THE COMET THAT STRUCK THE CAROLINAS

BY EDNA MULDROW

WHAT would happen if a comet should strike the earth? We do not like to dwell on that possibility, it is true; yet such evasion arises mainly because we are human and it is human to shun the unpleasant. So we bolster our sense of security by the assumption that what has not happened will not happen. This assumption is false. The truth is that the earth in the past has collided with heavenly bodies, and the more serious truth is that it may collide again.

If the planetesimal theory—which maintains that the world is still growing by the gradual accumulation of stray chips left after the stars had been formed out of chaos—is true, then such collisions in the past must have been numerous. H. H. Nininger, curator of meteorites of the Colorado Museum of Natural History, estimates that since Tertiary times there have been 45,000 meteoritic falls. Considering these 45,000 meteoric showers in our comparatively recent geologic past, considering the tens of thousands of comets still passing through our solar system, and considering that only as late as 1910 our earth passed through the tail of Halley's great comet, we must accept the fact that our journey through space is not without traffic hazards.

We have no assurance that on its next trip Halley's comet may not sideswipe us or that it may not be disintegrated by that time and have become a steady stream of meteors, so that each year we may plunge into its path and be pelted by falling stars of greater or lesser size. In fact, that disintegration may already have begun, for the Aquarids are meteorites strewn in the path of that famous comet.

This alarming supposition as to the chance of comet collision is not new. Astro-physicists, as they now call themselves, for centuries have been aware that the orbits of comets cross the orbit of the earth and more recently have learned that meteor streams are the debris-strewn paths of comets that have come to violent ends. Geological discoveries made within the last few years reveal that the earth in a dozen places is pitted by charging bodies from outer space, that whole sections are honeycombed by scars made by comets.

The latest of these discoveries reveals breath-taking implications and startling possibilities beyond the most fantastic imaginings of H. G. Wells. It presents the hypothesis that an enormous comet twice as large as Halley's once struck the earth in the region of what is now the Carolinas, and so recently that the scars still remain. For in the Carolinas there are 3,000 shallow pits, each surrounded by a circular wall. Some of the pits are several miles long and more than a mile wide. It is believed that 3,000 balls of iron, with perhaps some stone, bored those holes, and that the splashes made those 3,000 circular walls.

II

Surprising as it may seem, before 1931 only one man, L. C. Glenn, who wrote an article on the subject for an issue of *Science* in 1895, ever wondered how the walled pits in the Carolinas had been formed, in spite of the facts that these States had been carefully surveyed and that the Carolinians themselves had noticed their extraordinary system of drainage, or lack of drainage, and had given special names to the unique features of their landscape. They called them "savannas," "pocosins," or "bays."

Glenn's explanation was not satisfactory, yet no one attempted to find the true cause of the conformation until, as is so often the case, an economic need brought it to the attention of science. In 1931 an aerial map portraying the resources of the pine forests of Horry County, South Carolina, was made by the Fairchild Aerial Survey. When E. H. Corlett of that organization saw the completed mosaic map, he thought he saw a chance for additional sales, since beside catering to lumbermen seeking investments, his company also sold air maps to a professor who had promoted a retail business in distributing maps, pictures, and slides for use in the classrooms.

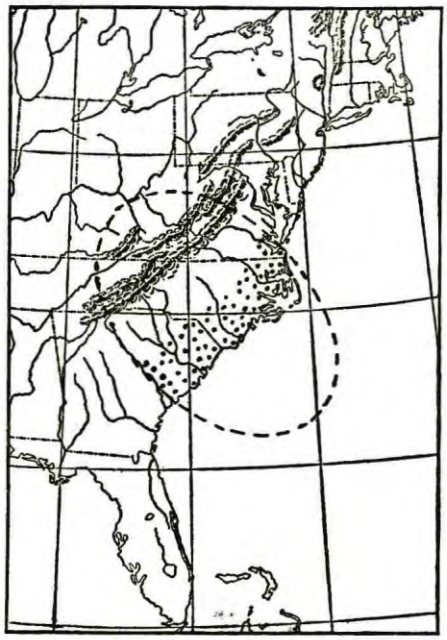
This professor was Dr. F. A. Melton, a geologist on the faculty of the University of Oklahoma. When Doctor Melton looked at the dark blotches on Corlett's map and considered Corlett's suggestion as to comet scars he was impressed. He knew that if they were really scars their discovery would be important to astro-physicists. He also realized that he would need the technic of a physicist to corroborate any story that the rocks might tell. If a swarm of stones should come in at an angle and strike a curved surface like that of the earth, the last stones to fall would make scars more nearly circular than those heavier ones which, less impeded by friction, would go farther and make more elliptical scars. Such intricate problems are a physicist's stock-in-trade. He could solve that one and many others involving abstruse mathematics. For instance, he could calculate the mass in the curved rims of the savannas and compare it to the bulk that must have been removed from the depressions. He would know what the action of heavenly bodies that had swung too close to the earth would be. Doctor Melton chose Dr. William Schriever, professor of physics at Oklahoma, to help determine all these things.

These two men obtained Corlett's permission to investigate. They went to the Carolinas to examine the land itself. The dark spots on the map *were* walled ellipses, just as they had supposed; but more than that, the long axes of the ellipses, which ran southeast-northwest, were parallel and every wall was higher on the southeast. This was more indicative than ever of comet fall.

They now had sufficient evidence to reason on the supposition that a comet once hurtled across the United States from the northwest and fell in the Carolinas. Since all heavenly bodies would travel in a straight line if it were not for the gravitational pull of other heavenly bodies, this comet must have approached the area where the earth's gravitational pull began to affect it, and then started earthward. Its momentum attempted to carry it in its accustomed course, but the earth's pull was the stronger. So it zoomed across our heavens in an arc, ever approaching the surface so that it struck a glancing blow.

It was a loose aggregation of iron rocks, each rock approximately a sphere and the whole group a roughly spherical mass. Compressed into one large ball, they might have measured

one hundred miles in diameter; in a widely spaced swarm they would cover many thousands of times that area, even though some individual balls were thousands of feet thick. Since these spheres struck the earth at an angle, the places of impact were elliptical, both for individual stones and for the whole group. Doctor Schriever and Doctor Melton surveyed the ellipticity of the savannas and found what physics maintains should be found if they were comet scars: the smaller bays are more nearly circular.



The ellipse indicates the approximate area of the comet's impact. Dots mark the region along the Atlantic coast where the impact scars are still visible.

In imagination they reconstructed what must have happened. Each iron ball shooting from the northwest plunged into the soft soil of the Carolinas, and each left an elliptical depression. Columns of debris spurted out in every direction as each iron ball drove down a mile into the earth, and this debris fell back in a wall or remained in a wall barricading each pit. This wall was higher on the side opposite that from which the comet came. Although this happened ages ago, the ellipses are still plainly visible from the air. The southeast rim is invariably the higher.

Now, because of the weathering throughout the ages, the rims are only five feet above the level of the surrounding land, while the depressions are about ten feet deep. The rise of the rims is very gradual, the base in some cases measuring 250 feet across. They are found along the sea coast for 400 miles, from Norfolk, Virginia, to the Savannah River, and are scattered inland for 100 miles.

Since the original area pitted by the comet must have been an ellipse with the long axis northwest-southeast, as each individual depression and higher rim on the southeast indicates, we are forced to believe that the 40,000 square miles of scarred tract is in reality a cross section of the original ellipse, the greater part of which has been erased by erosion and covered by the Atlantic Ocean. Doctors Schriever and Melton found no other alternative than to accept this conclusion, although the inferences to be drawn from it assumed astounding proportions. The 400 miles of dimpled coast must have been the short axis of an ellipse 650 miles long and covering an area of 190,000 square miles. At some time in the past, a comet must have dug for itself a grave that took in 300 miles of the Atlantic and the south Appalachians as far west as the boundary of Ohio.

"Although this hypothesis fits the situation exactly, we don't state positively that comet collision dented the Carolina coast," Doctor Schriever emphatically states. "We merely say that 'star-fall' most nearly explains the phenomena found, and we have tested

every theory that possibly could explain elliptical depressions with axes parallel and with walls higher at one end of the ellipses."

No other explanation, as Doctor Schriever says, suffices. Not that of wind scour, artificial earthworks, expansion of peat bogs or hydration of anhydrite, steam or gas explosions, oozing out of clay beds, weathering of dolomite, submarine springs, glaciation, or of uniformly elliptical buffalo wallows. Of all these wind scour seems the most plausible, but as yet no credible scheme of wind action has been presented.

By process of elimination comet fall is the explanation that most nearly fits the facts. If it be the correct one, a great mass of iron must lie buried beneath the surface of the region. By using a magnetometer—an instrument which indicates iron buried beneath the surface and which located the meteorite beneath the meteor crater near Coon Butte, Arizona—the two scientists found a pronounced reaction over a group of depressions. Even so they could not definitely say that iron lay under each depression. In all probability there was iron, but the depressions were too close together to say that each one marked a spot above its special ball. They hunted out one isolated savanna in the uplands, where neighboring iron deposits might not influence the sensitive instrument. Here the magnetometer registered a magnetic high of 140 gammas, almost twice as much as was registered by the Arizona meteorite, beneath whose crater the actual iron center of a comet has been located by bore holes.

One thing only remained for Schriever and Melton's proof to be complete, a comparison with other cases of meteoritic fall. Were the pock-marks in the Carolinas to exhibit the same characteristics as other comet graveyards?

More of these exist than one would imagine, for although the Carolina comet graveyard increases the known area of such places two hundred-fold, and although the size of it exceeds anything science has dared imagine, such places number about a dozen.

The two best known are the Arizona crater, just mentioned as the one place in all the world where a comet nucleus has been identified, and the spot where the scars were made by the Siberian fall in 1908, when the comet was actually seen to strike.

The evidence of the Siberian scars is absolute factual proof and cannot be refuted. In that instance a meteoritic swarm coming from the south pitted funnel-shaped cavities walled by rims which rise higher on the north, duplicating the conditions in the Carolinas, except that the Siberian fall came from the south instead of the northwest.

The Arizona crater measures 4,250 feet by 4,000, a slight ellipse. The height of the wall is 125 feet on the northwest and rises to 160 feet on the southeast. Other acknowledged scars of meteor fall present similar characteristics. They are: a rimmed shell-hole, 530 feet in diameter, 18 feet deep near Odessa, Texas; a lake, 340 feet in diameter, with a 20-foot rim, accompanied by six smaller depressions on the Isle of Essel in the Baltic; a group of elliptical depressions, one 50-feet deep with a long axis of 630 feet, in central Australia. There are still others, similarly described but not definitely measured, in Argentina, Africa, Afghanistan, and Arabia.

What is left for us to decide but that the existence of these craters substantiates the Schriever and Melton hypothesis?

If the hypothesis be accepted it will explain two extraordinary circumstances that have for a long time puzzled science: There is an abundance of iron meteorites in America

as contrasted with Europe where there is a higher ratio of stony meteorites; and although the southern Appalachian region is hilly and sparsely populated, more meteorites have been found in it than in any other section of similar size in the United States.

From the evidence of meteorites being found with frequency in certain sections, Nininger (quoted above) has predicted the discovery of great comet falls in the south Appalachians, in the United States Rockies on a northwest-southeast line with the Arizona crater, in South Africa, in Chili, and in Greenland. If, as now seems true, there have been in the past two great iron falls in the United States, the high ratio of iron meteorites found in America as compared with that in Europe is due to that accident and not to the presence on this continent of a magnetized area that would increase our hazards by attracting cosmic iron to it, a conjecture that has been seriously advanced.

The Carolina comet alone might account for the unusual number of meteorites that have been picked up in the southern Appalachians, for in a charging aggregation from space, the larger bodies carry farthest, while the smaller pieces retarded by friction pepper down last and more nearly vertically. In this case they would be found between the coast and Ohio.

Doctors Schriever and Melton felt that these facts corroborated their contention. They began to calculate the time when the presumed fall took place.

The depressions cannot be older than the youngest strata in which they have been excavated. That formation is the Waccamaw of Pliocene age, laid down about 50,000 to a million years ago. Therefore, the depressions cannot be more than 50,000 to a million years old—not a very definite conclusion, to say the least.

Having reached this vague conclusion as to the outside limit of the period of time since the depressions were formed, the two investigators tried to fix the inside limit: in other words, to find how old the depressions had to be.

Beach ridges obscure several of them. W. C. Cooke, of the United States Geological Survey, identifies these ridges as Pamlico or Satilla terrace or late Wisconsin in age. Now, if beach ridges cross the "bays," as they are called in Horry County, then the sea must have receded subsequently, since the "bays" are now on dry land. This recession of the sea began all over the world some 3,500 years ago and was due to the accumulation of polar ice, according to R. A. Daly, author of *Our Mobile Earth*. Whether all or only a part of that 3,500 years has elapsed since the depressions were torn into the earth, Doctors Schriever and Melton have found no way to determine.

The passage of at least thousands of years is indicated by the absence of bed-rock fragments, scraps of native rock ripped off when the shower of iron from the skies collided with the earth. Although they searched diligently, the investigators found no fragment larger than a grain of sand. It would take thousands of years, they believe, for such fragments to erode away, a process the damp climate would hasten.

On the other hand, both rims and the floor of the depressions under the very recent detritus are of fine white sand, the epitome of instability. The Siberian comet left impact holes from five to 150 feet in diameter, which, when viewed for the first time by a scientist in 1927, nineteen years after they had been made, were only ten feet deep. If after nineteen years these small craters are only 10 feet deep, and if the Carolina rims are only

five feet high and the depressions only 10 feet deep, the period of time since the Carolina fall must not have been great, even if we discount the ordinary rate of erosion because of the excessive flatness of the land, where no gullies wash and no dunes blow.

"I estimate that the caverns once were more than 800 feet deep with an elevated barrier of several hundred feet," Doctor Schriever has stated. "In fact, I know they were once 20 to 50 feet deeper, for beneath the detritus on the floor of each cavern the white sand of the rims recurs. Thus, under the sea floor, a long period of time must have elapsed for the rims to be washed away and the caverns to be filled until they are of their present size. This erosion has undoubtedly been great, for at least 95 per cent of the original rims have been washed away, since the material in the rims at present will not fill a twentieth part of the depressions which they enclose, detritus-filled though they are."

Again Doctor Schriever allows at least thousands of years for these events to have happened. From 1,000 to 50,000 years ago is far from a satisfactory answer to the question of time. We must wait for more definite evidence.

III

Our reach into the past of history is too short for us to reconstruct precisely what happened when the Carolina comet struck the earth. Only in imagination can we see again the flaming torch that streaked the sky from the northwest. Only in imagination can we experience the white-hot flame, the thunder and the cannonade of the exploding star, the terrific force of 190,000 square miles of compressed air collected between the falling projectile and the earth, the scorching air that exploded outward and devastated an area larger than the burial spot of the comet itself. Professor L. A. Kulik, on his expedition to the Siberian crater, found an area 100 miles wide devastated by compressed air beneath two square miles of comet; the havoc wrought by the Carolina visitor from space is almost inconceivable.

At any rate, somewhere between one thousand and fifty thousand years ago the Carolinas experienced a bad half hour, when the whole heavens burst into one blinding flame. The comet plunged down with a hiss that shook mountains, with a crackle that opened the sky. Beneath the down-plunging piston of star, compressed air gathered. Its might equaled and then exceeded that of the great star itself. It burst the comet nucleus. It pushed outward a scorching wind that must have shoved the waters of the Atlantic upon the European shores, and on land leveled three-hundred-foot pines, spreading them radially outward like matches in a box.

The comet struck, sending debris skyward, curtaining the east, darkening the west. Writhing clouds of steam swirled with writhing clouds of earth. For ten minutes there was a continuous bombardment, and the earth heaved and shook.

For 500 miles around the focal spot of 190,000 square miles, the furnace snuffed out every form of life. In the path of the comet itself were left gaping holes 800 feet deep, lined by fused stone, dusted by rock flour, rimmed by 400-foot walls. Beneath thousands of feet of broken earth the smoldering star lay buried.

After the last bit of dust had floated down, the earth through the ages healed her wounds until only the roughened surface of the grassy savannas and the barricaded peat "bays" tell the story of that monstrous moment when the stars fell.

If the disaster of the Carolinas should repeat itself in the vicinity of

New York City, all man's handiwork extending over a great oval spreading from Long Island to Ohio, Virginia, and Lake Ontario would be completely annihilated. One-half of the people, one-third of the wealth of the United States would be completely rubbed out. The world's greatest metropolis would lie a smoking ruin, land honeycombed by water-filled depressions where the star teeth had bitten deep. The world-famous sky-line would be crumpled trash; the world's greatest harbor, a chain of yellow pools; the Empire State, Radio City, a ruin of tumbled stone; the Palisades and the shining Hudson, a series of gaping perforations, each the tomb of some bit of star. Only a few broken struts set awry and throwing lengthened shadows across sullen lagoons would survive as reminders of the solid masonry of the city. Nature would have thrown off the bondage of man and returned to her favorite pattern, the flattened circle, the ellipse.

Outside this devastated area would be a larger ellipse, one thousand miles across, where compressed air had worked its will. Its force would level every city, every building; its fiery breath would kill every living thing as far west as Minneapolis and Kansas City, and as far south as Jackson, Mississippi, and Montgomery, Alabama.

Even Europe would not escape, for every Atlantic coastal plane would be ravaged by an enormous tidal wave put in motion when the compressed air forced the Atlantic back beyond the continental shelf.