daughter-chromosomes as they approach the poles. Thus the reduction in number is effected by an end-to-end fusion of the chromosomes, as Strasburger has already suggested.

The next division by which the pollen-tetrads are formed takes place probably according to the normal karyokinesis in plant-cells, as it is found to do so in *Lilium Martagon* and *L. chalcedonicum*. In these two species not only were the slender chromosomes forming the equatorial plate observed, but also their longitudinal fission which is similar to that which takes place in vegetative cells.

Before signs of approaching karyokinesis are apparent in the primary nucleus of the embryo-sac, fibres of great distinctness develop in the protoplasm of this cell, forming a spindle above and completely outside the nucleus, in position and appearance recalling Hermann's figure of the sperm-mother-cell of *Salamandra maculata* preparing for division (Archiv f. Mikrosk. Anat. 37). During division this nucleus behaves, so far as has been observed, with complete similarity to that of the pollen-mother-cells. In the later nuclear divisions in the embryo-sac, the doubling of the nuclear thread before the formation of the chromosomes, and the fission in the nuclear plate into V-shaped daughter-chromosomes, were not to be observed; in a few cases, however, the nuclear plate was seen to be composed of the humped chromosomes characteristic of the first division in this cell and in the pollen-mother-cells. But in the great majority of cases which were observed of these later divisions, the equatorial plate was formed of the usual slender bent chromosomes, which cleave longitudinally when in this position. Another point of interest connected with this embryo-sac is the fact that even without fertilization its central portion becomes occupied by a large number of nuclei. These nuclei arise by *direct* division and are formed as far as, at present, can be made out from the lower polar nucleus¹. H. H. DIXON.

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ABNORMAL NUCLEI IN THE ENDOSPERM OF FRITILLARIA IMPERIALIS.—In some material which was fixed during the spring of 1894, I have found some very peculiar forms of direct nuclear division, as well as intermediate forms between direct and indirect division. Nuclei before direct fission often attain monstrous

¹ Fuller details of this and the following note were laid before the Royal Irish Academy on Nov. 11, 1895, and will be published with illustrations in their Proceedings, Vol. III, Pt. 4.

dimensions; thus one nucleus measured 0.3 mm. long and 0.2 mm. broad. Sometimes these nuclei break up simultaneously into a large number of small nuclei, sometimes they become constricted in the middle, and after drawing out into the shape of an hour-glass divide into two equal daughter-nuclei. In another form of a direct division the nucleus forms a large number of bud-like projections from its surface which become separated from the parent nucleus. Ring-shaped nuclei were also often met with, which divide into two, three, or four daughter-nuclei according to the number of places in which the ring becomes attenuated.

It was in the smaller nuclei I observed transition-forms between direct and indirect fission. In these cases the nucleoli disappear and the nuclear thread breaks into a number of chromosomes; but without the nuclear membrane dissolving or the formation of a nuclear plate, the nucleus becomes constricted across the middle so that it appears dumbbell-shaped. The piece connecting the two daughter-nuclei usually lies more to one side than the other, and beside it is formed an apparently normal achromatic spindle. The solution of the nucleoli and the persistence of the nuclear membrane during these direct divisions prior to the formation of the spindle, supports the view that this latter structure is in part derived from the nucleolar substance. In these divisions I could not observe a longitudinal fission of the nuclear thread.

It is to be noted that the direct as well as the transition-forms of nuclear division were, in the cases observed, found in groups among nuclei exhibiting normal karyokinetic figures, from which we may conclude that the abnormal forms are not the result of imperfect fixing, and also that the same stimuli give rise to both kinds of division. Nearly all these forms of nuclear fission have been observed in animal cells, but so far as I am aware, they have not been recorded as occurring in plants.

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FURTHER INVESTIGATIONS ON SPORE-FORMATION IN FEGATELLA CONICA.—I have already (page 489 et seq.) described the chief points connected with the nuclear divisions in this plant. Since that paper was written my plants have fruited again, and as a large amount of material has rendered it possible to fill up some of the gaps existing in my previous account, I now briefly summarize the new results.

Dixon, Henry Horatio. 1895. "Abnormal nuclei in the endosperm of *Fritillaria imperialis*." *Annals of botany* 9, 665–666.

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