amount and quality of the meteorological material published in the first six numbers amply justifies the change of this periodical back to its position as the national meteorological magazine.

The daily weather maps of the northern hemisphere issued by the Weather Bureau were discontinued on August 6 on account of lack of European weather reports.

The European meteorological magazines are still being received regularly, although late.

"The Clouds of California," an address by Dr. Ford A. Carpenter before the Occidental College, has been published.[7] The discussion concerns not only the cloudiness of California, but also includes information about the composition and formation of clouds.

W. Bieber[8] has introduced a new factor to explain the blue of the sky. According to him, the action of ultraviolet light forms $NH_4NO_2 + H_2O$, a thin bluish fog in the stratosphere. The blue of the sky is also ascribed to the action on light of dust particles, exceedingly small, snow crystals, air molecules, water vapor and ozone. Recent observations on high mountains show the presence of sufficient ozone alone to account for the sky color.[9]

In Symons's *Meteorological Magazine* for several months there has been a discussion of unusual visibility of distant objects as a prognostic of rain. Haziness is due to the amount and visibility of the dust and other particles in the air and to optical disturbances caused principally by temperature differences. So the cloudiness usually preceding rain reduces dust haziness by cutting off the bright illumination of the particles, and reduces the optical haze by preventing the unequal heating of the lower air and the establishment of convectional currents. However, wind blowing from the direction of a city, which may be even far away, generally makes the air more hazy.[10]

"British Rainfall, 1913" contains rainfall returns from 5,370 stations during the year. Complete daily records were received from 3,370 stations and less complete daily returns from 364 others. For the stations sending these daily records, the density for the British Isles is roughly 42 per 1,000 square miles. The January, 1914, issue of *Climatological Data for the United States by Sections* includes daily rainfall records from 4,391 stations. Thus for the United States, as a whole, the number of rainfall stations is but 1.4 per 1,000 square miles. Even Rhode Island, the state with greatest density of rainfall stations, has but 8 per 1,000 square miles. Nevada has 0.6 for the same area. It is little wonder that the climatic maps of the United States are lacking in detail as compared with the British ones.

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October 26, 1914

[7] 18 pages. See *Nature*, London, August 6, 1914, p. 592.

[8] *Meteorologische Zeitschrift*, July, 1914, pp. 358–359.

[9] See *Scientific American Supplement*, September 19, 1914, p. 179.

[10] See *Nature*, London, August 6, 1914, p. 592.

SPECIAL ARTICLES

SOME PHYSICAL PROPERTIES OF THE CELL NUCLEUS

Investigations on the physical properties of protoplasm have received fresh impetus through the introduction by Kite[1] of Barber's pipette holder for dissection purposes. By means of fine glass needles manipulated in this holder it is possible to undertake the dissection of fresh tissue under the highest magnification of the microscope.

My results in cell dissection largely substantiate Kite's general statements on the consistency and physical make-up of protoplasm.

In this paper I wish to present the results of studies made on the nucleus of the male germ cells of the grasshopper, *Disosteira Carolina,*

[1] G. L. Kite and Robert Chambers, Jr., "Vital Staining of Chromosomes and the Function and Structure of the Nucleus," Science, N. S., XXXVI., p. 639, 1912; G. L. Kite, "Studies on the Physical Properties of Protoplasm," *Am. Jour. Phys.*, XXXII., p. 146, 1913.

and of the cockroach, *Periplaneta Americana*. The follicles of the testis are isolated under the dissecting microscope and, on tearing the follicular envelope, the cells are set free. A good medium appears to be diluted Ringer's fluid to which has been added a trace of egg albumin. For the cells of the cockroach I used the body fluid collected by means of a capillary pipette. As the cells are very susceptible to mechanical stimulation care is necessary in these preliminary manipulations.

An uninjured, normal, isolated spermatocyte when not in division assumes a spherical shape. The nucleus occupies the center of the cell and, during the growth period, appears almost perfectly hyaline. In *Disosteira* three bodies stand out in the nucleus, their indices of refraction being different from that of the surrounding medium. One of them is rather elongated and lies immediately under the nuclear membrane. The other two are more or less globular and frequently lie well within the substance of the nucleus. In the cockroach only one such body or nucleolus is apparent.

Occasionally nuclei are met with in which may be discerned a mass of hazy filaments of very ill-defined outlines. It is possible that these are nuclei which have been unduly stimulated in teasing the tissue. Other nuclei are also discernible in which hazy bodies, the prophase chromosomes, are to be recognized scattered throughout the substance of the nucleus. In cells undergoing division the chromosomes are plainly visible during the meta- and anaphases.

Injury and frequently mere mechanical agitation of the cell produces a remarkable change in the appearance of the nucleus. The hitherto optically structureless nucleus begins to give evidence of hazy filament of a loose granular aspect. They lie immediately under the nuclear membrane and one gains the impression that they are produced by a lineal condensation or precipitation of granules in the hyaline nuclear substance. Within a few minutes the filaments become more distinct and thicken as the granules appear closer together. Free ends are soon to be noticed and one may occasionally trace a filament from one end to the other throughout its irregular winding course. They can not, however, be counted because they are hopelessly entangled. A light line down the middle of the filaments gives them the appearance of being longitudinally split. The granules are collected in bunches all along the length of the filament, giving it a cross striated effect. In those filaments which can be seen on end the granules are found to be arranged more or less regularly about a hyaline core. Such a structure may explain the longitudinally split appearance of the filament when viewed on the side.

The nuclear substance is a more solid and viscous gel than the cytoplasm. The filaments are still more solid and may be caught in the middle with a needle and drawn out into an attenuated loop fully as long as the diameter of the nucleus. On being set free the filament tends to retract and to thicken again. After the nuclei under observation have reached this stage the filaments collect on one side of the nucleus, and despite all my attempts to prevent it, coalesce into an irregular gelatinous mass.

The above changes take place in a period of five minutes to half an hour. Tearing of the cytoplasm of the cell accelerates the process and my conclusion is that the greater the amount of injury the more rapidly do the filaments form. In many cases the tearing causes the cytoplasm to absorb water and to go into solution. In the nuclei of cells so treated the formation of filaments takes place very rapidly.

The cells may be similarly stimulated by exposure to ether vapor. The nuclear filaments and the chromosomes then stand out clearly. Formalin vapor, on the other hand, seems to kill the cells without bringing into evidence the nuclear structure.

The stimulus produced by injury may be transmitted from the injured cell to a sound one if there be a cytoplasmic connection between the two. This is to be seen on piercing one of the daughter cells in the very late telophase of the spermatocyte. Near the end of this stage the two daughter cells are connected with one another only by a narrow bridge of cytoplasm. Injury to the one causes the appearance of filaments in the nuclei of both. The changes in the nucleus of the cell directly injured take place more rapidly than do those in the nucleus of the other cell.

The formation or coming into evidence of the filaments is always accompanied by a slight increase in the size of the nucleus. After the filaments are formed the nucleus decreases in size often to something less than its original size.

The filamentous structure can be easily destroyed. For example, on sucking the entire nucleus containing filaments and nucleoli into a capillary pipette the bore of which is many times smaller than the diameter of the nucleus and on blowing it out again the nucleus presents itself as a homogeneous, glutinous mass with no structural elements whatever.

Frequently one comes across a cell the mechanical stimulation of which causes the appearance in the nucleus of ill-defined granular condensations which rapidly resolve themselves into the early prophase chromosomes familiar to investigators in fixed material, viz., crosses, rings and double V's. The ragged outlines characteristic of this stage are very pronounced and are due to the irregular granular aspect of the chromosomes. Gradually as one watches them the chromosomes become more and more compact. This appears to be due to an increase in the number of the granules and their coalescence. The large slender rings have thus been observed to transform themselves into ringlike, compact and homogeneous metaphase chromosomes. The crosses also become compact without losing their cross-like appearance. The same is true of the double V. One of these was observed which shortened and became so compact as to appear like a tetrahedron of which two opposite sides were somewhat more deeply dug out than the others.

This artificially induced formation of the chromosomes is unaccompanied by the dissolution of the nuclear membrane. The chromosomes soon clump together and become indistinguishable in an irregular glutinous mass. They are extremely viscous and adhere to the needle when touched. If one of the early prophase chromosomes with ragged granular outlines be seized by the needle and rapidly pulled across the field so as to stretch it the granules disappear and the whole substance becomes homogeneous. The entire nuclear substance is very glutinous and the chromosomes can not be taken out of the nucleus entirely free of the medium in which they lie. When torn out of the cell, however, in Ringer's fluid, the nuclear substance very soon absorbs water, swells and gradually disappears. The chromosomes thus laid bare in their turn swell and go into solution.

The chromosomes in metaphase are plainly visible. Movements while in the equator have been observed, these are ameboid, consisting in a swelling of one part of the chromosomes at the expense of another. One arm of a cross, for instance, will swell until the cross shape is indistinguishable and in another few seconds the swelling will decrease, the chromosomes returning to their original shape. I was unable to observe actual splitting of the chromosomes, but anaphase figures passing into telophase were frequently observed. The chromosomes collect at the poles of the spindle. They then swell into vesicles which appear to merge into each other much as fluid droplets, except that here incomplete outlines of the vesicles persist for a time giving the telophase nucleus an ill-defined network appearance.

During metaphase and anaphase the chromosomes lie imbedded in a hyaline substance the viscosity of which is higher than that of the surrounding cytoplasm, much resembling the matrix of the resting nucleus. This kinoplasmic mass retains its shape for a time after the cytoplasm has been destroyed by tearing and it is this that gives the characteristic spindle shape of the metaphase and hour-glass shape of the late anaphase figures.

When once the chromosomes have separated in metaphase, no interference short of total destruction of the cell will prevent the passage of the daughter chromosomes to their respective poles. By piercing and tearing the cytoplasm in the equator of the anaphase figure, the constriction in that region may be so inhibited as to cause the two daughter cells to reunite into one spherical cell but the daughter nuclei remain separate.

As this paper is concerned only with intranuclear structures I shall merely mention here that the mitochondrial threads characteristic of the orthopteran germ cell form the boundary of the kinoplasmic mass and give it an appearance of being composed of threads. I have been unable to ascertain the existence of spindle fibers. The chromosomes may easily be pulled out of the equatorial plate and give no evidence of being attached to such fibers. When one chromosome is dislodged from the equatorial plate the others leave their places, and if left to themselves, clump together into an irregular homogeneous mass.

A curious phenomenon connected with the dissolution of the cells is the production of long slender processes which radiate in every direction from the surface of the cells. The ends of the processes soon grow into rounded knobs which gradually increase in size and often break off in the form of droplets. These droplets rapidly go into solution. Within half an hour or so, however, the entire protoplasm of the cell takes up water and swells. The pseudopodia are then slowly retracted and the cell rounds up and may remain so for a long time.

During the first stages of their formation the pseudopodia occasionally perform irregular oscillatory movements. Their formation is similar to that of sea-urchin eggs when subjected to the cytolytic action of diluted KCl solution. Similar phenomena have been described by Kite[2] and Oliver[3] and Merk[4] in blood cells. Chromosomes show the same phenomenon when isolated in Ringer's fluid. In one case which was very striking a ring chromosome was removed from the equatorial plate. Within two minutes a pseudopod began to appear from one side of the ring. Within five minutes this had lengthened into an attenuated filament which oscillated slowly. The attenuated tip gradually resolved itself into a knob which soon was pinched off in the form of a droplet. By the time a second droplet was formed and pinched off the chromosome itself began to swell and rapidly went into solution.

According to the foregoing experiments the chromosome appears to be a highly viscous and glutinous protoplasmic gel readily swelling in water and possessing very much the same physical properties as the cytoplasm of the cell.

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October, 1914

2 G. L. Kite, "Some Structural Transformations of the Bloodcells of Vertebrates," *J. Inf. Diseases*, XV., p. 319, 1914.

3 SCIENCE, N. S., XL., p. 645, 1914.

4 *Arch. f. Mikr. Anat.*, 80, 1912.

THE GEOLOGIC HISTORY OF LAKE LAHONTAN

THE basin of the great lake that once covered much of western Nevada has been classic ground ever since the early geologists first studied it. The shore lines which are to-day practically as the receding waters left them, the calcareous deposits about its basin, the possibility of saline deposits of commercial importance, have made the deciphering of its history one of the goals of geologic endeavor. King,[1] believing all of the tufa was a pseudomorph after gay-lussite and witnessing the formation of the latter in the Soda Lakes, believed that Lahontan had become as saline through desiccation, had then fallen, depositing the tufa as gay-lussite, and that a second flooding of the lake had caused it to overflow, washing out the saline material and changing the tufa to calcite.

Russell[2] determined that Lahontan had never had an outlet and thereby vitiated King's hypothesis. Believing that the tufas were a deposit from waters saturated with calcium carbonate and taking his clue from the Great Salt Lake, Russell assumed that the waters of Lake Lahontan must have been equally saline, although much of his evidence

1 King, Clarence, U. S. Geol. Expl. of the 40th Par., Vol. 1, p. 522.

2 Russell, I. C., Monograph No. 11, U. S. Geological Survey, 1885.