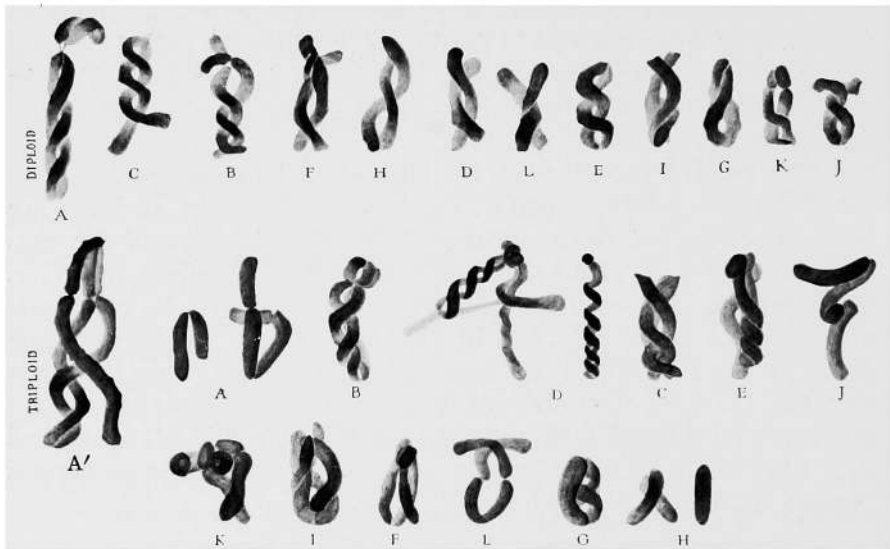


proportional to chromosome length. We corroborate this conclusion from our observations of diakinetid chromosomes in the diploid *Lilium tigrinum*. The greatest number of chiasmata was observed in the pair of A chromosomes in which there were as many as four interstitial and two terminal. Two terminals were observed for E, F, J, and K; none were observed for the pairs of B, D, E, and H. One interstitial was the rule for G, H, I, J, and K, two for D, E, F, and L; three for C; and four for A and B.



Text Fig. 2. Semi-diagrammatic drawings (made to scale) showing configuration of the various chromosome associations at diakinesis in both the diploid and triploid *Lilium tigrinum*.

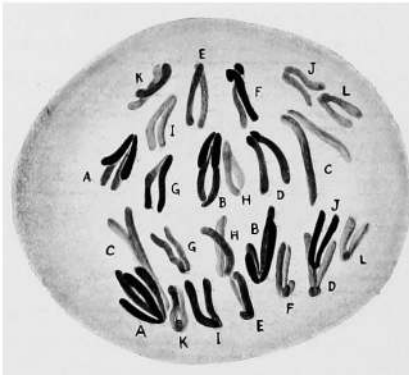
In the triploid *Lilium tigrinum*, the associations at diakinesis show three main types of irregularities: (1) lack of uniform association between the homologues, (2) chromosomes in different stages of shortening and straightening, and (3) the occurrence of unpaired chromosomes (plate 26, fig. 27). There are irregularities in the number of homologous chromosomes which synapse, and in respect to the reduction in the number of chiasmata and the straightening out of chromosomes the stage seems to be more advanced than in the diploid. Also the individual characteristics of the chromosomes are more evident; for example, the terminal ball on chromosome D is now clearly defined.

In respect to irregularity of association, two of the components are usually in closer contact with each other than with the third (plate 24, fig. 7). In text figure 2 the triploid associations for chromosomes A', B, C, E, G, I, and K illustrate this point. F, L, and J

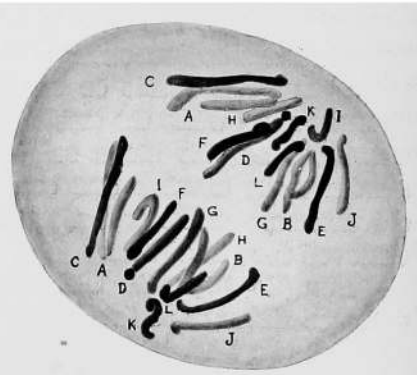
Takenaka and Nagamatsu (1930) reported that in the triploid *L. tigrinum* which they studied the number of trivalents ranged from 6 to 12 with the greatest frequency for 8. Our data indicates that the greatest number of trivalents is much higher than 8.

The associations of the long chromosomes (as A, B, and C) in trivalents present various configurations (text fig. 2, triploid A', A) which are no doubt the effect of differences observed earlier in the synapsis of parts of the threads or the results of chiasmata. The irregularities in the triploid at this stage involve numerical differences in the number of chromosomes which synapse and the configuration of those which are trivalent. In the trivalents there is contact at certain points between any one and the other two, but it is often the case that two are rather closely associated while the third is only partially bound to the others (plate 24, fig. 9). Complete terminalization of chiasmata proceeds up to the beginning of the anaphase but the high viscosity and cohesive qualities of the sheath preserve contact associations beyond that point.

The univalents, bivalents and trivalents are all brought into the level and plane of the equatorial zone (plate 26, fig. 27) and in this particular there are no lagging elements at this stage. The nuclear membrane soon disappears while at the same time the sheath of the chromosome increases in volume and its outer surface becomes more dense. The nucleolus loses its chromaticity at this point and its outline becomes irregular as though parts of it had already undergone partial dissolution. Owing to extreme contraction the individuality of the chromosomes is somewhat obscured.



Text Fig. 3. Semi-diagrammatic drawing made of a diploid P.M.C. of *Lilium tigrinum* at I-A showing the entire set of 24 chromosomes with partially separated chromatids evenly distributed between the two poles. (From an acetocarmine smear preparation).



Text Fig. 4. Semi-diagrammatic drawing made of a diploid daughter cell of *Lilium tigrinum* at II-A showing the entire set of 24 daughter chromosomes (former chromatids) evenly divided between the two poles. (From an acetocarmine smear preparation).

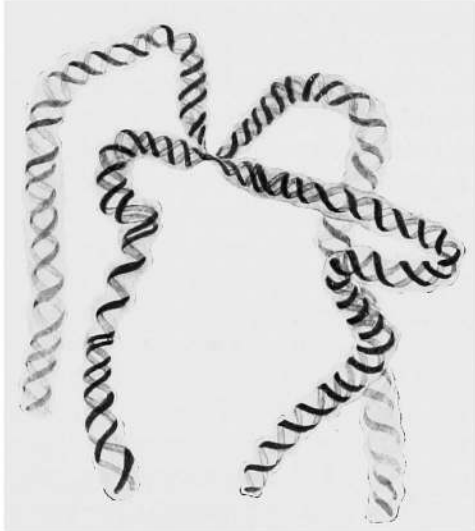
which extends for a considerable distance toward the two poles. If there is a persistent attachment in the distal portion of the two, an "anaphase bridge" (Jensen, 1936) is formed which is later bisected by the formation of a cell plate.

Unpaired chromosomes which lag rarely persist in the equatorial areas as such; that is, with the two chromatids intact in one unit or in partial attachment. It is the rule that the lagging univalents undergo premature separation of chromatids which is the final stage of duplications normally seen in somatic divisions and in the homeotypic divisions of meiosis.

The position and condition of the separated chromatids in the early anaphases indicate certain aspects of the processes which operate. The two sister chromatids separate promptly and completely during the early anaphase and for a time they lie near each other in a somewhat parallel position. They seem to float apart by a repulsion which is operating uniformly at all points including the point of spindle attachment. The separation appears to be largely independent of spindle fiber activity and the operation of such fibers seems to be largely lacking on the separated chromatids in later stages.

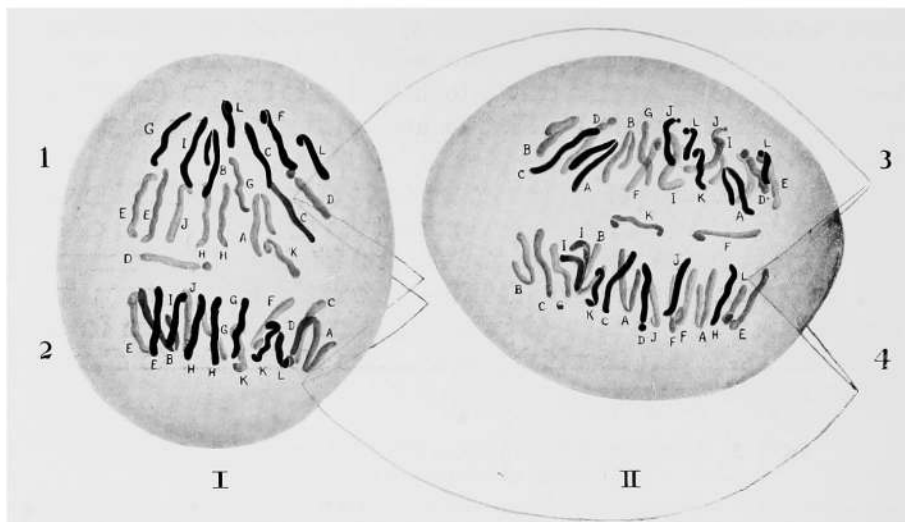
Chromosomes A, B, D, E, and K were all identified among the lags but it can not definitely be stated that certain chromosomes of the twelve do not lag. It is, however, certain that the chromosomes which most commonly lag are those for which associations are loose or lacking (as illustrated by chromosome D).

The spindle figures of the first division are bipolar and there is no evidence of the suppression or collapse of the general spindle apparatus which might result in restitution nuclei. All chromatin



Text Fig. 5. Chromosome A at interphase showing the duplicated chromonemata and the junction of the two chromatids at the constriction point.

elements and associations seen in diakinesis are brought into the metaphase plate. From this point on the distribution operates to distribute into two nearly equal groups the chromosomes which have been associated and which have disjoined, but fails thus to operate on



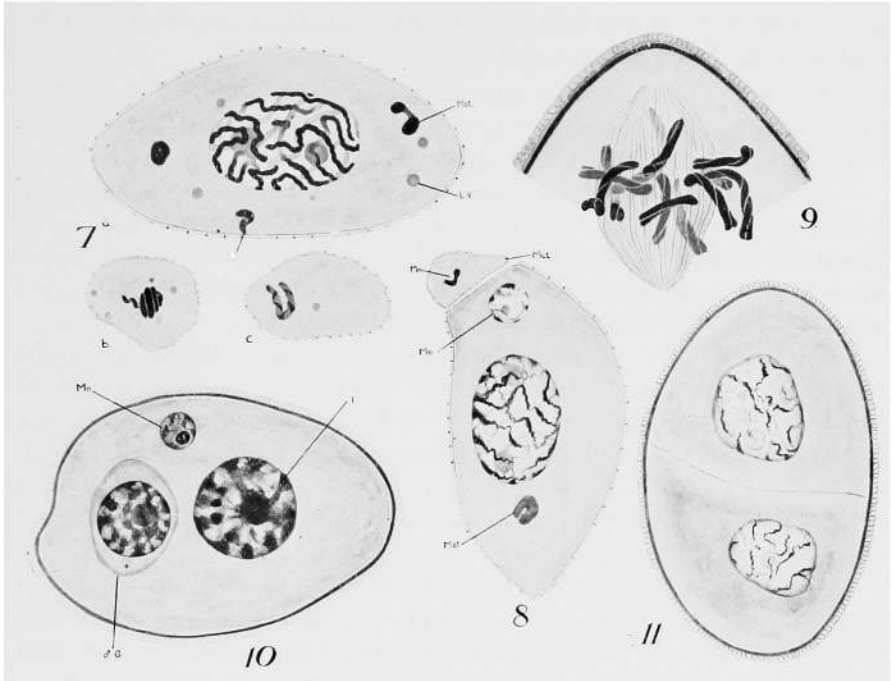
Text Fig. 6. The distribution and identity of all chromosomes of one pollen mother cell of a triploid *Lilium tigrinum* at the anaphase of the second meiotic division.

It is evident that in this case all chromosomes divided once only; that more than a complete set have passed to each of the four nuclei; and that two of the three homologous chromosomes enter either of the two nuclei of a pair by chance distribution to increase the number to more than 12.

Table 4. The distribution of 72 identified chromosomes between the entire four poles in the two daughter cells at II-A of the triploid *Lilium tigrinum*.

		A	B	CC	D	EE	F	GG	HH	I	J	K	LL	TOTAL
I	Nucleus 1.	A	B	CC	D	EE	F	GG	HH	I	J	K	LL	17
	Lags				D									1
II	Nucleus 2.	A	B	C	D	EE	F	GG	HH	I	J	KK	L	16
	Nucleus 3.	AA	BB	CC	D	E	F	G	H	II	JJ	K	L	17
	Lags						F					K		2
	Nucleus 4.	AA	BB	C	DD	E	FF	G	H	II	JJ	K	LL	19
	TOTAL	6A	6B	6C	6D	6E	6F	6G	6H	6I	6J	6K	6L	72

A special study was made of the number of lagging and extended chromatin elements in a large number of cases in which the number of chromosomes in the main nuclei could not be determined. The following table presents the various kinds of distribution of lagging elements observed in each of the two pairs of sister spores and in the additional microcytes. The lagging elements of the first division are given in *italics*, those of the second division are given in the ordinary type. In certain cases the identity of a chromosome was established as indicated in parentheses.

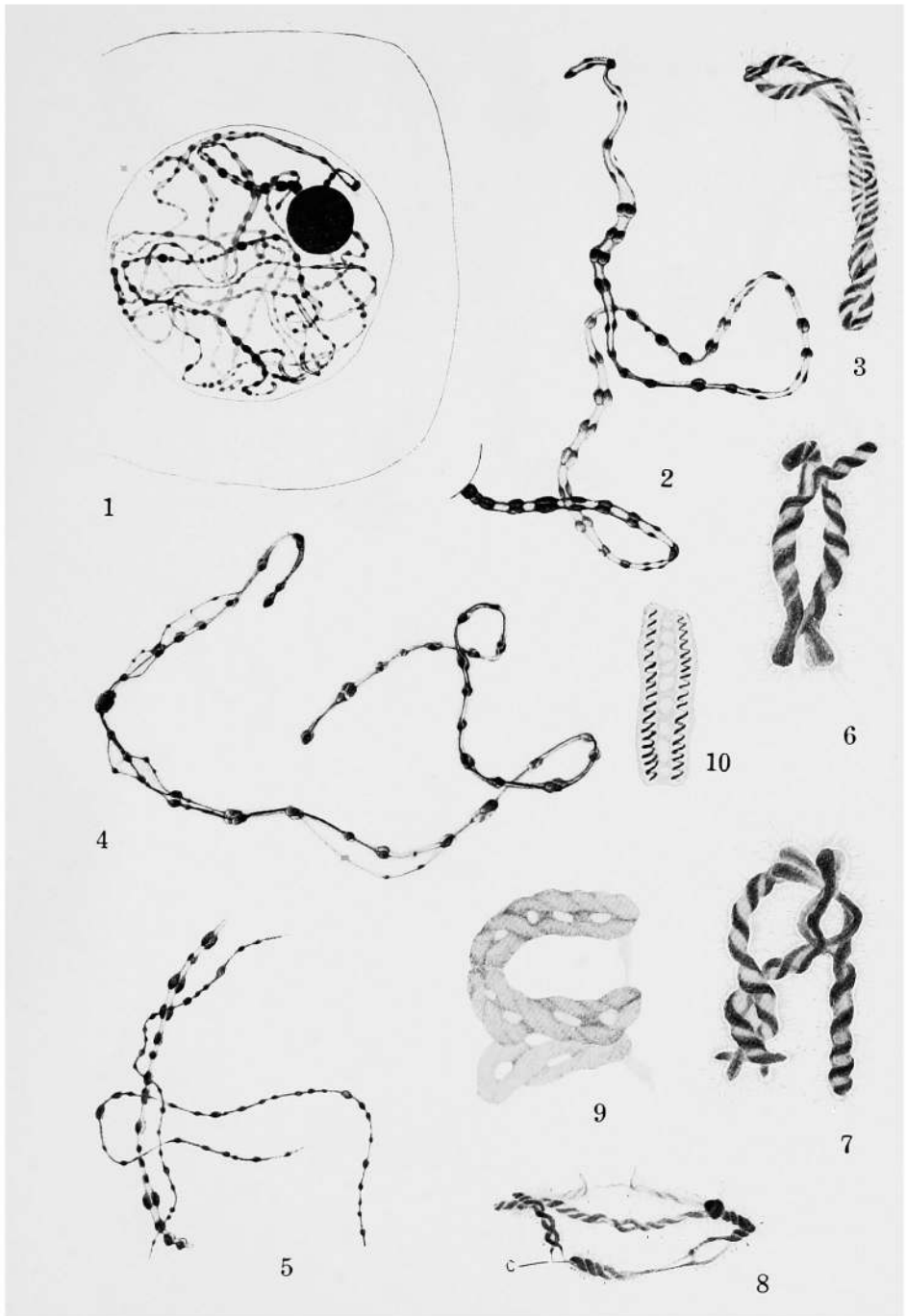


Text Figs. 7-11. Semi-diagrammatic drawings of stages in the development of the microspores of the triploid. 7, (a). Primary cell containing vegetative nucleus and extruded chromatin material; L. V., lymph vacuoles; Mst., microcysts; and F., chromosome fragment. (b). Microcyte. Chromosome rolling up before forming a micronucleus. (c). Microcyte containing one chromosome and lymph vacuole. 8. Microspore and microcyte drawn in their relative positions. Mn, micronucleus; Mct., microcyte; and Mst., microcyst. 9. Twelve chromosomes at the equatorial plate for the division of the vegetative nucleus. 10. Microspore. G, generative cell; Mn., micronucleus; T, vegetative nucleus. 11. Two vegetative cells in a single microspore.

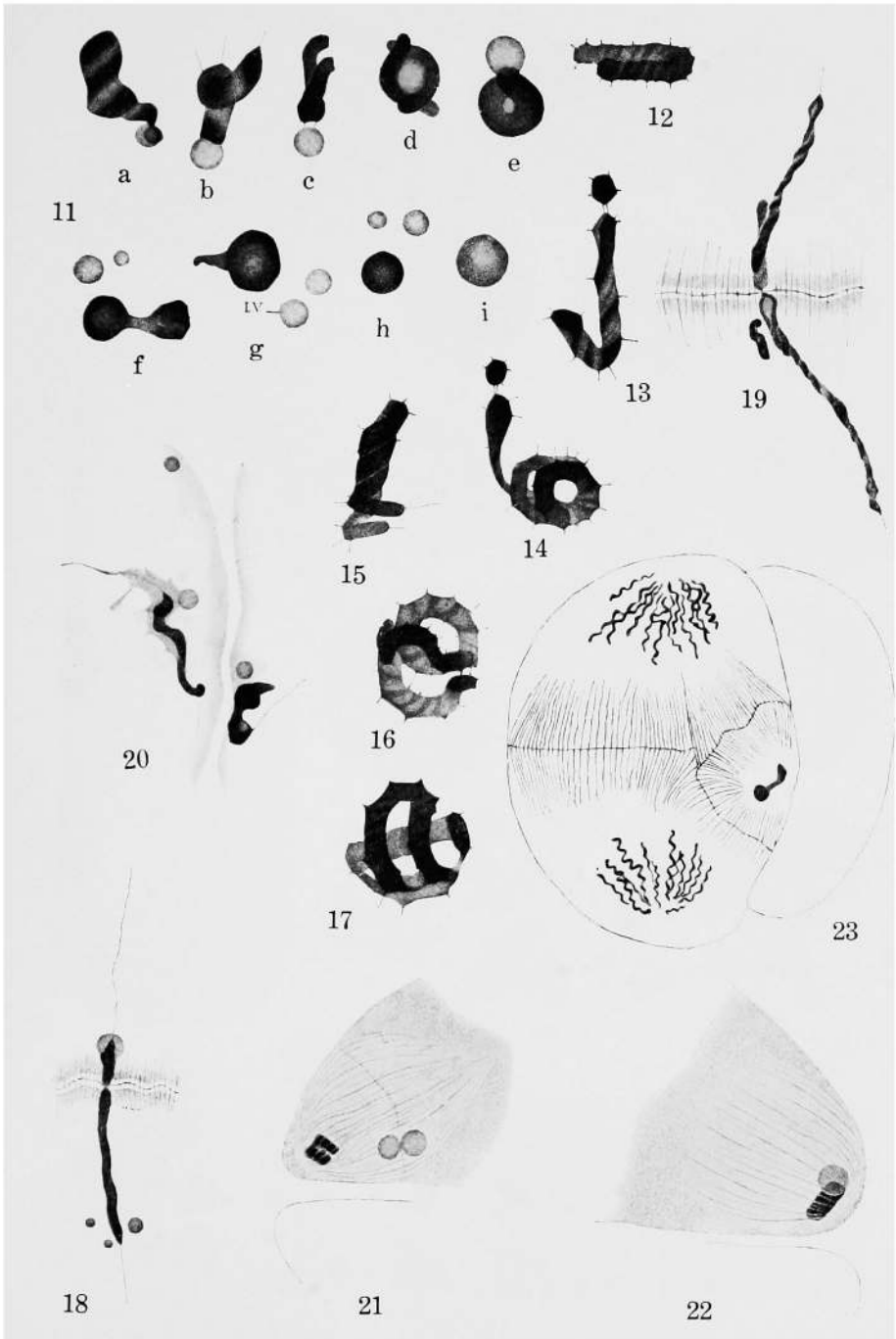
At the time when anthers of the triploid *Lilium tigrinum* are about to dehisce and discharge pollen there are two rather distinct classes of spores, (a) the large-sized *pollen grains* and (b) the small-sized *microcytes* and these exist in a ratio of about 9 to 1 (plate 26, fig. 39). All these spores contain at least some cytoplasm and have well formed walls. None have collapsed and none appear to be dead.

The Mature Pollen

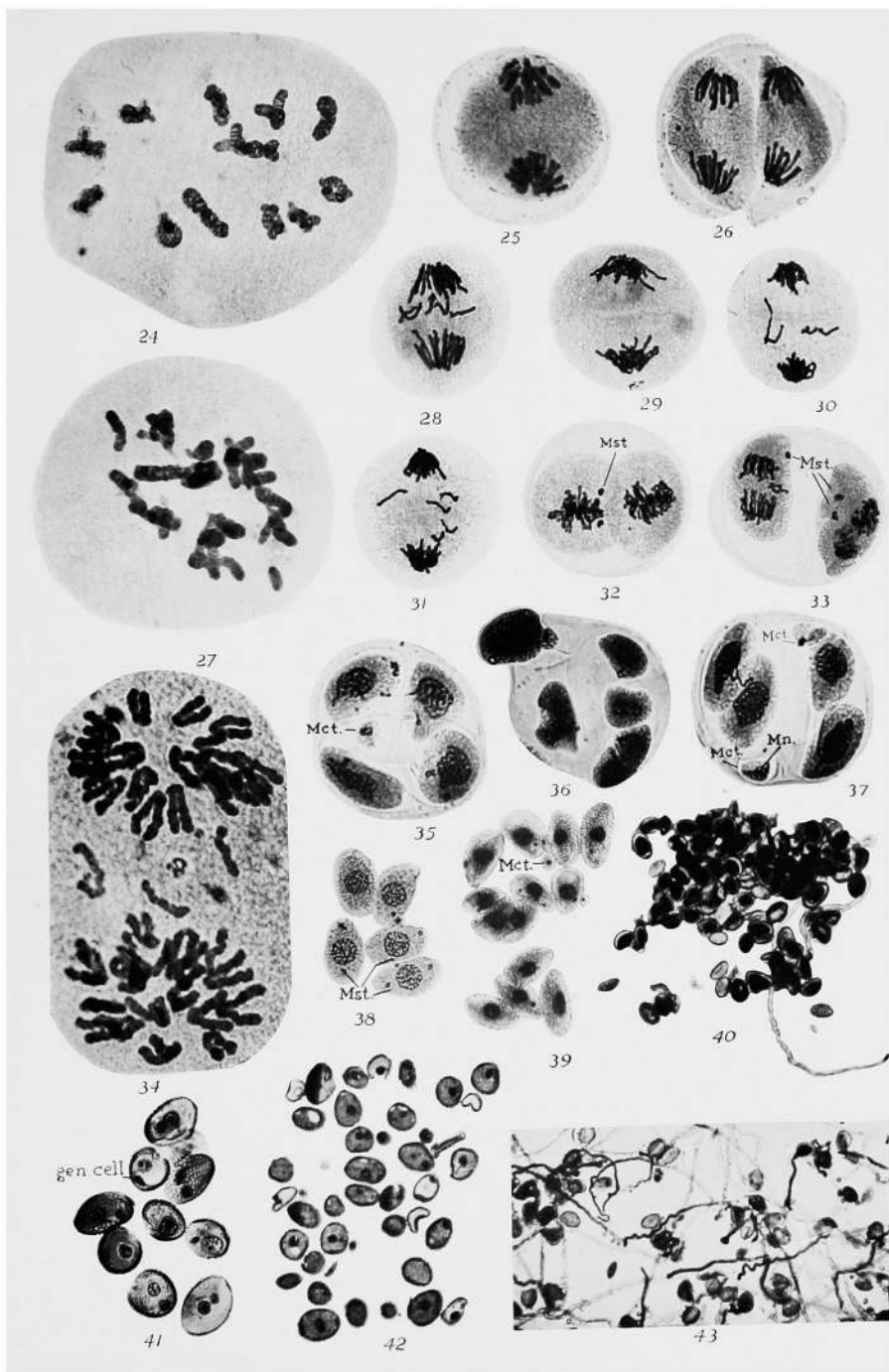
During the last few hours before the anthers dehisce and during the early stages of dehiscence while pollen is drying out noteworthy changes occur and obvious degeneration followed by abortion of entire cells appears for the first time. Certain of the large-sized pollen grains do not develop beyond the one-celled stage and these, it is believed, not only do not germinate but abort. It is to be noted



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