SOMATIC CELL DIVISION IN *ALOE VERA*, L.

BY

R. N. SUTARIA, B.A., M.Sc.,

M. R. Science Institute, Gujarat College, Ahmedabad.

Introduction.

The observations which form the subject of the present paper are based on the cytological study in *Aloe vera*, a common Liliaceous plant growing wild in Ahmedabad. Several papers (2, 8, and 9) have been published on the cytology of the *Aloinae*, but this particular species of Aloe has not been worked out. A detailed account of the somatic and reduction divisions would, therefore, be of some interest and the present paper only gives an account of the somatic division, leaving the description of the reduction division for a later communication.

Material and Method.

Collections of material were usually made between 12 a.m. and 1-30 p.m. on bright sunny days. The root-tips were either fixed in the field or from the plants kept in water in the laboratory for five to seven days to induce the development of the roots.

The material was fixed in Allen's modification of Bouin's fluid (4). To ensure quick penetration of the fixative, the air of the bottle was pumped out by an exhaust pump. The time of fixation was between two and three hours.

After fixation the material was gradually dehydrated with alcohol, cleared with xylol and embedded with paraffin 52°. Sections were cut at 9 to 12 microns and stained with Heidenhain's iron-alum haematoxylin without any counterstain.

Observations.

The somatic divisions have been studied chiefly in the root-tips and also in the premeiotic divisions of the archesporium and the walls of the ovary and the thalamus.

Metaphase.—It is convenient to begin with the metaphase stage because the chromosomes are quite distinct and can easily be studied. After the transverse breaking up of the spireme into segments or what are now called the chromosomes, the spindle fibres begin to appear. The origin of the spindle is not clearly observed; but it appears that

the chromosomes take up their position on the spindle very soon after it is formed. The spindle is pointed at both the poles. When the chromosomes are arranged on the equatorial plate of the bipolar spindle some of them show a distinct longitudinal split (Pl. I, Fig. 1).

The number of the chromosomes at this stage is fourteen, and these chromosomes are of unequal size—eight large and six small. Fig. 2 is a typical polar view of the metaphase and it is here that we can see the full number of large and small chromosomes. There seems to be some difference also in the size of the six small chromosomes. A typical large chromosome at this stage is more or less straight or rod-shaped but in the polar view many of them have a characteristic J-shaped appearance. The smaller chromosomes are attached to the spindle fibres by one end but the orientation of the larger chromosomes is not favourable at this stage for the observation of the attachment of the spindle fibres. Frequently in the cells of the wall of the ovary and the thalamus, the two sister chromosomes twist upon each other at their ends attached to the spindle fibres at the equatorial plate, while their free ends lie more or less in a plane parallel to the spindle (Pl. I, Fig. 3).

The occurrence of constrictions at particular points in the chromosomes is described by Mrs. Ferguson in the *Aloinae* (2), Fraser and Snell in *Viscia Faba* (3), Newton in *Galtonia* (6) and Taylor in *Gasteria* and *Aloe* (8 and 9). There are two distinct types of constrictions in *Aloe*. There is a sub-terminal constriction at the point where the spindle fibres are attached to the chromosomes. Such subterminal constrictions are quite distinctly seen in the polar views of the metaphase. Besides the subterminal constriction each of the long chromosomes shows many secondary constrictions on its entire length, giving a characteristic beaded appearance to the chromosome (Pl. I, Fig. 3). Such secondary constrictions are also described by Newton (6) both at the somatic metaphase and anaphase in *Galtonia*.

Anaphase.—Gradually the chromosomes get separated and pass to the poles (Pl. I, Fig. 4). At this stage, the long chromosomes look thinner than at the metaphase. The chromosomes overlap one another as they come closer and closer at the poles. Fig. 5 clearly shows eight large and two small chromosomes at the lower pole. Some of the chromosomes show subterminal as well as secondary constrictions. According to Taylor (8) one of the large pairs of chromosomes, besides the subterminal constrictions, carry at their distal ends small bodies called "Satellites". In my preparations such satellites are not observed. Mrs. Ferguson (2) also does not describe such bodies. Though the chromosomes are of homogeneous structure which may be due to the effect of the fixative, it is interesting to note

that in some of them a longitudinal split is occasionally observed at this stage. Miss Marriman (5) and Sarbadhikari (7) also refer to such a split in the chromosomes at this stage. As the chromosomes reach to the poles they shorten and thicken and become more closely massed, and thus the identity of the individual chromosome is not recognized. Fig. 6 is a polar view of the late anaphase showing the difference in size of somatic chromosomes.

Telophase.—This stage is seen very frequently in both the root-tip cells as well as in the archesporial tissue. Therefore, it seems that this stage is of comparatively longer duration than either the meta or anaphase.

The chromosomes form a compact deep staining mass at both the poles; and the barrel-shaped spindle is distinct. All the chromosomes do not anastomose at one and the same time (Pl. I, Fig. 7). Gradually the contracted mass becomes more compact and now it does not take stain as deeply as before (Pl. I, Fig. 8).

The clumped mass now opens and the chromosomes tend to separate from one another. The nuclear membrane as well as one or two nucleoli appear more or less simultaneously (Pl. II, Fig. 9). The cell-plate which appears very early (Fig. 8) now gets thicker and devides the whole cell into two parts. Fig. 10 represents an early stage in the reconstruction of the two daughter nuclei.

Prophase.—The approaching prophase begins with the appearance of the definite nucleolus in the nucleus which has not only grown bigger but also becomes somewhat irregular in shape. The nuclear material shows a faint and lightly stained reticulum of chromatin granules of very small size. The reticulum is more or less beaded or moniliform in appearance due to some portions of the fine interwoven threads getting thicker than the others (Pl. II, Fig. 11). Some of the nuclei at this stage show a clear space around the nucleolus (Pl. II, Fig. 12).

In the nucleolus of the root-tip cells a number of well-defined very small bodies are seen. With the change of focus they look like crystalline bodies similar to those as described by Miss Digby (1) and Miss Latter (4) (Pl. II, Figs. 12 and 13).

The chromatin which in the beginning occupied more or less peripheral position now gradually condenses to form a spireme. The spireme is arranged in coils and loops radiating somewhat irregularly from the nucleolus (Pl. II, Fig. 14). Though the spireme seems to be homogeneous yet very often it shows a clear split. At many places the thread of the spireme is double.

Chromosome formation.—Gradually the spireme thickens and becomes short. The segmentation of the spireme into chromosomes

occurs at this stage (Pl. II, Figs. 15–18). Distinct broad bands of spireme are seen in various shapes and sizes. Due to the uneven condensation of the individual chromosomes, the spireme is either spiral (Pl. II, Fig. 16) or forms a very irregular zigzag thread. Some of the spireme bands unite end to end (Pl. II, Fig. 17). The chromosomes which are scattered throughout the nuclear cavity often adhere to one another by fine threads (Fig. 18). The nuclear membrane soon disappears and the chromosomes come together and after being straightened out arrange themselves on the equatorial plate. The spindle which is bipolar appears in time and a typical metaphase results.

Summary.

1. The number of somatic chromosomes in *Aloe vera* is fourteen. They are of unequal size—eight large and six small.
2. Each of the large chromosomes exhibits a sub-terminal constriction at its proximal end. They also possess secondary constrictions on their lengths.
3. Some of the chromosomes of the anaphase stage show a longitudinal split.
4. Crystalline bodies are present in the nucleolus of the prophase stage.
5. The spireme occasionally shows a longitudinal split.

The writer wishes to express grateful appreciation to Prof. J. J. Asana for his advice and help at the beginning of the study, and to Prof. S. L. Ajrekar for his encouragement and careful criticism. He is also deeply indebted to the University of Bombay for the research grant which has facilitated the preparation of this paper.

Bibliography.

1. DIGBY, L.—The Somatic, Premeiotic and Meiotic Divisions of Galtonia candicans. Ann. Bot. 24; 727. 1910.
2. FERGUSON, N.—The Alœinæ: A Cytological study, with Especial Reference to the Form and Size of the Chromosomes. Phil. Trans. Roy. Society. Lon. Series B. Vol. 215: 225. 1926.
3. FRASER, H. C. and SNELL, J.—The Vegetative Divisions in Vicia Faba. Ann. Bot. 25: 845. 1926.
4. LATTER, J.—The Pollen Development of Lathyrus odoratus. Ann. Bot. 40: 277. 1926.

5. MERRIMAN, M. L.—Vegetative Cell Division in Allium. Bot. Gaz. 37 : 178. 1904.

6. NEWTON, W. C. F.—Studies on Somatic Chromosomes. Pairing and Segmentation in Galtonia. Ann. Bot. 38 : 197. 1924.

7. SARBADHIKARI, P. C.—"Cytology of Osmunda and Doodia. II. On the Gametophytic Tissue of Doodia". Ann. Bot. 41 : 1. 1927.

8. TAYLOR, W. R.—Cytological Studies on Gasteria II. A comparison of the chromosomes of Gasteria, Aloe, and Haworthia. Amer. Jour. Bot. 12 : 219. 1925.

9. ———— Chromosome Constrictions as Distinguishing Characteristics in Plants. Amer. Jour. Bot. 12 : 238. 1925.

Explanation of Plates.

All figures except 1-4 and 7 were drawn with the aid of the Abbe Camera Lucida with Leitz achromatic oil immersion $\frac{1}{2}$ inch N. A. 1.3 and Huyghenian ocular 5. Magnification about × 1260. Figures 1-4 and 7 were drawn with Leitz $\frac{1}{8}$ inch Fluorite objective N. A. 0.87 and ocular 5. × 830.

Fig. 1. Root-tip ; Metaphase. Some of the chromosomes show longitudinal split and also secondary constrictions.

Fig. 2. Ovary ; Metaphase polar view with eight large and six small chromosomes.

Fig. 3. Stamen ; Metaphase—showing the twisting of the chromosomes.

Fig. 4. Ovary ; late anaphase.

Fig. 5. Stamen ; late anaphase.

Fig. 6. Ovary ; anaphase polar view.

Fig. 7. Stamen ; late telophase—chromosomes contracted.

Fig. 8. Root ; late telophase—showing the aggregation of chromosomes.

Fig. 9. Root ; loosening of the confused mass of chromosomes.

Fig. 10. Root ; reconstruction of the daughter nuclei.

Fig. 11. Root ; early prophase.

Fig. 12. Root ; prophase—nucleolus showing crystalline bodies.

Fig. 13. Root ; nucleolus showing crystalline bodies.

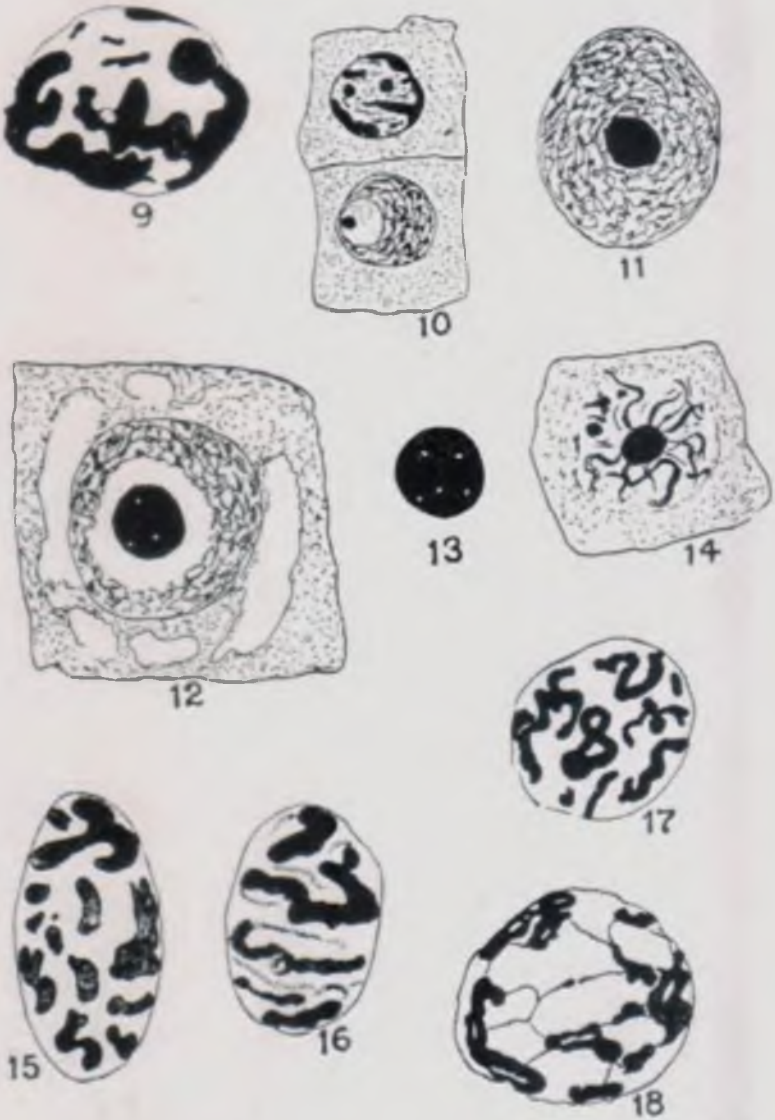
Fig. 14. Stamen ; early spireme.

Figs. 15 & 16. Root ; segmentation of the spireme.

Fig. 17. Stamen ; early chromosomes.

Fig. 18. Root ; newly formed chromosomes joined with one another by fine threads.


1
2
3
4
5
6
7
8


9
10
11
12
13
14
15
16
17
18