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THE CHROMOSOME COUNTS OF SOME TARAXACUM SPECIES[1])

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ABSTRACT

1) The chromosome counts of seventeen *Taraxacum* species were made, and fourteen of these are reported for the first time.
2) The four diploid species all occur in the Western Himalaya region, the probable place of origin of the genus.
3) The chromosome numbers of *T. nordstedtii* Dahlst., *T. obliquum* (Fr.) Dahlst. and *T. duplidens* Lindb. *f.* are concurred with those recorded by Gustafsson.
4) Chromosomal chimaera have been observed in *T. agaurum* v. Soest, *T. wallichii* De C., and *T. vulpinum* v. Soest.
5) The karyotype of a triploid form of *T. vulpinum* (Cult. 121) and *T. mitalii* v. Soest was analysed and matches with the idiogram recorded by Gudjónsson for the *Vulgaria* group.

The chief purpose of this paper is to report the chromosome numbers of some *Taraxacum* species, especially those collected by Prof. van Soest from Central Asia; VAN SOEST (1958) states that von Handel-Mazzetti places the origin of the *Taraxacum* in Western Central Asia, which he agrees. It is hoped that the cytological findings, together with the morphological and taxonomical characters, will throw some light on the interpretation of the phylogeny and phytogeography of the genus.

Material was selected from different taxonomical groups, especially with representatives from some of the little-known forms occurring in Central Asia. Achenes were collected by Prof. van Soest either from the field or from the plants cultivated in the Delft Botanical Garden.

Preserved specimens of all the material used for this study have been kept in the Herbarium van Soest, Leyden, and all the microscopic slides that served for the chromosome counts will be kept later in the same place to be available for re-examination and study in the future.

MATERIALS AND METHODS

The achenes were selected and placed in Petri dishes lined with moistened filter paper, under room temperature, warmer in day time and cooler at night, for germination. Some were placed in the incubator under constant temperature, or with pre-treatment by freezing. However, they germinated better in the former condition than those in the latter. It has also been found that the peak of mitotic activity is in the late forenoon, about 11:30 to 11:50.

[1]) The part of Taxonomic Survey has been prepared by J. L. van Soest.

Plate 1. Figs. 1–5. Root-tip mitosis of *Taraxacum* species: Fig. *T. heybroekii* (from type material), 2n = 16 (diploid); 2. *T. helianthum* (Srinagar, Cult. no. 17), 2n = 24 (triploid); 3. *T. mitalii*, 2n = 24 (triploid); 4. *T. vulpinum* (Cult. no. 121), 2n = 24 (triploid); 5. *T. nordstedtii*, 2n = 48 (hexaploid); all × 3000.

The root-tips were cut off, killed and fixed in the Carnoy's solution, in which they can be kept from a few hours to several days.

The smearing technique followed those recorded by JOHANSEN (1940) and SASS (1940). The chromosome stain recommended by LA COUR (1941) has been used. It shows that the acetic-orcein gives clearer and more satisfactory results. If the slides proved desirable, permanent mounts were made with "Euparal" as the mounting medium.

Text illustrations (Plate 1) were made from photographic basis following the technique used by MANTON (1950). The original photographs were enlarged at suitable magnifications of 3000 diameters and then by inking over the chromosomes first, followed by bleaching away the photographic images. By means of paper negatives the duplication of these illustrations were made.

OBSERVATIONS

Achenes of 26 samples of *Taraxacum* were received for this study; most of them were collected in 1961 from the plants cultivated in the Delft Botanical Garden and all of these have been taxonomically determined by Prof. van Soest. From the achenes of each sample, 10–30 of them were usually selected for germination. Seedlings and chromosome counts of 22 samples were obtained. The achenes of the other four samples failed to germinate although various methods had been applied and some of the procedures were repeated even two to four times. Due to this, the chromosome number of two species could not be investigated. The failure might be due to the fact that these achenes were either immature, abortive, or attacked by fungi during germination.

Achenes germinated usually one or a few at a time with the rate of germination about 50 % to 70 %. In a few cases many seedlings appeared during the same day with the rate of germination as high as 93 % to 98 % as in the case of *T. tortilobum* Florstr., *T. agaurum* van Soest and *T. mitalii* van Soest. In *T. heybroekii* van Soest 15 achenes were selected for germination and only one root-tip was obtained. The days required for germination in most cases were from 5 to 14.

The data from this study, *i.e.* material used, results concerning the germination, and chromosome numbers obtained, are recorded in the following table.

As recorded in the table below, among the twenty-two samples, there are four diploid, fifteen triploid, two tetraploid and one hexaploid. According to HEYWOOD (1960) in this genus about a dozen diploid sexual species are known scattered over Europe and Asia, and very many polyploid apomictic species, mainly known from western Europe and the Arctic region. It is very interesting to note that the four diploid species recorded here are from Western Central Asia where it is believed to be the place of origin of the genus (VAN SOEST 1958). The only known hexaploid species, *T. nordstedtii* Dahlst.,

Specific name & Locality collected	No. of achenes received/used for germination	Days required for germination	No. of slides made/in permanent mount	Somatic chromosomes (2n)	Ploidy (×)
T. agaurum Holland (Waalsdorp)	[1])∞/20	6	19/2	24; 32	3×; 4×
T. bessarabicum (Hortus Delft)	∞/40	—	—	—	—
T. dunense Holland (Waalsdorp)	∞/10	10–13	5/3	24	3×
T. duplidens (Cult. 5) Himalaya (Kulu)	20/20	12–24	4/3	24[2])	3×
T. elegans (India 246) Kashmir (Gulmarg)	17/8	10–14	5/3	16	2×
T. fulvo-brunneum (Cult. 44) Kashmir (Gulmarg)	∞/20	5–14	15/4	16	2×
T. fulvo-brunneum (Cult. 47) Kashmir (Tangmarg)	9/9	—	—	—	—
T. helianthum (Cult. 17) Kashmir (Srinagar)	∞/12	7–24	8/2	24	3×
T. helianthum (Cult. 102) Kashmir (Srinagar)	20/20	6–10	8/3	24	3×
T. heybroekii (type material) Himalaya (Rohtang Pass, Kulu)	20/15	12–21	1/1	16	2×
T. insigne (Cult. 61) Darjeeling	∞/15	6–14	10/4	24	3×
T. mitalii (Cult. 68) Sikkim & Nepal	18/15	5	14/5	24	3×
T. nordstedtii Holland (Vlijmen)	∞/30	5–10	14/5	48[3])	6×
T. obliquum Holland (Waalsdorp)	∞/30	9–12	4/1	24[3])	3×
T. phoenicolepis (Cult. 105) Kashmir (Shalimar)	20/20	—	—	—	—
T. rhaeticum (Cult. 18) Switzerland (Grisons)	∞/30	5–14	18/3	24	3×
T. schroeterianum (Chrom. LaF34) Switzerland (Valais)	∞/20	9–20	3/1	24(?)[4])	3× (?)

[1]) ∞ indicating more than 30 achenes.
[2]) This figure concurs with that recorded by GUSTAFSSON (1935).
[3]) Idem, (1932, 1933).
[4]) GUSTAFSSON (1932, 1933) reported as 2n = 32.

Specific name & Locality collected	No. of achenes received/used for germination	Days required for germination	No. of slides made/in permanent mount	Somatic chromosomes (2n)	Ploidy (×)
T. taeniatum Holland (Waalsdorp)	∞/10	12	6/2	24	3×
T. tortilobum Holland (Waalsdorp)	∞/25	8	23/3	24	3×
T. vulpinum (Cult. 45) Kashmir (Tangmarg)	20/20	6	18/3	24	3×
T. vulpinum (Cult. 48) Kashmir (Shalimar)	13/13	—	—	—	—
T. vulpinum (Cult. 121) Kashmir (Gulmarg)	∞/10	10–12	8/1	24; 32	3×; 4×
T. vulpinum (Cult. 123) Kashmir (Gulmarg)	10/10	14–28	4/2	32	4×
T. vulpinum (Cult. 123) Kashmir (Gulmarg)	25/10	5	7/3	32	4×
T. vulpinum (Cult. 132) Kashmir (Kokarnag)	∞/30	10–14	15/5	24	3×
T. wallichii (Cult. 101) Kashmir (Kokarnag)	∞/25	7–9	16/4	16; 24	2×; 3×

was first reported by GUSTAFSSON (1932, 1933, 1935, 1937) based on Småland material; its number found from the material of the same species collected at Vlijmen, Holland, concurs with his finding (Pl. 1, fig. 5 & Table) and fits into the pattern of species distribution in the southwestern area of Europe stated by VAN SOEST (1958).

The chromosome number of *T. obliquum* (Fries) Dahlst. is triploid (2n = 24), based on material collected at Waalsdorp, Holland, and this finding agrees with that recorded by GUSTAFSSON (1932, 1933). FÜRNKRANZ (1960) has reported three different somatic chromosome numbers in what he has named as *T. obliquum*, but according to Prof. Van Soest these plants are not real *T. obliquum* which does not occur in central Europe. Fürnkranz found among them 14 diploid (2n = 16), 2 triploid (2n = 24), and one hyperdiploid (2n = 19). Unfortunately, Mr. Fürnkranz did not keep voucher specimens.

In three *Taraxacum* species different chromosome numbers have been observed on the slide made from the same root-tip. In *T. wallichii* De C., in addition to the 2× (2n = 16) counts, there are occasionally also cells with 3× (2n = 24); in *T. agaurum* van Soest and in one of the samples of *T. vulpinum* van Soest, besides the 3× (2n = 24)

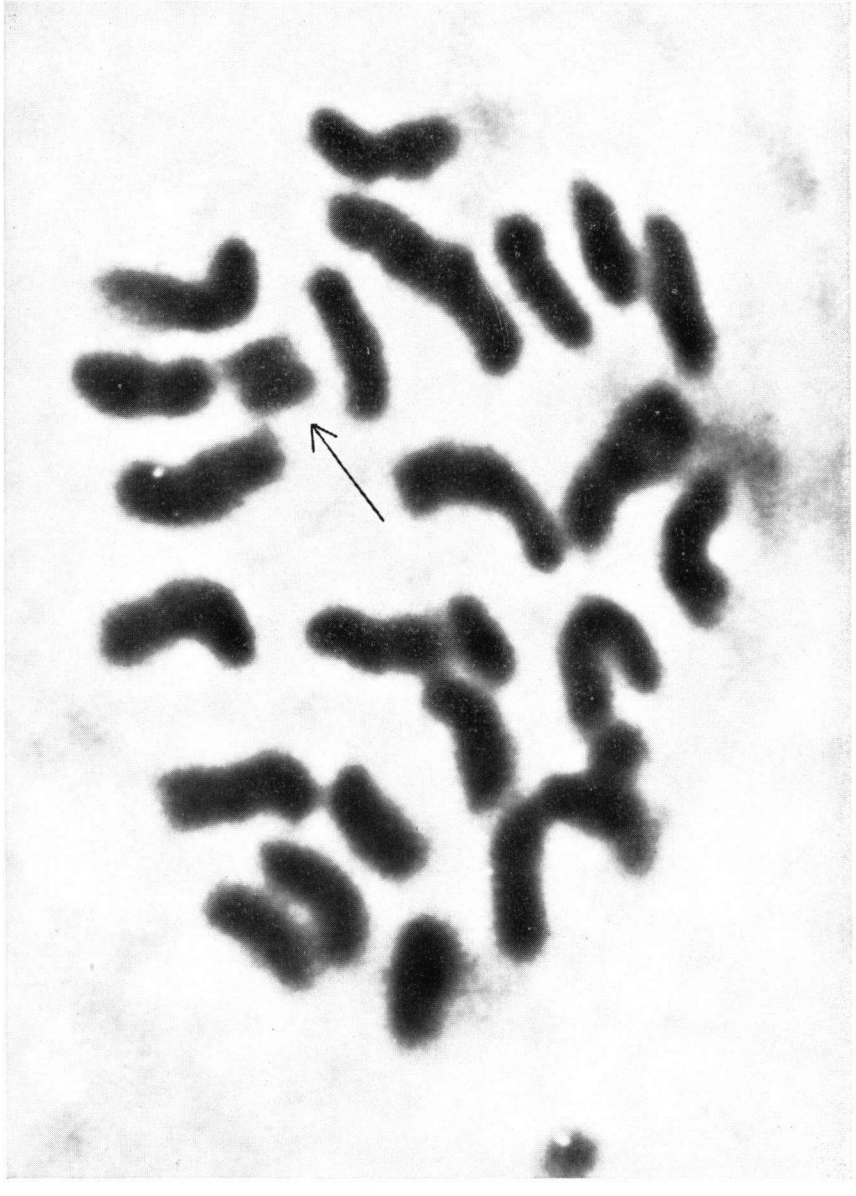

Plate 2. *Taraxacum helianthum* (from Srinagar, Cult. no. 17); somatic mitosis from root-tip, showing polar view of equatorial plate. The chromosomes are well separated and one of these bears small terminal satellites indicated by an arrow, 2n = 24 (triploid), × 7500.

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numbers, there are also some 4× (2n = 32) cells. The cells containing higher chromosome numbers are usually larger than those with lower ones. GUDJÓNSSON (1946) stated that an abnormal mitosis may take place in any somatic cell and a doubling of the chromosomes may likewise occasionally occur in some cells. By the use of this smearing technique, the cells are scattered on the slide; therefore it is not certain whether the phenomenon appearing in the above species is due to abnormal mitosis forming mixoploidy occurring in a few random cells, or it is resembling the sectorial type of chromosomal chimaera recorded in *Nicotiana* (RUTTLE 1928, SHARP 1934). This should be verified by further cytological study using also microtome technique and experimental field work.

GUDJÓNSSON (1946) stated that the apomitic triploid *Taraxacum* species are of an autotriploid nature. The fact is, according to GUDJÓNSSON, that the somatic chromosome complement of these plants consists of three morphologically identical sets of eight chromosomes each. Following the idiogram prepared by GUDJÓNSSON (1946), the karyotype of chromosomes of *T. mitalii* van Soest (Plate 1, Fig. 3) and *T. vulpinum* van Soest (Plate 1, Fig. 4) was analysed and found to match very well with the one recorded by him for the *Vulgaria* group.

Satellites were frequently observed and can be seen, for example, in Plate 2 as indicated with an arrow. Aneuploid chromosome numbers have not been found in this study.

TAXONOMIC SURVEY

by J. L. VAN SOEST

In the following survey, a * means sections or species of which a description will be given in the near future.

Sect. ERYTHROSPERMA Dahlst. em. Lindb.f.

Of the typical subsection 6 records by GUSTAFSSON (1932, 1933, 1935) and PODDUBNAJA-ARNOLDI (1934) are given, all being triploid. To these now *T. dunense* v. S. and *T. taeniatum* Hagl. can be added. Moreover, *T. agaurum* v. S. is triploid (tetraploid); it deviates from the other species by larger flower heads with dark yellow ligulas and flowering two weeks later.

Of the subsection *Dissimilia* (Dahlst.), GUSTAFSSON (1935) has given a count for *T. dissimile* Dahlst.: triploid. In addition now it appears that *T. tortilobum* Florstr. is also triploid.

In subsection *Fulva* (Christ.) a tetraploid species is known: *T. fulvum* Raunk., recorded by GUSTAFSSON (1935).

Sect. OBLIQUA Dahlst.

In agreement with GUSTAFSSON (1932, 1933) for Scandinavian plants of *T. obliquum* (Fries) Dahlst., also for plants from the Netherlands triploidy is found.

Sect. KASHMIRA v. S.*

T. fulvo-brunneum v. S.* is diploid; *T. phoenicolepis* v. S.* gave no

result; in *T. vulpinum* v. S.* twice triploidy was found, twice tetraploidy, and once triploidy and tetraploidy on the same root-tip.

Sect. PARVULA HM em. v. S.*

T. elegans v. S.* is diploid.

Sect. MACROCORNUTA v. S.

T. wallichii De C. is diploid (triploid).

Sect. TIBETANA v. S.

By GUSTAFSSON (1932, 1933) only *T. sikkimense* HM *is* mentioned as tetraploid. In addition, now can be given: *T. heybroekii* v. S.: diploid and *T. mitalii* v. S.: triploid; the latter species is not very characteristic for the section, however.

Sect. VULGARIA Dahlst.

By GUSTAFSSON (1932, 1933, 1935) and SØRENSEN (1946) 23 species are recorded: all triploid; in addition Małecka (1958) found triploidy in 27 biotypes of "*T. vulgare*" from Poland. Only once (GUSTAFSSON, 1937) a diploid species is given: *T. obtusilobum* Dahlst.

In this study the following species all are triploid: *T. duplidens* Lindb. f. (Himalaya), in agreement with GUSTAFSSON (1935) of plants from Europe; *T. helianthum* v. S.* (Himalaya); *T. insigne* Ekman (Himalaya); *T. rhaeticum* v. S. (Switzerland).

Sect. SPECTABILIA Dahlst.

From GUSTAFSSON (1932, 1933, 1935) it can be derived that characteristic species of the section are tetraploid, as far as known; a group, allied to the *Vulgaria*, is triploid (*T. maculigerum* Lindb. f. and *T. praestans* Lindb. f.).

Another group, for which *T. nordstedtii* Dahlst. is typical, deviates in the area of geographical distribution; in agreement to GUSTAFSSON (1935) experimenting with Scandinavian plants, *T. nordstedtii* Dahlst. appears to be hexaploid, also for plants from the Netherlands.

Sect. RHODOCARPA v. S.

T. schroeterianum HM is a very homogeneous and easily distinguished species. It therefore seems surprising that triploidy is found, where as GUSTAFSSON (1935) mentions tetraploidy.

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