

CHROMOSOME NUMBERS OF *ORNITHOGALUM UMBELLATUM* L. FROM THREE LOCALITIES IN ENGLAND

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ABSTRACT

The karyological examination of 49 specimens of *Ornithogalum umbellatum* L. from three localities in England showed the occurrence of two euploid cytotypes, a triploid ($2n = 27$) and a hexaploid ($2n = 54$). In one locality two aneuploid plants ($2n = 28$) were found among the triploids. A few cases of mixoploidy (polysomaty and aneusomaty) and some karyotype aberrations are described. The origin of cytological diversity within the population is briefly discussed.

INTRODUCTION

Ornithogalum umbellatum L. shows a high degree of cytological differentiation. Euploid ($2n = 18, 27, 36, 45, 54, 72$) and aneuploid cytotypes ($2n = 19, 20, 21, 22, 23, 28, 43, 52$) as well as plants with B-chromosomes occur within this species according to the data given by several research workers (Table 1). In addition some other aneuploid chromosome numbers unknown for adult plants were found by the author in young seedlings in the progeny of triploids (Czapik 1966).

It should also be emphasized that the cytotypes with 54 and 72 chromosomes have been reported chiefly for cultivated plants and that aneuploid specimens have been found more frequently in wild populations than in garden samples. In view of this, it seemed advisable to study a large amount of material of various origins. In this way the rôle of wild populations and cultivated material in the process of cytological differentiation within the species could be investigated.

MATERIAL AND METHODS

Origin of Plants

O. umbellatum is native in some parts of the British Isles (Warburg 1962) and occurs in natural habitats. It is also in cultivation and it may be a garden escape in many places (Perring, Sell & Walters 1964). The bulbs examined originated from three localities in England (Table 2). The plants growing on the heath near Icklingham (Suffolk, Grid ref. TL 7673) were probably native. The specimens from two other colonies, viz. a very small one on the roadside near Fleam Dyke (Cambridgeshire, Grid ref. TL 549542) and a large one in the pasture near the church in Hitcham (Suffolk, Grid ref. TL 983512) might be considered as garden escapes of unknown age.

The plants from Icklingham were collected by Mrs. M. Southwell. Since 1951 they have been cultivated in the University Botanic Garden, Cambridge. Six bulbs were dug out from various places of the bed but their clonal origin cannot be excluded.

Two adult plants and 6 young bulbs which belonged probably to two clones were collected by the present author in the locality near Fleam Dyke.

The material collected in Hitcham was more ample. The bulbs were taken from 7 well-separated groups of plants. According to the number of plants in each group only 2–10 bulbs of various size were taken for the karyological examination, and the remaining plants were left in situ.

Cytological Technique

This was the same as used in the author's previous studies on *Ornithogalum* (Czapik 1965, 1966). Single bulbs were grown in jars with tap water. Root growth began after

* The material was collected during the stay of the author at the Botany School, University of Cambridge, in May 1966.

TABLE 1. Karyological differentiation within *Ornithogalum umbellatum* L.

$2n$	Authors
<i>Euploid chromosome numbers:</i>	
18*	Neves (1952, 1956), Giménez-Martín (1958), Czapik (1965)
27*	Heitz (1926; $n=12-14$), Sprumont (1928), Nakajima (1936), Sató (1942), Pólya (1950), Neves (1952), Gadella & Kliphuis (1963), Czapik (1961, 1965)
36*	Neves (1952), Czapik (1965)
45	Sprumont (1928), Neves (1952)
54	Matsuura & Sutô (1935), Holzer (1952), Neves (1952)
72	Neves (1952)
<i>Aneuploid chromosome numbers in adult plants:</i>	
19*	Neves (1952), Giménez-Martín (1958), Czapik (1965)
20*	Neves (1952), Giménez-Martín (1958), Mesquita (1964)
21*	Neves (1952), Giménez-Martín (1958)
22*, 23*	Neves (1952)
28*	Neves (1952), Czapik (1965)
43, 52	Neves (1952)
<i>Aneuploid chromosome numbers in young seedlings and embryos only:*</i>	
24, 25, 26, 29, 30, 32	Czapik (1966)
<i>B-chromosomes (adult plants):</i>	
18+1	Neves (1952), Mesquita (1964-65)
18+3, 19+1, 19+2, 20+1	Neves (1952)
21+1	Neves (1952), Giménez-Martín (1958)
23+1, 27+1	Neves (1952)

* Found in the progeny of triploid plants (Czapik 1966)

approximately two months and was more abundant in darkness. Root-tips were fixed in a mixture of ethyl alcohol, chloroform and acetic acid (6:3:1) after pre-treatment with 8-hydroxyquinoline (0.002 mol./l. aqueous solution) and stained in bulk in alcoholic hydrochloric acid carmine (Snow 1963). Squashes were prepared separately from each root-tip in order to avoid the difficulties of interpretation in case of mixoploidy within a bulb or particular roots. The cellophane method was used to make the squashes permanent (Murin 1960).

RESULTS

The main results of cytological examination are summarized in Table 2. Three cytotypes were found in the material studied ($2n = 27, 28, 54$). In two localities triploid plants were prevalent ($2n = 27$, Plate 16a); in the third one near Fleam Dyke hexaploid cytotypes occurred ($2n = 54$, Plate 16d). The population in Hitcham showed some degree of cytological differentiation. The examination of 35 bulbs from 7 well separated groups of

TABLE 2. Chromosome numbers of investigated plants

Localities	$2n$	Number of bulbs
1. Heath of Seven Tree Road, Icklingham, Suffolk	27	6
2. Pasture, behind the churchyard, Hitcham, Suffolk	27	33
	28	2
3. Roadside near Fleam Dyke, Cambridgeshire	54	8

plants revealed that 33 bulbs belonged to triploid plants, while two others had 28 chromosomes (Plate 16b). The aneuploid number was found in single plants in two different groups. No group of plants consisted of aneuploids exclusively.

The same types of chromosomes were easy to identify in the karyotypes of the British plants as those of the plants originating from Poland (Czapik 1965). The haploid set consisted of one SAT-chromosome of medium size (chromosome VI), three large chromosomes with submedian centromeres characterized by various proportions of their arms (chromosomes I, II, III), two chromosomes of medium size with submedian centromeres (chromosomes IV and V) and three small chromosomes with submedian centromeres (chromosomes VII, VIII and IX).

The hexaploid and most of the triploid plants had normal karyotypes, and no distinct structural changes of chromosomes could be detected. It should be noted, however, that in the triploid plants only one of the chromosomes VI had a visible satellite. Two satellites could be discerned only in root-tip squashes of two plants from Hitcham. The numbers of satellites in the metaphase plates and their size, as well as the length of the constriction between the satellite and the arm, also showed some degree of variability in plants of *O. umbellatum* studied previously (Sprumont 1928, Czapik 1965). No special examination was done, however, to test the cause of this variation.

Only one triploid plant originating from Hitcham showed a change in the composition of its chromosome complement. It had two chromosomes VII while the chromosome IX was represented four times; the other types of chromosomes were present in the normal number.

In plants with 28 chromosomes a strictly triploid complement was increased by the additional occurrence of the chromosome IX, the smallest one in the karyotype. It is very remarkable that variation in the number of these particular chromosomes seems repeatedly to be responsible for the aneuploid differentiation in *O. umbellatum* (Neves 1952, Giménez-Martín 1958, Mesquita 1964, Czapik 1966).

Mixoploid root-tips were detected in one aneuploid and in two triploid plants from Hitcham. Polysomaty was observed in one triploid plant which had a hexaploid sector in one root-tip. One metaphase (Plate 16c), one anaphase and three prophases with 54 chromosomes formed an island among the triploid cells of the root meristem. This type of mixoploidy in *O. umbellatum* was described also by Neves (1952).

One of the aneuploid plants appeared to show a tendency to reversion to triploidy. Eight root-tips were examined: in six roots 28 chromosomes were counted consistently; by contrast in a single root triploid metaphases ($2n = 27$) occurred side by side with plates having 28 chromosomes and in the last root only triploid plates were found.

In a further plant three metaphases with 26 chromosomes were found among the normal triploid plates. In the same root-tip early telophases with bridges were visible. Such abnormalities might lead to numerical differences of the chromosome complements in adjacent cells (Rychlewski 1967). Bridges at anaphase and telophase occurred also in three other roots where no change in karyotypes could be detected.

The case of aneusomaty described above could be interpreted as a result of the influence of external factors on the mitosis; abnormal conditions created by water culture of bulbs before fixation must be also taken into consideration. In the majority of bulbs, however, these disturbances did not greatly affect the normal course of mitosis. The deviating chromosome numbers were also found in some young seedlings of *O. umbellatum* (the progeny of triploids) as well as in some root-tips of adult plants (Czapik 1965, 1966). In seedlings, however, such facts might point to some internal instability caused by aneuploidy.

DISCUSSION

Embryological investigations have shown that triploidy may play a role in the cytological evolution of *O. umbellatum* (Czapik 1966). The progeny of triploids show a wide range of karyological differentiation. Chromosome numbers from $2n = 18$ to 30 were found in seedlings while in embryos $2n = 32$ and 36 also occurred (Table 1). It seems that the

type of karyological differentiation revealed in *O. umbellatum* is similar to that known for *Hyacinthus orientalis*, where the full range of chromosome numbers between $2x$ and $4x$ exists in seedlings and adult specimens of the progeny of triploid plants (Darlington, Hair & Hurcombe 1951; Darlington 1956). However, some of hypo- and hypertriploid numbers ($2n = 24, 25, 26, 29, 30$ and 32) occurring in young plants of *O. umbellatum* have not yet been found in adult plants. The present author supposes that in Polish material the conditions of life in crop-field associations favour vegetative propagation and are disadvantageous for germination of seeds and undisturbed growth of seedlings. In this connection a careful examination of specimens from triploid populations of *O. umbellatum* having more convenient conditions for generative reproduction is needed.

The population of *O. umbellatum* in Hitcham seemed to grow in such a habitat. The cytological diversity observed there was, however, slight. Triploid specimens prevailed and only two from among 33 plants had 28 chromosomes. The aneuploids grew in two separate groups of triploid plants; no group consisted of aneuploids exclusively. According to Lövkvist (1963), in sexually reproducing plants that also reproduce vegetatively e.g. in *Cardamine*, *Sagina nodosa* and *Saxifraga granulata*, aneuploids may have a more pronounced ability to form vegetative diaspores than the euploids. Aneuploid plants of *O. umbellatum* do not seem to belong to this group. They were not found in great numbers nor was the existence of any exclusively aneuploid population reported. As far as the rarity of aneuploid cytotypes within the population is concerned the possibility of the elimination of the additional chromosomes in somatic tissue should be taken into consideration. It is possible that this process is sufficient to prevent the accumulation of aneuploid plants. The case of aneusomaty observed in one bulb of the plant with 28 chromosomes may be considered as an indication of a tendency towards such an elimination.

The vegetative origin of 28-chromosome plants also cannot be excluded. They may be bud sports like some of the garden varieties of *Hyacinthus* whose vegetative origin in cultivation is well documented (Darlington, Hair & Hurcombe 1951). Mixoploidy observed in a few plants from Hitcham seems to be rather common in *O. umbellatum* but the supposition of the vegetative origin of some aneuploids requires further examination.

The cytological differentiation established for *O. umbellatum* in the course of the present investigation does not exceed the limits of the variability hitherto known for this species. Still more material is necessary in order to get a more exact view of the processes contributing to the karyological evolution of the species.

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