A Particulate Component Found in Nucleoli of *Allium cepa* and *Vicia faba*.

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During an electron microscopic investigation of mitosis in the meristematic cells of *Allium cepa* and *Vicia faba*, a particulate component of distinctive character has been observed in many nucleoli. The most striking feature of these granules in thin sections of osmium-fixed material (1) is their great electron density which makes them stand out clearly from the rest of the nucleolar material (Fig. 1). The majority of such particles are doughnut-like in appearance but, within one field, wide variations in shape are found. They may be round, oval, or rod-like in profile, possibly as a result of the angle of sectioning. In diameter they vary from approximately 70 A to 200 A, with the majority at about 140 A (Figs. 2 and 3).

Wide variations have also been observed in the occurrence of the particles. They may or may not be present in nucleoli which otherwise look identical and which, moreover, belong to nuclei showing similar distribution of chromatin material. They are not found in the less dense areas of nucleoli, and are quite unevenly distributed throughout the rest of the nucleolar material. They occur in pairs and small clusters of three or more.

Whereas the above general description applies to nucleoli both from *Allium cepa* and *Vicia faba* material, a number of significant differences have been observed in the distribution of the dense particles in these two plants, especially during certain stages of the mitotic cycle.

During interphase (*Allium cepa*), nucleoli usually show a few light spaces of various sizes within which no particles are found. There also often occurs a large central area which either appears empty or contains material resembling the chromatin masses in density and fine structure[1] (Fig. 1). In such nucleoli, the particles are always localized in the outer dense material only.

In *Vicia faba* two different types of interphase nucleoli have been found. The most common type is homogeneously dense, except for a few light areas of rather small size, and shows the dense particles (Figs. 2 and 3). The second type of nucleolus consists of an outer dense shell and a much lighter central area, which so far has never been observed to contain chromatin material as in *Allium*. The boundary between these two nucleolar regions is exceptionally sharp and regular. So far, dense particles have not been detected in such nucleoli.

During prophase, the particles are found much less commonly in the nucleoli of both *Allium* and *Vicia*. They seem to disappear with the nucleoli in late prophase and are not observed during metaphase.

They appear again in late anaphase in *Allium* as small clusters between the chromosome arms, but at this stage in the *Vicia* material they have not been observed.

As the cell plate begins to form (*Allium cepa*), *i.e.* in early telophase, the granules are still located within many of these same interchromosomal regions, and they have greatly increased in number. Later on, during the formation of the telophase nucleus, they conglomerate into three or four small bodies, and finally appear exclusively within one or two larger structures, the nucleoli. Except for their smaller size and irregular outlines, these nucleoli look identical to those characterizing the well formed interphase nucleus. From late anaphase to interphase, there is a steady increase in the density of the areas within which the granules are located and, in late telophase, these areas match the chromosomes in density.

The situation is essentially the same during the later stages of mitosis in *Vicia faba*, except for the fact that the granules are not found in very early telophase. They apparently are formed later on, in middle telophase, when the chromosomes are beginning to be less tightly packed together. Many small bodies then appear and seem to fuse, as in *Allium*, to give rise to the nucleoli.

The problem of the origin and mode of formation of the nucleolus has received much attention in the past and, since Heitz's studies (2), it is well known that nucleoli arise on satellite chromosomes in close association with secondary constrictions. The significance of the particles described here is not yet known. It is possible that they represent

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[1] The fact that the material contained in the central part of some nucleoli is of chromatin origin is not clearly demonstrated in Fig. 1. However, sections cut at a suitable angle show that, in *Allium cepa*, certain nucleoli are cup-shaped in structure, the cavity containing a segment of one of the chromatin strands observed in interphase nuclei. Such images undoubtedly represent nucleolar organizers.

prenucleolar material around which the less dense portion of the nucleolus condenses during telophase. However, it should be recognized as a distinct possibility that this prenucleolar material does not really exist in the particulate form described here in the living material, but condenses out into granules of various sizes and shapes during the preparation procedures, especially during dehydration of the tissue.

A more extensive study of the mode of formation and structure of the nucleolus in both *Vicia faba* and *Allium cepa* is in progress and will be reported in due time.

Bibliography

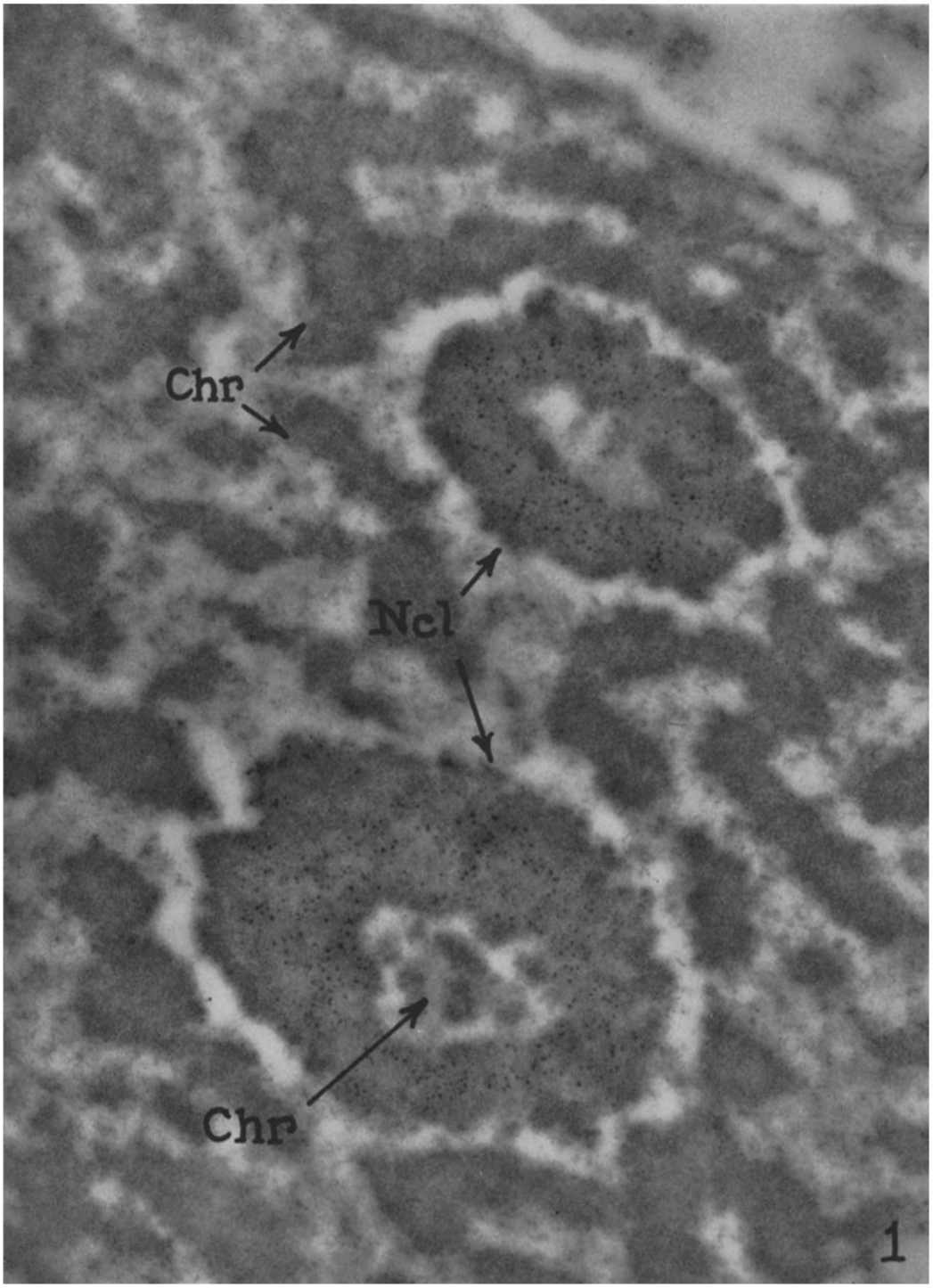
1. Caulfield, J. B., *J. Biophysic. and Biochem. Cytol.*, 1957, **3**, 827.
2. Heitz, E., *Planta*, 1931, **12**, 775.

Explanation of Plates

Plate 122

Fig. 1. Part of an onion root tip nucleus showing two nucleoli (*Ncl*). The micrograph illustrates the distribution of chromatin strands (*Chr*) observed during interphase. Their diameter here varies from 0.2 to 0.3 microns.

Both of the nucleoli contain the dense granules. It is readily noted that they are not present in the large light space in the center of the nucleoli. In the lower nucleolus, material of a density matching that of the chromatin strands is present in the central light space; the dense particles are never observed in this material, but remain localized in the outer shell of nucleolar material. × 34,000.



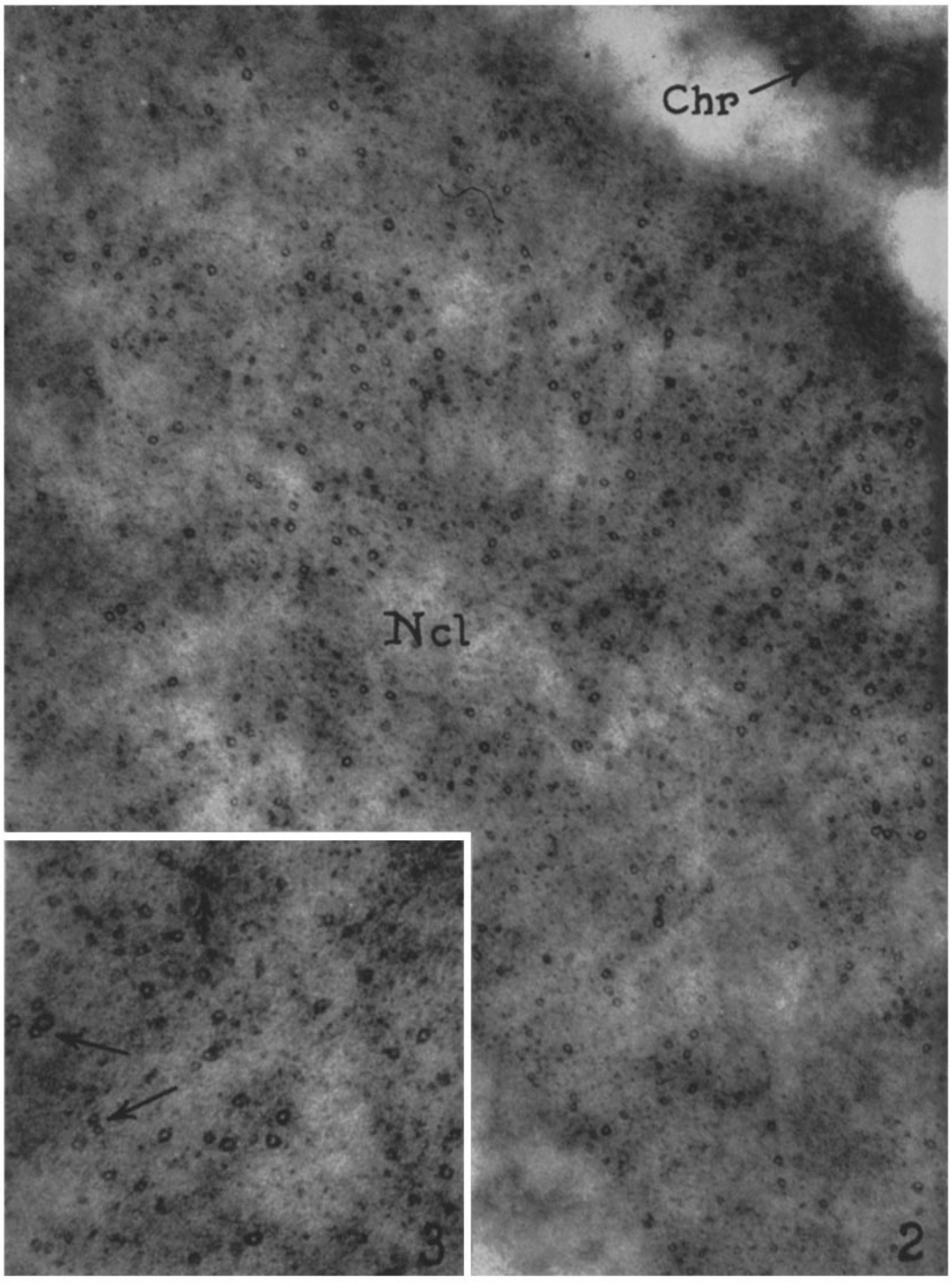
(Lafontaine: Nucleoli of *Allium cepa* and *Vicia faba*)

PLATE 123

FIG. 2. Electron micrograph illustrating part of a nucleolus (*Ncl*) and a segment of a chromatin strand (*Chr*) from an interphase nucleus of *Vicia*. A large number of doughnut-like particles characterize this nucleolus. They are not distributed uniformly throughout the nucleolus, but tend to be grouped into loose clusters. × 96,000.

FIG. 3. Higher magnification picture of part of the same nucleolus, showing more clearly the variations in size, shape, and structure of the dense particles. Their diameter ranges from approximately 70 A to 200 A, the majority being about 140 A.

Note the arrangement of such granules into small groups of two and three (arrows). × 145,000.



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