it has once begun, and thus a permanent change is brought about. If we consider this, then the objection that sometimes the changes of the organisms have disappeared after the normal conditions had been reestablished, does not hold good; in fact, this was to be expected (compare Naegeli's experiments with *Hieracium;* also de Vries's experiments furnish examples).

This way of looking upon the 'pressure of environment,' as producing a certain tendency to vary in a definite direction, easily explains it that we *have* evidence of definite variation. M. M. Metcalf[15] is inclined to believe that such instances are in favor of the assumption of the action of inner causes; but I do not see why this should be so. A repeated or constant action of the same external stimulus should produce in any organic form the tendency to react upon this stimulus in a definite way. This has been called *orthogenesis* by Eimer. Such cases are known, and I do not hesitate to attribute them to a permanent action of the same external force upon a multitude of individuals. Of course, as soon as this process is well started, inheritance begins also to play a part, and it is this latter factor that finally firmly establishes the new characters.

As to the value of experiments in the study of variation, I want to call attention to the difficulty in interpreting the facts, when such experiments are made under artificial and unnatural conditions, as, for instance, in the botanical garden, or with domesticated forms. Here it is apparent that such a complexity prevails, not only a few, but a large number of conditions being different from those in nature, that the experiment becomes a bewildering maze. In my opinion, experiments should be made in close touch with nature, changing, if possible, only one or a few of the conditions, so that we may be able to record the effects of each single changed factor in the environment. But I do not believe that this is an easy task. On the other hand, we should bear in mind that nature has made and is making these experiments for us: the process of variation is going on continuously, and the effects of former variation are seen in nature, and may be studied in the shape of the actually existing variations, varieties and species, and their relation to the environment (ecology). This work naturally falls within the scope of the systematist, and is largely field work; specimens of this kind of work have been furnished by Merriam, Allen and others, and the modern ecological researches are just what is wanted. But we must confess that so far we have only the beginning of this study, which should be encouraged and enlarged. For *ecology* teaches us what the different types of environment are, and how the different elements in the environment affect each other, and how changes of environment may effect changes in the organization of the different forms of life dependent on it.

A. E. Ortmann.

Carnegie Museum, Pittsburg, Pa.,
May 28, 1906.

[15] Science, May 18, 1906, p. 787.

Special Articles.

Corpuscular Radiation from Cosmical Sources.

In my address[1] before the Physical Society, I gave an account of observations made several times daily since May 9, 1905, in a search for the possible occurrence of an ultramundane radiation. The work was there summarized as follows:

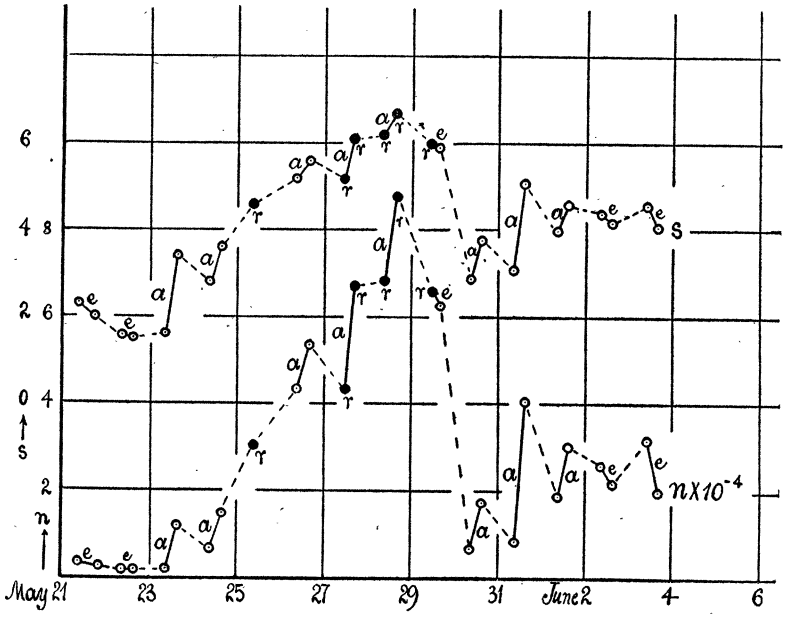
> Using the most sensitive condensation method, *i. e.*, that depending on the depression of the limiting asymptote of non-energized, dust-free air, no change of the quality of scrupulously filtered atmospheric air has thus far been detected. * * * Naturally (ions) would vanish during the slow passage of air through the filter, but fresh ions should be reproduced within the fog chamber by the same agency which generates them without * * *. Probably, therefore, the coronal method is as yet inadequately sensitive to cope with the variations of the small nucleations specified.

The ions, which are relatively large nuclei, withdraw much of the available moisture which would otherwise be precipitated on the colloidal nuclei of dust-free air. Hence the size of the terminal corona is diminished.

[1] *Physical Review,* XXII., p. 105, 1905; also p. 109 on 'radiant fields.'

The advantage of the method is its independence of the drop in pressure if this exceeds a certain value.

Since the announcement by A. Wood and A. R. Campbell[2] of the probability of cosmical radiation as evidenced by the existence of a daily period of the same, showing maximum ionization between 8 and 10 A.M. and 10 P.M. and 1 A.M., minimum ionization at about 2 A.M. and 3 P.M. (as near the time of the Wood and Campbell maxima and minima as my duties permitted) on the successive days and hours given by the abscissas.



Upper curve: Relative values of the angular diameters of coronas for the same drop of pressure, on the days and hours given by the abscissas. The branches *a* are in agreement with the Wood-Campbell discovery; the branches *e* show a tendency to inversion; *r* denotes rain. *Lower curve:* nucleations in ten thousands of colloidal nuclei per cubic centimeter of dust-free air computed from the preceding curve.

P.M. and 4 A.M., I have taken the subject up again. It seems possible that I overestimated the sensitiveness of the earlier method. I have, therefore, changed it in the present experiment, replacing the large terminal coronas by the small coronas very near the fog limit. The observations, in other words, are now made with a drop in pressure but just sufficient to produce coronal condensation on the larger colloidal nuclei of dust-free air ($\delta p = 21$ cm.). The sizes of coronas vary rapidly with the pressure difference and hence with the barometer, etc., and great care must be taken with these details. This, however, has been done and the results obtained are given in the following figure. The ordinates show the angular diameter, *s*, of the successive coronas, from which the number of efficient nuclei, *n*, per cubic centimeter may be obtained. Observations were made at about 9

The figure shows, in the first place, that minima and maxima of nucleation would generally have to appear at about the time at which Wood and Campbell observed maxima and minima of ionization, respectively; or that an inversion of Wood and Campbell's results is in question, since there is usually incremented nucleation in the afternoon as compared with the morning. This, however, may

[2] *Nature*, 1906, Vol. 73, p. 583. Reference is also due to the work of Burton and McLennan.

be explained, if the ions are large even in comparison with the larger gradations of colloidal nuclei. Fewer of these will, therefore, be captured in proportion as the ionization is larger. Hence the figure shows at *a* a corroboration of Wood and Campbell's results; at *e* an omission or inversion of the periods. But the *e*'s are much fewer in number, and in comparison with the amplitude of the *a*'s the *e*'s are frequently neutral.

In the second place the high nucleations during the period of rain are noteworthy. Here then few ions were present. As there is a modification of the atmospheric potential gradient during this time, one would favor an explanation on similar lines to the ideas suggested by Richardson.[3] From the above I could merely infer, however, that a region of rain is opaque to the cosmical radiation, though the periods are not wiped out. Moreover, the interpretation here is not straightforward and much must be left for future determination.

Since last August (1905) a systematic comparison between the dust contents and the ionization of the atmosphere has been carried out in this laboratory by Miss L. B. Joslin. As the paper is soon to appear in the *Physical Review*, I will merely state that no relation between the two curves of monthly ionization and the nucleation curve is discernible. Ionization and dust contents of the atmosphere are, therefore, not only to be referred to totally different sources, but are independent of each other. The origin of the former is, therefore, essentially non-local. Again the positive and negative monthly ionizations show curiously opposed periods in the successive months (August to March) which may be of relevant interest.

I may add in conclusion that if the final isothermal drop of pressure in the fog chamber, instead of being observed as was my custom heretofore, is computed from the volumes of the fog and vacuum chamber and the corresponding pressures, the data for the colloidal nucleation of dust-free air found in my large coronal chambers agree with the data which I endeavored to deduce from the disc colors seen by Wilson in his small and unique apparatus. In other words, the condensational efficiency which I have reached in spite of size is now surpassed by no other form.

[3] *Nature*, LXXIII., p. 607, 1906.

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RECENT MUSEUM PUBLICATIONS.

Report of the American Museum of Natural History for 1905.—It is difficult in reviewing the work of so large an institution, whose growth extends along many different lines, to select the more salient features of the year, but the completion of the work of preparing and mounting the skeleton of the great dinosaur *Brontosaurus* may be regarded as the feature of 1905. This one piece is probably responsible for a goodly portion of the 565,489 visitors, but the fine bird groups, one of flamingoes and one of the bird life of the San Joaquin Valley have attracted many.

As usual, many important fossil vertebrates have been secured during the year, including portions of the great carnivorous reptile *Tyrannosaurus*.

Special attention has been given to the public schools by preparing loan collections and by lectures; no less than 600 bird skins and 1,800 insects were purchased for the preparation of loan collections and 400 cabinets are now available for circulation.

In concluding his report President Jesup notes that this marks his twenty-fifth year of service and calls attention to the progress of the museum made possible by the support of the citizens of New York.

The Fourth Annual Report of the Horniman Museum notes a falling off in the number of visitors, primarily due to discouraging irresponsible and frivolous visitors from using the museum as a promenade. A noteworthy feature of the museum is the very considerable number of living animals, vertebrates and invertebrates, shown during the year, although this must necessitate much work on the part of attendants. On the other hand, living animals are very popular and instructive. The various little handbooks issued are very good