AN INTERESTING FORMATION OF ONE SATELLITED CHROMOSOME IN AN INDIVIDUAL OF ALLIUM CEPA

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In the course of our work with the so-called *Allium*-test for the study of the influence of various external factors on the chromosomes and mitoses of *Allium Cepa* we have come across now and again, among the great number of *Allium* individuals under observation in the course of years, single ones which exhibit a deviating chromosome situation. Thus, in a few instances we have found bulbs having the tetraploid chromosome number in all root tips. In other cases structural deviations have been noticed. An abnormality involving only a very small chromosome segment may become observable, if it affects the satellite, a change in the satellite being more easily traceable than changes in other chromosome regions. We may refer to the well-known case of tandem satellites in *Allium Cepa* first observed by TAYLOR (1926).

Heterozygosity in the satellite formation is seen now and again, one satellite being larger than the other. In the summer of 1954 we found an interesting case of this kind worthy of brief mentioning. In a series of *Allium* bulbs pretreated with oxyquinoline (*cf.* TJIO and LEVAN, 1950) one individual showed the following satellite situation in all root tips. One satellite chromosome had the normal *Allium Cepa*-type with a small normally stainable satellite attached to the shorter chromosome arm. In the other homologue the satellite seemed to be lacking. On closer observation, however, it was found that the stainable part of the satellite region was missing but this region was present as a strange very weakly stained zone developed as a diffuse bubble at the end of the shorter arm. This region had about the same dimensions as the satellite plus the attachment fibre of an ordinary satellite chromosome. The appearance of this structure is seen in Fig. 1, *c*, *f*, *i*, while the normal homologue is seen in *b*, *e*, and *h* of the same figure. Several instances of the two satellited homologues have been pictured in Fig. 2, showing their development from early metaphase to anaphase. Because of the oxyquinoline pretreatment the mitosis is of a c-mitotic type, the anaphases of Fig. 1, *g* and Fig. 2, *l* and *m* showing the characteristic «ski-pairs».

The present fixation, in 45 % acetic orcein, gives a characteristic appearance to the normal satellite region: during metaphase the stained satellite granule, forming the terminal end of the region,

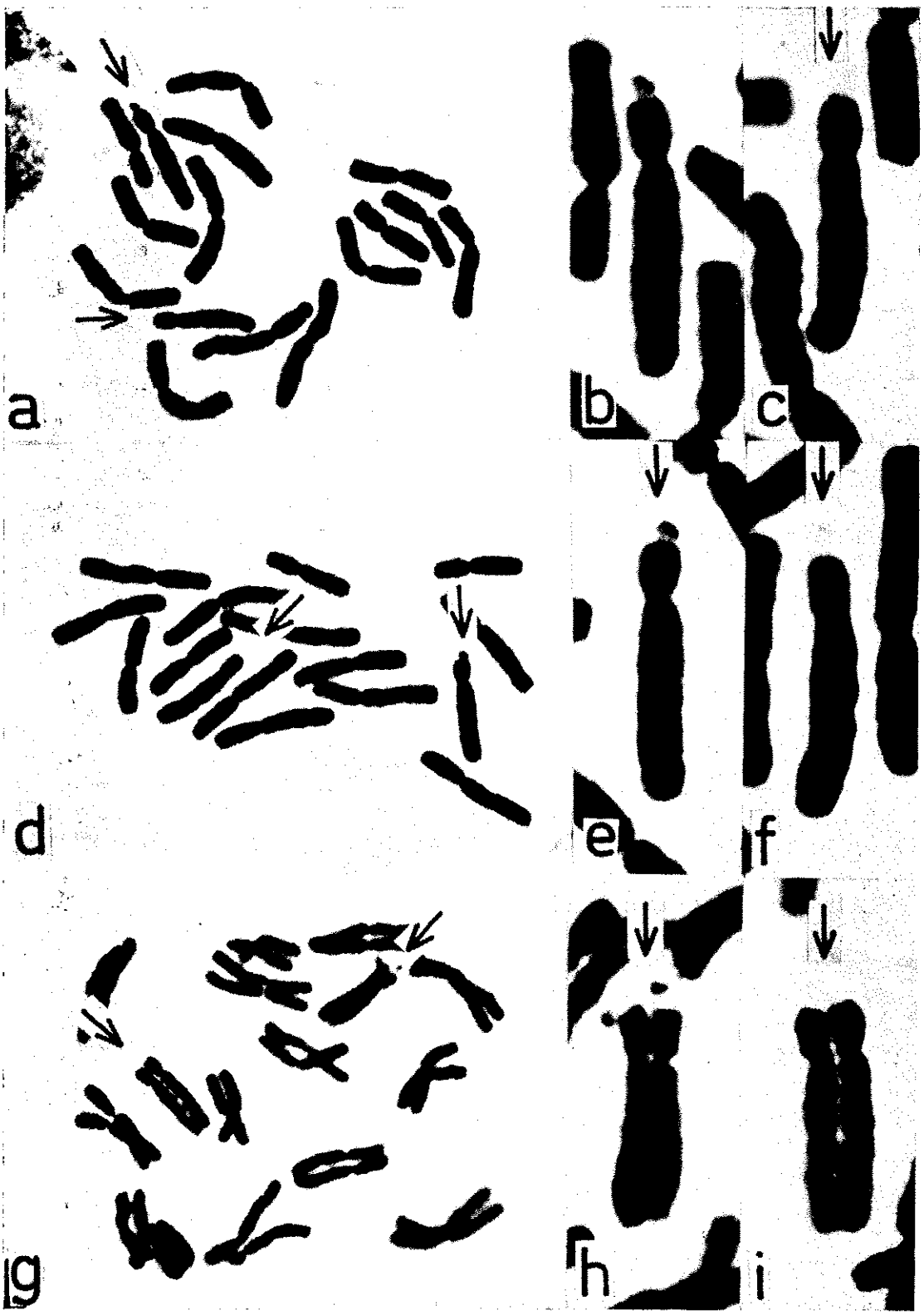

Fig. 1.—*a*, *d*, *g*: three root tip mitoses of *Allium Cepa* showing the normal and the deviating satellite chromosomes at the arrows; *a*, *d*: metaphase; *g*: anaphase. *b*, *c*, *e*, *f*, *h*, *i*: the satellite chromosomes from the three cells pictured at a higher magnification. — *a*, *d*, *g*: × 1600; *b*, *c*, *e*, *f*, *h*, *i*: × 3000.

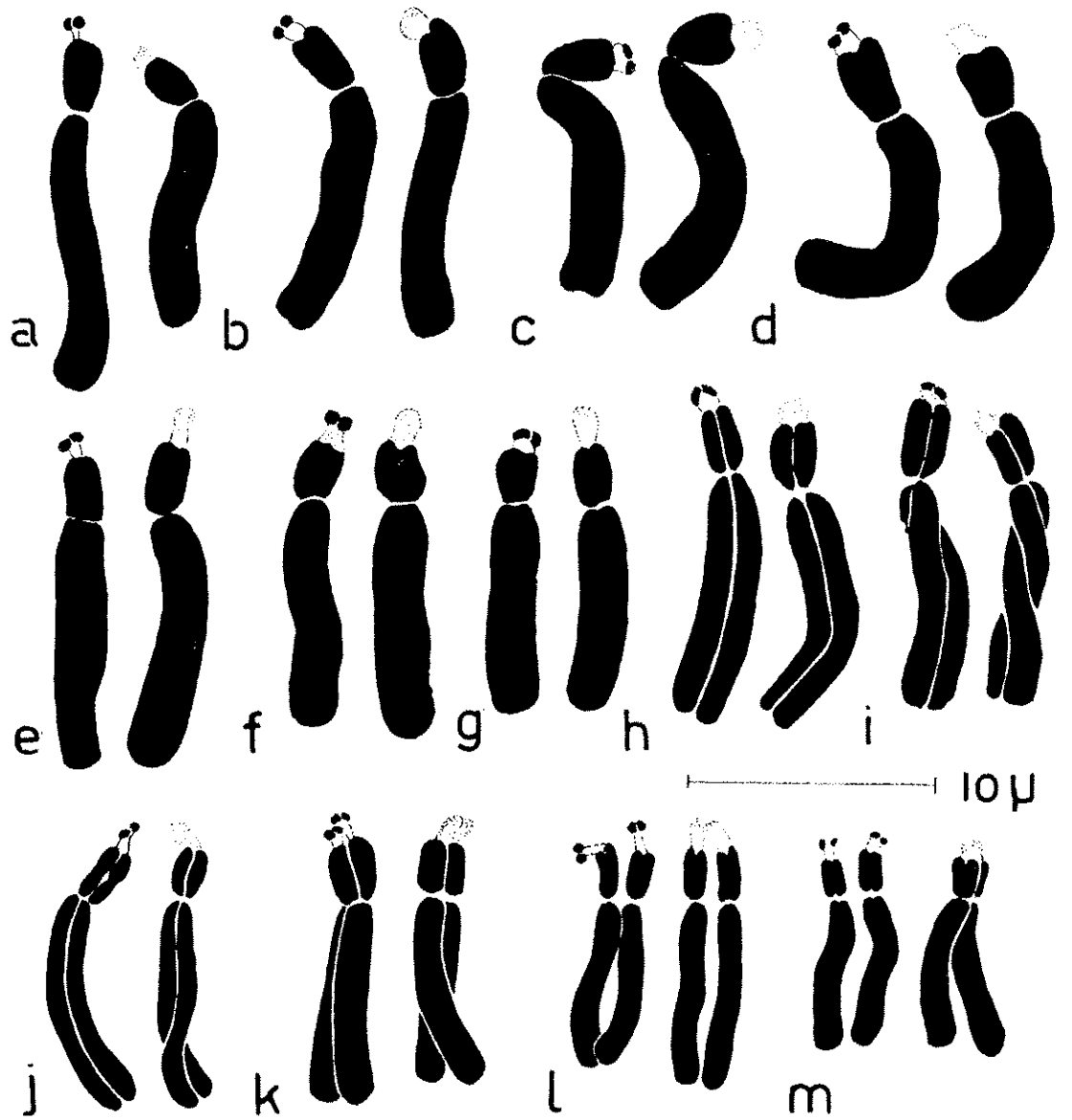

Fig. 2. Thirteen pairs of satellite chromosomes from metaphase (*a* - *k*) to anaphase (*l*, *m*). Note the subdivision of the satellites during late metaphase and anaphase (*k* - *m*). × 2700.

is usually separated into chromatids, even when the separation in chromatids is not clear within the main chromosome body. Between the satellite granules and the chromosome body a homogeneous faintly stained non-filamentous mass is often seen instead of the usual two attachment fibres. This mass is often divided lengthwise into two broad strands which represent the two daughter fibres of attachment. In agreement with what RESENDE (1940) and THERMAN-SUOMALAINEN (1949) have described in other materials the attachment fibres are

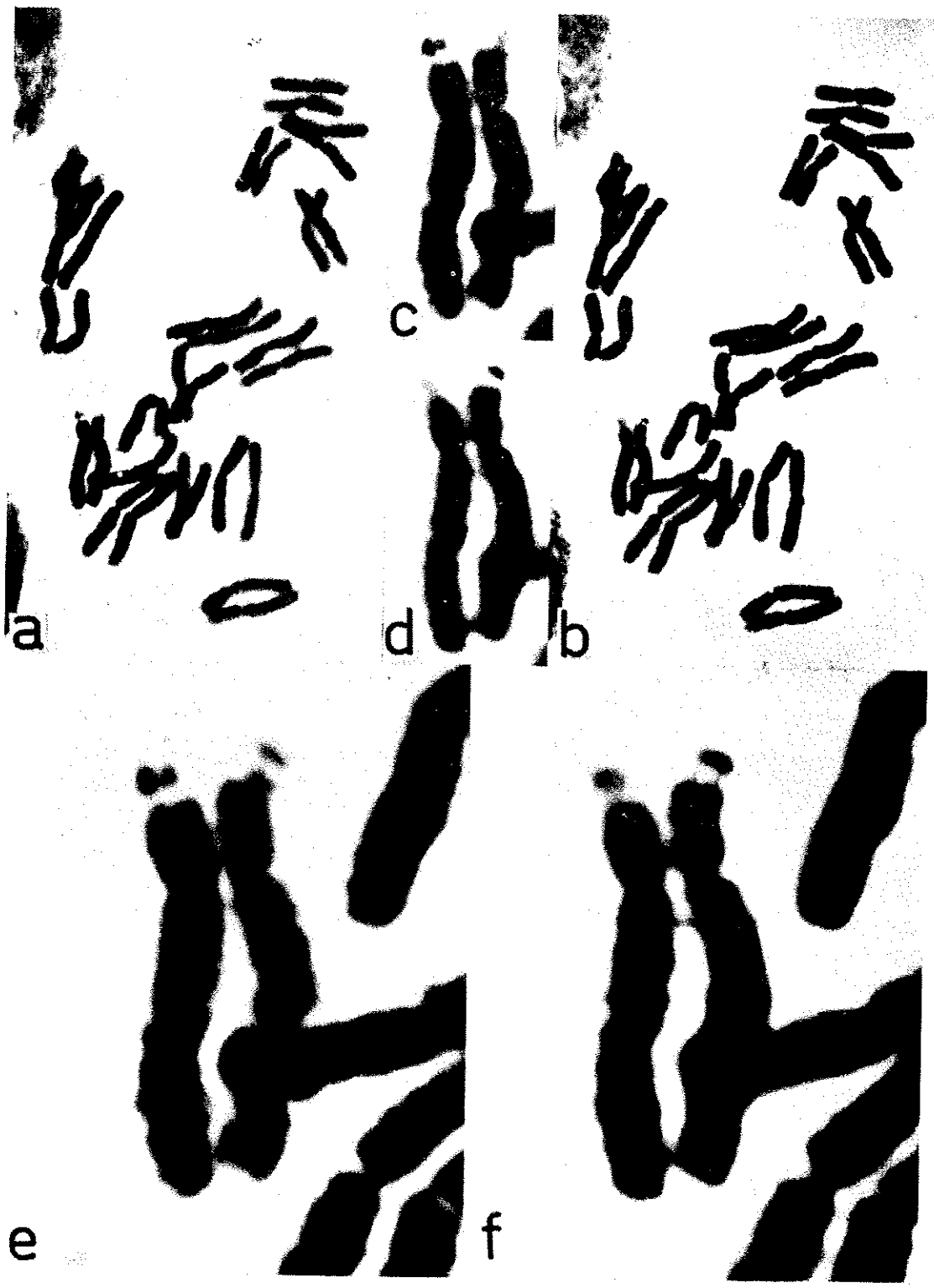

Fig. 3. – *a, b:* one anaphase cell at two foci. The satellites of one anaphase-«ski-pair» are divided, as clearly seen in the enlargements of *e - f*. – *a, b:* × 1400; *c, d:* × 4200; *e, f:* × 6200.

developed as a broad zone, only slightly narrower than the rest of the chromosome. It is perhaps significant in the present case that the entire satellite region of the abnormal homologue is of a similar appearance to the fibre zone of the normal homologue. It may well be that the difference between the two homologues is that the abnormal one is devoid only of the satellite granule, or has an extremely tiny satellite granule, while the satellite zone is present.

That possibly a very small stainable satellite granule may have been present and has become dissolved by the fixative is made probable by the observation that the most terminal part of the satellite zone of the abnormal homologue is usually somewhat darker than the rest; sometimes two faintly stained portions are seen corresponding to the two chromatids (Fig. 2, *b*, *e*, *h*, *k*). However, it is always a question of diffusely stained «clouds» rather than distinct granules.

In the «ski-anaphases» it was often observed that the normal satellite granule was clearly divided into two daughter granules in preparation for the next division. This phenomenon was mentioned by HEITZ in 1931, where an extra nucleolus in the telophase of *Aloë arborescens* was accounted for by the observation of «zwei Fäden mit je einem Trabant» in each anaphase satellite chromosome (l. c., p. 844). Since this feature has been pictured only rarely, and since there are still doubts about the doubleness of the anaphase chromosomes, we have made in Fig. 3 a representation of one especially clear case The cell photographed in two foci (Fig. 3, *a* and *b*) shows a typical c-anaphase. Among the «ski-pairs» the normal satellite chromosome has been enlarged at two foci in Fig. 3, *c-f*, showing clearly the doubleness of the satellite granule in the chromosome to the left, and the doubleness of the filament zone in the chromosome to the right This anaphase c-pair, as well as its abnormal homologue, are drawn in Fig. 2, *m*. The doubleness of the short chromosome arm in both cases is clear from the shape of the termination of the arm towards the attachment fibre zone.

SUMMARY

A case of heterozygous development of the satellited chromosome pair of *Allium Cepa* is described. One of the homologues had a satellite, while the other one had a satellite zone of normal size, but devoid of stainable satellite granule (Fig. 1, 2). Division of the satellite granule in preparation of the next mitosis was observed in anaphase chromosomes (Fig. 3)

RESUMEN

(UNA ANOMALÍA DEL CROMOSOMA SATELIZADO OBSERVADA EN UN EJEMPLAR DE ALLIUM CEPA)

Se describe un caso de heterocigosis en el par de cromosomas satelizados de *Allium Cepa*. Uno de los homólogos conserva el satélite, mientras que el otro carece de satélite coloreable, aunque subsiste la zona de constricción correspondiente, con su tamaño normal. En los cromosomas anafásicos se observó la división de dicho satélite preparándose para la próxima mitosis.

LITERATURE CITED

HEITZ, E.
1931 Die Ursache der gesetzmässigen Zahl, Lage, Form und Grösse pflanzlicher Nukleolen.—*Planta*, **12**: 775-844.

RESENDE, F.
1940 Über die Chromosomenstruktur in der Mitose der Wurzelspitzen. II. SAT-Differenzierungen, Spiralbau und Chromonemata. — *Chromosoma*, **1**: 486-520.

TAYLOR, W. R.
1926 Chromosome morphology in *Fritillaria, Alstroemeria, Silphium* and other genera.—*Amer. J. Bot.*, **13**: 179-193.

THERMAN-SUOMALAINEN, E.
1949 Investigations on secondary constrictions in *Polygonatum*. — *Hereditas*, **35**: 86-108.

TJIO, J. H., and LEVAN, A.
1950 The use of oxyquinoline in chromosome analysis.—*Anal. Estac. Exper. Aula Dei*, **2**: 21-64.