Tetraploid *Trollius europaeus* L.

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INTRODUCTION

The genus *Trollius* exhibits in general a constant number of chromosomes. Of the twelve species found on the territory of Europe and Asia all are diploid and contain 16 chromosomes. [Langlet 1927, 1932, Zhukova 1961]. Only for *Trollius americanus* Langlet (1932) reported a tetraploid chromosome number, $2n = 32$.

Trollius europaeus is thus a diploid with $2n = 16$ chromosomes. Karyological observations of representatives of this species from the far north: Kolguyev's Island in the Sea of Barents (Sokołovskaia 1958), Kirovsk on the Kola peninsula (Zhukova 1961) in the USSR as well as in central Europe: Białowieża (author's own observations), Tatra and Karkonosze Mts, the environs of Cracow (Skalińska, Czapiak, Piotrowicz *et al.* 1959) show no deviations from the diploid number of chromosomes.

In the course of investigations on the genus *Trollius* a number of trials were made in 1959 of crossing *Trollius europaeus* with *Caltha palustris*. The results were completely negative. *Trollius* pollinated with pollen from a different genus did not set seeds. On one plant, however, a well developed ripe seed was found in one follicle, much larger than normal *Trollius europaeus* seeds. The seed germinated and the seedling was transplanted in the ground. The plant flowered for the first time in 1961.

Cytological examination revealed that the plant is a tetraploid *Trollius europaeus* with $2n = 32$. The plant proved to be partially fertile and set a small number of seeds.

It seems on the basis of cytological and morphological examinations that the plant obtained by cross pollination is an autotetraploid of *Trollius europaeus* and not a hybrid between *T. europaeus* and *Caltha palustris*.

Comparison of diploid *Trollius* with the tetraploid

All specimens of *Trollius europaeus* reared in the Botanical Garden at Warsaw originated from natural habitats in the Białowieża forest. The tetraploid obtained grew with the other plants on experimental beds.

The tetraploid plant differed chiefly from the diploids by its larger dimensions, by its reduced fertility and later period of flowering.

In 1962 all the diploid specimens of *T. europaeus* flowered in the Botanical Garden between May 12 and 30, and the tetraploid plant between June 9 and 25.

The pollen fertility counts in acetocarmine with glycerine varied in the diploids from 80 to 100 per cent, in the tetraploid it was 73 per cent.

The ability of settings seeds was relatively low in the tetraploid: The diploids produced after free pollination a mean of 5.0 seeds per follicle. In isolating bags the setting of seeds is generally lower. The tetraploid gave in free pollination 20 well developed seeds from 42 follicles, that is a mean of 0.5 seeds per follicle. Under an isolating bag 94 seeds were found in 80 folicles, i.e. a mean of 1.1 seed per follicle. It would result from this that the tetraploid set seeds better when autopollinated under isolation than when free pollination with pollen from diploid plants was possible. From the 94 seeds 58 seedlings were obtained, thus half of the seeds were not capable of germination.

In general the fertility of the tetraploid as compared with that of the diploid plants is greatly lowered, nevertheless it can multiply sexually.

The shoots of the tetraploid plants are much taller and thicker. In 1962 the maximum height of shoots in the diploids during flowering was 58 cm, at the time of fructification — 78 cm, and in the tetraploid 100 and 120 cm, respectively. The leaves are very similar in both forms only somewhat more fleshy and shining in the tetraploid.

The flowers in both forms are spherical, the corolla is almost closed over the anthers and pistils and of a similar yellow colour (Aureolin 3 according to the Horticultural Colour Chart). There is a marked difference in the size of the flowers (Fig. 1 a, b, data in the Table 1).

Table 1

The size of perianth segments and nectaries of diploid and tetraploid *Trollius europaeus*

	Number of perianth segments	Length of perianth segments mm	Average length of perianth segments mm	Number of nectaries	Length of nectaries mm	Average length of nectaries mm	Average width of nectaries mm	Location of nectar-secreting depression mm
Diploid	8—18	16.0—37.0	26.2	6—21	6.0—11.0	8.6	1.3	0.6—3.8
Tetraploid	12—19	18.0—40.0	29.9	16—33	11.0—33.0	22.4	2.2	1.05—5.0

The widest differences were found in the morphology of nectaries. In the diploid plants the nectaries are relatively small ending in a round orange patch. The tetraploid has elongated linguiform linear nectaries more than twice larger than those of diploids (Figs. 2, 3, Table 1). Their

Fig. 1a. *Trollius europaeus*
 $2n = 16$.

Fig. 1b. *Trollius europaeus* $2n = 32$.
Life-size.

shape and dimensions resemble those of the nectaries of *Trollius chinensis* but are quite different than in the hybrids between *T. europaeus* and *T. chinensis*.

The location of the nectar-secreting depression on the nectaries varies widely similarly as in diploid plants. These variations depend in some extent on the length of the nectaries (Table 1).

In view of its large spherical flowers the tetraploid form of *T. europaeus* may serve as an attractive decorative perennial similarly as the garden forms of *Trollius*.

The increase of dimensions of the tetraploid involves also the stomata and pollen. The diameter of pollen grains in the tetraploid oscillates

Fig. 4. Comparison of the size of pollen grains from diploid and tetraploid *Trollius europaeus*. 100 grains for every plant were counted.

from 17.3 to 35.0 μ , the mean size for 100 measured grains is 23.0 μ . In diploids the pollen grain diameter varies from 16.1 to 19.8 μ and the mean is 18.2 μ (Fig. 4). Much larger differences occur between the dimensions of the stomata. As seen in the diagram (Fig. 5) the ranges of length of the stomata in both forms barely meet together.

The differences in the pollen grain size and still more that of the stomata may serve as distinguishing features between diploid and tetraploid plants.

Sokolovskaia (1958) when examining the number of chromosomes and the size of pollen grains in representatives of the *Ranunculaceae* family from Kolguyev's Island in the USSR found also distinct differences in the size of pollen grains in some closely related diploid and tetraploid *Ranunculus* species.

The tetraploid *T. europaeus* was obtained as the result of pollination of *Trollius* plants with *Caltha* pollen. It is not known, however, what role this pollen actually played in the process.

Meiotic divisions in diploid *Trollius europaeus* plants occur quite regularly. In metaphase I 8 bivalents appear and then the chromosomes segregate normally to the poles. No disturbances were observed either in the 1st or 2nd divisions.

In the tetraploid, on the other hand certain irregularities in meiosis were noted. In metaphase I besides bivalents a few tetravalents were

Fig. 5. Comparison of the length of stomata from diploid and tetraploid *Trollius europaeus*. 200 stomata for every plant were counted.

found. Disturbances also occurred in the anaphase segregation of chromosomes what might explain the increased variability of pollen grain dimensions and the lowered fertility.

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(Entered: 22.4.1963)

REFERENCES

- Langlet O., 1927, Beiträge zur Zytologie der Ranunculazeen, Svensk Bot. Tidskrift 21: 1—17.
 Langlet O., 1932, Über Chromosomenverhältnisse und Systematik der *Ranunculaceae*, Svensk Bot. Tidskrift 26: 381—400.
 Skalińska M., Czapik R., Piotrowicz M. et al., 1959, Further studies in chromosome numbers of Polish Angiosperms (Dicotyledones), Acta Soc. Bot. Pol. 28: 489.

- Sokołowska A. P., 1958, Saotnoszenije mieżdu czislom chromosom i wieliczinoj pylcewych zern u arkticzeskich widow *Ranunculaceae* i *Saxifragaceae*, Bot. Żur. 43: 1146—1155.
- Zhukova P. G., 1961, Kariologija niekotorych widow *Ranunculaceae* w poliarno-alpijskom Botaniczeskom Sadu, Bot. Żur. 46: 421—428.

Tetraploidalny Trollius europaeus L.

Streszczenie

Tetraploidalny *Trollius europaeus* otrzymano w wyniku zapylania *Trollius europaeus* pyłkiem *Caltha palustris*. Dane morfologiczne i kariologiczne wskazują, że otrzymana roślina jest autotetraploidem zawierającym 32 chromosomy, a nie mieszańcem między *Trollius* i *Caltha*.

Tetraploidalny *Trollius europaeus* odznacza się zwiększonymi wymiarami, późniejszym okresem kwitnienia i obniżoną płodnością. Posiada on wyraźnie większe ziarna pyłkowe i aparaty szparkowe niż rośliny diploidalne. Dzięki swoim dużym kulistym kwiatom może mieć znaczenie jako roślina ozdobna.