inated one of the original species from the old genus must be considered as a first reviser, since he thereby restricted the limits of the old genus. In like manner the author that subsequently eliminated one of the species from the restricted genus must also be considered a first reviser, and so on down the line. Where the old genus originally contained only two species, neither of which had been designated its type at the time the first reviser eliminated one of them as the type of a new genus, he thereby caused the remaining species to become, by elimination, the type of the old genus, although he did not so designate it. Elimination, therefore, instead of being in opposition to, is in reality a part of the first reviser method.

The action of the first reviser has been upheld by the botanists as well as by zoologists, and is in perfect accord with the fundamental law of priority. Its very reasonableness has commended it to practically all workers in every department of natural history. On the contrary, the first species rule demands that the action of the first reviser be nullified in all those cases where he had designated any other than the first species as the type of the old genus, or had taken the first species as the type of a new genus; it is, therefore, in direct opposition to the first reviser method plus elimination, and also is in opposition to the law of priority. The futility of attempting to force this unreasonable, non-scientific method upon thoughtful, reasoning workers would appear to be so self-evident as to require no further comment.

D. W. COQUILLETT

U. S. NATIONAL MUSEUM,
April 3, 1907

POLISHED PEBBLES

TO THE EDITOR OF SCIENCE: On page 392, in the issue of SCIENCE for March 8, 1907, it is stated that wind-polished pebbles from New Jersey are facetted. The wording of the assertion is such as to justify the possible inference that wind-polished pebbles are always facetted. It is doubtless true that in regions where the wind is prevailingly from one quarter, pebbles partially imbedded and held firmly during the polishing process, are usually facetted. On the other hand, where hard unimbedded pebbles and boulderlets lie on the surface of hard rock ledges, fully exposed to strong winds, they become highly polished, but seldom or never show even the slightest tendency to facetting. Facetting can not, therefore, be regarded as an unfailing characteristic of wind-polished pebbles. At White Rock, a few miles east of Boulder, Colo., beautifully polished quartz, quartzite and other pebbles lie by thousands on the wind-eroded surface of the Laramie and Fox Hills sandstones, but probably a day's search would not secure a single pebble showing the slightest suggestion of facetting. A few miles southwest of Villa Grove, in the same state, on a hill of Carboniferous limestone, perfectly polished pebbles are plentiful. No lapidary could do more perfect work, but facetting is not found. These are not gastroliths.

A very interesting discovery of polished pebbles was made by Mr. Philip Argall, of Denver, in the Santa Eulalia mining district, Chihuahua, Mexico. In one of the mines on Santa Eulalia Mountain, the shaft penetrating the massive Cretaceous limestone cuts a fissure leading to a chimney lined with low-grade ore. At the bottom of the chimney, at a depth of 1,200 feet below the surface, there is an elliptical cave-like opening thirty by fifteen feet. The bottom of the cave was plentifully strewn with perfectly polished flint pebbles which were cemented to the calcite-covered floor like plums. In other places the pebbles were found in pot-holes in the underground water courses. The history of these pebbles is believed to be as follows: The deposition of ores was followed by a period of solution during which the caves were formed, and the limestone in places rendered open and sponge-like by solution. The walls and floors of some of the openings were covered with calcite, deposited largely from standing water. Where calcite was not deposited, the solution of the limestone has left nodules of flint standing out from the walls of the caves. Similar nodules loosened from the limestone by solution and otherwise, have furnished the material for the polished pebbles of the caves and water-

courses. The polishing was accomplished by movement in the water-courses, aided by the carbonic acid and the calcium carbonate carried in solution. (The polishing work of such waters may be seen in certain caves in the Copper Queen mine at Bisbee, Ariz.)

The topography of the region, the character of the pebbles, their depth below the surface, their relation to the water-courses, the smallness of the joint openings at the surface and the absence of similar pebbles on the surface all make it improbable that the pebbles came from the surface.

R. D. GEORGE

SPECIAL ARTICLES

UPON THE TEACHING OF THE SUBJECT OF RESPIRATION[1]

AT least three totally distinct definitions of the term respiration are expressed or implied in current literature. These and varying shades of meaning are often confused even in the same discussion, and the result is very unsatisfactory.

The first definition occurs in works upon the physiology of the higher animals. Among the different senses in which respiration is there used, one refers to the functions of lungs and gills, processes essentially secondary and which take place far away from the cell.

A second definition is found in general works and especially in botanical ones, namely, that respiration is an exchange of gases, a sort of commerce between the cell and its environment. A majority of our botanical text-books give a categorical definition something as follows. "Respiration is the taking in of oxygen and the giving out of carbon dioxid and water." To this is often joined the idea that the amount of carbon dioxid given off is equal to that of oxygen absorbed, that in fact the oxygen which enters is the same as that which reappears immediately as carbon dioxid, and not seldom, some emphatic and sweeping statement that the living substance must obtain oxygen somehow all the time.

A third and entirely distinct meaning is given to the word in more scientific works such as Pfeffer and in at least two American text-books, namely, that respiration is a vital operation taking place within the cell, a metabolic process in which energy is released and which is ordinarily indicated by the gaseous exchange mentioned in the last definition. The steps of this process are not well known, but any discussion of them seems to include also anaerobic or intramolecular respiration and certain kinds of fermentation.

The confusion in words is inconvenient enough, but there is back of it a confusion of ideas which is more serious, and by which the teaching of the subject is more or less impaired. From the standpoint of the teacher it is imperative that the subject be cleared up somewhat. However, before dealing with the appropriateness of definitions, let us briefly look over the phenomena which we have to deal with. The most common forms of apparatus used by teachers in this country in the study of respiration are U tubes or thistle tubes in which flowers or germinating seeds are placed. The end holding the seeds is sealed and the other end placed in some reagent which will absorb carbon dioxid or oxygen, or both, or in mercury which will absorb none of the atmospheric gases and serve as a control. With such arrangements it is easy to obtain satisfactory and instructive proof that oxygen is absorbed and carbon dioxid given off. If the idea were carried no further all would be well, but there is a temptation to bring in also quantitative results, and, pointing out the fact that caustic potash rises about one fifth of the volume of the tube, to imply that the oxygen contained has been combined in the activity of the plant into an equal amount of carbon dioxid. Remarkable quantitative result is it not, that if in an enclosed space there is a plant absorbing oxygen and a reagent absorbing carbon dioxid, the result should be a reduction of volume to that of the nitrogen present?

Ordinary experiments and bright pupils are a combination which is likely to cause a disturbance in formal ideas of respiration. Suppose, for instance, that three U tubes with germinating peas in the sealed end are set up,

[1] Read before the Botanical Society of America at the New York meeting, December, 1906.