east are home to a number of dwarf bulbous plants. These only emerge after good late summer and autumn rains, and several dry years may pass in succession without these bulbs emerging from dormancy.

Namaquanula bruynsii is currently known from the highest sections of the Tiras Mountains occurring at an altitude of about 1900 m. These mountains are remote and rugged. Further exploration may indicate that the bulbs occur more widely than on the west central part of the range.

The mountain summit region consists of an uneven plateau with numerous boulder outcrops and rocky ridges. The latter are interspersed with some flat or gently sloping terrain. The plateau is drained by large streams with deep sandy beds lined by camel thorn trees, *Acacia erioloba.* These streams flow briefly after occasional good rainfall.

A small portion of locale on the plateau contains shallow washes with an almost imperceptible gradient, and this is the habitat of *Namaquanula bruynsii.* Water flows briefly in these washes after rainfall, and then the washes become seepage areas for short periods. The gradient in this habitat is so slight that this niche is stable and not subject to water erosion after heavy rainfall.

The bulbs grow singly or in small scattered groups of 3 to 6 bulbs, with rarely more individuals in a group. Most of the large colonies contain bulbs of different ages ranging from seedlings to large, well-established adult bulbs. Some of them grow beside woody-evergreen, low growing shrubs or in deep soil pockets between large stones. Bulbs are usually found at the fringes of the washes, and seeds are likely to have been distributed there via runoff after rainfall.

Bulbs occur deep in the soil, usually at least 12-15 cm below the surface. The bulb plates often rest on buried sheets of exposed rock. The latter is the slowest draining part of the microhabitat after good rainfall.

The summit of the plateau where the plants were studied is well grazed by cattle. The livestock keep the washes and surrounding areas free from dense accumulations of short grass tufts which are frequent all over the mountain summit.

Namaquanula bruynsii and species of the Genus *Lachenalia* and the Genus *Ornithogalum* respond to rainfall from mid-summer to early autumn. There seems to be a critical minimum of precipitation required to trigger flowering in the case of *N. bruynsii* and leaf production amongst the other dwarf bulbs. These conditions occur rather infrequently, and *N. bruynsii* bulbs probably spend a good deal of their lives in extended dormancy. Should sufficient rain fail to trigger flowering and leaf growth, the bulbs retain their foliage throughout the winter. The leaves die back in late August and September at a time when temperatures usually begin to increase sharply.

Namaquanula bruynsii is similar in its growth cycle and habits to several plants in different genera from the summer rainfall interior of South African. The latter, such as *Daubenya comata*, respond only to late summer and early autumn rains, flowering between March and June. Leaves start to wither during August.

Fig. 1. A *Namaquanula bruynsii* bulb with leaves about 2.5 cm tall, about 12 days after initial exposure to rainfall on 19 December.

Fig. 2. *Namaquanula bruynsii* flower buds fully formed and ready to open 12 days after the bulb was first exposed to rainfall.

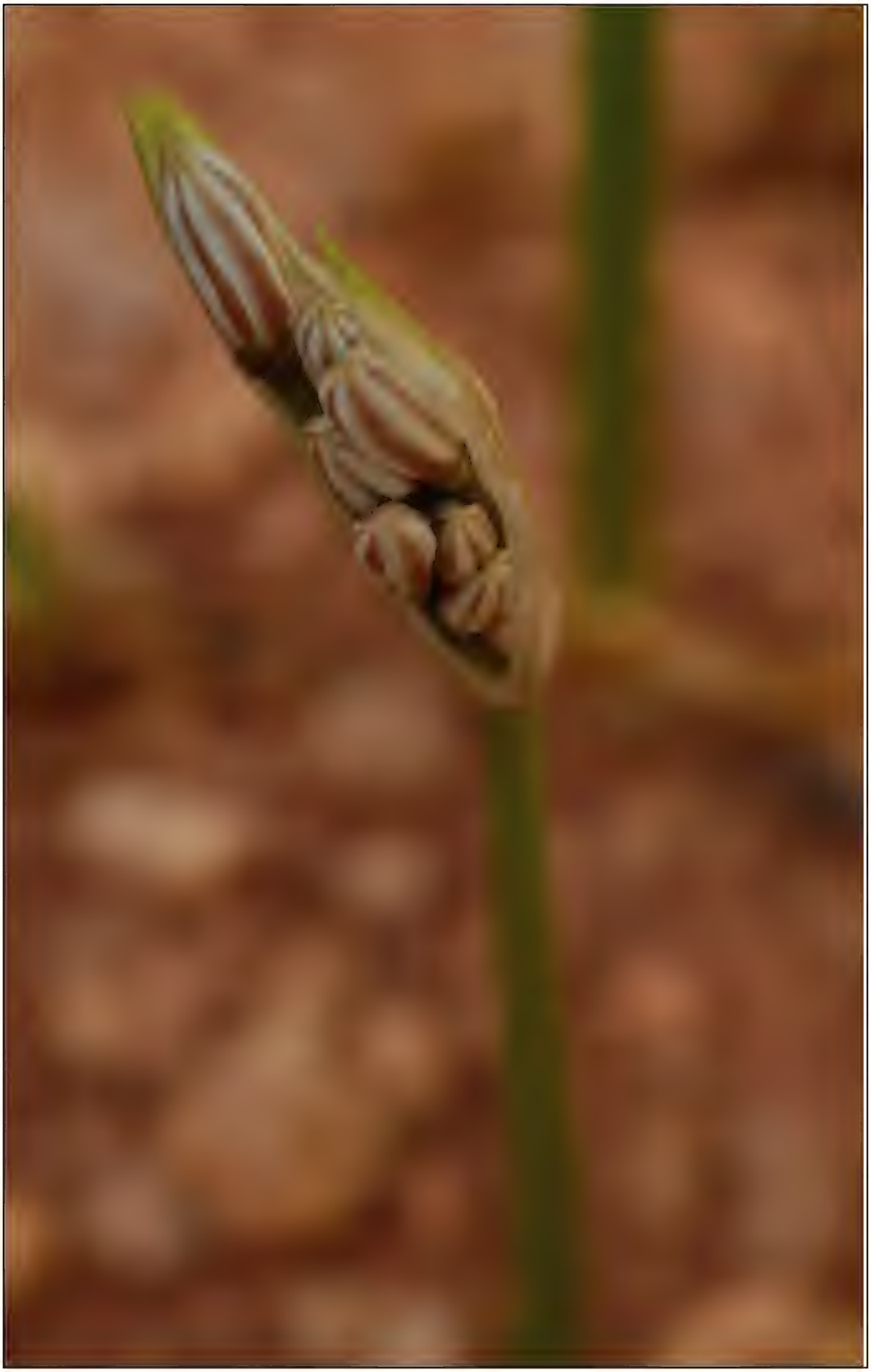

Fig. 3. *Namaquanula bruynsii* scapes usually emerge before the leaves, but on occasions leaves and scapes arise simultaneously.

Fig. 4. *Namaquanula bruynsii* starting to flower on 7 January after the bulbs had been exposed to several rain showers beginning 19 December. Flowers opened mostly between 0900 and 1000 am. All flowers on an umbel usually open within 6 days from the opening of the first flower.

A thorough search was conducted on the summit of the northern section of the Rooirand immediately east of the Tiras Mountains in late May 2000. The habitat was similar to that on the summit of the Tiras Mountains but found at a slightly lower altitude, about 1700 metres. Most of the small bulbs that were present on the summit of the Tiras Mountains, particularly *Lachenalia* and *Ornithogalum*, were also found there in almost identical habitats. However, no *N. bruynsii* were found. The summit plateau of the Rooirand was much narrower than equivalent terrain on the Tiras Mountains, and it also lacked the low gradient sandy washes. The latter may have explained the absence of *N. bruynsii* from the northern section of the Rooirand.

Namaquanula bruynsii is very well adapted to survive in an arid environment that experiences prolonged dry periods. The bulbs are encased in masses of old fragile bulb tunics. This phenomenon develops very early in the life of the bulb, from the second growth season after the seedlings have established. It is shared only by *Namaquanula bruce-bayeri* in the *Hessea*

Fig. 5. Details of *Namaquanula bruynsii* flowers.

and *Strumaria* group, a species that also frequents very arid habitats subject to frequent and prolonged droughts. Layers of compacted bulb tunics like those in *N. bruynsii* are regularly encountered in most *Brunsvigia* species.

CULTIVATION

Namaquanula bruynsii is cultivated in red Magaliesberg quartzite soil in Johannesburg, and it is grown in large terracotta pots resembling the conditions in their natural habitat. Quartzite grit is sparsely scattered across the surface of the soil.

Bulbs are grown in locations which only receive either morning or afternoon sunlight. During dormancy from early September until late December, they are kept in a well ventilated, hot sunny position and given no water. Bulbs are taken out of dormancy in late December and watered via exposure to rainfall. These cultivation conditions approximate the habitat found on the Tiras Mountains.

The flowering, seeding and leafing habits of the bulbs in cultivation are likely to have many similarities to bulbs in nature. The details of the 2006 flowering season are discussed below.

Fig. 6a (Top), 6b (Left), and 6c (Bottom). *Namaquanula bruynsii* photographed on 16 August. Leaves are typical of the period a few weeks before the bulbs enter dormancy with noticeable withering of the foliage from the leaf

FLOWERING OF *NAMAQUANULA BRUYNSII* IN JOHANNESBERG

Bulbs were taken out of dormancy on 19 December. They had gone dormant the previous August. Pots containing the bulbs were placed in strong direct sunlight out in the open and exposed to rainfall. Regular summer storms occurred most afternoons from 19-30 December.

Three bulbs produced flower buds 3-4 days after exposure to rainfall, and all 10 bulbs that flowered produced buds within 12 days after the initial exposure to rainwater.

Buds started to open and reveal individual flowers on the umbels from 14 days after bulbs were first exposed to rainfall. Flowering occurred on different umbels from 6-12 January.

Seed development was very rapid, and all seeds on the different umbels were fully mature by 28 January. Seeds were harvested, and the first few began to produce a root within 3 days after they were collected. The remainder, except for 4 out of 69, had roots within a week, and some quickly developed their first 1-2 young leaves. Seeds were stored on a flat-open plastic tray which was kept on a shelf in shade. Roots and leaves had all started to develop before planting.

The inflorescences with ripe seeds detached from the bulbs and were easily blown about in the wind. These ripe seeds were very heavy for the dry inflorescences. Some dropped off before the inflorescences detached from the bulbs.

The seeds were very large for a *Hessea* type plant. Most seeds were ½ cm long, indicating that they contained enough reserves to sprout and root with scant rainfall.

Leaves emerged at the time buds and flowers were formed in the case of plants that flowered. With respect to the non-flowering bulbs, most leaves emerged soon after exposure to rainfall, with only a few remaining dormant till about 5 weeks after they first received rainwater.

PROPAGATION

Namaquanula bruynsii is grown in Johannesburg in terracotta pots 20 cm deep and 25 cm wide that are filled in red-loamy, gritty quartzite soil collected from the Magaliesberg. This is almost identical to the conditions in habitat. Pots are exposed to rainfall from late December until the end of the rainy season. Thereafter pots are moved into the greenhouse, where the bulbs are deeply watered occasionally during the winter. The leaves wither in late August once the temperatures warm up, but bulbs are fully evergreen from late December to late August.

Well-rooted seeds are sown in sieved Magaliesberg-red-quartzitic loam and kept moist throughout the growing period. Individual seeds are sown 2-3 cm apart in the same type of containers in which the mature bulbs are cultivated.

The young bulblets had well developed leaves by the end of April and these continued to grow throughout the winter. In all characteristics, the young bulblets resembled mature bulbs. Leaves had the characteristic of dying back from their apices by May, and bulbs had developed their first protective tunics by late July. Foliage started to wither in the first half of August, and some bulbs were fully dormant by 20 August.

THE STATUS OF *NAMAQUANULA BRUYNSII*

The autecology of *N. bruynsii* is virtually identical to that of dwarf *Brunsvigia* species from the Northern Cape in South Africa.

The bulb structure of *N. brunysii*, particularly the masses of tightly packed, brittle bulb tunics, is the same in a new undescribed *Brunsvigia* species from the Pellaberg and surrounding area. This bulb tunic feature is also shared by *Brunsvigia namaquana* from the arid regions of the eastern Khamiesberg. The latter species grows in very similar habitat to *N. bruynsii.*

The large rounded seeds of *N. bruynsii* are roughly the same size as those of the Pellaberg *Brunsvigia.* The dried inflorescences of both species detach from the neck of the bulb in the same manner, liberating seeds as they are blown about in the wind.

January is the typical flowering month of the dwarf *Brunsvigia.* It may be no coincidence that *N. brunysii* flowers at the same time.

It may be useful in due course to reassess the taxonomic placement of *N. bruynsii,* taking into account its physical characters in conjunction with its autecology. It is possible that *N. bruynsii* may be more realistically accommodated in the Genus *Brunsvigia.*

REFERENCES

Snijman, D. A. 2005. A new species of *Namaquanula* (Amaryllidaceae: Amaryllideae) from Namibia with notes on the genus. Bothalia 35(2):153-156.

Fig. 7a. (Top) and Fig. 7b (Bottom) Juvenile *Namaquanula bruynsii* photographed on 16 August at the time the first bulbs started to enter dormancy. The seeds from which these bulbs developed were sown in late January. The immature bulbs resembled the adults in most respects with leaves well withered from the apices and with development of the initial bulb tunics

CRINUM FIMBRIATULUM BAKER

David J. Lehmiller, M.D.
18173 Hwy 326 North
Sour Lake, Texas 77659 USA
E-mail: drcrinum@aol.com

INTRODUCTION AND SOURCE OF MATERIALS

The type specimen for *Crinum fimbriatulum* Baker (Welwitsch **4018**, K) was collected by the Austrian physician and botanist Freidrich Welwitsch in Angola. Welwitsch served in the employment of the Portuguese Government, and he was sent to Angola from 1851 to 1863, where his mission was to study the flora and fauna. He collected over 5,000 botanical specimens during his stay. Although Welwitsch died in 1872, the specific identification of *C. fimbriatulum* was not published by Baker until 1878. The collection locality was specified as the Province of Loanda (Luanda), in meadows inundated during summer, and at elevations less than 1000 ft. Baker thought that this species closely resembled *C. broussonetii* (Redoute) Herbert, and the identification card on the type specimen actually shows where Baker had inscribed *C. broussonetii* as the initial identity, but later he crossed this out and wrote *C. fimbriatulum.* The type specimen consisted of a long tapering leaf and one flower including perianth tube and ovary.

Other than repetition of Baker's description, botanical literature was silent about this species until Hannibal (1970) published a photograph identified by Gordon McNeil as *C. fimbriatulum.* McNeil, of Ofcolaco, Transvaal, South Africa, was an IBS member, and he had traveled in Angola where he collected this species. The photograph represented a bulb in flower that McNeil had grown in cultivation. McNeil was best known for his work with *Clivia* and his association with the Blackbeard *Clivia* Collection; he died in 1986.

During my first visit to South Africa in 1987, I visited McNeil's widow at Ofcolaco to inquire about the disposition of his plant collection (Lehmiller 1987). Although I did not recognize it as such at the time, one of McNeil's *Crinum* was in bloom which I happened to photograph (Fig. 1), and upon my return, I compared it to McNeil's photo in Hannibal's publication and discovered that it was McNeil's *C. fimbriatulum.* When I returned to South Africa in 1988, I again visited Mrs. McNeil, and she kindly gave me a bulb that was marked with Gordon McNeil's label designating it as *C. fimbriatulum.*

Fig. 1. *Crinum fimbriatulum* Baker in bloom at the estate of Gordon McNeil, Ofcolaco, Transvaal, South Africa, January 24, 1987. All photographs by the author.

Fig. 2. *Crinum fimbriatulum* Baker in bloom, from Leach **14510,** cultivated in Southeast Texas.

Fig. 3. *Crinum fimbriatulum* Baker in bloom, cultivated in Southeast Texas.

During my visits to South Africa, I developed a close relationship with Dave Hardy (now deceased), senior horticulturist at the National Botanical Institute (NBI) in Pretoria, and we collected in the field in Southern Africa and Madagascar on seven occasions. During one of my visits to NBI, I discovered that McNeil had deposited one of his photographs of *C. fimbriatulum* in the herbarium photographic files. I also noticed a bulb in the nursery, Leach **14510** (PRE), which had been collected in Angola near Ruacana by the Cunene River and had been labeled as *C. kirkii* Baker; this bulb I recognized as identical to the *C. fimbriatulum* collected by McNeil. Hardy obtained seed from the Leach bulb and sent them to me. I cultivated the latter in the ground alongside McNeil's bulb, and indeed they proved to be the same species. These bulbs grew robustly in the warm moist climate of Southeast Texas, and they became large plants and multiplied via offsets as well as by self-seeding (Fig, 2, 3).

During two field trips, Hardy and I attempted to find this species along the Namibian side of the Cunene River near Ruacana, but we were not successful (Lehmiller, 1997). Presumably the Leach specimen collected in Angola by the Cunene River represented a solitary specimen that had washed down river from Central Angola and lodged in the rocks near Ruacana.

DISCUSSION

Crinum fimbriatulum is a unique species and differs from *C. broussonetii* by multiple characters, including: fruit with a long rostellum (Fig. 4) versus no rostellum in *C. broussonetii*, large bulky seeds (Fig. 5) with a pithy consistency versus small smooth seeds stacked in columns in *C. broussonetii*, and light tan anthers versus black anthers in *C. broussonetii.* Minor character differences include longer scapes, larger umbels, and longer leaves in *C. fimbriatulum.* DNA sequence studies separate these two species (Meerow et al, 2003), and this analysis suggests that the two species are not closely related.

Crinum kirkii is an East African species; its morphology differs significantly from *C. fimbriatulum* by possessing unique leaves with crispate margins, erect spathe which envelope the perianth tubes at anthesis, large red fruit lacking a rostellum, and smooth ovoid seeds. These two species are not closely related by DNA sequence studies (Meerow et al, 2003).

The description of *C. fimbriatulum* provided by Baker was limited, since he never observed a living bulb. Baker did utilize selected data provided in Welwitsch's field notes (see Rendle, 1899), but he neglected some of the field data; i.e., Welwitsch listed the length of the leaves as 2-5 feet long and described them as roundly grooved, long, and acuminate, whereas Baker only specified 2-3 feet long leaves which tapered to a point. A more detailed description from living plants cultivated under optimal conditions follows:

***Crinum fimbriatulum* Baker.**

J. Bot. London, p. 196, 1878.

Type: **Angola**. Province of Loanda (Luanda), Welwitsch **4018** (Holotype, K).

Description:

Bulb ovoid, covered with layers of brown papery scales, 70-160 mm in diameter, with an above-ground false stem 70-150 mm long; basal offsets produced. Leaves 12-16, forming a rosette, suberect and arching, widest adjacent to the base, deeply channeled but lacking a depressed midrib, long and tapering to a slender point, containing tiny wooly fibers when torn apart; margins finely serrated; green, usually with intact apices excepting old leaves, 900-1450 mm long, and up to 75 mm wide. Scape appearing after the leaves have formed, long and stout, light green, 1070-1400 mm long. Spathe valves spreading at anthesis, 115-135 mm long by 55-65 mm wide. Umbel (3)-10-21 flowered; flowers zygomorphic, bell shaped, sessile, pleas-

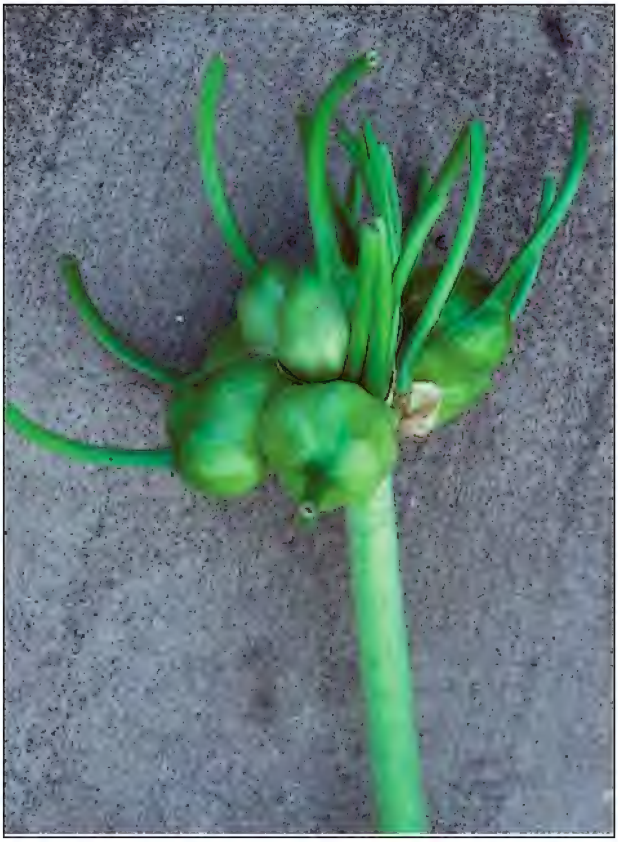

Fig. 4. Fruit of *Crinum fimbriatulum* Baker, cultivated in Southeast Texas.

antly scented. Buds initially erect, then migrating outward and inclining about 30 degrees below horizontal, then arising to horizontal or slightly above horizontal at anthesis. Perianth tube curved only in the distal 20-30 mm portion at anthesis, and at one day post-anthesis, the flower droops with only the distal tube curved; light green, 120-150 mm long. Flowers nocturnally opening. Segments white, with a ventral dark-pink stripe that does not extend to the segment tip, with a less prominent dorsal stripe, unequal with the inner broader and shorter, near lanceolate, 114-133 mm long by 27-38 mm wide; distal tips recurved at anthesis, with small apiculates. Filaments white, unequal with the inner longer, declinate, 80-95 mm long; anthers initially gray-white, turning light tan at maturity and becoming U-shaped; pollen light tan. Style white becoming light pink distally, 93-105 mm long; small capitate stigma. Fruit bulky and somewhat globular, with an apical rostellum 50-115 mm long, light green, turning dull yellowish at maturity, indehiscent, 40-60 mm in diameter; seeds 1-6 per fruit, large and bulky with a pithy texture, usually with branching small crevices in the outer surface, pale light green, 20-50 mm in diameter.

Habitat: In meadows flooded during the summertime.

ACKNOWLEDGEMENT

Botanical illustrator and IBS Member, Kristin Jakob of Valley Mills, California, is gratefully acknowledged for the botanical illustration of *Crinum fimbriatulum* Baker exhibited at the conclusion of this manuscript (Fig. 6). The latter represents the only known illustration of *C. fimbriatulum* currently in existence.

REFERENCES

Baker, J.G. 1878. *Crinum fimbriatulum.* J. Bot. London. p. 196.

Baker, J.G. 1888. Handbook of the Amaryllideae. J. Cramer Reprint, Lehre, 1972.

Hannibal, L.S. 1970. Garden Crinums. Bull. Louisiana Soc. Hort. Res. 3:248.

Lehmiller, D.J. 1987. A South African *Crinum* Safari. Herbertia 43:50-59.

Lehmiller, D.J. 1997. Synopsis of the Genus *Crinum* in Namibia. Herbertia 52:44-65.

Meerow, A.W., Lehmiller, D.J., and Clayton, J.R. 2003. Phylogeny and bio geography of *Crinum* L. (Amaryllidaceae) inferred from nuclear and limited plastid non-coding DNA sequences. Bot. J. Linn. Soc. 141:349-363.

Rendle, A.B. 1899. Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853-61. Volume II(1):33. British Museum, London.

Fig. 5. Seed of *Crinum fimbriatulum* Baker, cultivated in Southeast Texas.

Fig. 6. Illustration of *Crinum fimbriatulum* Baker by Kristin Jakob.

(POST-DATED) ADDENDUM NOTE: *CRINUM FIMBRIATULUM* BAKER

David J. Lehmiller, M.D.
18173 Hwy 326 North
Sour Lake, Texas 77659 USA
E-mail: drcrinum@aol.com

Photography by Wolfram Lobin

FIELD ACCOUNT

Dr. Wolfram Lobin recently contacted me concerning the identity of a *Crinum* species that he had encountered while collecting in Angola. From his beautiful field photographs, there was no mistaking that the species he saw was *Crinum fimbriatulum* Baker. He observed and photographed this species in Parque Nacional de Quicama (Quissama) south of Luanda at altitude 160 m, which possibly would be near the locality where Welwitsch originally collected this species. He also recalled seeing this species west of Luanda from his car.

His account augments the scant habitat details provided by Baker. The bulbs were growing in periodic flooded depressions in Dry-Forest-Communities where tree-layered *Adansonia digitata* and *Euphorbia conspicua* were rather common. His remarkable photographs indicate that the bulbs grew in full sun.

Several differences are apparent between field bulbs and the cultivated bulbs described in the preceding article, presumably due to cultivation artifacts:

1) Scapes appear during early leaf development in the field, whereas leaves are well developed when flowering occurs in cultivation.
2) Leaves of field bulbs display prominent undulations in many instances (Fig. 3), whereas this feature is not present in cultivated bulbs. (Leaf undulations in cultivated bulbs of many *Crinum* species frequently disappear or are greatly diminished, likely a result of abundant moisture available during cultivation.)
3) Field bulbs (Fig. 4) do not exhibit above-ground false stems as do the cultivated bulbs.
4) The reddish pigment in the petals is stronger or more vivid in the field bulbs. Reddish-brown pigment also is sometimes strongly evident in the scapes of the field bulbs, whereas the scapes are entirely green in cultivation.

Fig. 1. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 2. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 3. *Crinum fimbriatulum* Baker. Note the leaf undulations of the bulb in the lower right hand corner.

Fig. 4. *Crinum fimbriatulum* Baker. Note the lack of an above-ground false stem in the bulb in the background.

Fig. 5. Flowering umbel of *Crinum fimbriatulum* Baker.

Fig. 6. Flower close-up of *Crinum fimbriatulum* Baker.

Dr. Lobin has kindly offered to share his photographs to accompany the preceding article, and a sampling (Fig. 1-6) has been selected. Dr. Lobin's botanical explorations in Angola have been carried out through a project of CARITAS-Angola. His position is:

Dr. Wolfram Lobin
Kustos/Curator
Botanische Gärten der Universität Bonn
Botanic Gardens University of Bonn
Meckenheimer Allee 171
D-53115 Bonn, Germany
E-mail: botgart@uni-bonn.de
Homepage: www.botgart.uni-bonn.de

LEDEBOURIA SPECIES AFFINIS *LEDEBOURIA MONOPHYLLA* (HYACINTHACEA) IN HABITAT EAST OF ROOSSENKAL MPUMALANGA, SOUTH AFRICA

Charles Craib
Box 67142, 2021 Bryanton, South Africa
E-mail: www.penroc.co.za

Photography by Connall Oosterbroek

INTRODUCTION

Stephanus Venter (1993) originally describes *Ledebouria monophylla* in his Masters of Science Thesis from collections at Paradise Camp on the Mpumalanga escarpment north of Graskop. However, the name *L. monophylla* is also used in his Thesis for other collections of *Ledebouria* species from various parts of the Mpumalanga escarpment characterized mostly by "one leaf closely pressed to the ground." It may be that these latter plants, apart from the type collection, are something else. In this sense the presentation and discussion that follows refers to the plants as "sp. aff. *Ledebouria monophylla*." The autecological research must be published under some name, and "sp. aff. *L. monophylla*" is the one that seems to describe the plants best when there is presently nothing else published.

This bulb is quite distinctive and unlike any other *Ledebouria* species. Sp. aff. *Ledebouria monophylla* is found mostly in mist-belt mountainous grassland in Mpumalanga. At Mount Sheba in the Pilgrims Rest area, it occurs in grassland as well as under scrubby mountainous vegetation. Elsewhere the bulbs are found mostly in short grassland nearly always in moist habitats such as around seepages, in marshy areas, near streams and also in thick water-retentive swards of soil. These places with deep soil are usually at the sides of sheets of exposed rock which funnel off the water after rainfall. The bulbs also grow in deep pockets of soil on steep hillsides in locations experiencing frequent summer mists and rainfall. A study has been conducted concerning the autecology of bulbs growing on the Steenkampsberg, and the results are discussed below.

SP. AFF *LEDEBOURIA MONOPHYLLA* ON THE STEENKAMPSBERG

The Steenkampsberg is an isolated mountain east of Roossenekal in Mpumalanga. The southern parts of the mountain are mostly at an altitude of around 1800-2300 m, most of which lies in a mist belt. Sp. aff.

Fig. 1. Sp. aff. *Ledebouria monophylla* growing in newly created habitat beside a road over the Steenkampsberg. A large cutting, facing southeast, has been extensively colonized where there are artificially created seepage areas. Shattered rock fragments from the road construction process are visible amongst the plants.

Fig. 2. Sp. aff. *Ledebouria monophylla* often grows in deep pockets of soil amongst rocks on the Steenkampsberg in south-facing positions. These water retentive localities are often moist for week on end during the summer.

Ledebouria monophylla is restricted mainly to this mist belt growing on east, southeast, west, and southwest facing slopes.

The bulbs occupy water retentive habitats on the east and southeast facing slopes of the mountain. The more arid west and southwest facing slopes have fewer moist areas, and here the bulbs are confined to short marshy grassland beside large seepage areas or streams. The habitat has been artificially extended by water retentive depressions in a road reserve on the western summit of the mountain.

BULBS ON THE WESTERN AND SOUTHWESTERN SLOPES

Sp. aff. *Ledebouria monophylla* is locally plentiful on the western side of the Steenkampsberg where it is apparently entirely confined to the mist belt. The habitat is very restricted, consisting of moist grassland which is permanently damp for the duration of the summer and autumn. This habitat, found within 2-12 m from streams and in the immediate vicinity of seepage areas, is usually crowded with bulbs. They grow in close proximity to one another between tufts of grass as well as in the grass tufts themselves. The small size of mature bulbs allows them to occupy nearly all the niches in this limited area.

Bulb populations undergo fluctuations in numbers as a result of trampling by livestock, mostly cattle and sheep. The trampling often occurs during the flowering time in October and early November. The first green grass of the summer growing season is usually found around seepage areas and streams. In these places it is moist enough for the grass to start growing before the first rains which usually fall at the end of October and in early November. Once the rains begin, the livestock start to graze in the surrounding grasslands which do not form part of the *Ledebouria* habitat.

In places where grazing is heavy, much of the sp. aff. *L. monophylla* habitat can be destroyed by the hooves of grazing animals. However, grazing is very variable, and the flatter areas are most at risk from trampling.

Bulbs growing in artificial habitat in the road reserve are not grazed and may become very abundant. They quite often serve as reservoirs which produce seeds to repopulate adjacent areas of grazed farmland.

BULBS ON THE EAST AND SOUTHEAST SLOPES

Sp. aff. *Ledebouria monophylla* is more plentiful on the east and southeast slopes of the Steenkampsberg. There is a greater range of moisture retentive places here, and the slopes are free from the desiccating rays of the afternoon sun.

Fig. 3. Sp. aff. *Ledebouris monophylla* is usually in full flower shortly after the leaves begin to emerge. This photograph was taken on 24 October on the eastern slopes of the Steenkampsberg.

The bulbs are found around seepage areas, in damp soil on rocky hillsides, and on broad ledges of broken cliffs with deep, seasonally moist pockets of soil. A densely utilised habitat consists of seepage areas and their surroundings on a broad road cutting. This area is fenced off from the surrounding farmland and is not subjected to grazing pressures from domestic stock.

Groups of bulbs, though more frequent than those in the limited niches on the west slopes, are usually smaller. The reason is that the grass and herb cover is thick with fewer open places for sp. aff. *L. monophylla* to colonise. The bulbs are absent from much damp-stream-side habitat as the shrub and grass cover is too dense. Bulbs are better protected here from grazing livestock than they are on the western slopes, since they do not usually occur around streams. The boggy stream-side habitat is readily damaged by the hooves of grazing animals. Goats are not currently kept on the Steenkampsberg in the study area. If they are introduced, their grazing habits are likely to degrade the mountainside since they clamber into rocky and steep areas not usually frequented by cattle and sheep.

THE GROWTH CYCLE

Sp. aff. *Ledebouria monophylla* flowers in the spring usually during the last two weeks of October and the first week of November. Bulbs are normally in bud and sometimes also in flower at the time the leaves start to emerge. They initiate bud and leaf development before the summer rains begin, but this process is accelerated if the mountain is subjected to misty conditions in the early spring.

Leaves are fully developed by the time the bulbs have finished flowering and have started to form seeds. Seeds are liberated into the environment in late November and early December. They usually germinate around the parent bulbs, but seeds may be distributed some distance by water runoff after rain showers. Seeds germinate quickly if they ripen at the same time as the occurrence of regular rainfall. Those that land in moist places, usually around seepage areas, do not require rainfall in order to germinate.

This species, like most *Ledebouria* which grow in grassland, is dependent on periodic winter grass fires to clear the habitat of moribund vegetation. In the inter-fire years, flowering is restricted mostly to bulbs growing in open habitat. Bulbs grow well after fires, which is also the time when conditions for seed germination are optimum.

Bulbs enter dormancy in early May at a time when the habitat is drying

Fig. 4. *Ledebouria saundersonii* in full flower high up on the summit of the Steenkampsberg on 24 October. This species is often found growing in fine white sand derived from the surrounding quartzite rocks.

Fig. 5. *Brachystelma stellatum* is often found growing together with *Ledebouria saundersonii* on the Steenkampsberg as a result of road construction. The large step road cuttings create artificial habitats of moist rocky soil with sparse rocky cover ideally suited to these species requirements.

out at the beginning of the rainless winter. The first heavy frosts of the winter can be expected in early May. In years of late heavy rains, stream banks and seepage areas remain moist until well into the winter.

SP. AFF *LEDEBOURIA MONOPHYLLA* IN ARTIFICIAL HABITAT ON THE STEENKAMPSBERG

Many plants in South Africa have adapted to small scale pastoralism and subsistence agriculture. Some species are partially commensal with small-scale pastoralism such as *Zantedeschia jucunda* on the summit of the Leolo Mountains in Sekhukhuneland. (Craib, 2002/2003; 2004). This yellow flowered arum has had its habitat considerably extended by loosely packed stone walls which the local people build to fence in livestock and protect crops. Rock piles left at the edges of agricultural land after it has been cleared extend the habitat of this arum even further.

In western South Africa, agriculture and timber plantations transform habitats into various monocultures. Road building and deep level mining are two activities that respectively extend and preserve habitats. Road reserves and road cuttings preserve plants in areas where the surrounding countryside has become degraded through over grazing and other unsuitable land management practices. Deep-level gold mining, such as occurs west of Johannesburg, has inadvertently protected huge tracts of rocky grassland from habitat degradation and urbanisation (Craib, 2005).

Road reserves have played a significant part in increasing the numbers of sp. aff. *L. monophylla* on the Steenkampsberg, particularly on the summit where there are extensive cuttings or depressions beside the road. This roadside habitat has been stable for several decades since the R 577 roadway was constructed. One bulb population colonising a large road cutting is probably the biggest and most significant on the mountain.

Changes in land use patterns are critically significance for the future of South Africa's bulbous flora. This interesting subject is currently under research by the author for a book.

REFERENCES

Craib, C. 2002/2003. The autecology of *Zantedeschia jucunda* and *Zantedeschia pentlandii* from South Africa's Limpopo and Mpumalanga Provinces. Herbertia 57:77-86.

Craib, C. 2004. Stone walls and stock farmers. Veld and Flora. June, Pp. 52-53.

Craib, C. 2005. Grass Aloes in the South African Veld. Pp. 17-29. Umdaus Press, Hatfield, Pretoria.

Venter, S. 1993. A Revision of the Genus *Ledebouria* Roth (Hyacinthaceae) in South Africa. M Sc Thesis, Department of Botany, Faculty of Science, University of Natal, Pietermaritzburg.

(POST-DATED) ADDENDUM: TAXONOMIC NOTE ON THE IDENTITY OF *LEDEBOURIA MONOPHYLLA**

A.J. Hankey
Walter Sisulu National Botanical Gardens
South African National Biodiversity Institute
P.O. Box 2194
Wilropark 1731, Gauteng, South Africa
E-mail: hankey@sanbi.org

FIELD ACCOUNT

The concept of *Ledebouria monophylla* Venter ined (1993) as based on the material at the type locality is a sound and well defined concept. However, this concept is called into question when several other voucher specimens are examined, some of which are closer to *L. sandersonii* while others represent hitherto undescribed taxa, and these do not share synapomorphies with the type as delimited by Venter ined (1993); viz. *Leaf* solitary, appressed; *Inflorescence* solitary, with peduncle depressed; are included in Venter's concept. The plants from the top of the Steekampsberg as mentioned above by Craib represent a local variant or eco-type of *L. sandersonii* and not *L. monophylla* Venter ined (1993) *sensu stricto*, as the leaves are not always solitary, and the inflorescence is not always solitary and depressed. However, as the epitheton *L. monophylla* Venter has never been formally published, consequently the closest taxon that can be applied to this sub-population referred to by Craib on the Steenkampsberg remains that of *L. sandersonii* (Bak.) Edwards and Venter (2003).

REFERENCES

Venter, S. 1993. A Revision of the Genus *Ledebouria* Roth (Hyacinthaceae) in South Africa. M Sc Thesis, Department of Botany, Faculty of Science, University of Natal, Pietermaritzburg. (Unpublished)

Edwards, T.J. & Venter, S. 2003. A revision of *Ledebouria* (Hyacinthacae) in South Africa. 3. The reinstatement of *L. ensifolia*, *L. galpinii* and *L. sandersonii*. Bothalia 33.1:49-51.

*Editor's Note: *Ledebouria monophylla* sensu Venter has never been formally published, a fact that creates a taxonomic dilemma, especially since what actually constitutes *L. monophylla* may not be fully defined. The most recent opinion on this matter, based upon extensive field research, is that above by Andrew Hankey. Perhaps this issue will be resolved in the future.

MORPHOTAXONOMY AND PALYNOLOGY OF TWO ENDEMIC SPECIES OF *CRINUM* L. (AMARYLLIDACAE) FROM THE WESTERN GHATS OF INDIA

Sachin A. Punekar, Ruta B. Limaye and K. P. N. Kumaran
Palaeobiology and Palaeoclimate Group
Aagharkar Research Institute
G. G. Agarkar Road,
Pune 411 004, Maharashtra, India
E-mail: ruta.limaye@gmail.com

ABSTRACT

Two endemic species of *Crinum* L. (Amaryllidaceae) *viz.*, *Crinum brachynema* Herb. and *Crinum woodrowii* Baker have been studied from taxonomic, palynological and distribution viewpoints. These two species have been recollected after a gap of about a century. Considering their narrow range of distribution and rarity of occurrence in the Western Ghats of India, these little known taxa have far reaching floristic and taxonomic implications. The animal-plant interaction and phenological aspects have also been briefly discussed.

Keywords: India, Western Ghats, *Crinum brachynema*, *Crinum woodrowii*, Amaryllidaceae, taxonomy, pollen morphology, distribution, ecology.

INTRODUCTION

The genus *Crinum* L. (Amaryllidaceae) is remarkably widespread in the tropics and comprises about 120 species (Mabberley, 2000). It belongs to the tribe Amaryllideae (Baker, 1888; Meerow and Snijman, 2001, Meerow et al., 2003) and sub-tribe Crininae (Snijman and Linder, 1996). In India, it is represented by 12 species, 3 varieties and 1 form (Karthikeyan et al., 1989), of which three species and one form, *viz.*, *Crinum brachynema* Herb., *C. elenorae* Blatt. and McC. f. *elenorae*, *C. elenorae* f. *purpurea* Blatt. and McC., and *C. woodrowii* Baker are endemic to Mahabaleshwar and adjoining areas of the Western Ghats (Sundaraghavan and Singh, 1983; Sundaraghavan and Singh, 1984; Singh and Sundaraghavan, 1986; Ahmedullah and Nayar, 1986; Yadav, 1997; Mishra and Singh, 2001; Gaikwad and Yadav, 2002, Punekar et al., 2004). Recently, *C. brachynema* and *C. woodrowii* were recollected from the Kates Point of Mahabaleshwar after a lapse of 94 and 100 years respectively, and the remaining two, *C. elenorae* f. *elenorae* and f. *purpurea* were assumed to possibly be extinct (Yadav, 1997; Mishra and Singh, 2001; Gaikwad and Yadav, 2004; Punekar et al., 2004).

As both *Crinum brachynema* and *C. woodrowii* are restricted to Maharashtra, Gujarat, in a very small pocket of the Western Ghats (Fig. 1), they are considered to be critically endangered (Mishra and Singh, 2001; Gaikwad and Yadav, 2004; Punekar et al., 2004). Considering their precarious status and narrow range of distribution, a morphotaxonomic review including palynological and ecological observations and phytogeographical aspects is presented in the paper to appraise these little known taxa of Amaryllidaceae from the Indian subcontinent.

MATERIALS AND METHODS

The specimens of *Crinum brachynema* and *C. woodrowii* were collected during a floristic survey conducted from May 2000 to July 2004 in and around the Western Ghats of Mahabaleshwar, India (17° 56'. 270" N, 73° 41'. 488" E)

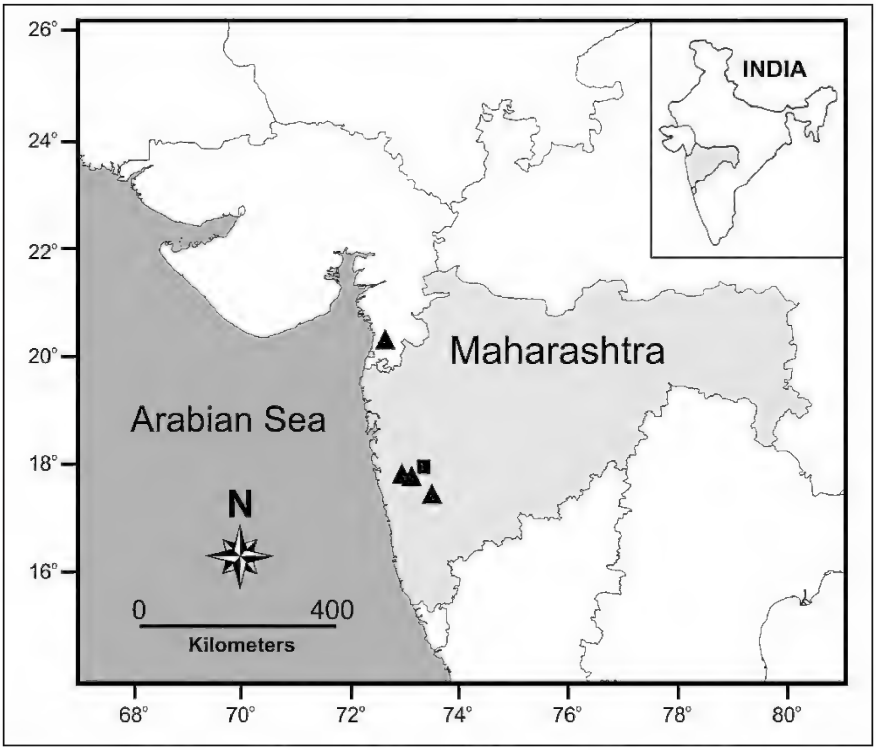

Fig. 1. Localities of *Crinum brachynema* (triangles) and *C. woodrowii* (rectangle) in Maharashtra and Gujrat States of India.

(Fig. 1). The voucher specimens of both species were collected for identification, and which were processed using conventional herbarium techniques and deposited in BSI and K. These two species were identified using the protologue and regional floras such as Herbert (1842), Hooker (1892), Baker (1898), Cooke (1967, Repr.), Deshpande et al. (1993), and Lakshminarasimhan (1996). Special efforts were made to document the habitats, microhabitats, association, phenology, pollinators and potential predators.

Pollen grains were prepared with the acetolysis method of Erdtman (1966). For light microscopy the pollen samples were mounted in glycerine-jelly, sealed with paraffin and then examined with a Leitz Laborlux S research microscope. Permanent slides were deposited at the Pollinarium, Palynological Laboratory of Agharkar Research Institute (A.R.I), Pune. Twenty pollen grains of each species were studied for pollen measurement such as diameter, echinae size (Table 1).

For scanning electron microscopy (SEM) we have followed Juniper et al. (1970) with slight modification. Acetolyzed pollen grains were first washed in 96% alcohol and then absolute alcohol, sputtered with 20 nm of gold with a sputter coater (VG Microtech- Polaron SC 7640, U.K.), and then observed with a Stereo Scan S120 (Cambridge instrument, UK). The terminology applied for pollen grain description in general follows that of Erdtman (1966) and Kremp (1968).

KEY TO SPECIES

1. Leaves not forming a pseudostem, folded, linear-oblong, dark green, obtuse at apex; perianth funnel shaped, segments oblanceolate to oblong; stamens included on the throat of perianth tube; filaments very short (ca. 1 cm long); style shorter than filaments, included in perianth tube; pollen grain exine with bulbous excrescences, micro verrucae dense becoming almost areolate .... **1. *Crinum brachynema***
2. Leaves forming a distinct pseudostem, flat, ensiform, bright green, acute at apex; perianth salver shaped, segments lanceolate; stamens well exerted from the perianth tube, filaments very long (6-7.2 cm long); style longer than filaments, well exerted from the perianth tube; pollen grain exine with echinulate excrescences, micro verrucae distant .... **2. *Crinum woodrowii***

Fig. 2. A. habit of *Crinum woodrowii*; **B**. inflorescence of *Crinum woodrowii*; **C-D**. caterpillar of *Polytela* sp. feeding on the flower and fruit of *Crinum woodrowii* respectively; **E**. flowering habit of *Crinum brachynema*; **F**. inflorescence of *Crinum brachynema*; **G**. vegetative habit of *Crinum brachynema*; **H**. fruiting of *Crinum brachynema*; **I**. seed germination stages in *Crinum brachynema*.

1. Crinum1} brachynema Herb in Bot. Reg. Misc. 28: 36, 1842; Hook. *f.* in Bot. Mag. t. 5937, 1871, *et* in Fl. Brit. India 6: 284, 1892; Baker in Handb. Amaryllid. 88, 1888; Woodrow in J. Bombay Nat. Hist. Soc. 12: 522, 1899; Cooke, Fl. Pres. Bombay 3: 258, 1967 (Repr.); Inamdar in Bull. Bot. Surv. India 10: 131, 1968; Shah, Fl. Gujarat 2: 668, 1978; Sundararagh. and Singh in Jain and Sastry (eds.), Pl. Cons. Bull. 3: 10, 1983, *et* in J. Econ. Taxon. Bot. 5(1): 163, 1984; Singh and Sundararagh. in *ibid.* 8(1): 35, 1986; Bachulkar in Rayat Res. J. 1(2): 114, 1993; Deshp. et al., Fl. Mahabaleshwar 2: 589, 1995; Lakshmin. in Sharma et al. (eds.), Fl. Maharashtra, Monocot. 94, 1996; Yadav in Pokle et al. (eds.), Flow. Pl. Syst. Diver. Part 1: 46, 1997; Mishra and Singh, Endemic and Threatened Flow. Pl. Maharashtra. 218, 2001; Gaikwad and Yadav in Pullaiah (ed.), Biodives. India. 3: 50, 2004; Punekar et al. in J. Econ. Taxon. Bot. 25(3): 629-630, 2001.

Bulbous herbs, 30-60 cm high; bulbs ovoid, 5-8 cm across. Leaves developing after flowers, folded, bright to dark green, linear-oblong, moderately firm, margin entire, apex obtuse. Scapes one, stout, sub-terete, 30-60 cm long. Flowers 5-20 in umbel, fragrant. Spathe valves (involucral bracts) two, opposite, lanceolate, 3-5 cm long. Pedicel as long as ovary. Perianth funnel shaped; tube slightly curved, greenish, 3-5 cm long; lobes six, pure white, ob-lanceolate to oblong, obtuse, cuspidate, many times longer than stamens, ca. 5 cm x 2 cm. Stamens six, included on the throat of perianth tube; filaments short, ca. 1 cm long, included in tube. Style shorter than stamens. Fruit sub-globose (Fig. 2 E-I).

Distribution and ecology: *Crinum brachynema* is distributed in the Kates Point, Mahabaleshwar and Kas Plateau of Satara District, Maharashtra State, India (Cooke, 1967; Bachulkar, 1993; Mishra and Singh, 2001; Punekar et al., 2001). This species further extends up to Dharmapur forest range of the Bulsar District, Gujarat State, India (Inamdar, 1968; Shah, 1978), 17° 56'. 270" N, 73° 41'. 488" E, growing at an elevation of ca. 1275 m, generally on the lateritic plateau in margins of semi-evergreen forest, rarely along the hill slopes, in association with *Curculigo orchioides*, *Curcuma neilgherrensis*, *Euphorbia panchganiensis*, *Habenaria crassifolia*, *H. grandifloriformis*, *Hitchenia caulina*, *Pteris quadriaurita*, *Scilla hyacinthina* and *Strobilanthes reticulatus*. In the Kates Point it starts flowering in the months of May and June, fruiting starts from June onwards. In the Dharmapur forest range of Gujarat, it grows at an elevation 700 m, 20° 36' N, 73° 20' E (Inamdar, 1968).

Specimens examined: **India**: Maharshtra: Mahabaleshwar, Kates Point, 10 Jun 2000, Punekar and Datar **186116** (BSI); same locality, 12 Jun 2004, Punekar **186499** (BSI).

2. Crinum woodrowii 1}Baker in Bot. Mag. 124: t. 7597, 1898; Woodrow in J. Bombay Nat. Hist. Soc. 12: 522, 1899; Cooke, Fl. Pres. Bombay 3: 257, 1967 (Repr.); Sundararagh. and Singh in Jain and Sastry (eds), Pl. Cons. Bull. 3: 10, 1983, *et* in J. Econ. Taxon. Bot. 5: 163, 1984; Singh and Sundararagh. in *ibid.* 8: 35, 1986; Deshp. et al., Fl. Mahabaleshwar 2: 591, 1995; Lakshmin. in Sharma et al. (eds), Fl. Maharashtra: Monocot. 97, 1996; Yadav in Pokle et al (eds)., Flow. Pl. Syst. Diver. Part 1: 46, 1997; Mishra and Singh, Endemic and Threatened Flow. Pl. Maharashtra. 221, 2001; Gaikwad and Yadav in Pullaiah (ed.), Biodivesity of India. 3: 50, 2004; Punekar et al. in Curr. Sci. 87(8): 1049-1051, 2004.

Tall herbs; bulbs 8.6-16.2 cm in diam., globose-spheroidal, outer tunics brown, membranous. Leaves contemporary with the flowers, sometimes appearing after flowering, many (8-17), 45.5-80 x 4.5-14 cm, ensiform, flat, bright green, slightly glaucous beneath, glabrous, apex acute, white waxy, scabrous along margin; leaf sheaths forming a pseudostem. Scapes one, rarely two, arising from bulb outside the tuft of leaves, stout, compressed, 53.5-82.5 x 1-3 cm, green at base and apex, purple in middle, faintly channeled. Flowers 10-20 in umbel, fragrant; pedicels 1-3 cm long, green with purple tinge. Spathe valves (involucral bracts) two, opposite, 8.7-10 x 2.7-3.9 cm, deltoid, obtuse or acute at apex, margin inflexed, often green, purple tinged, nervate, coriaceous. Bracteoles many, 3-8 cm long, filiform, pale yellow or green. Perianth hypocrateriform (salver-shaped); tube 4-8 cm long,

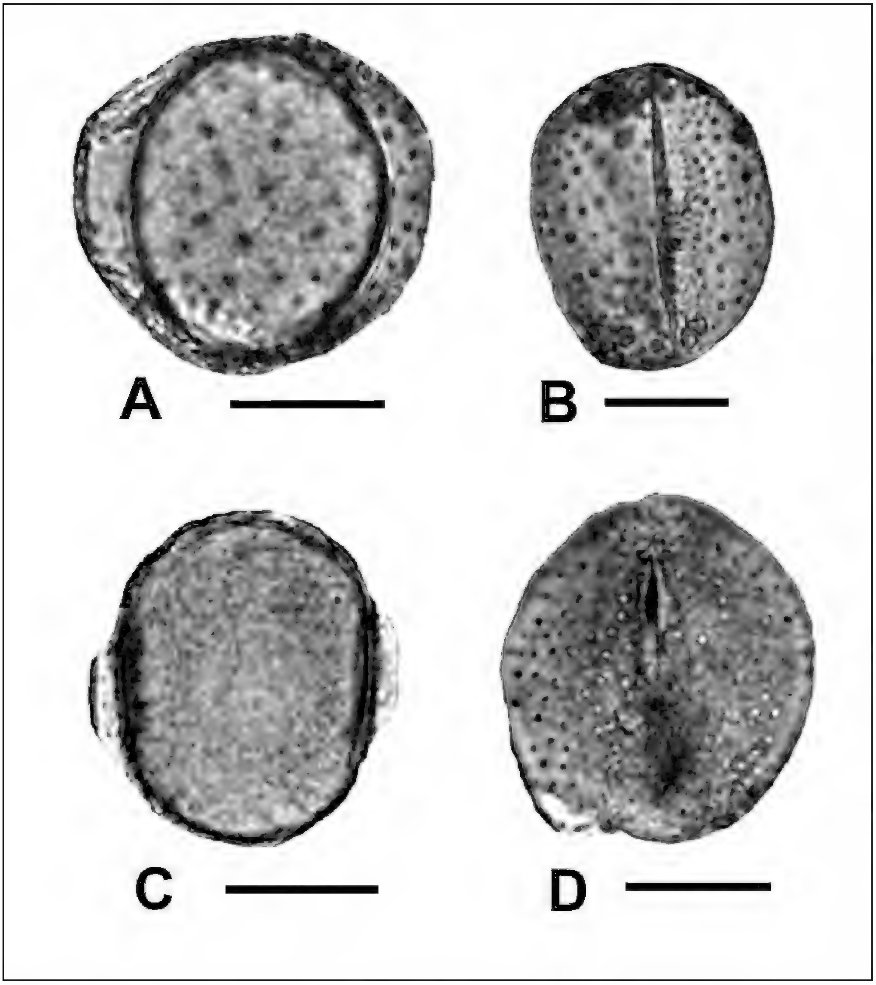

Fig. 3. Light microscopy photographs of pollen grains of *Crinum brachynema* and *Crinum woodrowii*. **A**. polar view of *Crinum brachynema* pollen showing aperture and echinate exine; **B**. equatorial view of pollen of *Crinum brachynema* showing colpus; **C**. polar view of *Crinum woodrowii* pollen showing aperture; **D**. equatorial view of pollen of *Crinum woodrowii* showing colpus and echinate excrescence.
A, **B**, **C**, **D**, scale bar = 25 μm.

terete, curved, green with purple tinge in flowers, purple in buds; segments spreading equally, white, lanceolate, acute at apex, longer than perianth tube, 8.6-10 x 1-1.8 cm, purple tinged on dorsal median line, shining. Stamens 6; filaments 6-7.2 cm long, filiform, white in lower half and at tip, red in upper half, shorter than perianth lobes; anther lobes versatile, linear, crescent, 1.2-1.5 cm long, yellow, grey when wet. Ovary oblong, 8-10 x 3-4 mm, 3-celled, with numerous ovules in axile placentation; ovules sessile; style terete, filiform overtopping the stamens, 15-15.6 cm long, white in lower half, red in upper half; stigma lobed. Fruit irregular in shape, 3-7 cm across, trilocular, finally bursting, apical rostellum ca. 3 cm long. Seeds ca. 3, large, rounded, testa thick, albumen very copious (Fig. 2 A-D).

Distribution and ecology: *Crinum woodrowii* is distributed in the Kates Point, Mahabaleshwar Satara District, Maharashtra State, India (Cooke, 1967; Mishra and Singh, 2001; Punekar et al., 2004), 17° 56'. 270" N, 73° 41'. 488" E, growing at an elevation of ca. 1275 m, on the hill slopes and in valleys in the margins of semi-evergreen forest, in association with *Ceropegia panchganiensis, Curculigo orchioides, Euphorbia panchganiensis, E. pycnostegia, E. rothiana, Lepidagathis cuspidata, Paracaryopsis coelesina, P. malabarica, Pimpinella heyneana, Pinda concanensis, Pteris quadriaurita* and *Themeda tremula.* Flowering starts in the months of May and June, fruiting starts from July onwards. The moth caterpillars of *Polytela* sp. were observed to feed on the scapes, flowers and fruit of this species, this being the first report of *Polytela* sp. pest on *C. woodrowii* (Fig. 2 C-D).

Specimens examined: **India**: Maharashtra: Bombay (Presidency), May 1899, *Woodrow, G. M. s.n.* (CAL); Satara District, Mahabaleshwar, Kates Point, 9 Jun 2001, Punekar, Kavade and Datar **178344** (BSI, K); same locality, 12 June 2004, Punekar and Kavade **187843** (BSI).

PALYNOLOGY

The pollen grains are mono aperturate 1}with the aperture being curved around 3/4th of the grain, leaving a proximal crust, which is fortified by a granular agglutination (Fig. 4D) or produced into a hillock like structure (Fig. 4C). However some grains look to be clearly one furrowed; i.e. monocolpate (Fig. 4B). The exine is heteromorphic with echinate or echinulate excrescences in *Crinum woodrowii* (Fig. 4G) or bulbous excrescences in *C. brachynema* (Fig. 4H); inter excrescences area is micro verrucate, verrucae being distant in *C. woodrowii* (Fig. 4E) and dense becoming almost areolate in *C. brachynema* (Fig. 4F). The comparative pollen morphology shows very clear differences in exine

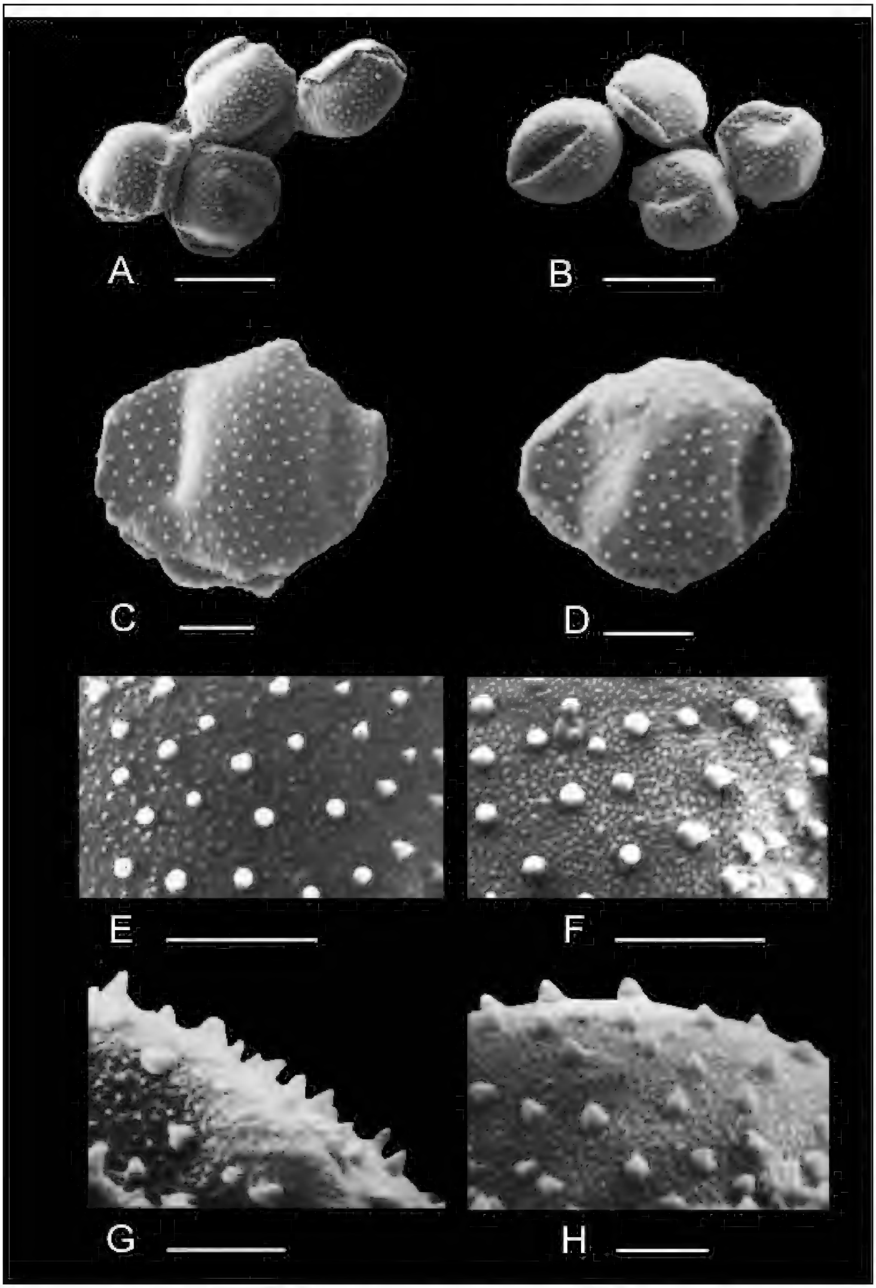

Fig. 5. Scanning electron photomicrograph of pollen grains of *Crinum woodrowii* and *Crinum brachynema*. **A**. pollen grains of *Crinum woodrowii*; **B**. pollen grains of *Crinum brachynema*; **C**. proximal view of *Crinum woodrowii* pollen showing echinate exine; **D**. proximal view of *Crinum brachynema* pollen showing echinate exine; **E**. dense echinulate excrescence and distant micro verrucae of *Crinum woodrowii*; **F**. relatively sparse bulbous excrescence and dense almost areolate micro verrucae of *Crinum brachynema*; **G**. part of exine of *Crinum woodrowii* showing echinate excrescence; **H**. part of exine of *Crinum brachynema* showing bulbous excrescence.

A, **B**, scale bar = 50 μm; **C**, **D**, scale bar = 20 μm; **E**, **F**, scale bar = 10 μm; **G**, **H**, scale bar = 5 μm.

surface ornamentation, both with regards to excrescences and the density of the micro verrucae, which are mentioned in Table 1.

Table 1. Comparison of pollen characters of *Crinum brachynema* and *C. woodrowii.*

Crinum brachynemaCrinum woodrowiiPollen grains ovoidPollen grains depressed globoseSize: 50 x 55 μmSize: 58.82 x 64.70 μmPollen grains mono-aperturate1}Pollen grains mono-aperturateExine with bulbous excrescences, obtuse at apex; base of echinae ca. 1.25 μm across Exine with echinulate excrescences, acute at apex; base of echinae ca. 0.9 μm acrossMicro verrucae dense almost areolate (ca. 420 per 10 μm^{2})Micro verrucae distant (ca. 155 per 10 μm^{2})

DISCUSSION

Both *Crinum brachynema* and *C. woodrowii* are at present restricted to a few pockets of the Western Ghats, and this narrow distribution plus their later rediscovery after a lapse of about a century have floristic and taxonomic implications. In fact, Mishra and Singh (2001) and Gaikwad and Yadav (2004) even thought that *C. woodrowii* was possibly extinct in the wild, while Punekar et al. (2004) considered it a critically endangered species since rediscovering a population of ca. 150 individuals from Mahabaleshwar. *Crinum brachynema* also has a status of critically endangered as suggested by many workers1}. It has also been observed that these two species are found in association with certain bulbous, rhizomatous and tuberous plants, *viz.*, *Ceropegia panchganiensis, Curculigo orchioides, Euphorbia panchganiensis, Hitchenia caulina, Paracaryopsis coelesina, P. malabarica, Pimpinella heyneana, Pinda concanensis* and *Scilla hyacinthina*, within an ecological niche on lateritic plateaus and hill slopes, indicating a habitat preference over other areas. This may be attributed to soil cover of the area which is dominated by a lateritic profile that does not hold water for very long periods. The other probable reason may be that the area is exposed to a much longer dry period, except for the months of the SW monsoon (Jun-Aug), leading to a stressful environment for the bulbous, rhizomatous and tuberous plants. We have also observed that *C. brachynema* generally prefers lateritic plateaus with soil cover, while *C. woodrowii* generally occurs on the slopes and valleys. Another noteworthy observation is that *C. brachynema* has an association with plants found on the plateaus, whereas *C. woodrowii* is found with plants that are typical of slopes and valleys. As bulbs of these two species are attractive to local inhabitants for medicinal and aesthetic purposes (Cooke, 1967; Bachulkar, 1993; Punekar et al., 2004), both species are over-exploited, and as such their survival is threatened. Nevertheless, there is potential for sustainable utility of both species, as they have fragrant and attractive flowers that can be commercially utilized in the pharmaceutical and perfume industries, and they can be multiplied through horticultural development practices. By considering all the facts that we suggest for the conservation of these two critically endangered and endemic taxa, total protection should be given to their microhabitats. *Ex situ* conservation and domestication of these two species in greenhouses and gardens, as well as their reintroduction in the wild in similar habitats, are the most urgent needs. We have also noted that the caterpillar of *Polytela* sp. (a moth) feeds on the scapes, flowers and fruit of *C. woodrowii*, which presents a severe threat to its population as it only feeds on the reproductive parts.

Although palynology of Amaryllidaceae is known (Erdtman, 1966; Kuprianova, 1948), there is hardly any account on pollen of *Crinum* species except that of *C. americanum* L. (Erdtman, 1966; Willard et al., 2004) and *C. pratense* (Nayar, 1990). Comparative pollen morphology of *C. brachynema* and *C. woodrowii* shows very clear differences in exine surface ornamentation, both with reference to excrescence and density of the micro verrucae. It may be noted that the apertural character is primary, and the exine ornamentation is secondary in the levels of phylogenetic importance, the latter of which provides conclusive structural features for taxonomical differentiation of these two species of the genus *Crinum*.

Being bulbous, *Crinum* generally propagate vegetatively. However, seed setting and germination are found within *C. brachynema* (Fig. 2 I) and *C. woodrowii,* and in fact, very common in the former and rare in the latter. We found stingless bees (*Trigona* sp.) and jewel beetles foraging on these two species and are probably associated with pollination. Though three different kinds of dispersal modes, *viz.*, anemochory, atelechory (rain wash) and autochory were reported by Snijman and Linder (1996) in the tribe Amaryllideae, we have observed at Mahabaleshwar that atelechory is present in both the species as this area experiences significant annual rainfall of ca. 6000 mm during the SW monsoon (Jun-Aug) (Deshpande et al., 1993).

The above high resolution morphotaxonomic characters have far reaching floristic and ecological implications to appraise the potential of these two little known endemic taxa for conservation and sustainable utilization.

REFERENCES

Ahmedullah, M. and Nayar, M.P. 1986. Endemic plants of the Indian region. Botanical Survey of India, Calcutta. 1:241.

Bachulkar, M.P. 1993. Endangered endemic taxa of Satara District, Maharashtra. Rayat Res. J. 1:14.

Baker, J.G. 1888. Handbook of the Amaryllideae including the Alstroemerieae and Agaveae. George Bell and Sons, York Street, Convent Garden, London.

Baker, J.G. 1898. Botanical Magazine. 124: t. 7597.

Cooke, T. 1967. The Flora of the Presidency of Bombay. Vol. 3. London (Repr.)

Deshpande, S., Sharma, B.D. and M.P. Nayar. 1993. Flora of Mahabaleshwar and Adjoinings, Maharashtra. Vol. 1. Botanical Survey of India, Calcutta.

Erdtman, G. 1966. Pollen Morphology and Plant Taxonomy. Angiosperms. Hafner, New York.

Gaikwad, S.P. and Yadav, S.R. 2004. Endemic flowering plant species of Maharashtra and their possible utilization. p.50 in Pullaiah, T. (ed.), Biodivesity of India. Vol. 3. Regency Publications, New Delhi.

Herbert, W. 1842. Botanical Register Miscellaneous. 28:36.

Hooker, J.D. 1892. The Flora of British India. Vol. 6. London.

Inamdar, J.A. 1968. A preliminary survey of the Flora of Dharmapur forests in Gujarat. Bull. Bot. Surv. India. 10:126-132.

Juniper, B.E., Cox, G.C., Gilchrist, A. and P.R. Willam. 1970. Techniques for Plant Electron Microscopy. Blackwell Scientific Publications, Oxford and Edinburgh.

Karthikeyan, S., Jain, S.K., Nayar, M.P. and M. Sanjappa. 1989. Florae Indicae Enumeratio: Monocotyledonae. Flora of India Series 4. Botanical Survey of India, Calcutta.

Kremp, G.O.W. 1968. Morphologic Encyclopedia of Palynology. Univ. Arizona Press, Tucson.

Kuprianova, L.A. 1948. Pollen morphology and the phylogeny of the monocotyledons. Comm. Komarow Inst. Acad. Sci. 1:7. [In Russian.]

Lakshminarasimhan, P. 1996. Monocotyledons. In Sharma, B.D., Karthikeyan, S. and N.P. Singh (eds.). Flora of Maharashtra State. Botanical Survey of India, Calcutta.

Mabberley, D.J. 2000. The Plant Book, ed.2. Cambridge University Press (Repr.).

Meerow, A.W. and Snijman, D.A. 2001. Phylogeny of Amaryllidaceae tribe Amaryllideae based on nrDNA ITS sequences and morphology. American J. Bot. 88:2321-2330.

Meerow, A.W., Lehmiller, D.J. and J.R. Clayton. 2003. Phylogeny and bio geography of *Crinum* L. (Amaryllidaceae) inferred from plastid and nuclear non-coding DNA sequences. Bot. J. Linn. Soc. 141:349-363.

Mishra, D.K. and Singh, N.P. 2001. Endemic and threatened flowering plants of Maharashtra. Botanical Survey of India, Calcutta.

Nayar, T.S. 1990. Pollen flora of Maharashtra State India. Scholary Publications, Houston, Texas, U.S.A.

Punekar, S.A., Kavade, S.P., Datar, M.N., Lakshminarasimhan, P. and P.S.N. Rao. 2004. *Crinum woodrowii* Baker (Amaryllidaceae), hitherto assumed to be extinct, rediscovered after a century from Mahabaleshwar, India. Curr. Sci. 87:1049-1051.

Punekar, S.A., Datar, M.N. and P. Lakshminarasimhan. 2001. *Crinum brachynema* Herb. (Amaryllidaceae), an endemic species found again in Mahabaleshwar, Maharashtra State. J. Econ. Taxon. Bot. 25:629-630.

Sundaraghavan, R.S. and Singh, N.P. 1983. Endemic and threatened flowering plants of Western India. p.10 in Jain, S.K. and A.R.K. Sastry (eds.), Plant Conservation Bulletin, Vol. 3. POSSCEF, Botanical Survey of India, Calcutta.

Sundaraghavan, R.S. and Singh, N.P. 1984. An inventory of endemic and vulnerable species of Western India deserving conservation. J. Econ. Taxon. Bot. 5:163.

Shah, G.L. 1978. Flora of Gujarat State. Part II. Sardar Patel University, Vallabh Vidyanagar, Gujarat.

Singh, N.P. and Sundaraghavan, R.S. 1986. Materials for plant conservation in Western India. J. Econ. Taxon. *Bot.* 8:5.

Snijman, D.A. and Linder, H.P. 1996. Phylogenetic relationships, seed characters and dispersal system evolution in Amaryllideae (Amaryllidaceae). Ann. Missouri Bot. Gard. 83:362-386.

Willard, D.A., Bernhardt, C.E. and L. Weimer. 2004. Atlas of pollen and spores of Florida Everglades. Palynology 28:175-227.

Yadav, S.R. 1997. Endemic plants of Peninsular India with special reference to Maharashtra. Pp.31-51 in Pokle, D.S., Kanir, S.P. and V.N. Naik (eds.), Proceedings, VII IAAT Annual Meet and National Conference. Aurangabad, Maharashtra.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Agharkar Research Institute, Pune, and to the Joint Director, Botanical Survey of India, Pune, for facilities and encouragement. Our thanks are due to P. K. K. Nair, Director, Environmental Resources Research Centre, Thiruvanthapuram, for critical comments on palynological aspects, and to Mr. Rajdeep K. Dongre, Electron Microscopy Laboratory, Agharkar Research Institute, Pune for taking SEM photographs. S. A. P. and R. B. L. acknowledge the Council for Scientific and Industrial Research (C. S. I. R.), New Delhi, for providing Senior Research Fellowships.

A STUDY OF *DAUBENYA COMATA* IN THE GRASSLANDS NEAR STILFONTEIN, SOUTH AFRICA

Charles Craib
Box 67142, 2021 Bryanton, South Africa
E-mail: www.penroc.co.za

Photography by Connall Oosterbroek and Carol Knoll

INTRODUCTION

Daubenya comata has been recorded from widely scattered areas across the high altitudes of the west-central South African interior. At the eastern extremity of its distribution range, the bulbs are often associated with heavy black clay soils and short grassland. This species has been recorded only in small numbers, but it was once extremely common around the Modder River east of Bloemfontein in the Orange Free State and east of Stilfontein in the same province. Bulbs decline rapidly in large numbers under conditions of habitat degradation. Habitats become degraded through invasion of the grassland by alien plants and overgrazing by livestock. The account which follows concerns a two year study of *D. comata* in its habitat south-east of Stilfontein in the Orange Free State.

THE STUDY AREA

The study area lies at an altitude of about 1300 m close to a large tributary of the nearby Vaal River, one of the largest watercourses in South Africa. The habitat consists of low lying flats or gently undulating areas of heavy black clay soil. The clay area is only about 300 m wide and is flanked by clay loam which comprises the greater part of the soil profile in the general area.

Daubenya comata occur plentifully in the clay but very sparingly in the adjacent clay loam. They are scattered over an area about a kilometre in length, the bulk of which has been surveyed for a housing development. Houses have not yet been built, probably owing to the difficulty of laying foundations on the clay. The surrounding loamy areas have numerous houses.

Many parts of the habitat are heavily degraded with annual and perennial weeds. Several weeds are indigenous and probably became established during a previous period when the grassland was consistently overgrazed. Other areas of the surrounding veld, particularly those adjacent to the Vaal River, have been completely transformed by the kikuyu grass *Pennisetum*

Fig. 1. *Daubenya comata* habitat at the peak of the flowering season, March 28, 2006. The grass cover was very dense owing to the lack of a grass fire the previous winter and probably the preceding year. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 2. A tributary of the Vaal River in flood after prolonged late summer and early autumn rains. Low lying parts of the habitat were periodically flooded for days or weeks during the late summer and early autumn rains in 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 3. The habitat in early winter, June 6, 2005. *Daubenya comata* were most frequent in the open areas such as those in the foreground. Carol Knoll.*Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 4. The rose coloured *Daubenya comata* in habitat on April 30, 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

clandestinum. The commonest indigenous plants that have assumed the status of a weed are the daisy, *Cotula anthemoides*, and to a lesser extent, another daisy, *Nidonella hottentotica.* The commonest indigenous weeds benefit *D. comata* in the absence of regular winter grass fires, by preventing excessive accumulations of moribund grass. Thick accumulations of dead grass prevent sunlight from reaching the bulbs, and few bulbs come into flower during long intervals between winter grass fires.

BULBOUS AND CORMOUS SPECIES GROWING IN THE SAME AND ADJACENT HABITAT AS *DAUBENYA COMATA*

Daubenya comata and *Moraea* stricta are both able to utilise the heavy clay soil in the habitat. *Moraea stricta* flowers in late winter and early spring at a time when the clay is hard, cracked and dry.

Nerine falcata is well distributed in the clay loam which borders the *Daubenya* habitat, often growing in scattered large clumps of bulbs. It flowers in late January and February. The same clay loam habitat is frequented by a *Ledebouria* species with canaliculated leaves that appears to be undescribed, and by a *Syringodea* species that also may be undescribed. The *Syringodea* species flowers at the same time as *D. comata* in March and April.

THE GROWTH CYCLE

Daubenya comata is dormant from the end of August until the end of January. Occasional unseasonably late rains in July and August may extend the leafing period of a few bulbs until about mid-September.

The first bulbs to produce leaves normally do so in early to mid-February if there has been consistent good rainfall. These bulbs usually grow in depressions which accumulate water after rains. The majority of bulbs produce leaves during March and early April. Flower buds start to form from the time the leaves emerge, usually taking 4-6 weeks to mature.

The flowering period extends from mid-March to early May, reaching a peak from the last week in March to the third week of April. Occasional bulbs flower in late May and early June.

There was an unusual record of a small group of bulbs flowering in mid-July 2006. The latter bulbs were located at the edge of a flooded gulley joining a tributary of the Vaal River. This area was underwater for a few weeks during the peak leafing and bud formation period. It was likely that the late flowering period occurred as a result of these unusual conditions.

Most flowering occurs amongst bulbs growing in open places or where the grass is short. Bulbs in areas with thick layers of dead herbage come into leaf but rarely flower. Winter grass fires play a critical role in keeping the veld sufficiently clear of dead grasses to allow the plants to flower well. The study site lies in an area where fires are actively prevented owing to the nearby housing development. During the non-fire years, mass flowering is restricted to the sides of two infrequently used dirt roads, with one of these roads having a firebreak at its edge. In addition, good flowering occurs each season where there are extensive patches of perennial weeds. The latter have largely replaced the grasses in parts of the study area. Some flowering takes place each season in limited parts of the habitat where the grass cover is naturally sparse.

Flowers are either deep or pale rose, white, or pale to dark lavender. Some white flowers have distinctive lavender anthers. The blooms are strongly scented, having a fragrance reminiscent of frangipani flowers with musky undertones. The probable diurnal pollinators are honey bees and flies. The two different levels of fragrance are interesting, the musky or yeasty tones attracting flies. Bees and flies mostly visit flowers in open situations and where there is sparse grass cover growing nearby. Nocturnal insects do not pollinate the flowers either on cultivated bulbs or those in habitat.

SEEDING AND SEED DISPERSAL

Daubenya comata seeds are well developed a few weeks after pollination but remain green throughout the winter months. The entire infructescence is retracted just below the soil surface after pollination. If there are late rains, these structures are usually covered in clay silt.

The night temperatures often drop to 0°C or lower from late May until early August with severe frost at times. The leaves and seeds forming just below the surface of the soil remain undamaged. The seeds start to ripen in the second half of August. At this stage the infructescence emerges level with the surface of the soil. As the seeds begin to dry out, the entire structure is pushed up 5-7 cm or more above the soil surface. After about 2-3 weeks the dried stem detaches completely from the bulb. The seeds are starting to fall out at this stage and are further distributed as the dry infructescence is blown about by the wind. Some seeds are dispersed when a dry infructescence is crushed under the wheels of a vehicle. All the seeds are exposed when crushed under wheels. They are too heavy to be dispersed further by wind, but they may be transported around the habitat by runoff water when the rains begin in October.

Daubenya comata is capable of producing huge quantities of seed in open habitat readily reached by pollinators. Twenty dried infructescences randomly collected from open parts of the habitat on September 12, 2006 yielded a total of 569 fertile seeds (Table 1). Germination rates are high for this species, and the habitat can quickly become crowded with young bulbs.

Seeds become buried in the habitat before and during the early summer rains. Germination does not however occur until February and March at about the same time the mature bulbs begin to sprout leaves.

DAUBENYA COMATA IN THEIR MODERN HABITAT

Daubenya comata is essentially living in an altered grassland habitat in the study area. The lack of regular winter grass fires has had the effect of restricting the bulbs to open habitats. In addition, porcupines, *Hystrix africaeaustralis*, are very destructive in some years such as during the winter of 2006. These animals are attracted by masses of *Daubenya* bulbs growing close together. They dig into the soil to a depth of 10-30 cm or more and eat nearly all the bulbs. Porcupines feed last in areas containing the fewest numbers of *D. comata* such as denser grassland. These latter areas are usually exploited by the porcupines once the open places have largely been cleared

Fig. 5. Lavender, pink and white flowered *Daubenya comata* growing together in the clay habitat, April 30, 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 6. Pale rose flowered *Daubenya comata* in full flower, April 30, 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 7. White and pink flowered *Daubenya comata*, April 30, 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 8. Pale rose flowered *Daubenya comata* at the peak of the flowering season, April 30, 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 9. White flowered *Daubenya comata* in habitat, April 30, 2006. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

Fig. 10. White flowered *Daubenya comata* sometimes have distinctively pink tinged anthers. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

of bulbs. The areas which have the least numbers of bulbs are usually used as feeding areas towards the end of winter during late July and August. Sometimes the animals dig up single bulbs scattered throughout the habit, and these shallow cavities are dug just deep enough to extract the bulbs.

An estimated three quarters of the existing population of *D. comata* was destroyed by porcupines during the winter of 2006. It will probably take several decades for the population of bulbs to build up to former numbers, should the animals not feed on these bulbs to any significant extent during subsequent winters.

The countryside near the *Daubenya* habitat harbours large numbers of porcupines. These rodents have become common in the region owing to the elimination of natural predators and to the increased food supply provided by agricultural crops.

In addition to *D. comata*, porcupines attempt to feed on *N. falcata* which is common in the adjoining habitat. A few *Nerine* bulbs have been excavated by porcupines, superficially nibbled and then discarded. These bulbs may be toxic to the rodents. The *Ledebouria* species and the *Syringodea* species have not been eaten by these foraging rodents.

Fig. 11. *Daubenya comata* at the beginning of the winter, June 6, 2005. Cracks have started to form in the clay around the plant, typical of the habitat in the winter months. Connall Oosterbroek.*Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

ADAPTIONS OF *DAUBENYA COMATA* TO GROWING IN CLAY

Few bulbous genera frequenting the grassland interior of South Africa have evolved that thrive in clay. However, some bulbous species have adapted to clay based soil, but these are usually found flowering in pans of water or marshes inundated at flowering time. Typical examples of the latter are *Crinum bulbispermum, Gladiolus papilio* and *Nerine platypetala.*

The clay in the *Daubenya* habitat has the characteristic of shrinking and cracking during the later part of the winter and in the early summer before the rains. During the rains the clay absorbs a great deal of moisture and becomes thick and glutinous. *Daubenya comata* grows and flowers in the autumn at a time when the clay is at its wettest and most stable condition.

Towards the end of the winter during July-September, many *Daubenya* bulbs become exposed in the wide fissures that open up in the clay. The bulbs stick to the sides of the clay walls in the fissures. They may be exposed to air and sunlight for 3-4 months before the soil expands once more and the cracks seal up with the beginning of the summer rains.

Large quantities of seed fall into cracks in the dried clay at seeding time in late winter and early spring. These lodge in places where they are too deep to germinate when the clay becomes moist and the cracks seal over.

Fig. 12. *Nerine falcata* flowers in large numbers at the edge of the habitat about 5-6 weeks earlier than *Daubenya comata*. In the background are gathering storm clouds typical of many summer afternoons. Connall Oosterbroek.*Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

INTRODUCTING *DAUBENYA COMATA* TO POPULAR CULTURE

Daubenya comata is a good subject for popular horticulture. It has an attractive, broad, creamy-yellow vertical stripe down each leaf and strongly scented attractive flowers. The bulbs are also easily stored out of the growing medium during dormancy. They thrive in most types of soil even though they are most abundant in clay areas in their natural habitat.

Hadeco, a large bulb company based in Johannesburg, South Africa, will be introducing *D. comata* to popular horticulture in the near future. The bulbs bloom and seed well in cultivation in Johannesburg. The seed producing stocks can be grown in large containers in open sunny places where they can be regularly visited by pollinators throughout the flowering period.

Table 1. Ripe *Daubenya comata* fruit randomly sampled in open areas of the habitat on September 12, 2006.

A. Fruit size ranging from 0.6 cm tall x 1.0 cm wide to 1.4 cm tall x 1.2 cm wide.	B. Fruit size ranging from 2.0 cm tall x 1.2 cm wide to 2.2 cm tall x 1.8 cm wide.
1. 15 fertile seeds, 3 infertile seeds 2. 23 fertile seeds 3. 10 fertile seeds 4. 8 fertile seeds 5. 8 fertile seeds 6. 9 fertile seeds 7. 13 fertile seeds 8. 16 fertile seeds, 1 infertile seed 9. 14 fertile seeds 10. 5 fertile seeds, 2 infertile seeds	1. 31 fertile seeds 2. 34 fertile seeds, 1 infertile seed 3. 40 fertile seeds, 1 infertile seed 4. 27 fertile seeds 5. 41 fertile seeds 6. 77 fertile seeds 7. 73 fertile seeds 8. 36 fertile seeds 9. 42 fertile seeds 10. 47 fertile seeds
Total fertile seeds = 121 Total infertile seeds = 6 Averages seeds/fruit = 12.1	Total fertile seeds = 448 Total infertile seeds = 3 Average seeds/fruit = 44.8

Fig. 13. *Daubenya comata* fruit at the time the supporting peduncle is pushed up above the ground and the seeds are ready for liberation into the environment. Connall Oosterbroek. *Crinum fimbriatulum* Baker in habitat south of Luanda, Angola.

THE IDENTITY OF *CRINUM CRASSICAULE* BAKER (AMARYLLIDACEAE)

David J. Lehmiller, M.D.
18173 Hwy 326 North
Sour Lake, Texas 77659 USA
E-mail: drcrinum@aol.com

BACKGROUND

While camped at Koobie Wells (Köbis) in Ngamiland, Botswana, botanical artist Thomas Baines sketched a watercolor of an unknown *Crinum* in October 1861. He only had a depauperate scape available to illustrate, the specimen having been brought to him by a traveling companion. Needless to say, the watercolor (Fig. 1) was peculiar, and Baines was aware of its imperfections. Quoting Baines(1864): "I sketched a very beautiful umbel of white and pale purple flowers brought home by Chapman, apparently a kind of amaryllis…The flower had been too long gathered to restore itself to form when placed in water, but I believe that when fully opened they turn gracefully outward like the many similar flowers of the country." The umbel consisted of 10 buds and one drooping withered flower; Baines illustrated the withered flower, but he promoted the buds to anthesis. He also wrote in pencil in the margin of the painting that the specimen had been collected on the flats at Koobie Wells, the umbel was badly faded, and that the perianth segments were more recurved in fresh flowers than shown in the watercolor. Adjacent to these comments, he sketched a small trumpet-shaped flower (Fig. 2) characteristic of Subgenus Codonocrinum. (The drooping withered flower demonstrated in the October 1861 painting – with inwardly collapsed segments enclosing the filaments and style – also was characteristic of Subgenus Codonocrinum.) After completing the watercolor, Baines pressed the depauperate scape (Fig. 3); no leaves accompanied the specimen.

Baines maintained detailed maps during his travels. He indicated that Koobie Wells was located circa 45 km south of Lake Ngami, situated in an arid region falling within the fringes of the Kalahari Desert. While still camped at Koobie Wells, Baines painted another flowering *Crinum* in situ (Fig. 4) in November 1861. Quoting Baines: "Sketched a couple of beautiful amaryllidae with which the country now abounds. I find it of no use whatsoever to bother myself with trying to paint the background round the outline of the flower, …" (Baines painted two amaryllids that November day in

Fig. 1. *Crinum crassicaule* Baker, painting by T. Baines, October 1861. (Courtesy of K.)

Fig. 2. Penciled flower by T. Baines in margin of Figure 1 painting. (Courtesy of K.)

Fig. 3. *Crinum crassicaule* Baker. **Botswana**. Koobie Wells, Ngamiland, T. Baines, s.n., October 1861, Holotype, K. (Courtesy of K.)

Fig. 4. *Crinum crassicaule* Baker, painting by T. Baines, November 1861. Lectotype illustration per N.E. Brown. (Courtesy of K.)

1861, the other being *C. lugardiae* N.E. Brown, although the latter painting was never formally identified or acknowledged by either Baker or Brown; it lies unidentified in the archives at Kew.)

When Baker received Baines's pressed specimen and paintings at Kew, he classified it as a new species of Subgenus Crinum. Baker's original handwritten identification on the holotype specimen stated: "*Crinum crassicaule* Baker. South trop. Africa. Oct. Nov. 1861. Coll. T. Baines." (The November date ties together both illustrations.) Baker's description of this species was very brief.

N.E. Brown(1909), a coworker of Baker at Kew, worked on the identification of botanical specimens collected during Major Lugard's 1896-1898 expedition to Kwebe Hills in Ngamiland, Botswana. While doing so, Brown equated painting #45 by Mrs. Lugard with the type specimen for *C. crassicaule* Baker and Baines's two paintings. Brown wrote on Baines's November 1861 painting that it represented the type illustration, and he published an emended detailed description for *C. crassicaule.*

Verdoorn(1969) was confused by the type specimen for *C. crassicaule* Baker. She only examined black and white photographs (taken by E.G.H. Oliver) of the type specimen, Baines's two paintings, and Mrs. Lugard's #45 illustration; she was unaware of Baines's handwritten comments in the margin of the October 1861 painting as well as the penciled sketch of the funnel-shaped flower. She concluded that Baines's October and November paintings represented two different taxa. Verdoorn dismissed Brown's account, claiming that it also represented two different taxa, and she implied that Mrs. Lugard's #45 illustration depicted a taxon belonging to Subgenus Crinum. (The latter interpretation was fallacious; Mrs. Lugard's #45 illustration consisted of two sheets, one displaying a spherical bulb with undulant leaves, a short scape with flowering umbel, and an unambiguous funnel shaped flower characteristic of Subgenus Codonocrinum. Mrs. Lugard's illustration was highly compatible with *C. crassicaule.*) Having thus stated her opinion, Verdoorn defined a new species of Subgenus Codonocrinum, *Crinum foetidum* Verdoorn. She acknowledged that Baines's November 1861 painting was cospecific with *C. foetidum.*

Verdoorn(1973) then completely muddled the situation. She published what she believed to be *C. crassicaule* Baker, complete with a botanical illustration – unfortunately she chose a species of Subgenus Crinum occurring in the Okavango Delta swamps and the flood plains of the Zambezi River that had been described previously, *Crinum subcernuum* Baker. In support-

Fig. 5. *Crinum crassicaule* Baker. Botswana. 50 km east of Maun, Ngamiland. January 1992.

ing her premise, Verdoorn erroneously claimed that Baines had collected *C. crassicaule* in the Okavango swamps north of Lake Ngami. Verdoorn's mistaken account of *C.* crassicaule was widely disseminated. Nordal(1977) and Lehmiller(1992, 1997) commented that Verdoorn had misidentified *C. subcernuum* as *C. crassicaule.*

The confusion generated by Verdoorn led to a formal attempt to declare *C. crassicaule* Baker an illegitimate taxon (Nordal et al, 2002), but this proposal was rejected by the Committee of Spermatophyta. However, lest confusion persist because the type specimen is a depauperate scape lacking leaves, the designation of a topotype specimen is in order.

SELECTING THE TOPOTYPE SPECIMEN

In January 1992, Dave Hardy, Senior Horticulturist from the National Botanical Institute in Pretoria, and I traveled to Maun, Botswana, where we rented a vehicle and began exploring the region about Lake Ngami. Our first encounter with *C. crassicaule* occurred 50 km east of Maun (Fig. 5). Later we traveled south to Kwebe Hills (Quaebie Hills, Kgwebe Hills) where we were driven out by a fierce thunderstorm and were fortunate to escape back to the main tarred highway; we did not observe any *Crinum* at Kwebe Hills, but our encounter was very brief. We traversed Lake Ngami, which

Fig. 6. Topotype inflorescence, *Crinum crassicaule* Baker, May 2005.

was now a dry lake bed overgrown with trees. Then we set off to our main destination, the road from Toteng to Ghanzi (Ghanze, Gantsi) that traveled south of Lake Ngami. The terrain was Kalahari Desert sand, a very arid ecology, and it was currently dry but fortunately there had been some earlier rainfall. Periodically we observed bulbs in leaf of *C. crassicaule*, but beginning 11.5 km north of the Kuke Animal Control Gate at the Ghanzi District boundary until 5.5 km north of the Kuke Gate, *C. crassicaule* was locally common. Per Baines's map, Kuke Gate was located very close to the site of Baines's camp at Koobie Wells (my estimate from Baines's map was less than 10 km); however, the locals and guards at Kuke Gate were not familiar with a location called Koobie Wells or Köbis. (The similarity between "Kuke" and "Koobie" is tempting to speculate upon.) It was during this excursion south of Lake Ngami that a bulb was found in fruit, and the seeds were collected. From these seeds, a flowering bulb was raised in cultivation, and a herbarium specimen was prepared to become the topotype specimen for *C. crassicaule* Baker (Fig. 6-7).

***Crinum crassicaule* Baker.** Handbook of the Amaryllidaceae, p. 85, 1888.
Type: **Botswana.** Koobie Wells, Ngamiland. T. Baines, s.n., October 1861, K.
Type Illustration (per N.E. Brown): T. Baines, November 1861, K.
Emended: N.E. Brown. Bull. Misc. Inform. No.3:142, 1909.
Topotype (designated herein): **Botswana.** 41 km SW of Toteng, Ngamiland.Seed collected 25 January 1992 and cultivated in Texas; Lehmiller **1950**, May 2005, TAMU.
Syn.: *Crinum foetidum* Verdoorn. Bothalia 10: 56-58, 1969.

Fig. 7. *Crinum crassicaule* Baker. **Botswana.** From seed collected 41 km SW of Toteng, Ngamiland, 25 January 1992, and cultivated in Texas. Lehmiller **1950**, May 2005, Topotype, TAMU.

Description (from living plants):
Bulbs large, solitary, spherical, covered with a thick, dark brown parchment-like tunic that turns black when wet, 10.0+ cm diameter, tapering to an underground neck to 14 cm long; with tough wire-like yellowish-white roots to 0.4 cm diameter. Leaves 5-12, forming a rosette, low arching to sprawling on the ground, broadly channeled and often undulant, lacking a midrib effect, margins distinctly ciliate, containing small wooly fibers when torn with torn edges emitting a foul scent, widest near the base, tapering, dull bluish green, 29.5-80.5 cm long and 10.5-21.0 cm wide. Scape short, subterranean to 16 cm long. Spathe valves reflexed at anthesis, dull red with greenish streaking, 18.5-19.5 cm long by 4.8-6.0 cm wide. Umbel 5-17 flowered; flowers zygomorphic, nocturnally opening, suberect at anthesis but inclining soon after sunrise, strongly scented, honey bees noted. Pedicels 2-3 cm long. Ovaries shiny light green, 1.1 cm diameter and 2.0 cm long. Perianth tubes straight at anthesis, becoming curved soon after sunrise, 10.5-12.0 cm long. Buds initially erect, then inclining outward with curved perianth tubes to a horizontal position, before arising to a suberect position with straight perianth tubes at anthesis. Segments lanceolate, distally recurved, white with a pinkish keel only on the dorsal surface, unequal with the inner slightly broader and shorter, 12.5-16.0 cm long and 1.9-3.1 cm wide. Filaments distally curved, white, unequal with those attached to the inner segments longer, 6.8-9.5 cm long. Style white, colored pinkish purple distally, capitate, 11.5-14.5 cm long. Anthers bowed at maturity, light tan, pollen light yellowish tan. Fruit ovoid to slightly lobulated, usually bearing an apical rostellum 1.0-6.0 cm long, green turning light yellow at maturity, indehiscent, 2.5-4.5 cm diameter. Seeds 1-6 per fruit, ovoid to focally angulated from compression by adjacent seeds, papillose, turning brownish black at maturity, foul smelling, 0.8-2.0 cm in diameter.

ACKNOWLEDGEMENTS

I wish to thank personnel at the Herbarium (K), Royal Botanic Gardens, Kew, United Kingdom, for their assistance in locating the paintings and specimens referenced in this manuscript, particularly Mrs. Jill Cowley. My appreciation is extended to Dr. Piet Vorster, Department of Botany and Zoology, University of Stellenbosch, South Africa, for his critical review of this manuscript.

REFERENCES

1. Baines, T. 1864. Explorations in South West Africa being an account of a journey in the years 1861-1862 from Walvisch Bay, on the western coast, to Lake Ngami and the Victoria Falls. London. Reprint (1968) by Gregg International Publishers Ltd, England.
2. Baker, J. 1888. Handbook of the Amaryllideae. London. Reprint (1971) by J. Cramer, Lehre.
3. Brown, N.E. 1909. List of plants collected in Ngamiland and the northern part of the Kalahari Desert, chiefly in the neighborhood of Kwebe and along the Botletle and Lake Rivers. Bull. Misc. Inform. No.3:142.
4. Lehmiller, D.J. 1992. Additional notes on Namibian (South West Africa) *Crinum.* Herbertia 48:75-85.
5. Lehmiller, D.J. 1997. Synopsis of the genus *Crinum* (Amaryllidaceae) in Namibia. Herbertia 52:44-65.
6. Nordal, I., Zimidzi, C., & R. H. Archer. 2002. Proposal to reject the name *Crinum crassicaule* (Amaryllidaceae). Taxon 51:187-188.
7. Verdoorn, I. 1969. Amaryllidaceae, a new species of *Crinum.* Bothalia 10:56-57.
8. Verdoorn, I. 1973. *Crinum crassicaule.* Flow. Pl. Afr. 42:t.1676.

Fig. 8. Topotype bulb in fruit, *Crinum crassicaule* Baker, July 2005.

Fig. 9. *Crinum crassicaule* Baker in cultivation. Photograph taken approximately 15 minutes after sunrise while perianth tubes were still erect. Note similarity with Baines's October 1861 painting including the drooping withered flower.

THE AUTECOLOGY OF *STRUMARIA SPECIOSA* ON THE SONNENBERG, SOUTH-WESTERN NAMIBIA

Charles Craib
Box 67142, 2021 Bryanton, South Africa
E-mail: www.penroc.co.za

Photography by Connall Oosterbroek and Carol Knoll

FIELD ACCOUNT

Strumaria speciosa is one of three recently described species (Snijman, 2005) and has so far only been recorded from the steep uppermost south-facing slopes of the Sonnenberg. The summit slopes of the mountain lie at an altitude of just under 1000 m. The Sonnenberg is the highest of several mountains adjacent to the Orange River to the southeast of Rosh Pinah.

The region in which the species grows is very remote and inaccessible. The bulbs may well occur on the peaks north of the Sonnenberg, one of which rises to an altitude of 1219 m, and also on the peaks around the Namusberg to the northwest, the highest of which lies at an altitude of 1228 m.

The summit and upper slopes of the Sonnenberg attract moisture from cold fronts during the winter months mostly between May and September. There is usually some soft-penetrating rain above 800 m during poorly-developed frontal systems which fail to bring any precipitation to the lower slopes and valley floors.

Present indications are that *S. speciosa* is found growing on dolomite in soft, moisture-retentive, very fine-grained soil. The bulbs occupy three distinct habitat niches. They grow in deep soil pockets between rocks on broken cliff faces, in deep soil on scree immediately below the cliffs, and are sparsely scattered near succulent shrubs up to about 90 metres from the cliffs. These are all positions which attract an abundance of moisture during fog or rain. These *Strumaria* are shaded for most of the day during the winter months, and the soil where they grow remains moist for several days after rain.

At the locality where the investigation was conducted, most of the bulbs grew singly, a few to many metres from one another. Occasionally scattered groups of 2-3 plants were found. The largest bulbs had necks ranging in length from 8-10 cm tall at the point where they emerged from the ground. The bases of the bulb necks, just above the ground, ranged from 2.5-4.5 cm

Fig. 1. The striking fan-shaped foliage of *Strumaria speciosa*, showing the exposed bulb neck and remains of leaves of the previous winter growing season. Photograph by Graham Duncan.

Fig. 2. *Strumaria speciosa* leaves develop quickly after the bulbs receive moisture in April or early May. The bulb necks are typically well exposed above the surface of the soil. Photograph by Connall Oosterbroek.Topotype bulb in fruit, *Crinum crassicaule* Baker, July 2005.

Fig. 3. *Strumaria speciosa* bulbs in full leaf at the end of May. After four weeks of growth, which started at the end of April, leaves are fully developed. Leaves remain in this state until September and then die back with the beginning of warmer weather. Photograph by Connall Oosterbroek.

Fig. 4. *Strumaria phonolithica* in leaf is usually indistinguishable from *S. speciosa*. Photograph taken in late April at the beginning of the leafing season. Photograph by Connall Oosterbroek.

Fig. 5. *Strumaria phonolithica* in full leaf at the end of May. Leaves of this species are fully developed within a month, reflecting the same progress of leaf development that occurs in *S. speciosa*. Photograph by Connall Oosterbroek.

in width. Most of bulk of the bulb necks was comprised of masses of old compacted, water-absorbent bulb tunics that resembled blotting paper in texture.

Smaller bulbs had necks ranging in length from 5.5-6.5 cm at the point where they emerged from the ground. The compacted masses of old bulb tunics ranged in width from 0.5-1.5 cm.

The fan of falcate leaves and the exposed bulb necks with water absorbent qualities are likely to play an important role in trapping moisture and irrigating the bulbs. Further research on this interesting subject is required.

The small population of bulbs widely scattered across the habitat is not readily explained. It is probably linked to the erratic flowering of individual plants and to the extremely rugged and precipitous characteristics of the habitat. Little seed would land in places where it could take root and develop into young bulbs. The population size is also limited by the restricted amount of habitat available. The bulbs only occupy the south-facing slopes close to the summit of the Sonnenberg, and much of this terrain consists of cliffs and stony scree with limited niches for the bulbs to colonise.

The *Strumaria* share their habitat with a rich bulbous and geophytic flora. *Boophane ernesti-ruschii* grows at the same altitude as does an apparently undescribed tuberous *Othonna* with a few large rounded succulent leaves like those of *Tylecodon singularis.*

NOTE

Strumaria phonolithica occurs on the Aurus and Klinghardt Mountains in the Sperrgebiet (forbidden diamond area) in the Namib Desert southeast of Lüderitz. In leaf, *S. phonolithica* is usually indistinguishable from *S. speciosa.* Likely these two species are closely related.

REFERENCE

Snijman, D. A. 2005. Three new species and a new synonym in *Strumaria* (Amaryllidaceae: Amaryllideae) from Southern Africa. Bothalia 35:21-27.

CRINUM ACAULE AND ITS ARTIFICIAL HABITATS IN ZULULAND, KWAZULU NATAL, SOUTH AFRICA

Charles Craib
Box 67142, 2021 Bryanton, South Africa
E-mail: www.penroc.co.za

Photography by Connall Oosterbroek

HABITAT DISCUSSION

The habitat of *Crinum acaule* in Zululand has been transformed in many areas where coastal grasslands have been replaced by timber plantations. This is particularly evident west of Lake St. Lucia, between Hluhluwe and Matubatuba. Further south around Monzi the modern countryside consists of a mixture of timber plantations and sugar cane fields.

The autecology of *C. acaule* has been discussed by Craib and Blackmore (1997). The purpose of this short account is to examine in more depth the artificial habitat frequented by *C. acaule* in areas heavily planted with timber and in sugar cane fields. In these areas *C. acaule* occurs on road reserves, on extensive grassland corridors for the placement of pylons between timber plantations, on grassy runways of small aerodromes, and also on verges of timber-plantation access roads. All of these habitats share similar characteristics. The grass is regularly mowed particularly in the summer growing season. The soil is shallowly rotovated (dug up) by machinery to eliminate weeds and timber. Plantation debris (leaves, bark, twigs) is periodically dumped on some road reserves for collection by logging trucks.

In its natural habitat *C. acaule* is part of the coastal grassland ecosystem. Many grassland plants are dependent on fire to clear moribund grasses and shrublets from the habitat. *Crinum acaule* fails to flower if the habitat becomes thickly covered with an accumulation of dead plant material or when the grass cover is dense. In years when the grass is thick and tall, flowering is restricted to naturally open areas or those that have been kept open by animals such as warthogs (Craib and Blackmore, 1997). *Crinum acaule* differs from all other *Crinum* species in South Africa except *C. minimum* sensu Verdoorn in that flowers appear at or just above ground level. This renders the species very susceptible to degradation via the invasion of weeds, woody plants and grasses if there is a lack of periodic grass fires. In many areas where timber is grown, such as the afforested western areas of the Greater St. Lucia Wetland Park, fire is actively excluded except for local-

Fig. 1. *Crinum acaule* growing along a broad road reserve in the Greater St. Lucia Wetland Park near Charters Creek. The short mowed grass and rotovated soil is visible in the foreground with a typical plantation of exotic *Eucalyptus* in the background.

ized areas where burns are carefully managed. In contrast, *C. delagoense* is better suited to degraded or irregularly burnt habitat on the northern Zululand coastal plain. The latter's flower umbels are held aloft from grass cover, and larger bulbs manage to flower even when the grass is dense.

Crinum acaule has an extended flowering period in artificially maintained grassland habitats. This lasts mostly from September to late November, and one large bulb often produces several scapes during this time. In this respect *C. acaule* is quite unlike other South African *Crinum* species. Its flowers, being highly colourful and large, stand out amongst the short mowed grass and are very attractive to pollinators. They are strongly fragrant from the time they first open usually in the late afternoon or early evening until the time they wither a day or two later.

Flowering plants in areas densely planted with timber often have their reproductive biology affected in a negative manner, failing to attract pollinators. This applies particularly to many of the grass *Aloe* species (Craib, 2005). However, extensive timber plantations do not appear to affect the pollination of *C. acaule*, since bulbs growing in the artificial grassland habitat are regularly found in seed. *Crinum acaule* is one of only two South African *Crinum* species that bears small numbers of seed. The latter are very large with a distinctive rugose covering. They lodge readily around the adult plants. Clumps of 4-14 bulbs are common in the artificial habitats. In natural grassland *C. acaule* rarely forms bulb clusters as opportunities for flowering and producing seeds are more limited.

An undetermined number of seeds and young bulbs are destroyed during mowing and rotovating. These grass cutting and weed controlling activities slow down the recruitment of young bulbs to the artificially maintained *C. acaule* populations. Bulb clumps would be much larger were weed control measures only carried out during the winter and late summer after seeds had the opportunity to establish themselves as young bulblets.

South Africa's grasslands are set to undergo increasing levels of habitat destruction and degradation during the course of this century. It will thus become increasingly important to assess artificially created and maintained habitats for the preservation of different plants. In the case of *C. acaule*, the only bulbs occurring over a wide area of natural grassland habitat are those in the Greater St. Lucia Wetland Park. The latter locality represents a fraction of the total area once frequented by this species. It is important to note that outside of Greater St. Lucia Wetland Park, *C. acaule* populations are well maintained solely as a result of the methods used for maintaining tim-

Fig. 2. *Crinum acaule* prior to anthesis at dusk along a mowed road reserve near Charters Creek, Greater St. Lucia Wetland Park.

Fig. 3. *Crinum acaule* flowers shortly after anthesis in the early evening. Photograph taken at a recently mowed road reserve near Charters Creek, Greater St. Lucia Wetland Park.

Fig. 4. Large bulbs of *Crinum acaule* producing several scapes simultaneously. Photograph taken along a road reserve near Charters Creek in the Greater St. Lucia Wetland Park.

ber plantations, power line reserves and road reserves. Any changes to the status of these artificially maintained areas could have a detrimental impact on the existing populations of this species.

REFERENCES

Craib, C. 2005. Grass *Aloes* in the South African Veld. Pp. 13-16. Umdaus Press, Hatfield Pretoria.

Craib, C. and Blackmore, A. 1997. *Crinum acaule* in Zululand, South Africa. Herbertia 52: 72-80.

CONVERSATION POLICY STATEMENT

The following policy statement was developed by an international consortium which included the representatives of the International Bulb Society, Alpine Garden Society (UK), North American Rock Garden Society, Chicago Botanic Garden and American Daffodil Society.

The total populations and diversity of many plant species across the world are in decline. Habitats are faced with increasing threats of destruction as mankind continues to develop the environment for urban, agricultural and recreational uses.

Plant societies are dedicated to understanding, preserving, growing, selecting, propagating and appreciating the natural flora of the earth. As plant enthusiasts, we share a responsibility to embody the principles of conservation in such a way that our activities as gardeners, horticulturists and botanists are in harmony with the wider concerns of preserving the environment.

Collection of plant material from the wild has left some species of plants facing extinction. The memberships of the undersigned organizations have agreed to abide by the following Code of Best Practice:

- We strive to support organizations that seek to preserve valuable wildlife habits as the sources for genetic variations and naturally thriving plants for generations to come.
- We do not support the practice of wholesale collection for resale of wild plants from their natural habitats. We condemn the practice of misleading the public by calling such collected plants nursery grown or nursery propagated.
- We support the practice of collection of seeds, cuttings, divisions, and the occasional selected individual from large populations of wild plants by knowledgeable and responsible individuals for the purposes of growing, studying, selecting, hybridizing and ultimately propagating and distributing such material to others.

Our support is tendered only where the value of such collection lies in scientific research, preparing herbarium records or propagating such material for horticultural or conservation purposes, and is further based upon the provisos that:

- Discretion is exercised in collecting seed, such that only part of the seed productions is taken.
- Living material is collected only in small amounts.

- In the case of rare plants, material is collected only upon a very limited basis and only where there is sufficient local stock to successfully perpetuate that population.
- We encourage our members to familiarize themselves with and comply with national and local legislation or regulations regarding the conservation of habitats and the collection of plant material.
- We support the sentiments of the various international conventions, such as CITES and the Biodiversity Convention.
- We welcome like-minded organizations to agree to follow this Code of Best Practice.

Schedules: Each plant society or conservation organization is encouraged to list species or classes of plants whose dwindling populations are of imminent concern to them. In this way, all groups can be guided by the knowledge of the specialists and share their concerns.

Adopted by International Bulb Society, July, 2000
Adopted by American Daffodil Society, November, 2000
Adopted by North American Lily Society Board, January 2001

CONTRIBUTOR'S 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 petaloid families rich in bulbous, cormous or tuberous plants, but articles treating any aspects of geophytes are welcome. Articles may be formal (scientific), informal (practical, informative), field reports, historical accounts, addendum notes, and timely reports of Society activities. Contributors are asked to adhere to the following guidelines when submitting papers. Manuscripts departing grossly from this format will be returned to the author(s) for revision.

1. Scientific or technical articles (e.g., taxonomy, plant physiology) submitted for publication in **Herbertia** will often be sent to an appropriate reviewer for peer review. Any article may be scrutinized for accuracy by an appropriate reviewer. Final decision for "acceptance" or "acceptance with revision" of manuscripts resides with the Editor; authors of rejected articles may appeal the decision to the IBS Board of Directors.

2. Manuscripts **must** be typed or produced with legible ink jet or laser printers on 8 1/2 x 11 inch paper. Double spacing should be used throughout.

3. An electronic copy of the manuscript **must** accompany the written copies. This should be provided on a CD/DVD or sent to the Editor as an e-mail attachment. Microsoft Word for Windows versions 6, 7, 97, 2000 and XP are preferred.

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

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

   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, 7.7-10 cm long, 6-7.7 cm in diameter; tunics tan-brown; neck (2.5)-5-8 cm long, 2-2.6 cm thick. Leaves 2, hysteranthous; petiole 27-35 cm long, 7.5-10 mm 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. 10 mm in diameter proximally, ca. 4-6 mm in diameter 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)-22-33 mm long, 1-2 mm in diameter; 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, 5-7 mm long, ca. 5-6 mm wide, constricted at the ovary to ca. 3.8 mm wide, concolorous with the tepals for most of its length, green only at the base; tepals spreading dorsally and ventrally to 23-29 mm wide, recurved and sometimes stained green apically; outer tepals (20)-23-29-(36) mm long, 5-6 mm 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. 9.5 mm wide and situated laterally above the 2 lateral outer tepals, the third one 5-7 mm wide, ventrally declinate and with the lower lateral tepals forming a pseudo-labellum. Stamens subequal, 8.5-11 cm long, filiform, long-declinate, ascendent in their distal 1/4, green; filaments dilated and connate in their proximal 2-3 mm; globose nectar glands present at the perianth throat, each 1-2 mm in diameter; anthers 5.5-6 mm long, oblong; pollen green, the exine mostly tectate-perforate. Style 10-11 cm long, green; stigma less than 1 mm wide. Ovary ellipsoid, 6.5-9 mm long, 4-4.5 mm wide; ovules 20 or more per locule. Capsule 2.5-3 cm long, 17-22 mm in diameter; pedicel 5-6 cm long; seeds numerous, blackish-brown, ca. 6.5 mm long, 1.5 cm 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 specimens **must** be deposited in a herbarium listed in the current edition of *Index Herbariorum.* A diagnostic drawing and/or photo documentation sufficient to distinguish the new taxon **must** accompany the text.

7. Figures preferably should be cited in numerical order in the text as follows: Fig. 1, Fig. 2, etc.; tables as Table 1, Table 2, etc. Figure captions should be provided for all figures at the end of the manuscript. If high quality digital scans of figures can be sent, this is preferred. Scans must have a minimum resolution of 1000 DPI, regardless of size.

8. Literature citations should follow the Harvard system. Author and year of publication are 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 of journal articles and book chapters is capitalized. Journal titles should not be abbreviated.

Sample literature formats are as follows:

Journal Article:

Stebbins, G.L. 1984. Mosaic evolution, mosaic selection and angiosperm phylogeny. Botanical Journal of the Linnean Society 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:

Baker, J.G. 1888. Handbook of the Amaryllideae. George Bell and Sons, London.

9. Figures accompanying contributions may be good quality line drawings, 35 mm slides, or high quality black and white or color photographs (as images). Electronic format for figures is strongly encouraged, and these should be sent in uncompressed TIF format. Color or gray scale photos should be scanned at 1000 dpi; line drawings at 1200. If black and white or color prints are submitted, a charge may be assessed to convert them to electronic format.

10. Financial assistance is welcomed if funds are available to defray costs of publication. Contact the Editor at the address below for more information.

11. **Herbertia** provides one contributor's copy of the journal to each author free of charge as well as an Adobe Acrobat PDF file of the article. Authors desiring printed reprints of their articles must notify the editor when they submit their manuscript. Purchase of reprints will be negotiated directly with the printer by the author, and details will be forwarded on request after the article is accepted for publication.

12. Manuscripts should be sent **in duplicate with electronic version** to:
    David J. Lehmiller, Editor
    HERBERTIA
    18173 Hwy 326 North
    Sour Lake, TX 77659 USA
    Email: drcrinum@aol.com

TWO IBS PINS TO CHOOSE!

(So why not buy both?)

IBS has now produced TWO International Bulb Society pins. Both have been produced in a limited quantity and are destined to become valuable collector's items. Actual size is one inch (25 mm) high x .75 inch (19mm) wide with a tie tack-type back. Number one features *Galanthus nivalis* on a dark blue field (enamel) with "IBS" in gold tone and the whole framed in a gold tone edge surrounding the enamel. The second pin features a photo of *Hippeastrum papilio* with IBS in orange on a maroon background. Order one or both!

$10.00 each

These beautiful collectors' items are available only while supplies last. Order now.

NAME: ____

ADDRESS: ____

CITY ______________________ STATE _____ ZIP OR POSTAL CODE _________

COUNTRY: ________________

QUANTITY ORDERED:
Galanthus nivalis ________ *Hippeastrum papilio* _______ TOTAL ______________

TOTAL ENCLOSED: $_______________

Send your check, cash, or postal money order made out to "International Bulb Society " (US funds only) to: Dave Lehmiller, 18173 Hwy 326 North, Sour Lake, TX 77659, USA. Email to: IBSMEM@aol.com

NOTES

NOTES

NOTES