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COLLECTION AND CONSERVATION OF *ALLIUM* SPECIES FROM UZBEKISTAN AND NEIGHBORING AREAS AND THEIR EVALUATION FOR ORNAMENTAL, EDIBLE, AND MEDICINAL TRAITS

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Executive Summary

Central Asia is the principal center of genetic diversity of the genus *Allium*. About 230 of the 700 *Allium* species grow wild in this region, and over 100 are endemic to the area. The aim of the project is the collection, documentation preservation and initial evaluation of *Allium* flora from Uzbekistan and neighboring areas. The missions are aimed at: (1) Recording information on the distribution of wild populations of *Allium* spp. in Uzbekistan and neighboring areas in Central Asia; (2) Collecting representative samples of wild *Allium* species in the explored regions and of edible alliaceous land-races in Uzbekistan and its neighboring areas.

In the spring-summer of 2001, collecting missions went to the West Tien-Shan area (Chimgan), the southern regions of Uzbekistan and Turkmenistan, to Aksu-Dzhebagly (Kazakhstan), Chatkal biosphere reserve, Ugam-Chatkal national park (Uzbekistan) and to the Fergan depression. The collected material was classified, documented and representative samples of 21 *Allium* species were transferred to Israel for preservation and evaluation. A duplicated parallel collection was established in Tashkent, Uzbekistan.

Evaluation of the preserved material started in October 2001, both in Uzbekistan and Israel. Phenological observations revealed a significant horticultural potential of several *Allium* species as new ornamental crops. The kinetics of florogenesis of *A. ampeloprasum* and the association between phenological cycles and intra-bulb developmental processes was studied, and the scientific foundations were laid for future utilization of these plant species as new ornamental crops in both countries.

Section I

A) Research Objectives:

The present project aims at collecting germplasm of economically important *Allium* species from Uzbekistan and neighboring areas, documenting the geography and environment at their natural habitats, evaluating horticultural traits of and their potential economic importance. We deepened or studies of the phenology, life cycle, morphology and florogenesis of some selected species with apparent economical potential, and determined the environmental conditions required for their efficient seed production.

The objectives for the second year were as follows:

1. To continue and intensify our collecting efforts of *Allium* species from Uzbekistan and neighboring areas; document the geographical locations of their natural habitats and the environmental conditions, Documentation, sorting, and shipping of healthy-looking representative samples of each of the collected material to Israel;
2. To conserve the collected plant material in two parallel gene-banks: in Israel and Tashkent, Uzbekistan, thus guaranteeing the safe keeping of the collection;
3. To perform phenological observations of the material collected in 2001;
4. To study the florogenesis of selected species with ornamental potential and develop methods for bulb forcing thus time, enhance and regulate flowering;
5. To study seed germination of selected species with ornamental potential for future development of propagation systems

B) Research Accomplishments:

Collection missions

Emergence, sprouting and growth of *Allium* flora in Central Asia (Uzbekistan and neighboring areas) occur early in the spring. However, due to size, shape and color, these plants can hardly be detected before summer, when in bloom (Baitulin *et al.*, 1986; Kamenetsky, 1986). The time of bloom varies considerably with species and ecotype, with geographical region, and with environment. It can stretch over a few months, even within a single region. Hence, the success of a collection mission depends on basic knowledge and intimate acquaintance with the plants' phenology and on the local climatic conditions prevailing both in the previous and current growing seasons. The Uzbek (FK) and the Israeli (RK) PIs expertise on the phenology of *Allium* flora in these regions are therefore instrumental for the success of the collection chapter of this project.

The long distances and enormous terrain covered in these missions prohibit repeated return of the plant haunters to the collection sites at the time of seed maturation. Hence, only vegetative propagules (e.g., bulbs, rhizomes, etc.) of the target plants are collected. Such a material can easily transmit pests, and thus requires thorough inspection and at least one growing season under quarantine conditions before it can be safely transplanted into the field genebank or to a designated plot for seed production.

In April 2001, the first collecting mission was carried out by Dr. F. Khassanov, together with Dr. R. Kamenetsky and Prof. H. D. Rabinowitch, in the West Tien-Shan area (Chimgan mountains). Nine accessions of six *Allium* species were collected at bolting or early flowering. An additional four-week mission was organized to the southern regions of Uzbekistan and Turkmenistan in May, during which 23 accessions of 15 species were collected, mostly at flowering stage. A third

two-week mission left in June for three mountainous natural reserves: Aksu-Dzhebagly (Kazakhstan), Chatkal biosphere reserve, and Ugam-Chatkal national park (Uzbekistan), where 12 accessions of seven species were collected. At the end of June, a forth one-week collection mission went to the Fergan depression, where nine accessions of five species were collected. In total, 58 accessions of 34 (of about 380 bulbs) *Allium* species from Uzbekistan and neighboring areas were collected. A detailed map of the region and the actual collection sites are given in Fig. 1. Geographical details and information on the natural habitats were documented in accordance with IBPGR rules (Astley *et al.*, 1982). One half of the collection was planted in the living collection plot at the Botanical Garden, Tashkent. The other part was thoroughly inspected and cleaned before sending to Israel, in July 2001.

In Israel, bulbs were again thoroughly inspected for pests and diseases, sterilized, and stored under low temperatures in accordance with their morphological and taxonomical traits. Rhizomatous species, however, were planted on arrival, without cold treatment. Most bulbous plants were forced (4°C x 8 weeks or 9°C x 4 weeks), prior to planting in November-December, in a net house designated for the *Allium* living collection (Bet Dagan) (Table 1). Phenological observations were performed during the growth and development of the plants.

Phenological observations and assessment of growth and development

Phenological observations in the 2001/2002 season are presented in Table 2 and Figures 2-4.

In Israel, sprouting of *Allium* spp. commences in the autumn, and growth and development occur through the winter, followed by flowering and bulbing in the spring and early summer. The initial phenological characterization of 40 *Allium* entries indicated uniformity within populations of most species (Table 2). Plant populations markedly differ in flowering period. It is not clear yet whether these physiological differences resulted from environmental effects, plants' age or true genetic

variation. Continued observations and studies are necessary to better understand the data in Table 2.

In 2001, the field genebank in Uzbekistan, was reconstructed and accessions were properly identified and tagged. In Tashkent, detailed phenological characterization of 12 *Allium* species demonstrated a significant variability between species in annual development (Figs 2-4). Leaf sprouting begins in November-January. However, low temperatures are required for leaf and floral stalk elongation and thus blooming became obvious mostly in March-April, followed by flowering in April-May.

Seed germination of nine *Allium* species was investigated in Uzbekistan. Imbibitions at 20-25°C resulted in only poor germination, whereas exposure to 4-5^{0}C improved seed germination. Moreover, seeds' stratification of *A. heliocophillum* and *A. giganteum* not only weakened dormancy but also improved germination rate under high temperatures (Figs. 5-6). It became obvious that the ecological conditions in the natural habitat and the consequent genetic make up of the specific mother-plants, growth conditions during seed development and seed maturation at harvest, play an important role in seed germinability. However, closely related plants exhibit similar response and therefore taxonomic relationship can be used as an indication of the conditions required for fast and successful germination.

Florogenesis and developmental morphology of *A. ampeloprasum* was investigated using stereoscope and Scanning Electron Microscopy (SEM). The Uzbek trainee, Dr. H. Shomuradov, carried out this part of the project in Israel.

The kinetics of florogenesis of *A. ampeloprasum*, received from the *Allium* living collection at the Experimental Farm of the Hebrew University at Rehovot, was studied and the association between phenological cycles and intra-bulb developmental processes were elucidated. The

valuable information will be used for educated introduction of the above and related plants as new ornamental crops in both countries.

A. ampeloprasum is perennial bulbous plant with annual root system, and globose bulb. Each of the compact inflorescences contains 50-100 flowers. At bloom, the floral scape bears a spherical, multifloral, dense umbel with purple flowers. Floral development of *A. ampeloprasum* does not occur during storage (Kamenetsky et al., 1999), as initiation of the floral meristem occurs during leaf elongation in plants with already developed 11-13 leaves,.

For microscopic observations by SEM, the vegetative apices or the reproductive meristems were isolated and fixed in a solution containing glacial acetic acid: 40% formalin: 70% ethanol (5:5:90). After dehydration in a graded acetone series (35%, 70%, 70%, 90%, 100%, and 100%), the samples were then critical point dried using liquid CO_2 in Biorad 750 (England) critical point dryer, mounted on SEM stubs with double stick tape, sputter-coated with a 10 nm layer of gold, and studied in a JSM-35C Scanning Electron Microscope (JEOL Japan), using a 15 kV accelerating potential (Kamenetsky, 1994).

***Annual life cycle of A. ampeloprasum in Israel- a general description*:** The initial development of the adventitious roots occurs in October- November, immediately after bulb planting. At this time, several leaf primordia are already differentiated in the apical meristem. Sprouting occurs in November. Thereafter, the leaves grow and elongate quite quickly. The scapes become visible in February and March (Table 3), respectively, while flowering occurs in May, and lasts for two to four weeks. In late-June early-July, after leaf withering and seed maturation, the roots die back and the plants enter a 'rest' period of 3-5 months.

Morphogenesis of monocarpic shoot: *A. ampeloprasum* foliage develops in a sympodial order and is perennial and polycarpic. The renewal bulbs (one-two per plant) perpetuate the perennial growth. They develop in the axils of the youngest leaves, near the base of the floral scape. In

addition, numerous (50-180 per plant) bulblets develop in the axils of outer leaves. These bulblets serve for the vegetative propagation of the species.

Flower initiation begins in January, after formation of 11-13 leaf primordia. Leaf formation ceases with the formation of a leaf homologue, the spathe. This protective tissue differentiates at the apex to form a nearly uniform ring, which envelops the apical meristem. Then, the flat vegetative apex increases in size, becomes spherical and turns into a reproductive apex.

Elongation of the floral stalk and initiation of individual flowers occur simultaneously and become evident early in February, when ten differentiated flower primordia or more become visible (Fig. 7a). Two weeks later, perianth lobes and anthers were observed in some flowers (Fig. 7b), followed by differentiation and development of other floral organs (7c). By the end of March, the inflorescence was almost complete and the floral stalk was ca. 30 cm long, and most flowers were clearly differentiated (Fig. 7d). In each inflorescence, floral differentiation and development are uneven. The inflorescence is made of numerous clusters, each containing 12-15 undifferentiated primordial flower buds and complete flowers (Fig. 7e). However, only oldest flower buds reached full development, while youngest flower buds frequently abort (Fig. 7f)

Table 3. Growth and development of *A. ampeloprasum* plants, in Israel. Bulbs were planted in November and measurements were taken between February and May 2001 (Rehovot, Israel)

Parameters	**Observation Dates**					
	Feb 21	Feb 28	Mar 14	Mar28	Apr 18	May 1
Bulb diameter, cm	2	2.5	2.5	2.5	3	3
Total leaf number	12.5	13	13	13	13	13
Dry leaf number	6.5	9.5	10	11	12	13
Floral scape length, cm	-	8	30	35	53	56
Spathe length, cm	-	6.5	7.5	8	11	12

C) **Scientific Impact of Collaboration:**

Rina Kamenetsky and Haim D. Rabinowitch visited Uzbekistan in April 2001 for coordination, planning of collection missions of wild and domesticated *Allium* spp., and collected information on alliums consumed by man in Central Asia. Together with the Uzbek PI, Dr. Furkat Khassanov, the Israeli PIs participated in several collecting trips in the Tashkent area and in Urgench (desert zone) and visited the living collections of the Botanical Garden in Tashkent. Dr. Khassanov's knowledge on *Allium* taxonomy and phenology is instrumental for the success of the expeditions. The discussions we had during this trip on the appropriate methods of gene banking, with special emphasis on field collections, documentation, preservation and evaluation provided the sound basis for the re-establishment of a local collection in Tashkent. The discussions were illuminating and contributed to the Israeli PIs understanding of the nature of the wild *Allium*'s population distributions in the primary center of evolution in Central Asia.

In January- August 2001, an Uzbek trainee, Dr. Habibullo Shomuradov visited Israel for seven months. During his training the respective *Allium* living collections at the Volcani Center (Bet Dagan) and the Faculty of Agricultural. Food and Environmental Quality Sciences of the Hebrew University of Jerusalem (Rehovot) were studied. During his training, Dr. Shomuradov was exposed to state of the art technologies of light and scanning electron microscopy for developmental and morphological studies, and participated in a study on quality traits in alliums, using chemical analyses and computerized techniques for data analysis.

Most of the above methods and techniques were new for the Uzbek trainee. The use of modern methods for plant evaluation is instrumental for the study and evaluation of the *Allium* living collection in Tashkent, as well as for introduction of other useful species from the natural population of Central Asia.

D) Description of Project Impact

Due to diversity in blooming and its interaction with environment, the collecting missions were successful in collecting the targeted natural *Allium* flora of Uzbekistan and neighboring areas in Central Asia. However, additional missions are essential for collection of many additional species of interest at the center of origin.

The collected material arrived safely in Israel and sprouted in the fall. Luckily, most of the collected material seemed to be free of deleterious pests, and following one annual life cycle under quarantine they were safely introduced into the respective field gene banks with a minimum risk to the current collections. In Israel, *Allium* spp. grow through the winter and spring. We therefore make comparisons of the phenology and launched an initial evaluation study of *Allium* seedlings and adult plans in Israel and Uzbekistan. Plants of interest will be reevaluated in 2002/2003, and the most promising material will be propagated and tested for its potential as new sources of edible, ornamental, or functional crop.

E) Strengthening of Developing Country Institutions: Collection missions in Central Asia have been successful only when support was obtained to cover expeditions' costs as well as the equipment needed for the field works in the natural habitats, and for the maintenance of the living collection. The passport data was recorded in accordance with IBPGR standards by the Uzbek team, and relayed to the Israeli PIs using equipment obtained with the project's funds (computer, printer, fax etc.). This equipment allows the Uzbek researchers to directly link (via internet) into global databases of genetic resources and become an integral donating and receiving members of the international community of scientists in the field. In addition to the significant contribution to our collaborative relations, the seven months training- visit of Dr. Shomuradov to Israel, and the acquisition of modern technologies during his working experience at the laboratories of RK and

HR has strengthened the capabilities of the individual. Moreover, on his return to his homeland this experience will affect also the qualifications of his colleagues and students, as well as those of the scientific community in Uzbekistan. Dr. Shomuradov has also considerably improved his skills in computer analysis of scientific data and his command of English. The administration of the Botanical institute in Tashkent supported the establishment of the living collection. All funds allocated were spent on field trips, salary of technicians and purchase of the necessary equipment.

F) Future Work:

Detailed goals for 2002/2003 vegetative season:

1. Continue the collection activities of *Allium* species in different regions in Central Asia, accurate documentation of the geographical locations and the environmental conditions at the collection sites, according to the International Plant Genetic Resources Institute (IPGRI, Rome) guidelines. A complete documentation, a meticulous sorting, and thereafter shipping of healthy-looking representative samples of each of the collected material to Israel;
2. Conserve the collected plant material in two parallel gene-banks: in Israel and Tashkent, thus guaranteeing the safe keeping of the collection;
3. Perform phenological observations of the material collected in 2002;
4. Study intrabulb florogenesis of the species with ornamental potential;
5. Evaluate samples of the collection in Israel for their nutraceutical traits (dry matter and S-containing compounds).

Section II

A) Managerial Issues: The project is being carried out according to the original plan.

B) Budget: Since this research is seasonal, most of our budget is spent in Uzbekistan during the summer period (for plant collecting) and in Israel during winter and spring (for propagation, cultivation and evaluation of the collected plants). Consequently the money is being spent at an uneven rate.

C) Special Concerns: The project is being carried out according to the original plan, and we cannot foresee any major problem.

D) Collaboration, Travel, Training and Publications: Reciprocal visits, and continuous personal communication between the Uzbek and Israeli participants by E-mail and FAX, were instrumental for planning, coordination and organization of the collection missions. This ongoing communication has resulted in tightened research and personal relationships between the research teams. International standards and rules related to the above goals and activities have been introduced in Uzbekistan and adopted by local scientists as standard procedures.

E) Request for American Embassy Tel Aviv or A.I.D. Actions No requests

Figure Legend:

Fig. 1 Collection sites in Uzbekistan, Kazakhstan, Kirgizia and Tadjikistan in 2000-2001. Entry numbers as in Table 1.

Fig. 2. Phenological characteristics of *Allium helicophyllium, A. protensum, A. victoris* and *A. alaicum* from the living collection in Tashkent, Uzbekistan.

Fig. 3. Phenological characteristics of *A. giganteum, A. issakulii* ssp. *nuratense, A. issakulii* ssp. *subkopetdagenses* and *A. backhousianum* from the living collection in Tashkent, Uzbekistan.

Fig. 4. Phenological characteristics of *A. lipskyanum, A. aflatunense, A. zengericum* and *A.pseudowinklerianum* from the living collection in Tashkent, Uzbekistan.

Fig. 5 Effect of stratification at low or high temperature on germination rates of *Allium pseudowinklerianum, A. protensum, A. helicophillum, A. alaicum,* and *A. giganteum.*

Fig. 6 Effect of stratification at low or high temperature on germinination rates of *Allium lipskyanum, A. aflatunense, A. victoris* and *A. zengericum*

Fig. 7 Photomicrographs of floral development of *Allium ampeloprasum*

a- Floral initiation in reproductive meristem. Individual flower primordia (fp) and differentiated flowers (f) are visible. Spathe (sp) removed. Scanning electron microscopy, February 2001. Bar=0.1 mm

b- Uneven floral differentiation in the apical meristem. Individual differentiated flowers (f) at various stages of development are visible. Scanning electron microscopy, February 2001. Bar=0.1 mm

c- Differentiation of the individual flower: perianth lobes (pl) and anthers (a) form first, gynoecium (g) form in the center of flower later. Scanning electron microscope, February 2001. Bar=0.1 mm

d- Perianth lobes of the differentiated flowers attain greenish-purple color. Stereoscopy, March 2001

e- Flower differentiation in March. Inflorescence consists of numerous differentiated flowers (f) Scanning electron microscope, March 2001. Bar=0.1 mm

f- Developed inflorescence of *A. ampeloprasum* before spathe opening in May. Fully differentiated flowers (f) with elongated pedicels are visible. In the inflorescence basis, many flower primordia are aborted (af). Stereoscopy, May 2001.

Table 1. List of *Allium* species collected during 1999-2001 in Uzbekistan (UZ) and other Central Asia countries. Following quarantine inspection and appropriate storage, the propagules were planted at the Volcani Center, Bet Dagan. Original records are kept in Bet Dagan.

Passport Number	Entry Number	Botanical name	Country	Date of collection	Location	Storage
1	X-1-99	***A. isamulii ssp. nutanense***	UZ	Oct 99	*Allium* genebank, Tashkent	4^0C Oct 27- Dec 10
2	X-2-99	***A. popovii***	UZ	July 99	West PamiroAlai, Nuratau mnts	-
3	X-3-99	***A. aroides***	UZ	Aug 99	West PamiroAlai, Gissar mnt	4^0C Oct 27- Dec 10
4	X-4-99	***A. protensum= A. shubertii***	UZ	June 99	Kizilgiri, Bukhara	4^0C Oct 27- Dec 10
5	X-5-99	***A. motor***	UZ	May 99	Chimgan	4^0C Oct 27- Dec 10
6	X-6-99	***A. turkestanicum***	UZ	July 99	Pamiroalai, Djizak	-
7	X-7-99	***A. filidens***	UZ	June 99	West Tian Shan	-
8	X-8-99	***A. sabulosum***	UZ	June 99	Kizil Kum	-
9	X-9-99	***A. aff. simile***	UZ	Aug 99	West Tian Shan, Ugam ridge	4^0C Oct 27- Dec 10
10	X-10-99	***A. filidens***	UZ	June 99	Nuratau range	-
11	X-11-99	***A. rosenorum***	UZ	June 97	Varzob	4^0C Oct 27- Dec 10
12	X-12-99	***A. victoris***	UZ	June 98	Alymtau	-
13	X-13-99	***A. backanstanum = A. gulczense***	UZ	May 98	Tian Shan, Fergan montain range, near vil. Gun'ga	4^0C Oct 27- Dec 10
14	X-14-99	***A. aflatunense***	UZ	June 97	West Tian Shan, near Sarigenen	4^0C Oct 27- Dec 10
15	X-15-99	***A. pallasii***	UZ	June 98	Near Osh town	-
16	X-16-00	***A. chinense***	UZ	Feb 00	Dasha	-

17	X-17-00	*A. sp. (sect. Allium)*	UZ	Jan 00	Tachkent-Akademgorodok	-
18	X-18-00	*A. zergericum*	KR	July 00	Uzgen	4^0C Nov 8- Dec 10
19	X-19-00	*A. giganteum*	UZ	June 00	Surkhandarja disrtict	4^0C Nov 8- Dec 10
20	X-20-00	*A. zergericum*	KR	July 00	Uzgen	4^0C Nov 8- Dec 10
21	X-21-00	*A. filidentiforme*	KR	July 00	Dzalabad	9^0C Nov 8- Dec 10
22	X-22-00	*A. alaicum*	KR	July 00	Aravan	9^0C Nov 8- Dec 10
23	X-23-00	*A. margaritae*	KZ	June 00	Chu-Ili mnts	9^0C Nov 8- Dec 10
24	X-24-00	*A. protensum*	KZ	June 00	Chu-Ili mnts	9^0C Nov 8- Dec 10
25	X-25-00	*A. talassicum*	KZ	June 00	Chu-Ili mnts	-
26	X-26-00	*A. pseudowinklerianum*	KR	July 00	Uzgen	9^0C Nov 8- Dec 10
27	X-27-00	*A. aff.fetissowii*	UZ	June 00	Chimgan	9^0C Nov 8- Dec 10
28	X-28-00	*A. altissimum*	UZ	June 00	Nuratau reserve station	4^0C Nov 8- Dec 10
29	X-29-00	*A. aff.altissimum*	UZ	June 00	Dhizzak	4^0C Nov 8- Dec 10
30	X-30-00	*A. aff.altissimum*	UZ	June 00	Dhizzak	4^0C Nov 8- Decr 10
31	X-31-00	*A. aff.altissimum*	UZ	May 00	Samarkand	4^0C Nov 8- Dec 10
32	X-32-00	*A. griffithianum*	UZ	May 00	Samarkand	4^0C Nov 8- Dec 10
33	X-33-00	*A. sarawschanicum*	UZ	May 00	Samarkand	9^0C Nov 8- Dec 10
34	X-34-00	*A. sarawschanicum*	UZ	May 00	Samarkand	9^0C Nov 8- Dec 10
35	X-35-00	*A. suworowii*	UZ	May 00	Samarkand	4^0C Nov 8- Dec 10
36	X-36-00	*A. stipitatum*	UZ	May 00	Samarkand	4^0C Nov 8- Dec 10

37	X-37-00	*A. oschanini*	UZ	May 00	Samarkand	-
38	X-38-00	*A. lipskianum*	UZ	June 00	Shargun	4^0C Nov 8- Dec 10
39	X-39-00	*A. aff.simile*	UZ	Aug 00	Sidzhak	4^0C Nov 8- Dec 10
40	X-40-00	*A. oreoscordum*	UZ	Aug 00	Sidzhak	-
41	X-41-01	*A. christophii*	TR	April 01	60 km eastern Ashgabat	4^0C Sep 23- Nov 25
42	X-42-01	*A. giganteum*	TR	April 01	60 km eastern Ashgabat	4^0C Sep 23- Nov 25
43	X-43-01	*A. helicophyllum*	TR	April 01	60 km eastern Ashgabat	4^0C Sep 23- Nov 25
44	X-44-01	*A. protensum*	UZ	June 01	Tashkent living collection	4^0C Sep 23- Nov 25
45	X-45-01	*A. cupuliferum*	UZ	April 01	West Pamiroalai, mnt Aktau	4^0C Sep 23- Nov 25
46	X-46-01	*A. longicuspis*	UZ	April 01	West Pamiroalai, mnt Akatu, near Langar vil.	4^0C Sep 23- Nov 25
47	X-47-01	*A. baissunense*	UZ	May 01	West Pamiroalai, Baissun mnts, near Bajssun vil.	4^0C Sep 23- Nov 25
48	X-48-01	*A. verticillatum*	UZ	May 01	West Pamiroalai, Hissar mnts, near Derbent	9^0C Sep 23- Oct 25
49	X-49-01	*A. gypsaceum*	UZ	May 01	West Pamiroalai, Bajssun mnts, near Bajssun vil	4^0C Sep 23- Nov 25
50	X-50-01	*A. margaritiferum*	UZ	May 01	West Pamiroalai, Bajssun mnts, near Bajssun vil.	9^0C Sep 23 – Oct 25
51	X-51-01	*A. nevskianum*	UZ	May 01	Hissar mnts, near Sangardak vil.	4^0C Sep 23- Nov 25
52	X-52-01	*A. taeniopetalum*	UZ	May 01	West Pamiroalai, Aktau mnts, near Langar vil.	-
53	X-53-01	*A. karataviense*	UZ	May 01	West Tien-Shan, Kurama mnts, near Chetsu vil	4^0C Sep 23- Nov 25

54	X-54-01	*A. tashkenticum*	UZ	May 01	West Tien-Shan, Chatkal mnts, near Akasagata vil	-
55	X-55-01	*A. eriocoleum*	UZ	May 01	West Tien-Shan, Chatkal mnts, near Akasagata vil	-
56	X-56-01	*A. filidens*	UZ	May 01	West Tien-Shan, Chatkal mnts, near Akasagata vil	4^0C Sep 23- Nov 25
57	X-57-01	*A. caesium*	UZ	May 01	West Tien-Shan, Ugam mnts, near Khumsan vil	9^0C Sep 23- Oct 25,
58	X-58-01	*A. motor*	UZ	May 01	West Tien-Shan, Chatkal mnts, near Aksagata vil	9^0C Sep 23- Oct 25,
59	X-59-01	*A. sewerzovoides*	UZ	May 01	West Tien-Shan, Chatkal mnts, near Akasagata vil	4^0C Sep 23- Nov 25
60	X-60-01	*A. sewerzovoides*	UZ	May 01	West Tien-Shan, Chatkal mnts, near Chimgan vil	4^0C Sep 23- Nov 25
61	X-61-01	*A. stipitatum*	UZ	June 01	Tashkent living collection	4^0C Sep 23- Nov 25
62	X-62-01	*A. oreophilum*	UZ	July 01	Chatkal reserve	4^0C Oct 15 -Dec 15
63	X-63-01	*A. bashkyzylsaicum*	UZ	July 01	Chatkal reserve	9^0C Oct 15 -Nov15
64	X-64-01	*A. pskemense*	UZ	July 01	Chatkal reserve	-
65	X-65-01	*A. sp. nov*	UZ	Aug 01	Surchandarja district, Bajssun mnts	-

Table 2. Phenological characterization of some *Allium* species collected in Uzbekistan and Central Asia during 1999- 2001. Following quarantine inspection and appropriate storage, the propagules were planted at the Volcani Center, Bet Dagan. Original records are kept in Bet Dagan.

Entry	*Allium* species	Sprouting	Bolting	Flowering	Senescence	Color
1-99	*A. isamulii*	26. 11	2. 01	20. 02	26. 03	purle
3-99	*A. aroides*	27. 11	26. 02	24. 03	25. 03	purple
4-99	*A. protensum*	19. 11	4. 01	15. 01	28. 03	pink
5-99	*A. motor*	11. 12	-	-	5. 03	
7-99	*A. filidens*	15. 11	-	-	5. 03	-
8-99	*A. sabulosum*	6. 11	-	-	5. 03	-
9-99	*A. aff. simile*	14. 11	11. 02	25. 02	26. 03	purple
11-99	*A. rosenorum*	-	-	-	5. 03	-
12-99	*A. victoris*	14. 11	died			
13-99	*A. backanstanum*	-	died			
14-99	*A. aflatunense*	-	died			
18-00	*A. zergericum*	28. 12	8. 02	20. 03	24. 04	purple
20-00	*A. zergericum*	15. 1	-	-	25. 03	-
21-00	*A. filidentiforte*	24. 12	-	-	25. 03	
22-00	*A alaicum*	21. 12	-	-	25. 03	-
23-00	*A. margaritae*	12. 11	-	-	25. 03	
24-00	*A. protensum*	26. 12	8. 02	15. 03	5. 04	white
25-00	*A. talassicum*	15. 11	-	-	25. 03	-
26-00	*A. pseudowinklerianum*	6. 01	10. 03	15. 03	1. 04	purple
27-00	*A. aff fetissowii*	15. 01	19. 03	1. 04	12. 04	purple
28-00	*A. altissimum*	4. 01	-	-	25. 03	-
29-00	*A.aff.altissimum*	27. 12	4. 03	19. 03	1. 04	purple
30-00	*A. aff. Altissimum*	31. 12	4. 03	15. 03	15. 04	purple
31-00	*A. aff. Altissimum*	2. 01	11. 02	19. 03	12. 04	pink
32-00	*A. griffithianum*	20. 12	4. 03	12. 03	10. 04	purple

33-00	*A. sarawschanicum*	4. 1	4. 03	28. 03	12. 04	white
34-00	*A. sarawschanicum*	3. 1	11. 2	28. 03	12. 04	rose
35-00	*A. sitworowii*	28. 12	-	-	25. 03	-
36-00	*A. stipitatum*	28. 12	11. 2	19. 03	12. 04	pink
37-00	*A. oschanini*	25. 11	28. 2	12. 04	30. 05	white
38-00	*A. lipskianum*	28. 12	4. 03	12. 3	1. 4	white
39-00	*A. aff. simile*	14. 1	-	-	25. 03	-
40-00	*A. oreoscordum*	5. 12	-	-	25. 03	-

Fig. 1 Collecting sites in Uzbekistan, Kazakhstan, Kyrgyzstan and Tajikistan in 1999-2001.

Entry numbers as in Table 1

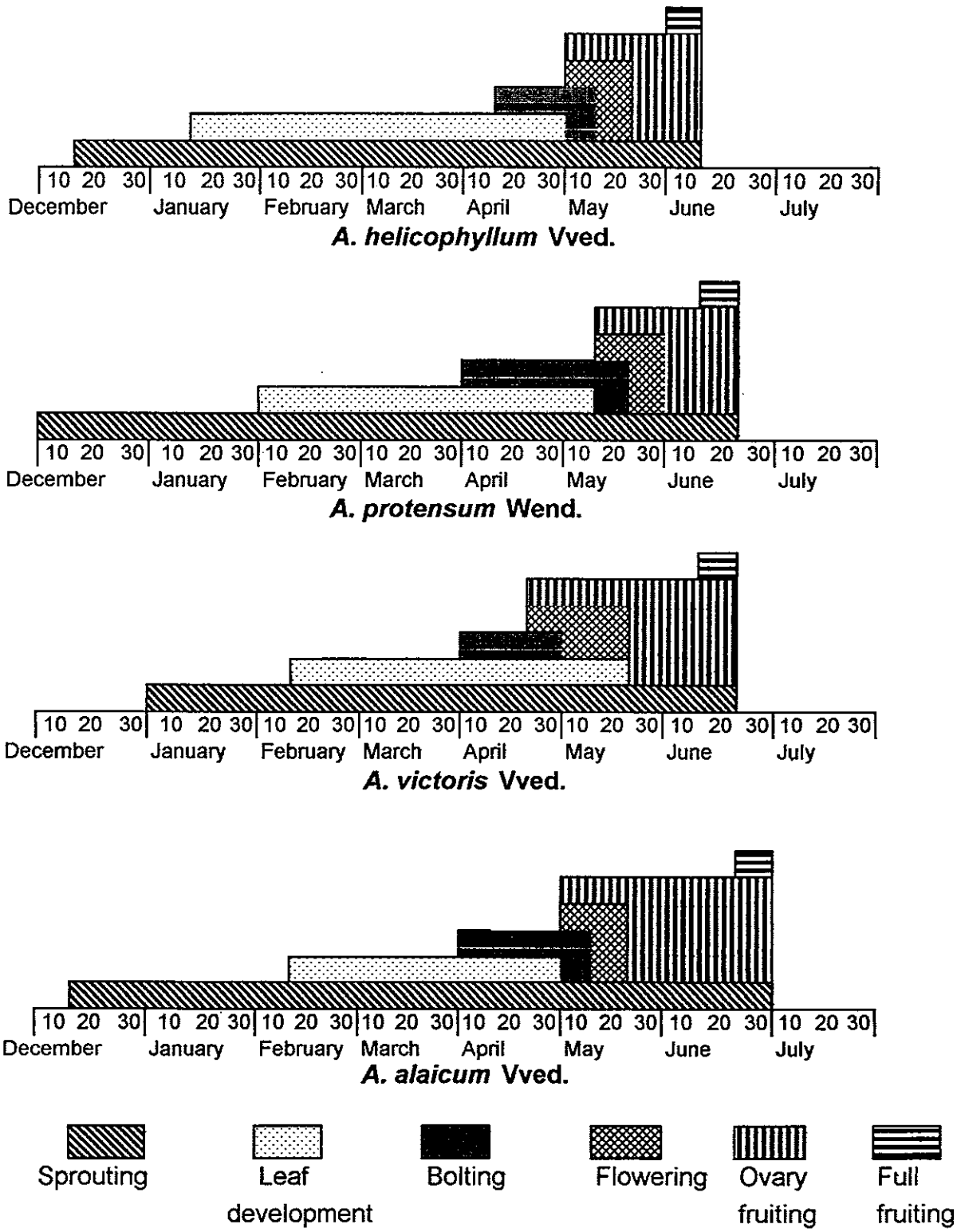
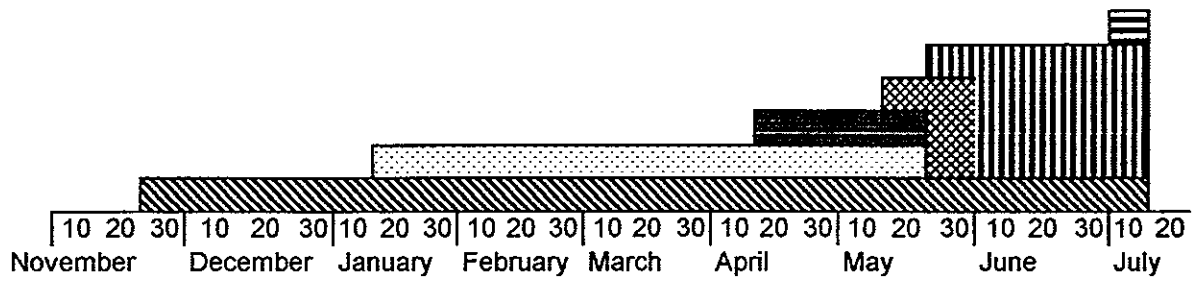
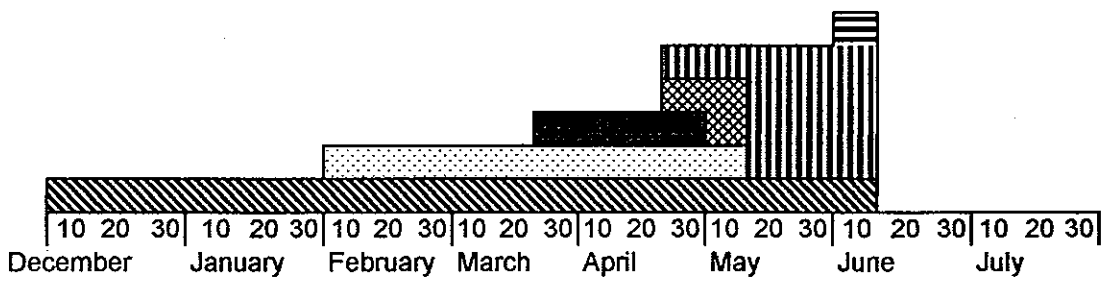

10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30
December January February March April May June July
A. helicophyllum Vved.
10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30
December January February March April May June July
A. protensum Wend.
10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30
December January February March April May June July
A. victoris Vved.
10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30
December January February March April May June July
A. alaicum Vved.
Sprouting
Leaf development
Bolting
Flowering
Ovary fruiting
Full fruiting

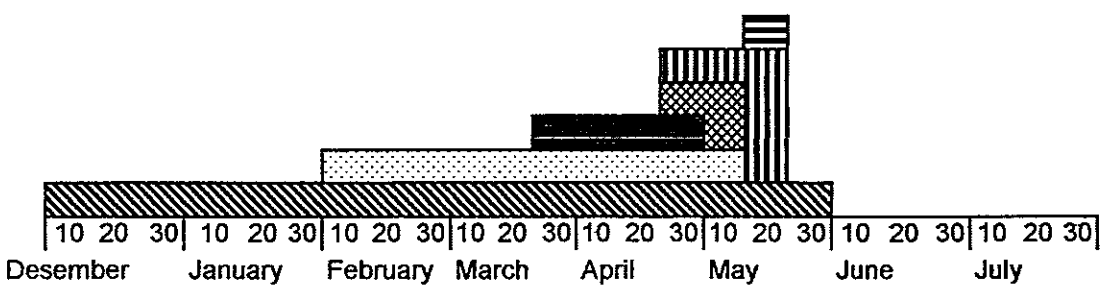
Fig. 2



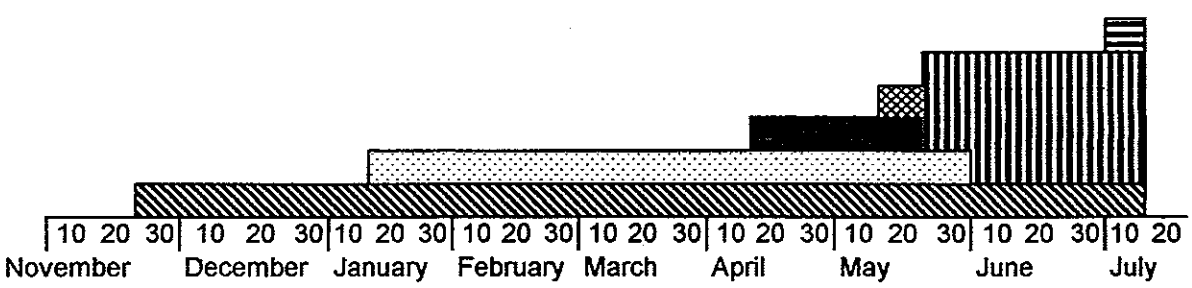
A. giganteum **Rgl.**



A. issakulii **ssp.** ***nuratense*** **R.M. Fritsch et F.Khass.**

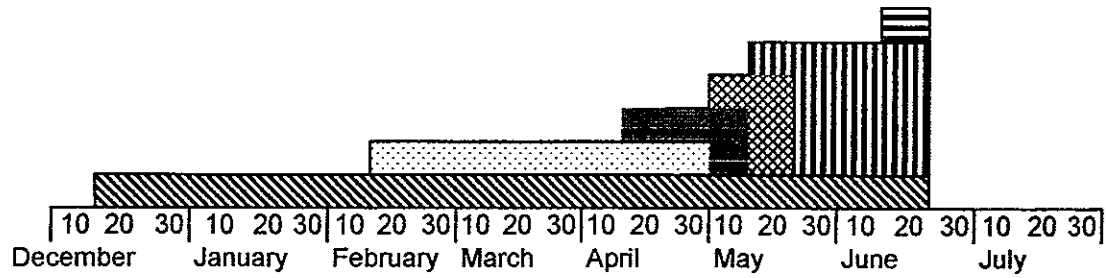


A. issakulii **ssp.** ***subkopetdagense*** **R.M. Fritsch et F.Khass.**

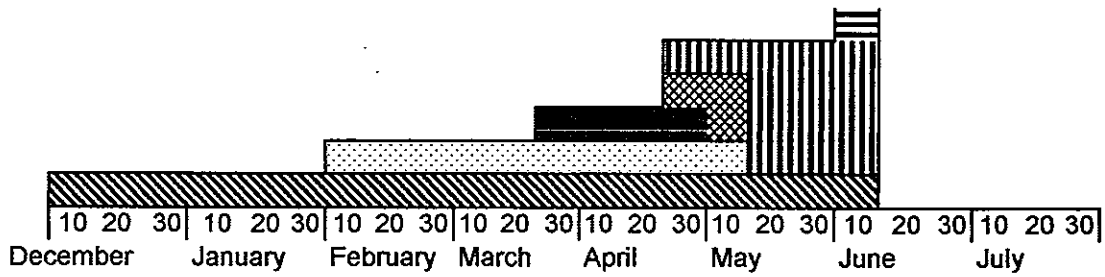


A. backhousianum **Rgl.**

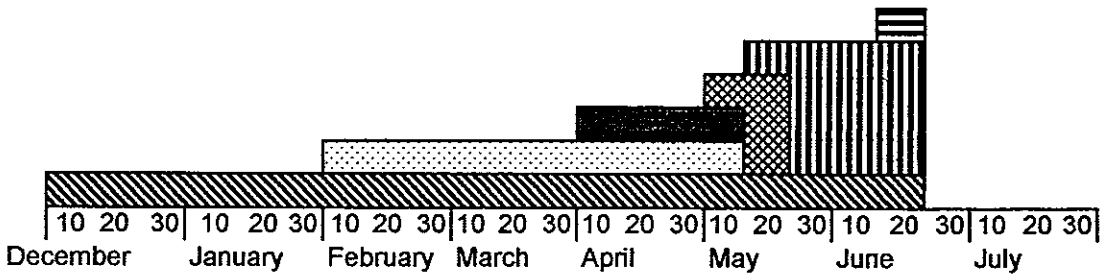
Fig. 3



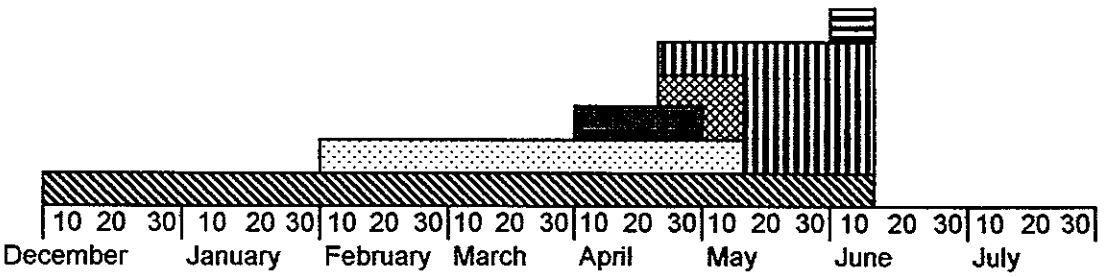
***A. lipskyanum* Vved.**



***A. aflatunense* Rgl.**



***A. zergericum* F.Khass. et R.M. Fritsch**



***A. pseudowinklerianum* R.M. Fritsch et F.Khass.**

Fig. 4

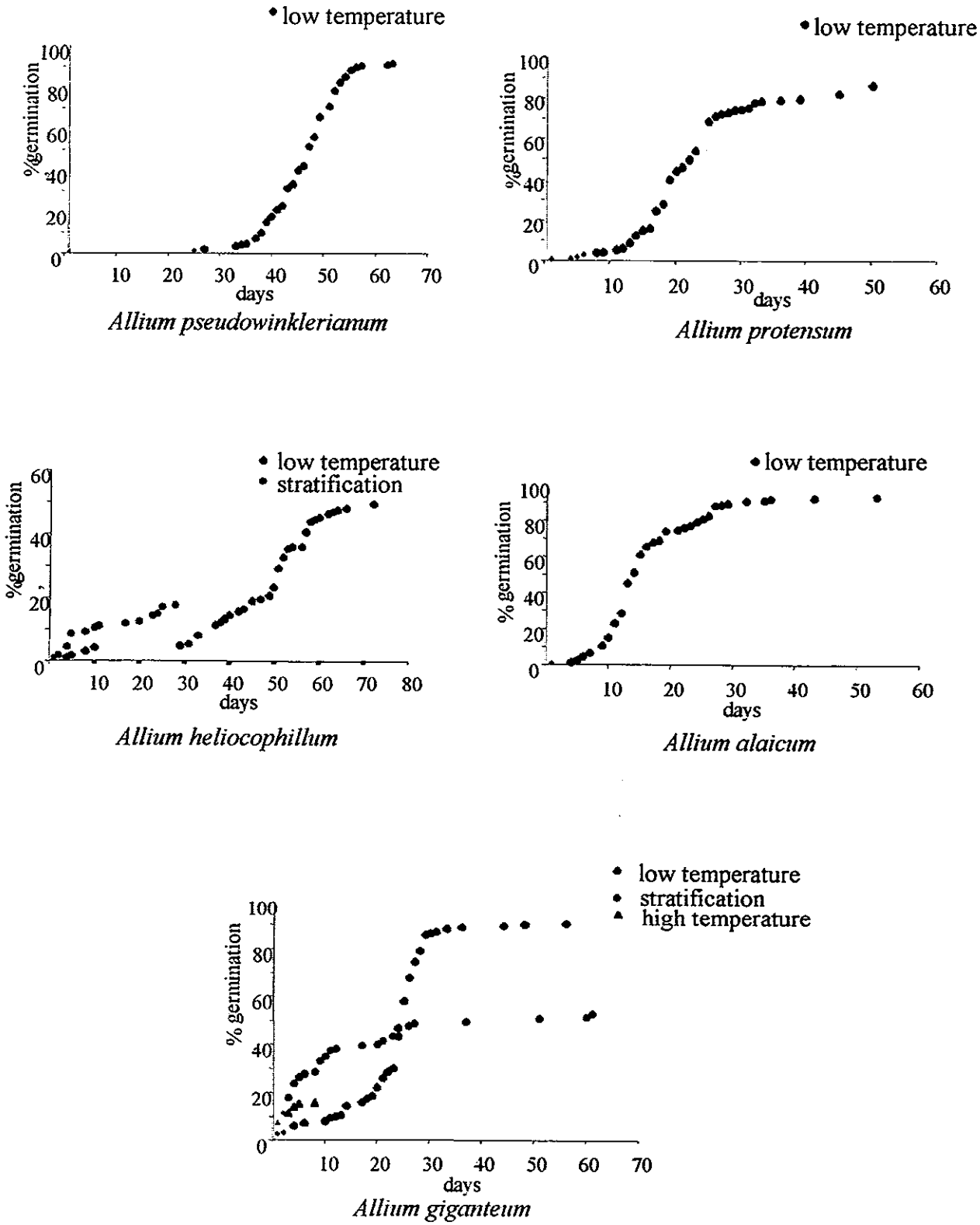

low temperature
%germination
days
Allium pseudowinkleriamum
low temperature
%germination
days
Allium protensum
low temperature
stratification
%germination
days
Allium heliocophillum
low temperature
% germination
days
Allium alaicum
low temperature
stratification
high temperature
% germination
days
Allium giganteum

Fig. 5

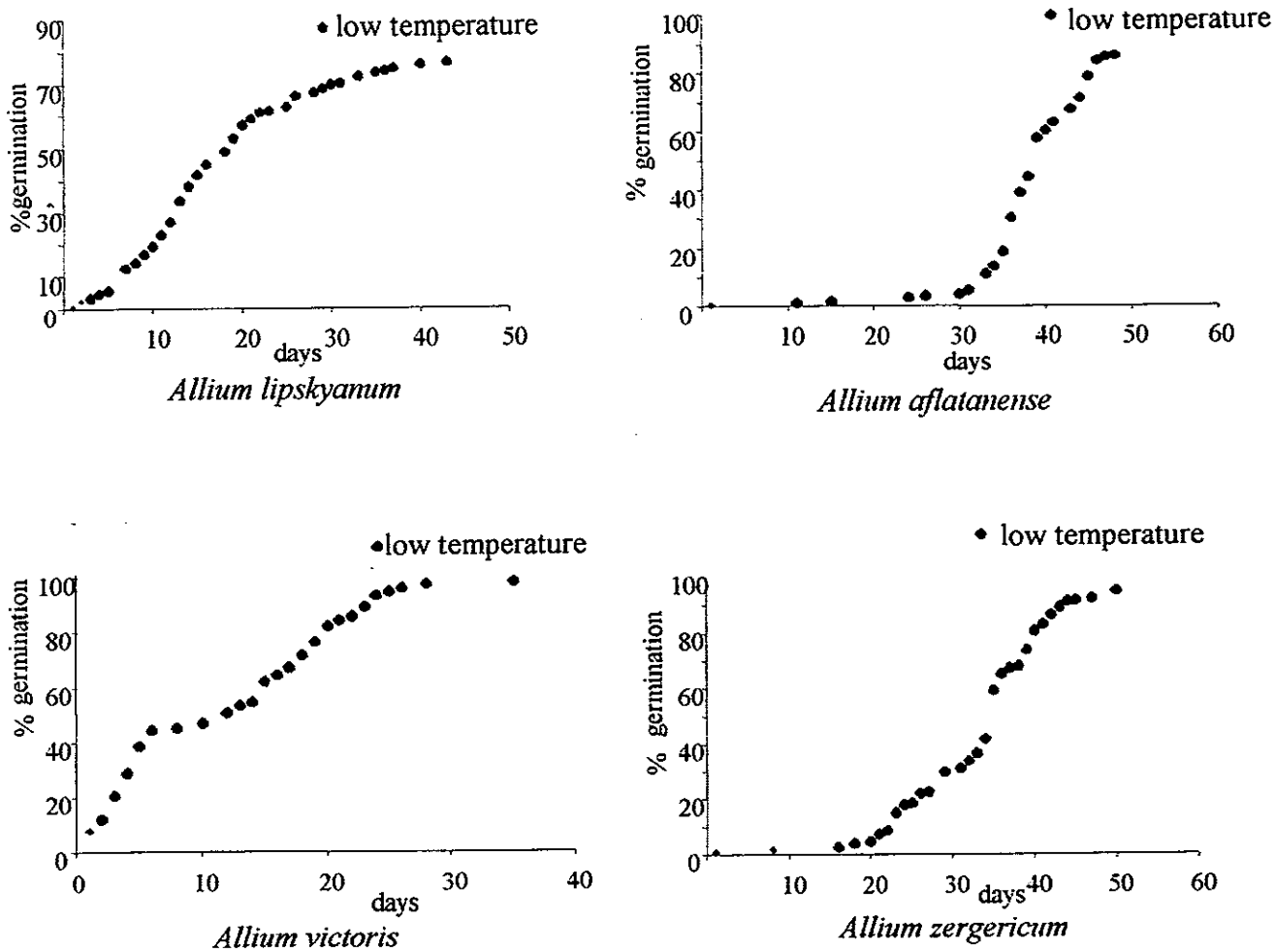

low temperature
%germination
days
Allium lipskyanum
low temperature
% germination
days
Allium aflatanense
low temperature
% germination
days
Allium victoris
low temperature
% germination
days
Allium zergericum

Fig. 6

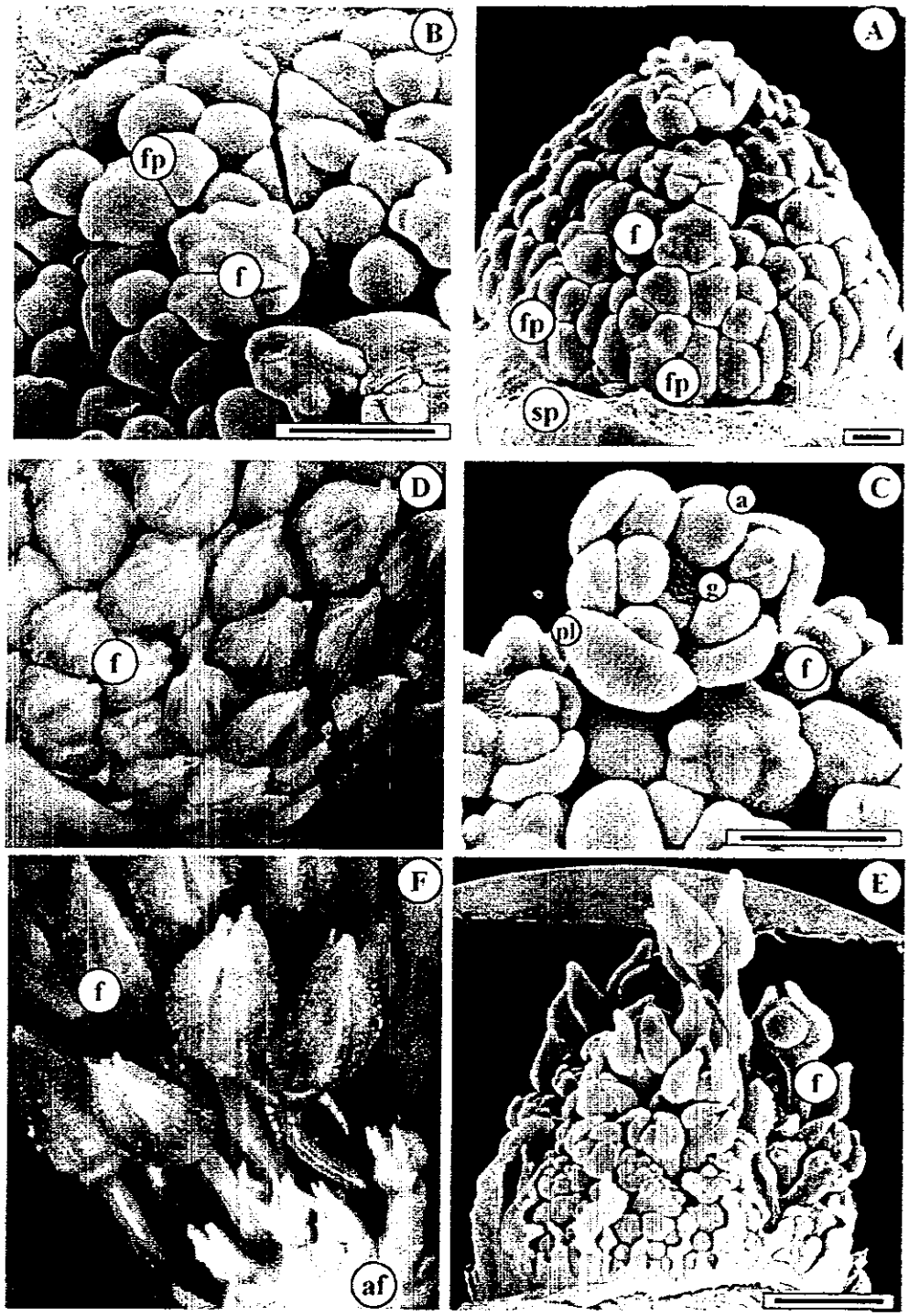


Fig. 7