of one of the churches were broken, and almost every house having windows on the western side suffered from the stones. One of the largest stones was measured, the result showing a circumference of nine inches; it was irregular in form, one and a half inch thick and the edge was deeply indented in places. This was not an exceptional stone, as a great many of this size were found.

W. K. Gregory.
American Museum of Natural History.

SAUROPODAN GASTROLITHS.

To the Editor of Science: It may be of interest, in connection with Mr. G. R. Wieland's recent description of the gastroliths found with the sauropod remains in Montana, to call attention to an apparently unrecorded similar discovery at Morrison, Colo. In 1877, Professor O. C. Marsh's party, in charge of Professor Arthur Lakes, obtained among the bones of the type specimen of *Atlantosaurus immanis* Marsh, a number of rounded and highly polished siliceous pebbles whose surface peculiarities resembled those of the gastroliths described by Mr. Wieland. No material of similar size, form, surface markings or composition occurs elsewhere in the Atlantosaurus clays of this vicinity. Professors B. F. Mudge and S. W. Williston were with us when some of these pebbles were found and considered them as identical in origin with the stomach stones that they had recently found with plesiosaurian remains on the plains of Kansas. With the exception of one specimen, now in the collection of fossils in the Denver High School, these specimens were probably sent to the Peabody Museum of the Yale University and might be found in the collections sent to Professor Marsh by Professors Lakes and Mudge from the neighborhood of Morrison during the years 1877 and 1878. The field notes of Messrs. Lakes, Mudge and Williston, if obtainable, might afford additional data and possibly confirm a suspicion of the writer that some gastroliths were also found in connection with the type specimen of the species formerly known as *Apatosaurus ajax* Marsh.

Geo. L. Cannon.
Denver, Colo.

THE SMITHSONIAN INSTITUTION AN INSTITUTE OF RESEARCH.

To the Editor of Science: I desire to emphasize the suggestion made by David Fairchild in Science for June 8, in which he advocates changing the Smithsonian Institution from a museum to an institute of research. It seems to me that this idea ought to appeal strongly to men of science generally throughout the country. It can not be denied that the greatest impetus to research in pure science in the past has been the working together of men earnestly engaged in special lines of research, and the value of such researches has been greater whenever the several investigators have been brought together in one institution or in one laboratory. Experience has shown that under such conditions only as are found, for example, in the Biological Station at Naples, or in the laboratories of the greater German universities, does the most stimulating atmosphere of research exist.

The elaborate and well-endowed scientific projects now in operation, although extremely valuable, can not do for the progress of knowledge what such institutions as the above mentioned are doing. We have in this country large and well-endowed museums that are amply able to care for the work that falls within their respective provinces, but there is no institution that can be looked upon as a common center of research to which the investigator may go to pursue his studies with the necessary equipment and in an atmosphere whose vigor comes from the helpful suggestions and from the keen but friendly criticism of his many colleagues.

Let the Smithsonian Institution, therefore, be the nucleus of such a great national or international institute of research.

David M. Mottier.
Indiana University.

SPECIAL ARTICLES.

EVIDENCES OF GLACIATION IN SOUTHERN ARIZONA AND NORTHERN SONORA.

In the spring of 1905, during a professional trip to Sonora the writer was interested in observing along the Sonora Railway, south of

Nogales, frequent exposures of material resembling in every way, except in its component rocks, that of the terminal moraine of New York and New Jersey. These exposures were between Nogales and Imuris, occurring frequently in a distance of some fifty miles, and exhibited sections of till and boulder clay with large angular rock fragments and the occasional partial stratification characteristic of various portions of the terminal moraine in the northeast.

Having then no opportunity to verify these observations, they were briefly noted, to be amplified on some future occasion.

During the months of April and May of the present year, a further opportunity was afforded to traverse the same country and secure additional data bearing on the phenomena mentioned.

These last observations have convinced me that there is, in the vicinity of Nogales, both in Arizona and in Sonora, and for a number of miles north and south of the national boundary, an area of some width in which land ice transportation has been operative and has resulted in the formation of morainal deposits of various types.

A complete absence of detailed maps in northern Sonora makes it difficult, without extended study in the field, to form any generalizations concerning the centers of accumulation from which the glacier or glaciers may have flowed.

In Arizona, the publication, during 1905, of the Nogales, Patagonia and Tucson quadrangles affords an opportunity to locate the more important phenomena observed and determine the possible sources of ice action.

Some ten miles north of Nogales rises from the general level of the surrounding desert country a high range known as the Santa Rita Mountains. At the desert level, which is about 2,700 feet, this range has a base approximately thirty miles long and from eight to fifteen miles wide. Its highest peak has an altitude of 9,400 feet and a considerable area of the range (perhaps twenty square miles) is above the six-thousand-foot level. Within a mile or two of the southeastern base of the range passes the Sonora Railway, which, here as in Sonora, by its numerous cuts and borrow pits, gives an opportunity to study the composition of a formation which has all the characteristics of a moraine deposit, but which, in the absence of sections, a casual observer might pass by as a terrane of volcanic material rotted in place.

In connection with the structure exposed by the sections, one recognizes at many points the rolling topography and pitted surface of a moraine. At one or two points are observed depressions, similar to those which in the north have been formed by stagnant ice, surrounded by kame terraces and their concordant phenomena. One of these is just south of Huachuca Station.

About three miles south of Nogales is a very extensive borrow pit, formed in the construction of the railroad, in which has been left a number of large rock fragments which are clearly of transported material. Among these, the writer noted several blocks of dark blue limestone which did not belong to the crystalline terrane beneath and which had evidently been transported some distance.

A marked difference between the transported material here and that in the north lies in the comparative absence of large boulders, for none were seen to exceed about two feet in diameter. This is probably due to the character of the volcanic rocks and their manner of decay. A cliff of andesite or rhyolite does not in Arizona or Sonora seem to yield talus fragments of as large size as a cliff of granite or gneiss in New York.

The total extent of these glacial formations could not be determined without an extended reconnoissance which the writer had not time to make, but they are apparently limited to the vicinity of the higher mountain ranges. About twenty miles west of the Santa Rita Mountains, between Sopori and Arivaca, on the west of the Atascosa Range, is a long stretch of low hills and rolling country, trending southwesterly, which has a morainal appearance; but in the absence of sections no decisive conclusion was reached.

In northern Sonora, near the valley occu-

pied by the railroad and between Nogales and Imuris, one sees near the mountain bases low benches which have been eroded into overlapping oblique ridges of which the material seems to be all of morainal character. These overlapping ridges form prominent features in the landscape and are locally called by the Mexicans *cordones,* or 'chains.' They have not been observed by the writer south of Magdalena.

In traveling eastward from Benson toward El Paso, at a few points, mountain masses were observed, rising from the desert plains, around the bases of which were slightly elevated benches corresponding in some measure to the bench of morainal material along the eastern base of the Santa Rita Mountains. Occasionally, also, the railroad cut through low rolling ridges of material, morainal in structure and clearly not formed by sheet flood erosion.

On the Rock Island Railway, about a mile southwest of Santa Rosa, N. M., near the southeastern bank of the Pecos River, is a train of rolling hills which show morainal structure in the railroad cuts.

These observations lead to the conclusion that the quaternary history of some portion of this region is more complex than has been supposed. Clearly before the present period of arid climate and periodic sheet flood erosion was a time of low temperature and accumulated precipitation in the form of land ice which resulted in the formation of extensive deposits of rock debris around the bases of at least the higher mountain ranges. Climatic conditions limited the extent of these moraines so that the present desert basin areas, in many cases, remained unglaciated.

A further point of interest is the hypothesis, suggested by the facts observed, that some of the quaternary conglomerates which are abundant in northern Sonora and are so puzzling in respect to their origin may in part be the result of glaciation. The writer has, so far, been unable to formulate any other theory of origin which will account for the presence, in some of these beds, of boulders as large as two feet in diameter, in a matrix of angular fragments, of many different kinds, mingled with fine material. In a bed of true volcanic breccia one does not ordinarily find several different kinds of eruptive rock varying greatly in composition.

Frederick J. H. Merrill.

New York City.

ZYGOSPORES AND SEXUAL STRAINS IN THE COMMON BREAD MOULD, RHIZOPUS NIGRICANS.[1]

From the preliminary communication of J. I. Hamaker in the May 4 number of Science, entitled 'A Culture Medium for the Zygospores of *Mucor stolonifer*' (*Rhizopus nigricans*), one would be led to suppose that the method of obtaining the zygospores of this species by admixture of strains from different sources was unnecessarily troublesome and uncertain. After having obtained the zygospores frequently for three months, he is brought to the conclusion, which is printed in italics, that 'with proper conditions of moisture and temperature, success is apparently dependent only on the nature of the substratum.' As a favorable substratum, a corn muffin bread is recommended and a detailed formula of the ingredients is given.

In a preliminary summary of a study of the sexual conditions in the Mucorineæ,[2] the present writer has used this same common bread mould *Rhizopus nigricans,* as a type of the heterothallic (*i. e.,* dicœcious) group in which each species is to be considered an aggregate of two distinct sexual strains the interaction of which is requisite to zygospore formation. In contrast to homothallic (*i. e.,* hermaphroditic) species in which the mycelia are sexually all equivalent and which may produce zygospores from the sowing of a single sporangiospore, it is necessary in the heterothallic species, in order to obtain the zygospores in pure cultures, to sow spores together from both the sexually opposite strains which have been provisionally designated by the terms

[1] This paper was written while working under a grant as research assistant to the Carnegie Institution.

[2] 'Zygospore Formation a Sexual Process,' Science, N. S., **19**: 864–866. 1904.