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CYTOLOGICAL OBSERVATIONS ON CARAGANA MATERIAL FROM BOTANICAL GARDENS IN THE NETHERLANDS

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Within the subtribe *Galegeae* of the *Papilionaceae* the genus *Caragana* L. represents one of the smaller genera. According to KOMAROV (1908) there are 56 species in all, but this and later publications (SCHNEIDER, 1912; POJARKOVA, 1945; REHDER, 1947; MOORE, 1958) give the impression that the taxonomical classification is still rather dubious. Several genera of the *Galegeae* show a world wide distribution, may it be that it is possible to indicate one or more geographical centres where areas of variable extension yield a number of types that may be distinguished as separate species. In many cases, moreover, chromosome differences between the various types support these classifications (c.f. *Astragalus, Oxytropis, Indigofera, etc.*).

Caragana, however, is restricted to one large area comprising the arid regions of Southeast Russia, Central Asia and East Asia from Mantchuria to far south in Western China. Roughly speaking their distribution is situated between 25–135° longitude and 35–61° latitude in the western part, 35–55° latitude in the eastern part of the area. Ecologically, its habitat may be described as low, often spiny and bushy shrubs, living on dry riverbanks, rocky places and ridges and salt deserts, in many cases at considerable altitudes (9000′–13000′).

According to Pajorkova in the Russian Flora part XI, there are 33 species, including about 12 new ones discovered since Komarov's monography, which are present in the Soviet Russian area. The gene centres of these 33 species are mentioned, apart from the actual regions where the species may be found. Except for a number of endemics, the greater part seem to have had its origin in the mountain region starting from Pamir to south-east from the Baikal Lake. At least 16 species appear to have their origin in or near Dzungaria, the extreme NE part of the Chinese border. Perhaps a second or secondary gene centre is situated in the mountainous regions of West China; the greater part of these species do not reach the Soviet Russian area.

From the second half of the 18th century (BOOM, 1959) *Caragana* has had the interest of European horticulturists and since then quite a number of these winterhard shrubs have been imported in Western Europe and the U.S.A. for ornamental purposes: Rehder mentions some 30 species and varieties as cultivated. For *C. mollis* (DC) Bess.,

which seems not to be present in The Netherlands, POJARKOVA even states that it has been in culture since 1718, and *C. grandiflora* (M.B.) DC. since 1823.

During the years 1959 and 1961 it was possible to obtain seeds from a number of species, varieties and cultivars, thirteen in all which are present in the various botanical gardens in the Netherlands. For the kind assistance in obtaining this material the present writer acknowledges her gratitude to the Directors of the Institutes mentioned below.

Material

KOMAROV's monography (1908) divides the genus *Caragana* into eight series. The thirteen types investigated in this paper are:

Series I. *Frutescentes* Kom.	
C. sinica Rehd. (= *C. chamlagu* Lam.) . .	Arboretum Wageningen 1961
C. grandiflora DC.	do 1960
C. frutex K. Koch f. *latifolia* Schneid. . .	do 1961
Series II. *Pygmeae* Kom.	
C. pygmaea Poir..	Botanical Gardens Delft 1959
C. aurantiaca Koehne.	Arboretum Wageningen 1960
Series III. *Spinosae* Kom.	
C. spinosa (L.) DC.	Hortus Botanicus Amsterdam 1961
Series IV. *Erinacanthae* Kom.	
C. tibetica (Max.) Kom.	do 1961
Series VII. *Occidentales* Kom.	
C. decorticans Hemsl.	Arboretum Wageningen 1960
Series VIII. *Altaganae* Kom.	
C. arborescens Lam. var. *Lorbergii* Khne. .	Botanical Gardens Delft 1961
C. arborescens Lam. f. *pendula* Zab.. . . .	Arboretum Wageningen 1961
C. sophoraefolia Bess.	Hortus Botanicus Amsterdam 1961
C. fruticosa Bess..	Arboretum Wageningen 1960
C. microphylla DC. var. *megalantha* Schneid.	do 1960

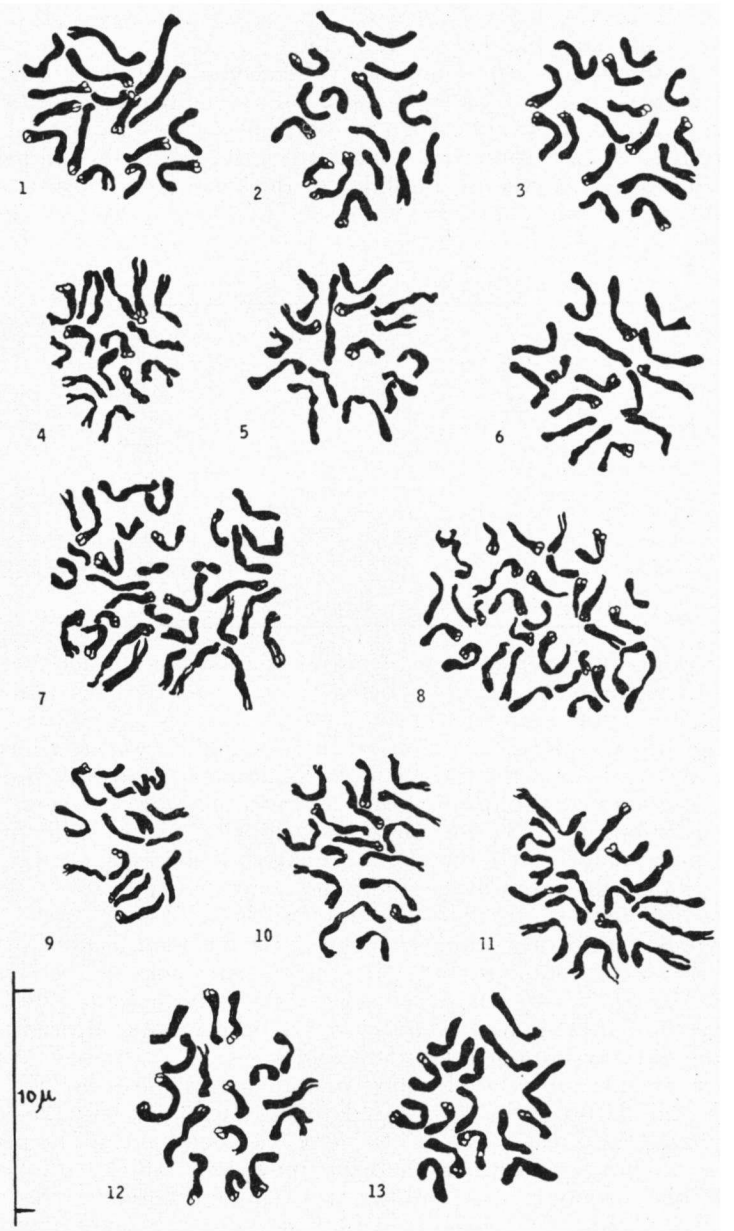
Note. By splitting a number of series and by raising a few sub-species and forms into the status of species, POJARKOVA (1945) comes already to twelve series for the 33 species of the Soviet flora. E.g. *C. grandiflora* belongs with two endemic new species to the series *Grandiflorae*. Series VIII *Altaganae* has vanished altogether: *C. arborescens* and its ornamental forms with *C. fruticosa*, *C. turkestanica* and *C. Praini* are brought together in the series *Arborescentes*, a rather heterogeneous group when observed from a geographical standpoint, for the gene centres are situated in N.W. Mongolia, China, Dzungaria and Indian Himalaya resp. East Afghanistan. *C. microphylla* in its turn, gets a lonely place in the series *Microphyllae*.

Apparently, the available material from the Soviet Union has been treated without taking into consideration the *Caragana* types elsewhere in Asia.

This is the reason why Komarov's classification has been maintained.

RESULTS

Root tip counts show that the base number of the species and varieties hitherto investigated is n = 8.



Legend to Fig. 1. 1. *Caragana arborescens* var. *Lorbergii;* 2. *C. arborescens forma pendula;* 3. *C. sophoraefolia;* 4. *C. fruticosa;* 5. *C. microphylla* var. *megalantha;* 6. *C. decorticans;* 7. *C. spinosa;* 8. *C. frutex forma latifolia;* 9. *C. aurantiaca;* 10. *C. pygmaea;* 11. *C. grandiflora;* 12. *C. sinica;* 13. *C. tibetica.*

Eleven cases appear to be diploid, 2n = 16; *C. spinosa* and *C. frutex* f. *latifolia* are tetraploid, 2n = 32 (Fig. 1).

The individual chromosomes are rather small, varying from 4.3 μ for the largest ones, to 1.2 μ for the smallest among them. Identification appeared to be impossible. In a number of cases two or three pairs of chromosomes are somewhat longer than the others, but in general the variation of lengths is gradual. On the whole, there exists much resemblance in the chromosome sets of the various types. Table I contains a list of total lengths in μ.

TABLE I

C. sinica	38.6
grandiflora	49.8
frutex f. *latifolia*	70.0
pygmaea	43.8
aurantiaca	32.7
spinosa	80.9
tibetica	42.2
decorticans	44.2
arborescens var. *Lorbergii*	45.3
arborescens f. *pendula*	40.7
sophoraefolia	39.3
fruticosa	38.2
microphylla var. *megalantha*	41.6

Even the total chromosome lengths do not vary much between each other, the only exception being *C. aurantiaca* with its somewhat smaller and more slender chromosomes.

As to the tetraploids, it might be supposed that *C. spinosa* has four identical sets of 8 and the total length also points to a possible duplication of the average diploid sets. In *C. frutex* f. *latifolia*, however, there is a suggestion of the 32 chromosomes belonging to two different sets of 16 chromosomes each and the total length is somewhat lower than twice the length of the average diploid set, if we take exception to *C. aurantiaca* with its smaller chromosome shape (Fig. 2).

Previous reports on chromosomes in the genus *Caragana* are present in an article of TSCHECHOW (1932) on chromosomes in the *Galegeae* and of MOORE (1958) who discusses the status of *C. boisii* Schneider.

Tschechow investigated *C. arborescens* Lam. on material originating from the Saratov Botanical Gardens and gives 2n = 16 as the diploid number; furthermore, he obtained material of *C. frutescens* DC. from Tomsk: this latter species appeared to be tetraploid with 2n = 32. *C. frutescens* DC. is a synonym for *C. frutex* K. Koch., and so the present writer's observation of *C. frutex* being tetraploid tallies with that of Tschechow. Moore points out the very small differences that exist between *C. Boisii* and *C. arborescens* Lam. s.l. and thus takes opposition against Komarov who considers *C. Boisii* as a distinct species of the series *Altaganae*. The only support which remains for a separate taxon seems to exist in the fact that both Komarov's and Moore's specimens of *C. Boisii* were either herbarium material or plants grown from seeds collected in eastern Szechwan. According to both Komarov

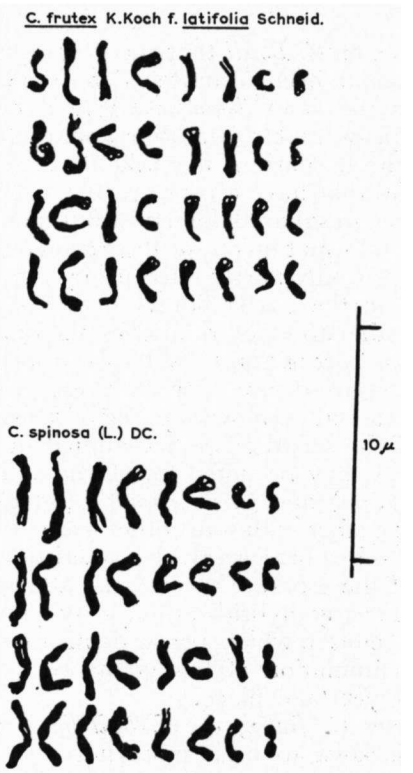


Fig. 2

and Pojarkova, indeed, the area of *C. arborescens* s.l. is situated from the banks of the Ob in Western Siberia at 61° NL via Eastern Siberia, east from the Irtysh and then via the Altai and Southern Sayan mountains to Irkutsk. According to the lastmentioned author it is even not sure that the species is occurring in the Trans-Baikal region of Dauria. The gene centre, according to her, should be situated in NW Mongolia. Moore comes to the proposal to include *C. Boisii* as a variety of *C. arborescens*. Furthermore, he mentions the chromosome number 2n = 16 for *C. arborescens*, *C. arborescens* f. *Lorbergii* and several selections of *C. arborescens* found in American nurseries and also for all plants received as *C. Boisii* and states that no differences in the morphology of the chromosomes of these various plants could be found. However, as is to be gathered from the present writer's results, the solution of taxonomic problems in the genus *Caragana* does not find much support from the cytological data. Moore's pleas do not support, neither reject his proposal of including this altogether excentric taxon in the species *C. arborescens*.

DISCUSSION

Moore's statement on *C. Boisii* that the geographic range of plants of this phenotype has not been accurately determined may be extended to all types within the genus *Caragana*. When studying Komarov's monography it appears that this author apparently bases the areas of occurrence on the herbarium material that came to his disposal and for those species that have a considerable dispersion he estimates the approximate area in square kilometres. But he himself is obviously aware of the scanty information on the dispersion of the various species and types. This gap is only partly filled up by the more recent treatment of the genus in the Soviet flora.

When mapping the areas of the series mentioned by Komarov we find a continuous part of South Eastern Europe and Asia in which the ecological factors are decisive for the presence of the genus. The continuity of the area and even overlapping of the surfaces also applies for the majority of the separate species studied in this article. More or less isolated areas may be noted for *C. fruticosa* (Mantchuria), *C. tibetica* (Western China) and *C. decorticans* (Afghanistan).

This continuity together with some other features, such as a gradual merging into each other of several characteristics which hampers a clear delineation of the separate species, the almost identical chromosome sets and the easy hybridization, may point to a relatively recent status of the genus in which a clear delineation of natural species by means of the elimination of less viable types and chromosome alterations did not yet take place.

Within the species *C. frutex*, the *f. latifolia* is reported by both Komarov and Pojarkova to be a more northern type: Tschechow does not mention to what type his material from Tomsk pertains. As to the other tetraploid hitherto found, *C. spinosa*, Komarov reports its presence in high parts of Central Asia, in deserts and salt deserts. According to him, this species is entirely absent in China. Pojarkova mentions its ability for dune formation in the sandy steppe regions (barkhan formation).

Before, however, any clear insight into the taxonomical status of the species within the genus *Caragana* can be reached, a very intensive study as to the ecological features should be undertaken and an extensive study as to possible hybridisation and cytology.

A few statements in report with the current confusion in synonymous names in horticultural literature might be cleared by the cytological results.

1) *C. frutescens* is generally synonymous for forms of *C. frutex* Koch, (TSCHECHOW, 1932, this publication).

2) The statement by FITSCHEN in the "Gehölzflora" 4th ed. 1950, as to *C. spinosa* DC being sometimes present in gardens as *C. tragacanthoides* Poir. can be accepted only when specimens under the latter name are shown to be tetraploid; otherwise, the specimens under the latter name belong to an other taxon.

SUMMARY

Root tips counts in 11 species, varieties and forms of the genus *Caragana* resulted in 2n = 16 for eleven of them: tetraploid 2n = 32 was found for *C. frutex* K. Koch *f. latifolia* Schneid. which is in accordance to a former report of Tschechow (*C. frutescens* DC. being synonymous with *C. frutex* K. Koch) and *C. spinosa* DC.

No differences in chromosome type could be found for the species, except that in *C. aurantiaca* Koehne the chromosomes are more slender and somewhat smaller and that the two tetraploids are differing considerably in total chromosome length; it is suggested, moreover, that *C. frutex* is of allopolyploidous nature.

The still considerable chaos in *Caragara* taxonomy and nomenclature cannot be cleared before a more thorough study is being made of the ecological factors, the geographical distribution and the cytology together with the genetics in this typical Mongolian genus.

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