described above are followed by cell divisions. Thus the supernumerary pollen-grains are produced by the organization of distinct cells round all the nuclei, whether these have been formed in the regular course of mitosis, or by the isolation of irregularly distributed chromosomes.

I can find no evidence of the existence of secondary divisions of the cells such as Wille described, nor do my observations give any support to this author's suggestion that a fusion (or non-separation) of primitive mother-cells (Urmutterzellen) might occur in those cases in which the additional microspores were very numerous.

A definite relation appears to exist between the number of chromosomes entering into a nucleus, the size of the nucleus, and the size of the cell produced.

It may be further added that the small cells, with only a few chromosomes entering into the composition of their nuclei, develop pollen-walls, which differ neither in structure nor in chemical composition (viz. they give the same staining reactions) from those surrounding the pollen-grains which have received the normal number of chromosomes.

It will be seen that these facts have an interesting bearing upon the theory of the localization of specific characters in particular chromosomes, but the discussion of this matter must be left for my full paper upon the pollen development of *Fuchsia* and some other plants.

RUDOLF BEER.

CONTRIBUTIONS TO THE CYTOLOGY OF HUMARIA RUTILANS FR.

(Preliminary Note.)—*Humaria rutilans* is a small orange Discomycete occurring in abundance on sandy soil. It possesses exceptionally large nuclei, the nucleus of the uninucleate ascus measuring about $14\,\mu \times 9\,\mu$.

The ascocarp originates as a tangle of septate hyphae, each cell containing one or a few nuclei. Sexual organs are not differentiated. Very early a sheath of rather thick-walled cells can be distinguished, and within this ramify numerous hyphae, growing upwards till, while the ascocarp is still quite minute, paraphyses and subsequently asci appear. At and rather before this stage two sorts of hyphae can be distinguished in the hypothecium by the size of their nuclei, though they do not otherwise differ. The larger nuclei are about twice the size of the smaller, and are formed by the *fusion of these in pairs*. This would appear to constitute a process of reduced fertilization, or apogamy, quite comparable to that observed in the prothallus of *Nephrodium*, and representing a stage in the reduction of sexuality more advanced than that found in *Humaria granulata*, where an ascogonium is organized and the female nuclei fuse in pairs. The hyphae containing the larger, or fusion-nuclei, may thus be regarded as sporophytic, the others as gametophytic.

Asci arise from the sporophytic or ascogenous hyphae. The hypha, on reaching the subhymenial layer, bends over and its two terminal nuclei undergo simultaneously a karyokinetic division in the prophase of which sixteen chromosomes may be counted. As first described by Dangeard, a terminal uninucleate and a penultimate binucleate cell are now cut off, the latter constituting the young ascus.

The terminal cell may continue its growth and give rise to a hypha, the penultimate cell of which again forms an ascus. The two nuclei of the ascus appear to be, in such cases, of the relationship of cousins.

Each of the two nuclei of the ascus now enters on the early prophases of hetero-

type division; the chromatin becomes aggregated to one side, constituting the 'first contraction figure' of Farmer and Moore. This is followed by the appearance of a more loosely coiled spireme in each nucleus, and, here and there, longitudinal fission of the thread may be seen.

At this stage the ascus-nuclei fuse.

The longitudinal split now becomes more evident, but later it disappears for a time as the fusion-nucleus passes into synapsis.

The subsequent stages of the first and second divisions in the ascus are in agreement with those described by Farmer and Moore for the spore-mother-cells of *Osmunda regalis*; as the nucleus passes out of synapsis, loops become obvious, each of which represents a bivalent chromosome. The chromosomes divide transversely in the first mitosis and, in the second, the longitudinal fission begun in the first prophase takes effect. In each of these divisions the number of chromosomes is sixteen.

This number was first observed, in *Humaria rutilans*, in 1904–5, by Guillermond, who also noted the occurrence of a longitudinally split spireme, and of a synapsis in the first division.

In the prophase of the third division sixteen bent chromosomes appear, but in the anaphases only *eight* chromosomes pass to each of the daughter-nuclei.

The spores are delimited by radiations passing out from the centrosome, but the direction of these is, to some extent, regulated by the position of neighbouring vacuoles, which may also aid in the delimitation of that part of the spore remote from the nuclear beak.

The processes observed in connexion with the development of the ascus suggest the following interpretation:—

The sporophytic number of chromosomes, as seen in the ascogenous hypha, is sixteen.

The ascus, when first formed, resembles other cells of the mycelium in being multinucleate[1]. Each of the nuclei, typically two in number, of the ascus enters independently on the meiotic phase. Fusion then takes place, the two spiremes becoming indistinguishably mingled.

The sixteen chromosomes which appear in the first and second divisions, and in the prophase of the third, may be regarded as representing two sets of post-meiotic (or gametophytic) chromosomes united within one membrane, half having been derived from each spireme.

On the spindle of the third division the chromosomes separate away from each other, and the true gametophytic number, eight, becomes apparent. The premeiotic (or sporophytic) number is restored by the apogamous fusions in the hypothecium.

It seems not impossible that the fusion of the nuclei in the young ascus is due to their close proximity at a time when the nuclear wall is disappearing. A probably similar fusion has been several times observed between two of the four nuclei present in the ascus after the second division. The fusion in the ascus would be thus in no sense sexual, having been, moreover, preceded by a sexual fusion, in this case reduced. It appears comparable rather to the fusions of sporophytic nuclei artificially induced by Němec in root-tips.

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[1] Asci containing more than two nuclei were occasionally observed, but their fate could not be determined.