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Russian dandelion (*Taraxacum kok-saghyz*): one more example of overcollecting in the past?

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Summary

Taraxacum kok-saghyz is a rubber producing plant that once was a strategic source of natural rubber in Soviet Union but with no current usage as a crop species. In this paper we 1) review the existing literature on kok-saghyz, most of which exists only in Russian; 2) describe kok-saghyz germplasm collecting undertaken in 2005 and 2006 and results of analysis for rubber content in the germplasm sampled. We found the kok-saghyz plants to be very rare in the area where they were common in the past and having very low rubber content. A reason may be overcollecting in general and especially of plants with high rubber content in the 1930ies to 1950ies of the last century.

Introduction

Russian dandelion, *Taraxacum kok-saghyz* Rodin was discovered in 1931 and described in 1933. *T. kok-saghyz* was reported to occupy small area of ≤ 8,000 km^2 in Kazakhstan and to be endemic, although its distribution range may extend into China (Fig. 1). Almost immediately after discovery, high rubber content in the roots of *T. kok-saghyz* (around 20%) made this species a strategic source of natural rubber in Soviet Union and boomed its research and development in the next two decades. Optimal soil and water requirements were determined, and agrotechnology was developed in the 40th. Because of strategic importance of rubber, the best lands with good drainage, fertility and high rainfall located in Russia, Ukraine and Belorussia were used for cultivation of Russian dandelion in the 1940ies. We may assume that cost of rubber production from dandelion was high and, as import of natural rubber from *Hevea* since the 1950ies started to rise in the Soviet Union, cultivation of Russian dandelion started to decline. Development of technology of synthesis of rubber also contributed to decline in demand for dandelion rubber. Subsequently synthetic rubber and natural rubber from *Hevea* completely replaced dandelion rubber. No scientific publication appeared in the Soviet Union since 1953.

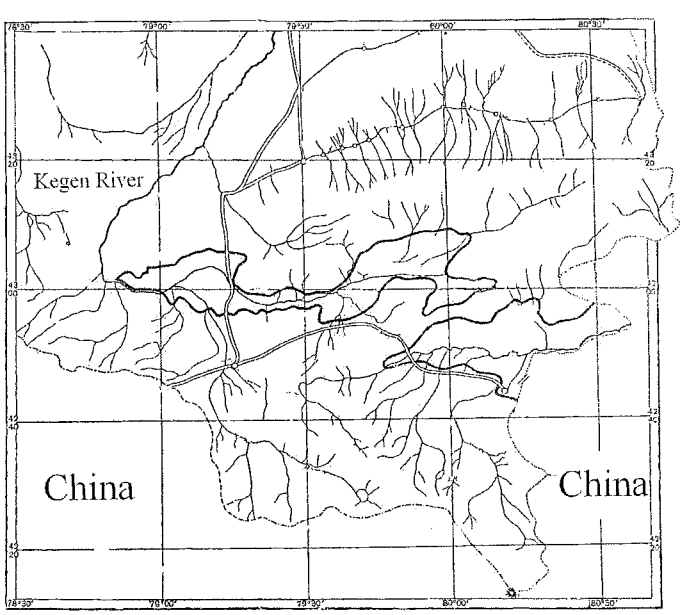

Fig. 1: Map of kok-saghyz distribution (solid line) (after Lipshiz, 1958).

Despite high quality of Russian dandelion rubber, and attention of scientists interested in identification of genes involved in rubber biosynthesis and creation of genetically modified highly rubber productive plants (PRIYA et al., 2006), this species nowadays is completely abandoned as a crop. The accessions and varieties that were developed during the 1930ies to1950ies in the USSR no longer exist. The only germplasm of this species is represented by a few accessions held in USDA collection. No scientific communication about natural populations of Russian dandelion or plants sampled in nature appeared in the last 50 years.

The two purposes of our study included 1) review the existing literature on kok-saghyz, most of which exists only in Russian and is unavailable for English reader, 2) visit and assess kok-saghyz natural populations in Kazakhstan.

Summary of current knowledge on kok-saghyz

T. kok-saghyz Rodin (Asteraceae) is a perennial 4-30 cm in height that grows in a narrow belt that embraces several valleys of the Alatau mountain range at altitude 1800-2100 m with annual rainfall of around 350-400 mm (LIPSHITS, 1953). Average temperature during July-August ranges 12-17°C and during January-February ranges –12-18°C (LIPSHITS, 1953). In this area Russian dandelion occupies several distinct microhabitats that differ in soil texture, salinity and productivity, relief and vegetation (NEIMAN, 1951, LIPSHITS, 1953). All soils of natural *T. kok-saghyz* populations are salinized to various degrees. This species can be found in and survives even high salinity of solonchaks, but shows signs of depressed growth there (NEIMAN, 1951). Salinity of the soils on which the species grows ranges from 0.1 to 6% (LIPSHITS, 1953). This species usually starts flowering in the second year in its natural habitats, but exhibits predominant flowering in the first year when cultivated under optimal conditions. *T. kok-saghyz* is a diploid (2n=16) predominantly outcrossing species. Its pollinators are thrips and beetles (Phalacridae). Viability of pollen and receptivity of stamens is 5 days. Inter-specific hybridization with other *Taraxacum* species is possible, but germination percentage of pollen of other *Taraxacum* species on *T. kok-saghyz* stamen is low (PODDUBNAYA-ARNOLDI, 1939). Propagation is usually by seeds, but also vegetatively when root is damaged. Average number of seeds per flower head is 50-60, and number of heads per plant is 5-9. Seeds are very small - 2900-3100 seeds per one gram. Temperature optimum for germination is 25-30°C and humidity 80% with germination ranging 26-89%, being on average 56% (LIPSHITS, 1953). Seeds are dormant upon maturation and dormancy is released after stratification for at least 10 days below 1°C (MINBAEV, 1946, cited in LIPSHITS, 1953) or 20

days at 0-2°C (POPZOV, 1938), or two weeks at 5 or 10°C (LEVITT and HAMM, 1943).
Soviet literature on *T. kok-saghyz* reports yield up to 10 tons/hectare (NEIMAN, 1951). Rubber content is highly variable in natural populations, ranging 0 to 47.9% (LIPSHITS, 1953). High variability is also reported for root mass, onset of flowering and other traits.
Selection and breeding in this species resulted in three varieties, Velikoalekseevskiy, № 485 and a tetraploid of Navashin (PHILLIPOV, 1953). Elite varieties propagated through root cuttings and planted under optimal agrotechnology were pruducing 250-350 g (fresh weight) (PHILLIPOV, 1953).

Collection

In August 2005, KU and SV travelled to the Kegen river area for kok-saghyz collection and rough assessment of natural populations (density, rareness). This was a first scientific visit to kok-saghiz distribution area since the 1950ies.
Search for kok-saghyz plants started at Kegen village (N43°00.467, EO79°14.617) (Fig. 2) and continued about 10 km along the river. The habitat was an intensively grazed swampy meadow (Fig. 3). Only nine kok-saghyz plants (out of several hundreds dandelions checked) were identified and sampled as flower heads with mature seeds, individually baged and marked.
In August 2006, KU, accompanied by a highly qualified botanist, Michail Danilov, Institute of Botany and Phytointroduction, Kazakhstan, went to the same area for further collection. Kok-saghiz plants were found down of Sarigas village among meadow vegetation along brooks leading to the Kegen river. These plants were surrounded by many non-kok-saghiz dandelion plants having larger flower heads and different shape bracts (Figs. 4 and 5). While in 2005 kok-saghiz plants were found in closed swampy vegetation dominated by *Lasiagrostis splendens*, in 2006 Russian dandelions were recorded and sampled in open meadow vegetation. In total, 32 plants were sampled as roots, 22 presumably one-year old and 10 two-year old plants. The age distinction was based on root size. Again, as in the collecting trip in 2005, kok-saghyz plants were extremely rare representing a negligibly small fraction of non-kok-saghyz dandelions in the area.

Fig. 3: Sampling of kok-saghyz in 2005.

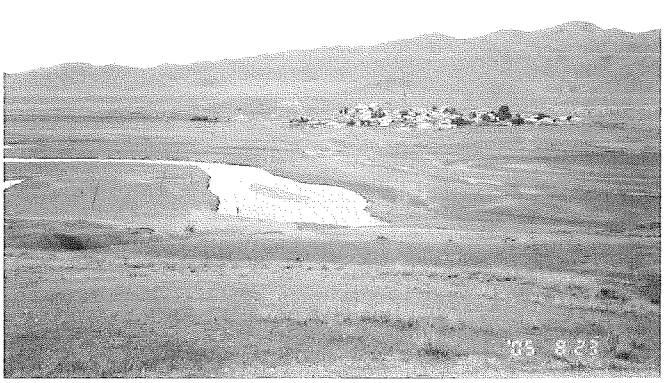

Fig. 2: The Kegen river.

Rubber content

Seeds collected in 2005 were sown in winter 2005 in a greenhouse (Beere Sheva, Israel) and grown for two years in commercial potting mixture. The roots collected in 2006 were immediately planted at

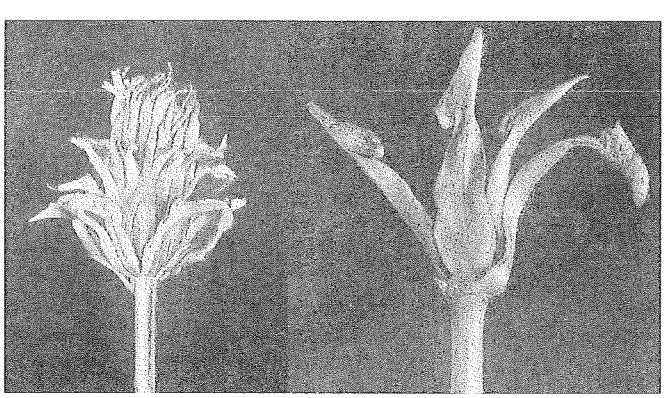

Fig. 4: Capitulum (left) and involucre with bracts (right) of kok-saghyz (from Lipshiz, 1958)

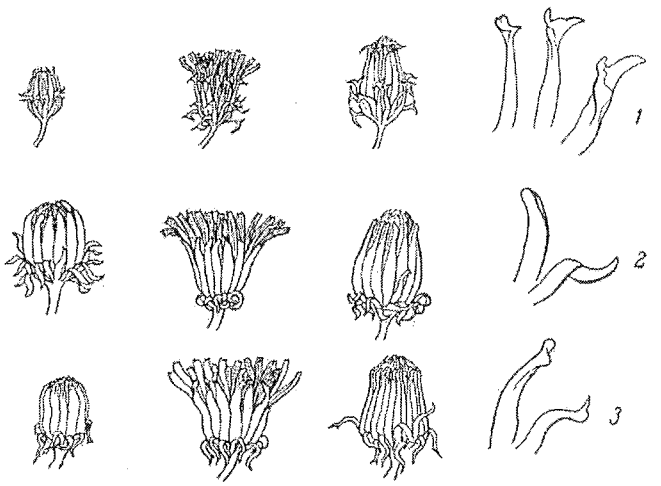

Fig. 5: Flower heads with involucre and bracts that differentiate kok-saghyz (1) and non-kok-saghz (2) plants (from Lipshiz, 1958).

Tab. 1: The information about tested accessions.

Running number	Year of collecting	Collecting location	Plant (Family)
1	2005	2	1
2	2005	2	2
3	2005	2	3
4	2005	2	4
5	2005	3	1
6	2005	3	2
7	2005	4	1
8	2005	4	2
9	2005	4	3
10	2006	1	1
11	2006	1	3
12	2006	1	6
13	2006	1	7
14	2006	1	11

field of Institute of Botany and Phytointroduction, Kazakhstan. Five roots were taken by SV to Israel and kept in potting mixture until analysis.

Roots were cleaned from the soil, washed, blotted dry and weighed. The roots were then dried at 70°C for 48h and weighed. Resins and rubber were extracted with acetone and cyclohexane, respectively, following the procedure described in BLACK et al. (1983).

Root fresh weight varied among individual plants from 1 to 5 g with one exception of 21 g (Fig. 6). The acetone fraction that might contain resins contained no substances as determined gravimetrically. The highest rubber concentration was 1.4% and the lowest was 0.1%. It should be noted that plants collected from stations 3 and 4 contained more rubber that plants collected in the other stations, although the amount was still negligible from commercial point of view.

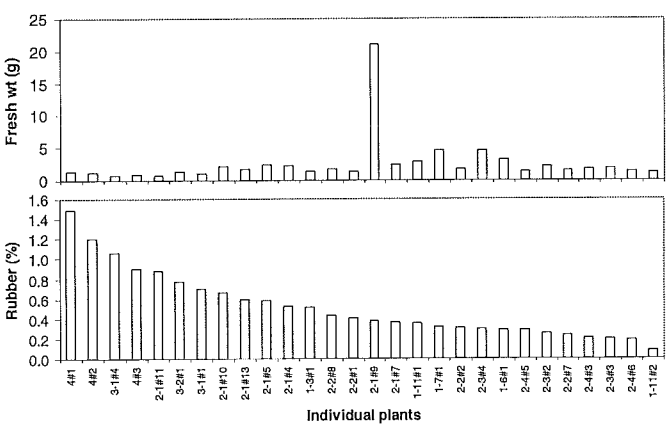

Fig. 6: Fresh weight (g) and rubber content of individual plants grown in the greenhouse for 12 months. First digit of each plant notation is the collecting location (see Tab. 1), the second digit is the original plant number from which seeds were collected and the last digit denotes seeded plants of the same mother plant.

Discussion

A general impression is that kok-saghyz as a recognized species is extremely rare, at least in the Kegen river valley region. Identification key is complex and needs to be verified by other methods (e.g. molecular markers).

Our results on latex content in the plants tested, on one hand, are discouraging as very low latex content was found. On the other hand, the negative results of two collecting trips raise questions that need to be addressed in the future. Does very low latex content in sampled plants mean that they are not true *T. kok-saghyz*? As plant identification was done strictly by the identification key, which is based on shape of bracts (Figs. 4 and 5) and in the second trip identification was done by a highly qualified specialist, misidentification should be ruled out. This, however, would mean that true kok-saghyz plants became extremely rare in the area where the species was formerly quite common. A reason may be overcollecting in the past. The available literature does not contain information about commercial collecting of kok-saghyz in wild, but such sampling is highly probable. If plants were correctly identified, our results may suggest that latex content in true kok-saghyz plants since 1950ies dropped to nearly zero. There were always kok-saghyz plants with low and very low latex content (LIPSHITS 1953). But what would cause such uniform decrease in latex content in the last 60 years?

The facts that morphological variability of kok-saghyz plants is very high (which is reflected in the identification key), and that kok-saghyz root latex content is reported in the literature to vary from 0 to 47.9% (LIPSHITS, 1953), may imply that the *T. kok-saghyz* "species" represents not a species but a latex producing form of common dandelion *T. officinale* that has a minor morphological difference in bract shape. Kok-saghyz always occurs together with *T. officinale* and is very similar to it (Fig. 5).

In summary, the results of two expeditions require extended, more systematic and more representative searching of kok-saghyz to allow understanding of this species status with respect to systematic, conservational and industrial items.

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