One of the author's most successful plans in the forests of North America was to mount his apparatus in the bow of a boat manned by a selected crew, and then to set forth in search of his quarry. Describing the photographing of a deer the presence of which has been made known by the light reflected by his eyes, the author writes that "The flashlight-apparatus has been raised well above any obstructions in the front of the boat, the powder lies in the pan ready to ignite at the pull of a trigger; everything is in readiness for immediate action. Closer comes the boat, and still the blue translucent eyes watch it. . . .

FIG. 2.—A Raccoon taking his own portrait. From the *National Geographic Magazine*.

Suddenly there is a click, and a white wave of light breaks out from the bow of the boat—deer, hills, trees, everything stands out for a moment in the white glare of noonday. A dull report, and then a veil of inky darkness descends. Just a twenty-fifth of a second has elapsed, but it has been long enough to trace the picture of the deer on the plates of the cameras, and long enough to blind for the moment the eyes of both deer and men. Some place out in the darkness the deer makes a mighty leap; . . . and soon he is heard running, as only a frightened deer can."

A variation of the plan is to let the creature take its own portrait, and here again we may quote the author's own phraseology:—

"A string is passed across a runway or other point where the deer are likely to pass, which, when touched, sets off the trigger and ignites the magnesium powder. The same method can be used for daylight pictures, except that here a slender black thread is laid across the path, one end of which is attached to the shutter of the camera. The shutter revolves as soon as there is any pressure upon the thread, and a picture of any passing object is taken instantaneously. Not the least interesting part of this species of photography is that the operator does not know until he develops his plates what manner of beast, bird, or reptile has caused the shutter to open."

Although many of the portraits thus obtained are not in every detail satisfactory to the naturalist, yet they frequently reveal the animal in characteristic and unsuspected attitudes, or display peculiar alarm-features, such as the expansion of the hairs of the light rump-patch of the wapiti revealed in one of the author's pictures. Such pictures are indeed especially valuable in the case of many of the smaller mammals, the nocturnal habits of which make it so difficult to become acquainted with their mode of life.

Whether photography—flashlight or otherwise—will, as the author and Sir Harry Johnston (in the introduction to the English edition of Mr. Schillings's book) hope, ever induce sportsmen to be satisfied with pictures instead of the lives of their quarry remains to be seen.

R. L.

A SEARCH FOR A BURIED METEORITE.

THE mode of origin of a remarkable terrestrial feature, known as Coon Butte or Coon Mountain, has been the subject of much speculation and study, of which an account was given in the year 1895 to the Geological Society of Washington by Mr. Grove Karl Gilbert, of the United States Geological Survey, in a presidential address entitled "The Origin of Hypotheses."

This so-called mountain, situated in Central Arizona, rises only 130 to 160 feet above the surrounding plain. When climbed, it is found to contain a crater 530 to 560 feet deep, the dry bottom being thus 400 feet below the level of the land surrounding the rim. The crater is almost exactly circular, and is nearly three-quarters of a mile across, two diameters at right-angles with each other measuring 3654 and 3808 feet respectively. From the crest of the rim to a distance of about three and a half miles outwards the surface of the country is strewn with fragments of sandstone of various colours; for the first half-mile the fragments are large blocks, some of them of enormous size, 60 or even 100 feet in diameter; for the next half-mile the fragments are smaller and less plentiful; beyond this distance they are isolated from each other, and become smaller and less frequent as the distance from the crater increases.

In 1886 some shepherds encamped on the slopes of Coon Mountain found among the rock-fragments on the rim some lumps of iron, which they mistook, as is not infrequently the case, for native silver. The general distribution of the fragments and the nature of their material suggested to the shepherds that all the scattered masses, both stony and metallic, had been shot from the crater of the mountain. A few years later some of the metal fell into the hands of the late Dr. A. E. Foote, of Philadelphia, for whom it was analysed by Prof. G. A. Koenig, of that city. In structure and chemical composition the metal proved to be identical with ordinary meteoric iron, but of exceptional interest as enclosing microscopic diamonds. Since that time the celestial origin of the iron masses found about Coon Mountain has been recognised as beyond doubt, and the meteorite has become well known under the name of Cañon Diablo, small masses having been found in the cañon of that name distant about two and a half miles from the mountain. During the oral discussion which followed the reading of the paper of Dr. Foote on August 20, 1891, before the American Association for the Advancement of Science, Mr. Gilbert, who chanced to be present, suggested that the fall of the iron masses might have been connected with the formation of the crater, and that the large hole might have been caused by the penetration of the earth by an enormous iron meteorite, perhaps 1500 feet in diameter, large enough to be termed an asteroid. In such case the asteroid is buried in or near the hole and probably at no great depth.

Not being at that time at liberty to visit Coon Mountain himself, Mr. Gilbert asked his colleague, Mr. Willard D. Johnson, to examine the district and try to discover what had been the mode of origin of the crater. On his return Mr. Johnson reported that the crater had probably been produced by a tremendous steam explosion, the fragmental material around being the original contents of the hole. Within a radius of fifty miles there are hundreds of vents, from which lava has issued during the later geological periods, and thus there existed at one time a neighbouring mass of molten material sufficient to account for the production of the required amount of steam. In such case the fall of the masses of iron had been independent of the formation of the crater.

The rocks in the region containing the crater, however, are stratified and of sedimental origin, and the strata, except at the hole itself, are still quite horizontal. They are of late Carboniferous age, and consist, to a considerable depth, of coloured sandstones, one kind being so calcareous as to have claims to be regarded as a limestone. But all round the hole itself the strata have been bent, and are now directed upwards, approximately towards the same point.

This explanation and report being of an extraordinary character, Mr. Gilbert's interest in the problem became even greater than before, and he soon seized an opportunity of making an examination himself. This was done with such minuteness that he was able to draw contour lines of the crater and district for every ten feet of difference of level, and could form an approximate estimate as to the positions of the contour lines at the time the crater had been formed; hence he was able to calculate the respective volumes of the crater and the fragmental material. He came to the conclusion that the two volumes were virtually equal (eighty-two millions of cubic yards), and thus that no asteroid could have buried itself there. Further, he made a delicate magnetic survey of the district; no magnetic disturbance being discoverable, he concluded that no mass of iron large enough to have produced the crater could be lying within some miles of the earth's surface, whereupon he renounced the asteroidal hypothesis, and accepted the explanation which had been given by his colleague.

Some years later the crater and the speculations as to its origin became known to Mr. D. M. Barringer and Mr. B. C. Tilghman. They formed the opinion that the asteroidal hypothesis had been renounced by Mr. Gilbert on insufficient grounds. In the first place, according to their calculations, there is a great difference between the volume of the crater and that of the fragmental material; in the second place, the absence of magnetic disturbance may be due to the asteroid having been broken up into smaller masses, each of them polarised, and each having its magnetic axis in an accidental direction. So convinced were they that in 1903 they "located" the mountain under the United States Mineral Land Laws, and at great expense proceeded to sink shafts and make bore-holes with the hope of finding the buried asteroid. The results of this work, so far as it has yet gone, were recently recorded in two papers published in the Proceedings of the Academy of Natural Sciences of Philadelphia (December, 1905). One of them has been written from the point of view of the geologist (Mr. Barringer), the other from those of the physicist, chemist, and mathematician (Mr. Tilghman). The former says:—"They do not leave in my mind a scintilla of doubt that this mountain and its crater were produced by the impact of a huge meteorite or small asteroid"; the latter feels that "he is justified, under due reserve as to subsequently developed facts, in announcing that the formation at this locality is due to the impact of a meteor of enormous and unprecedented size."

It may be mentioned that a few years ago a successful search was made by Finnish geologists for a large meteorite which was believed by them to have buried itself within a certain area. But in that case the presumptive evidence was very strong. A meteor had lighted up a large extent of the country, and the next morning a newly made hole, with cracks radiating from it in various directions, had been found in the ice covering the Baltic Sea, near Bjurböle, in Finland. After a patient search the mass was at last located at a considerable depth below the sea-bottom, and eventually extracted. What are the prospects of a similar success at Coon Mountain?

For many miles round the crater the order of succession of the rocks, beginning at the surface, is as follows:—

(1) Red sandstone, 20 to 40 feet thick.
(2) Yellowish (calcareous) sandstone, 200 to 350 feet.
(3) Whitish sandstone, probably 400 to 500 feet.
(4) Yellow sandstone, thin layer.
(5) Reddish-brown sandstone, more than 1000 feet.

The uppermost stratum has been largely eroded, and remains only as widely separated flat-topped buttes scattered about the plain.

This upper stratum of red sandstone still existed at the place at the time when the crater was formed, for it is the material of the upper part of the rim. It has been raised 140–180 feet above its original position. The upper part of the interior of the crater consists of sandstone cliffs, the lower part of talus. The lower portion of the latter is covered with horizontally stratified sediments having a total thickness of 60–100 feet and a nearly level upper surface of circular outline and 1800 feet in diameter. The material must have settled in a shallow fresh-water lake once occupying the crater.

The fragmental material of the rim consists of the débris of the strata in which the crater has been formed, the blocks being piled one upon another in the utmost confusion. Further, there are many millions of tons of pulverised sand-grains, much of the material being an impalpable powder. It constitutes a great part, not only of the rim, which is three miles in length round the base, but also of the bottom of the crater, for it has been found by means of bore-holes to extend to a depth of more than 850 feet.

The masses of meteoric iron, being of pecuniary value as specimens, have been much sought for, and masses small and large, amounting altogether to about fifteen tons, have been found among the upper blocks on the rim, and on or near the surface of the surrounding plain in all directions from the crater; none have been found within the latter. Several masses weigh from 600 lb. to more than 1000 lb. Mr. Gilbert states that some of the iron has been found outside the range of the rock débris, one large mass being as much as eight miles distant from the crater. There have also been found lumps of oxide of iron, in great quantity and having a similar distribution to that of the metal. Mr. Gilbert (and also Dr. Foote) regarded them as also being of meteoric origin, and as perhaps having resulted from the weathering of a particular constituent of the meteorite, namely, the protosulphide of iron; but Mr. Barringer and Mr. Tilghman have found that they contain much nickel, and that many of them consist internally of magnetic oxide of iron, sometimes itself containing a nucleus of meteoric iron. Mr. Barringer, like Dr. Foote, suggests that the magnetic oxide resulted from the combustion of the iron when the meteorite was travelling through the air, but in the opinion of the present writer all the oxide, magnetic or not, is a result of weathering. There has been plenty of time for this action, for cedars now 700 years old are growing on the rim of the mountain. Further, the masses of iron found on the surface of the plain must have penetrated the earth to some depth at the time of the fall, and have been since exposed by denudation of the penetrated material. The authors roughly estimate the fall to have taken place not more than 5000 years ago, perhaps much less.

Though all the masses of iron found in the rim have been got from the surface, lumps of the meteoric oxide have been met with to a depth of 27 feet, and this is of interest because some of them were lying beneath big blocks of sandstone, through which, whether as metal or as oxide, they could not have passed. They must have taken up their present positions at the same time as the blocks themselves. To the present writer it seems probable that they had been buried, possibly a long time, in the upper layers of sandstone, and were ejected with the rock-fragments when the crater was formed, but Mr. Barringer explains them as fragments which had been broken from the asteroid during its passage through the air, had diverged from the path of the meteor, and had while still burning become entangled, and afterwards smothered, among the blocks of sandstone and minute débris projected into the air through the penetration of the earth by the main mass.

As for the enormous amount of pulverised silica, the authors hold that it cannot have been produced otherwise than by the action of an enormous projectile penetrating the sandstone. But it is difficult to see why the crushing of the grains could not have been produced by an enormous pressure of steam, such as must have preceded, according to Mr. Johnson, the formation of the crater. The following remark made by the late M. Daubrée was published by him in 1879, before Coon Mountain had been heard of, and is also suggestive ("Géologie Expérimentale," part ii., p. 645):—"In the deep and hot portions of the globe, for instance in volcanic reservoirs, water is present under enormous pressure. The pressure of that which forces lava up to the summit of Mt. Etna must certainly exceed 1000 atmospheres. It is therefore quite comparable with the tension developed in the chamber in which these experiments have been made. When water escapes to the surface by narrow fissures in such circumstances, it must bring different substances into a state of pulverisation simulating that of volatilisation."

Two other observations are relied on by the authors in their support of the asteroidal hypothesis. According to the first observation, obstacles at a great depth and probably of small size were found to interfere with the boring. They were inferred, chiefly from their hardness and from the difficulty of removal of a magnet let down to the bottom of the bore-hole, to be probably metallic iron, and to be parts of the broken asteroid. But the presence of some small masses of iron beneath the crater is to be expected if all the masses were lying embedded in the sandstone before the crater was formed. Those which were projected nearly vertically upwards must have fallen back into the large hole and be deep down among the débris. According to the second observation, a stratum at a considerable depth contains small particles of oxide of iron thought to be of meteoric origin. The same kind of material is said to occur on the surface of the surrounding country for several miles. The material in which these small particles of oxide are distributed in the crater must either be *in situ* or have fallen back into the hole: in the former case they cannot be of meteoric origin, for small particles would not have had the requisite penetrative power; in the latter case, it is probable that they were lying near the surface before the steam-explosion, and fell back with the fragmental material into the hole.

It is found as a matter of experience that meteorites on striking the ground have a comparatively small velocity—only a few hundreds of feet a second. Is it possible that an asteroid after passing through the earth's atmosphere could retain a velocity large enough for the production of such a crater? Applying a method devised by Schiaparelli and numerical data obtained from artillery experiments, the present writer has made some calculations as to the velocity of a meteoritic ball on reaching the ground, the ball being supposed to have a specific gravity seven times that of water, to have entered the earth's atmosphere at a speed of fifty miles a second, and to have travelled vertically. Neglecting the small additional velocity due to the action of gravity for the few seconds of flight, and the diminution of size of the ball during the flight, the numbers are as follows:—

Radius of ball in metres	Final velocity in metres
0·1	21
1·0	694
10·0	2590
100·0	8261
1000·0	25,461

According to Mr. Gilbert, it has been found in artillery experiments that a spherical projectile striking solid limestone with a velocity of 1800 feet a second will penetrate to a depth of something less than two diameters. It would appear, then, that a meteorite of large size would not be prevented by the earth's atmosphere from having a penetrative effect sufficient for the production of such a crater.

L. FLETCHER.