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VARIATION OF CHROMOSOME NUMBERS IN *LEUCANTHEMUM* HEPTAPLOIDS

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Introduction

The present paper describes natural heptaploids of *Leucanthemum* (7x), found in one population on the mountain of Treskavica in Bosnia (Vratlo, 1700 m above sea level). This is the first finding of a *Leucanthemum* heptaploid in Yugoslavia. Natural heptaploids are very rare in *Leucanthemum;* only Villard (1970) described three plants from Switzerland (Hautes-Alpes) as natural hybrid heptaploids.

The results obtained suggest that the heptaploids of *Leucanthemum* species from Treskavica (2n = (7x) = 63) are hybrids derived from the octoploid L. *montanum* var. *heterophyllum* (Willd.) Briq. et Cav. 2n = (8x) = 72 (Mirković 1969), which grows on mountain rocks, and from the hexaploid L. *chloroticum* Kerner et Murbeck 2n = (6x) = 54 (Papeš 1972 a) from coastal mountains.

Materials and Methods

All plants examined were collected from a natural habitat in 1967 by Dr Č. Šilić from Sarajevo, and raised at the Botanic Garden in Zagreb.

The details of the cytological methods have been described in a previous paper (Papeš 1972 b).

Results

Eight plants investigated were collected from one population belonging to the association *Drypetum lineanae* growing on a mountain scree of Treskavica (Vratlo, 1700 m above sea level).

The results of the chromosome analyses are shown in Table 1. All plants were heptaploids 2n = (7x) = 63, and aneuploids (heteroploids, Stebbins 1971) which gained or lost two to four chromosomes in their complements. The chromosomes were metacentrics or submetacentrics, very similar in size. The only recognizable feature in the comple-

ments were the eight small submetacentric chromosomes with satellites. In some plants accessory chromosomes or B chromosomes (P a p e š 1971) were also found (Plate I: Figs. 1, 2, 3 and 4). The number of chromosomes of the normal complement and of B chromosomes did not vary from individual to individual only, but also from cell to cell of the same plant. Certain plants (69.180, 69.182 and 71.514) from the population had no B chromosomes at all, but in some as many as ten could be counted (70.529). All B chromosomes were of the same shape i. e. small metacentrics (Plate I). It is rather difficult to prove the existence of B chromosome because some chromosomes of the normal complement are of similar size and shape.

Table 1. Chromosome numbers of the natural *Leucanthemum* heptaploids

Cyt. No.	2 n	Pollen stainability
69.180	63—64	85%
69.182	59—62	
70.529	63 + 8—10 B	87,5%
70.879	61—63 + 2—7 B	
71.511	63 + 2—8 B	
71.512	63—64 + 6 B	
71.513	62 + 8 B	
71.514	61—63	

The meiotic pairing (in two plants: 70.529 and 70.879) is not so irregular as one would expect in such high polyploids which are aneuploids and hybrids at the same time. Bivalents and univalents are usually present; the latter indicate B chromosomes. Trivalents and quadrivalents occur too. Associations of six or more chromosomes are rare, but they reveal the polyploid character of their ancestors which probably come from closely related species (Plate II: Figs. 5 and 6). Pollen tetrads are usually normal and contain four nuclei of the same size, but in some pollen tetrads 2 to 4 micronuclei have been found. Pollen stainability is not reduced in plants with 2 to 10 B chromosomes (e. g. 70.529). The size of pollen grains varies from 30 to 40 μm (Plate II, Fig. 7). In general the plants are not sterile but produce seeds only occasionally. It seems, however, that sexual reproduction takes place alongside with asexual, because some plants have not flowered for two or three years.

The heptaploid plants show a mixture of morphological characteristics of both parents, with predominant feature of the octoploid *L. montanum* var. *heterophyllum*, with the exception of the pale edges of the involucra, which is the main trait of the hexaploid *L. chloroticum*.

Discussion

Once again the fact has been confirmed, that both polyploids and hybrids are more vigorous than their ancestors (S t e b b i n s 1950, 1971). In such an extremely disturbed habitat as is a lime stone scree 1700 m above sea level (with *Drypetum lineanae*), only plants with extremely capable genotypes are able to survive.

It has been widely reported that natural polyploids with very different levels of ploidy are numerous in *Compositae*, especially in genera *Chrysanthemum* and *Leucanthemum*. Heptaloids are, however, very rare, as they are in *Angiosperms* in general. A list of polyploid species in *Angiosperms* [made by John and Lewis 1968 (based on Darlington and Wylie 1955)], shows that among 627 species from 17 genera only two species were heptaploids: *Chrysanthemum rubellum* and *Caltha palustris*. [In Britain 96% of plants of C. *palustris* appeared to be heptaploids (Kootin-Sanwu and Woodell 1969)].

In the genus *Leucanthemum* only Villard (1970) found three plants which were natural heptaploids and hybrids at the same time. The heptaploids from Treskavica were all collected from one population at random, which might suggest that the heptaploids were predominant in the population. Among 8 investigated plants 8 different chromosome numbers have been found. Usually they represented an unbalanced state, whether they lost or gained chromosomes and regardless of whether they had B chromosomes or not. These aneuploid individuals did not vary morphologically. This appears to be the case in many plants which are polyploids of hybrid ancestry [e. g. cultivated *Hyacinthus orientalis* (Darlington, Hair and Hurcombe 1951), *Claytonia virginica* (Lewis 1962), *Caltha palustris* (Reese 1954) and *Holcus mollis* (Jones 1958)]. In such cases, where the chromosomes are not so much differentiated, certain kinds of unablance are hardly inferior to the normal state, so that changes in chromosome number by gain and loss appear to have little effect (John and Lewis 1968). On the other hand aneuploidy in diploids usually causes sterility and a great deal of phenotypic abnormality.

The meiosis of the investigated plants is not so irregular as one might expect. It has been reported (Lewis 1962) that meiotic abnormalities of aneuploid polyploid plants vary from 10 to 40% of the PMC examined and that in most cases the pollen appears to be normal and very probably functional. In the *Leucanthemum* aneuploids (heptaploids), the pollen stainability was indeed relatively high (from 85 to 87,5%). For four years the plants under study were not sterile, but they flowered very rarely (once to twice in four years). If we take into account that the *Leucantheum* species are perennial, it can be supposed that the unstable plants propagate for several years either vegetatively or by occasional production of fertile seeds. In this way these genetically unstable plants are able to form a stable population.

Summary

The natural heptaploid of *Leucanthemum* (2n = (7x) = 63) has been found for the first time in Yugoslavia (on the mountain of Treskavica, at Vratlo, 1700 m above sea level). This is a hybrid derived from the octoploid L. *montanum* var. *heterophyllum* (2n = (8x) = 72) and the hexaploid L. *chloroticum* (2n = (6x) = 54). Since the population includes aneuploids with 2 to 10 B chromosomes or without them, the chromosome numbers vary considerably, both from plant to plant and from cell to cell.

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Plate I — Somatic chromosomes of the *Leucanthemum*-heptaploids.
Tabla I — Somatski kromosomi u *Leucanthemum* - heptaploida.

Fig. 1. Plant with cyt. no. 71.512; 2 n = 64 + 7 B.
Sl. 1. Biljka sa cit. br. 71.512; 2 n = 64 + 7 B.

Fig. 2. Plant with cyt. no. 71.511; 2 n = 63 + 7 B.
Sl. 2. Biljka sa cit. br. 71.511; 2 n = 63 + 7 B.

Fig. 3. Plant with cyt. no. 71.513; 2 n = 62 + 8 B.
Sl. 3. Biljka sa cit. br. 71.513; 2 n = 62 + 8 B.

Fig. 4. Plant with cyt. no. 70.529; 2 n = 63 + 8 B.
Sl. 4. Biljka sa cit. br. 70.529; 2 n = 63 + 8 B.

Plate II — Meiotic chromosomes and pollen grains of the *Leucanthemum*-heptaploids.
Tabla II — Mejotski kromosomi i polenska zrnca u *Leucanthemum*-heptaploida.

Fig. 5. Plant with cyt. no. 70.529; 2 n = 62—63 + 5—7 B (3 IV, 1 III, 23 II and 7 I).
Sl. 5. Biljka sa cit. br. 70.529; 2 n = 62—63 + 5—7 B (3 IV, 1 III, 23 II i 7 I).

Fig. 6. Plant with cyt. no. 70.529; 2 n = 62 + 10—11 B (2 IV, 1 III, 23 II and 11 I).
Sl. 6. Biljka sa cit. br. 70.529; 2 n = 62 + 10—11 B (2 IV, 1 III, 23 II i 11 I).

Fig. 7. Pollen grains.
Sl. 7. Polenska zrnca.

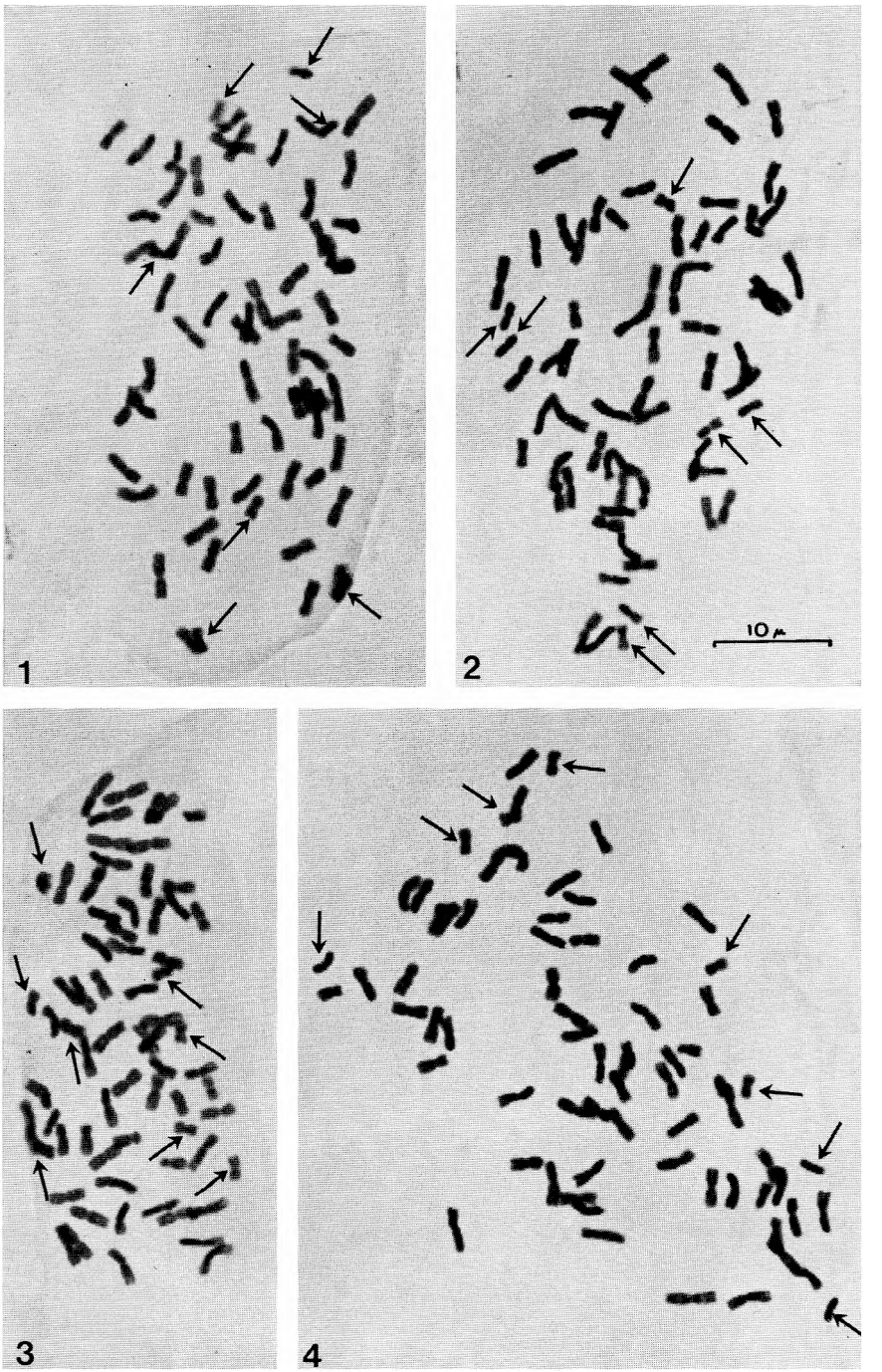
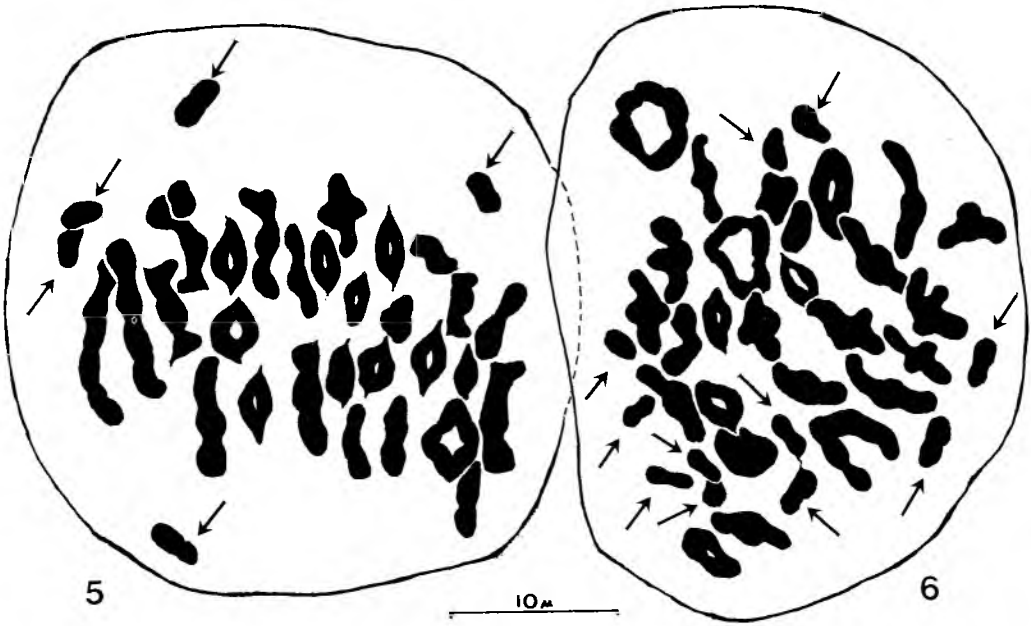


Fig. 1—4.



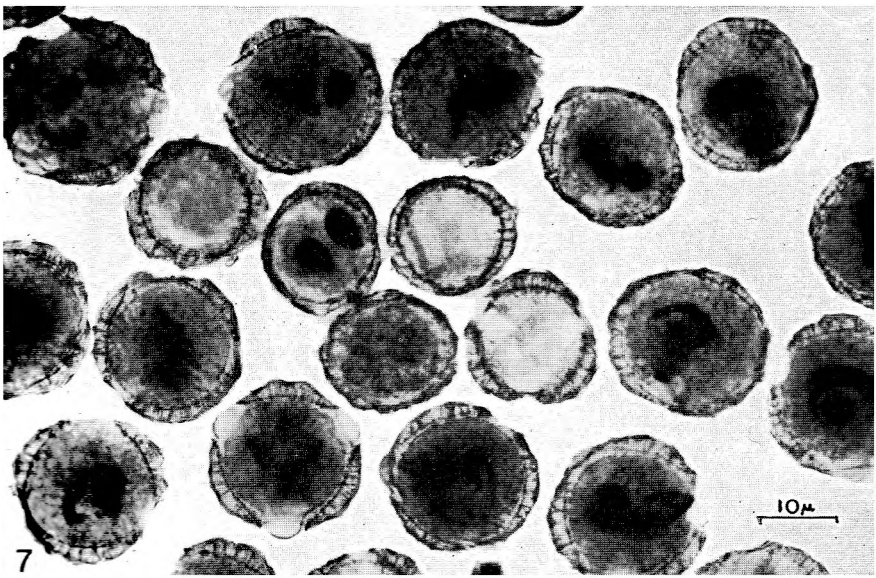


Fig. 5—7.

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SADRŽAJ

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U ovom radu opisan je prvi put prirodni *Leucanthemum*-heptaploid 2n = (7x) = 63, nađen u Jugoslaviji. Ovaj heptaploidni oblik nađen je samo u jednoj populaciji, kojoj se stanište nalazi na vapnenačkom siparu u asocijaciji *Drypetum lineanae*, na planini Treskavica blizu vrha Vratlo, 1700 m nad morem.

Rezultati istraživanja citologije i morfologije u osam biljaka pokazuju da su one heptaploidi, a također i križanci, nastali od oktoploidne visokoplaninske vrste L. *montanum* var. *heterophyllum* (Will.) Briq. et Cav. (2n = (8x) = 72) i heksaploidne vrste L. *chloroticum* Kerner et Murbeck,

koja je došla s obalnih planina. Ovi *Leucanthemum*-heptaploidi također su i aneuploidi, kod kojih broj kromosoma veoma varira, kako između biljaka tako i u samim biljkama u istom tkivu od stanice do stanice. Osim toga u nekim biljkama može se pretpostaviti postojanje B-kromosoma čiji broj također varira (tabela 1, tabla I: slike 1, 2, 3 i 4).

Usprkos tako velikoj kromosomskoj nestabilnosti, kao što je neparna poliplodija (7x), aneuplodija i B-kromosomi, biljke nisu bile sterilne. Istraživani primjerci davali su povremeno fertilno sjeme, ali su veoma rijetko cvali: 1—2 puta u četiri godine. Vjerojatno se ova populacija održava više putem vegetativnog razmnožavanja, stvarajući vriježama nove biljke, a manje spolno, ali tada dajući nove kombinacije aneuploida i B-kromosoma.

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