(4) In places the quartz sand in the Coconino sandstone forming the lower part of the walls has been fused to glass (lechatelierite). This is astonishing in view of the extremely high melting point of quartz (nearly 1500° Centigrade). Evidently the crater has been subjected to intense heat, such as could be generated only in some exceptional way. (See A. F. Rogers, "A Unique Occurrence of Lechatelierite or Silica Glass," *Am. Jour. Sci.*, vol. 19, 1930, pp. 195–202).

In brief, all the evidence indicates that a violent explosion played a prominent part in the formation of the crater. The weight of this evidence was appreciated by the earliest investigators, and naturally the idea of a gaseous volcanic eruption was given serious consideration. The abundance of meteoritic iron on and around the butte, however, has given strong support to the theory that the great pit was caused by impact of a close swarm of meteorites, and by an explosion after the swarm penetrated to considerable depth. Owing to the strength of this theory the butte acquired its present name.

Mr. Dellenbaugh sees support for his own hypothesis in the fact that both the inside and outside slopes of the crater show the effects of erosion. Whatever its origin, the crater has been outdoors since its formation, and modification of its slopes by erosion has been inevitable. This fate it shares with every other landscape feature.

Finally, Mr. Dellenbaugh "sees nothing . . . that substantiates in the slightest degree the meteor theory." If he has in mind the particular hypothesis that called forth his discussion—Professor Fairchild's suggestion of a stony meteorite—I quite agree with his view. Although Fairchild's idea has interest to a geologist, it appears to be wholly speculative, and creates difficulties more serious than those it purports to remove. There is strong observational evidence, however, in favor of the theory involving metallic meteorites. Some of this evidence is discussed by Mr. D. M. Barringer in SCIENCE for January 16, 1931. An excellent non-technical review of the facts about Meteor Butte, accompanied by fine illustrations, has been published by William D. Boutwell ("The Mysterious Tomb of a Giant Meteorite"; *National Geographic Magazine*, Vol. 53, 1928, pp. 720–730).

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BRANCHINECTA AT LEADVILLE, COLORADO

DURING the summers of 1929 and 1930, while engaged under the auspices of the United States Geological Survey in areal mapping and mine studies in Colorado, the writer found the phyllopod crustacean *Branchinecta coloradensis* (Packard) at 11,450 feet (3,500 meters) near Leadville, Colorado. The species has generally been regarded as alpine, and collections have been made nearby at Twin Lakes and Weston Pass in similarly elevated regions.[1] The occurrence is not surprising, but it raises again two perplexing questions.

In the upper part of Evans Amphitheater, due east about five miles from Leadville, are two larger lakes now serving as water reservoirs. Here is a well-developed recessional "kettle" moraine of late (?) Wisconsin glaciation. On the south side of the gulch near the reservoirs the moraine contains two small ponds, neither over 10 feet deep and both less than 100 feet wide. Both ponds, but the upper especially, are well separated from nearby water bodies. Indeed, it would require a valley flooding of at least a quarter of a square mile to a depth of 50 feet to connect the more isolated pool with a stream or with the reservoirs mentioned. Both pools are permanent, lasting throughout the short summer, but both are probably completely frozen during the winters at their elevation of 11,450 feet.

In these two pools the writer has found *B. coloradensis* during the past two summers. On July 18, 1929, *Branchinecta,* the females with brood pouches and eggs, were collected from the more easterly and isolated pond; by September 1, no live specimens were found, though a few remains of carapaces could be seen in the sediment. Again early in July, 1930, many *Branchinecta* were seen, the females again with eggs, this time in both pools; yet only a very few were in evidence by September 1. These observations are in general agreement with those of Shantz[2] near Pike's Peak, of Packard at Gray's Peak,[3] and of the latter especially in the case of related forms farther east,[4] where the disappearance is even earlier and is clearly not the result of lowered temperature. Shantz has suggested that the death of *Branchinecta* is related to parasitic plant forms, but the explanation does certainly not account for the Leadville records. It would seem that activity ceases in these Alpine species about September 1, and it would be interesting to develop an adequate explanation.

The other question is the unusual matter of "seeding" isolated ponds with *B. coloradensis,* or, for that matter, with other members of the family. The remarkable continuity of these phyllopods in a given pool, despite seasonal vicissitudes, is readily ex-

[1] A. S. Packard, U. S. Geol. Survey Ann. Rept. (Hayden), XII, Part I, 339, 1883; H. L. Shantz, *Biol. Bull.*, IX, 249, 1905; G. S. Dodds, U. of Colo. Studies, XI, 272, 1914–15; G. S. Dodds, U. S. Nat. Mus. Proc., LIV, 66–77, 1919.

[2] *Op. cit.*, pp. 256–258.

[3] *Op. cit.*, p. 339.

[4] *Op. cit.*, p. 342.

plained, but how did they come to their present habitat? Are we to assume that they represent a strain whose isolation dates back to glaciation, say, 10,000 years? If so, here is live material for the geneticist. Certainly a detailed study of their life history is merited.

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HEARING WITHOUT COCHLEA?

"THUS, even deaf persons whose eardrums no longer function properly, *but whose nerve centers are intact,* can hear radio."

By the distressed mother of a deafened child my attention was called to the above quotation from an article by Dr. Gustav Eichhorn in *Radio-Craft,* January, 1930, p. 330. "Thus" there means by the use of a patented device being essentially a membrane with one metal surface and one dielectric surface, which is held with its dielectric side close to the head. A telephone current passes to the metallized side of the membrane as to one condenser plate and to the human body (at any point) as if the body were the other condenser plate. The mother wanted to give her child this aid in hearing. There are many mothers like her.

The same matter is also described by the same author in the German periodical *Funk,* July 12, 1929, and still earlier in Jahrbuch f. drahtlose T. u. T., January, 1929. Since the eardrum, mentioned by the author, is no essential part of the auditory organ, I corresponded with him in order to know why he mentioned as the *exclusive* condition that "the nerve centers be intact." He was kind enough to reply that he had no definite opinion. Such a frequency of muscle function (6,000 and more per second) acting on the cochlea seemed to me unbelievable, and I felt inclined, therefore, to assume that we had here indeed a case of direct stimulation of the auditory nerve, especially since the author speaks of auditory perception of modulated currents by "Gehörlose," that is, the absolutely deaf. Those who can hear their muscle contractions are of course not Gehörlose.

If the auditory nerve could be used directly for hearing, that is, without the necessity of a mechanical function of the cochlea, this would be of tremendous importance for all those deaf people whose cochlea might be destroyed, but whose auditory nerve might be essentially intact. Dr. Eichhorn's description seemed to hint in this direction when it said that the electrical contact had to be made "gegen das Ohr oder an anderen Partien des Kopfes in der Nähe des akustischen Gehörzentrums," that is, "on the head in the neighborhood of the auditory braincenter."

I could not induce the author to send me one of his patented membranous devices. So I decided to experiment as well as I could. I used as source partly an oscillating electric system furnishing frequencies continuously between 50 and 20,000; partly amplified pick-ups of constant pitch phonograph tones of various frequencies. I removed the loud speaker, took one of the metal wires firmly in one hand, grasped the other wire end by its insulation and with its metal touched myself within the auditory meatus or behind the auricle; and to my astonishment in either case I heard faintly but clearly the very tone a moment ago produced acoustically by the loud speaker. After some experimentation I learned how to train others, many others, to perform the experiment with equal success, so that all possibility of "mere imagination" was excluded. It seemed to be true, then, that a new era of hope for the deaf had arrived, that the auditory nerve could be directly stimulated electrically and in agreement with the electrical frequency.

But after still more prolonged experimentation I now reject that hopeful conclusion. I shall mention three reasons why we must conclude that the hearing in question is due neither to direct action on the nerve nor to muscle contractions, but simply to a vibration of the horny skin surface caused by its electrostatic charge.

First, one does not hear anything when one touches the head with the wire end firmly. That is, there must be no electric conduction between the metal and the head. Nevertheless the metal must be held *close* to the skin for the sake of the electrostatic effect. This condition is realized by *gently rubbing* the wire over the skin, because then there is no real electric contact. As soon as one ceases to move the wire over the skin, the tone is gone, although that condition ought to be best for stimulating the nerve. I first thought that one might have to distinguish between an electrostatic and an electrokinetic stimulation of the nerve. But what would be the real difference?

Second, one hears more often the higher octave (that is, double frequency) than the actual cycle frequency. This is exactly what one should expect if the skin, statically charged by the neighboring wire end, is attracted and repulsed by the charge of the latter. A slight stretching of the skin is naturally advantageous.

Third, I succeeded in hearing the same tone when I rubbed the wire end gently over the slightly stretched skin of my wrist, holding the latter near enough, but not touching, one of my ears, nor touching any point of my head. The circuit then goes from one hand to the other hand by way of shoulder to shoulder. But there is no auditory nerve center