for the first six months of the present year has been 100,000 above that of 1929. The attraction of the museum (especially the working models) to children is noted, and the purpose of a special children's gallery or galleries set forward. The advisory committee comment gratefully upon the support received from industrial firms, institutions and private individuals in the form of gifts and loans, which have totalled 1,150, apart from three exhibitions. Willingness to offer objects of historical worth and interest to the museum maintains the collections, it is observed, at a trifling cost to the state. The need for the center block of new buildings is described as urgent, since it is space which is lacking to show current practice in the various collections of the museum, rather than willingness to lend. The lectures given normally by guide-lecturers were attended by 20,845 persons, compared with 10,600 in 1928. Special lectures were given to 3,851 persons, composing 155 parties, and 7,000 persons also visited the museum in parties under their own arrangements. The work of extending the library periodical collections has been extended, and both periodicals and books have been lent in increasing numbers.

DISCUSSION

THE BARRINGER METEORITE

I WAS much interested in Professor Fairchild's article, in SCIENCE for November 7, 1930, on the "Nature and Fate of the Meteor Crater Bolide." Especially was my attention attracted because he presents therein a completely new conception of the extra-terrestrial body that made the crater. He visualizes it as a single, stony meteorite, containing nodules or segregations of metallic nickel-iron; further, he conceives of the stony part (the major part) of the body having been totally destroyed by the impact and by subsequent weathering, leaving only the minor iron nodules, of which many representatives have been found.

The article, while extremely interesting, is not convincing in its proof of the above hypothesis. May I call attention to some of the reasons why my brothers and I have not been persuaded by it to alter our conception (which was my father's) of the body? That theory visualized the body as a compact swarm of nickel-iron meteorites, containing in all probability no stony individuals whatever. Professor Fairchild appears to ignore this theory, but raises several objections to the bolide's having been a solid spheroidal mass of iron 400 feet or so in diameter. Such a body would certainly not fulfil some of the conditions found at the crater, and the idea has not been seriously entertained by us.

Many of the iron individuals, or parts of individuals, of the swarm contained sufficient chlorine to cause rapid oxidation on exposure to ordinary atmospheric conditions. Those that had been so exposed before the discovery of the crater were promptly converted to the hydrated oxides of iron and nickel, giving rise to the material known as "iron shale." But quite a number of others, dug up since the discovery of the crater, were found to have been so well protected by the rock flour of crushed sandstone grains from the Coconino that oxidation had made little or no headway in them. Upon exposure to the air they oxidized rapidly, some of them going entirely to oxide in a year or two. Others, of course, have been preserved in paraffin. Still others exhibited unoxidizable nuclei, which stayed metallic and bright even after years of exposure.

From this it is seen that burial in the rock flour around the crater was a nearly perfect protection from all forms of erosion, for of course no frictional erosion could have taken place without breaking the air-seal and allowing penetration of oxygen. Now a great many iron meteorites have been found in the silica by trenches and shafts. But not a single stony meteorite, or a single piece of rock in any way foreign to the normal geology of the region, has so far been discovered. If the original mass had consisted largely, or even partly, of stone, and if any stone had survived the impact, some of it would without question have been preserved in the ejected débris.

To this argument Professor Fairchild replies that all the stone was destroyed at the instant of impact, leaving only the metallic nuclei broken entirely free of their matrix. This means that not even a minute chip or fragment of stone could have survived, or remained adhering to the iron, for some of it would otherwise have been found. Such complete destruction is hardly conceivable. Meteoric stone is usually of the nature of a dense crystalline igneous rock, certainly harder and more resistant than the soft Coconino sandstone, and probably just as tough as the Kaibab limestone. Yet great masses of the Kaibab escaped the pulverization supposed to have been meted out to the stony bolide, and even boulders of the Coconino were thrown out of the hole at the moment of impact without great damage to themselves. That part of the Coconino which was in immediate contact with the impinging mass should have been even more seriously affected than the mass itself. Yet

we find pieces of that sandstone close enough to have been stained by nickel-iron vapors, and liquefied by the friction of the mass itself, but still clearly recognizable as products of the Coconino sandstone. Had there been any appreciable amount of meteoric stone involved in the impact it would seem impossible that evidence of it should not have been found.

I have elsewhere[1] summed up the reasons for believing the impacting mass to have been a compact cluster of millions of small, rounded individuals, rather than a single mass of iron (or stone) or a single large mass accompanied by a few satellites. This conception of the body coincides with the accepted belief as to the nature of comets. One of the reasons for this conception is that most, if not all, of the Canyon Diablo irons, when in their original condition (*i.e.*, when not acted upon by terrestrial erosion) are of a rounded or oval outline. This is explained by the long-continued attrition between individuals of the clusters, attrition that may have been very slow, but that had millions of years in which to accomplish its results. If, then, the cluster had contained at its inception any appreciable number of stony individuals, they would have been subjected to exactly the same process as that which takes place in a ball mill; that is, they would have been chipped and shattered to total disintegration long before the iron members had been worn away. The dust they became would have been blown away from the comet by the pressure of light if the comet had ever come near the sun; if not, it would at least have been filtered out of the swarm at the first touch of the earth's atmosphere.

Professor Fairchild mentions the pitting of the typical Canyon Diablo irons, ascribing it (and I think rightly) to the removal of some enclosing matrix from around the unoxidizable iron. But this matrix he believes, from no evidence that I know of, to have been stone. There is strong evidence, on the other hand, that the matrix was not stone but the oxidizable variety of nickel-iron, for a good many of the pittings are partially filled with iron oxides, firm in texture and adhering closely to the iron. Also, as I have mentioned above, some of the oxidizable but metallic individuals preserved in the rock flour show unoxidizable nuclei. Here is clear evidence that the matrix which originally enclosed the Canyon Diablo irons was chlorine-bearing iron. There is no evidence to indicate it to have been stone.

The rounded shape of the original irons (for all the fragments found preserved in the rock flour were rounded) also argues against their having been inclusions in a large mass of stone. Many stony meteorites exhibiting iron inclusions are known, but those inclusions show no evidence of rounding, being on the contrary of irregular, angular shapes, filling spaces between crystals or chondrules of the enclosing matrix, or ramifying through the rock as irregular veinlets. Why should a large hypothetical siderolite exhibit such a totally different structure from the known small ones?

One stony meteorite was found at the crater, or rather at a distance of a mile or so from the rim. This is mentioned in my father's paper[2] of 1909, and part of it is now in the Meteor Crater collection in the Guyot Museum at Princeton. It was distinctly an individual piece, hardly to be thought of as a chip from a larger mass, and had markedly rounded outlines. As is pointed out in my father's paper, there is strong reason for believing that this was a separate and later fall than the Meteor Crater swarm.

Interesting as Professor Fairchild's conception of the Barringer meteorite is, he has presented no new evidence in support of that conception, and his conclusions from the old evidence do not warrant, to my mind, a change from the more accepted picture of the comet. My father's visualization of the celestial intruder, as a cluster of small rounded iron meteorites, containing in all probability no stony members or parts, still has all the evidence in its favor. But, though we differ from Professor Fairchild in this particular conclusion, I am deeply sensible of his long and helpful interest in the question, and of his frequent and sturdy assistance in the problems connected with it.

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[1] *Scientific American*, July, August, September, 1927.

[2] "Meteor Crater," by D. M. Barringer, read before the National Academy of Sciences, November 16, 1909.

CONCERNING THE RATE OF FORMATION OF STALACTITES

DURING the past summer I visited old Fort Pickens, on the west end of Santa Rosa Island, opposite Pensacola, Florida. In prowling around one of the dismantled structures, I came upon a room the ceiling of which held a number of stalactites. Considerable stalagmitic material also covered the floor. This unusual occurrence of deposits aroused my curiosity, as I thought they might throw some light on the rate of deposition of certain cave deposits.

The room where the stalactites were found was made of brick, laid in lime mortar. Both the walls and the roof were four or five feet thick. The roof was somewhat overgrown with vegetation growing from loose earthy material covering the brick. There were ample openings in the walls for a free circulation of air, yet not situated so as to allow violent winds to strike the interior. The conditions seemed quite similar to those of a limestone cave, as far as the formation of stalactites was concerned.