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SOME EFFECTS OF HURRICANES ON THE TERRESTRIAL BIOTA, WITH SPECIAL REFERENCE TO CAMILLE¹

by

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INTRODUCTION

There have been very few articles concerning the effects of hurricanes upon marine and shore organisms. Some effects on fishes have been described by Hubbs (1962) and in that paper he reviewed some of the previous references.

Information on animals killed or injured by hurricanes is scarce because potential observers in areas where they strike are generally more concerned with practical personal matters than biological studies right after a bad storm. The senior author has been in or very close to seven West India hurricanes as they came ashore. Each time he was somewhat forewarned and had determined to make some type of quantitative appraisal of killed animals following these storms. However, on no occasion has this been done. Nevertheless, the two writers have collected some fragmentary information worth recording.

Some Damages to the Fauna on the Mississippi Coast Hurricane Betsy—9-10 September 1965

When Betsy passed the Mississippi Coast on its way to devastating areas of New Orleans, the center was approximately 50 miles south of Horn Island. Thus the wind blew more or less from east to west along the Ocean Springs-Pascagoula coastal area. Following this storm hundreds of sea balls mostly of the marsh grass *Spartina* were found on the mainland beach of Mississippi Sound near Gulfport.

The water rose to a height of about six feet on the Laboratory grounds and left a strand of debris along the beach. In areas where there was marsh grass, thousands of little drowned mice, the Eastern Harvest Mouse, *Reithrodontomys humulis*, lined the shore in a little brown windrow which was sometimes 100 yards long without a break. Also lying on the beach every ten yards or so was a dead raccoon, *Procyon lotor*. There were so many on the Laboratory grounds that they

¹ This is a *verbatim* reprinting of the paper with the same title published in Volume 3, Number 2 of this journal, which was so improperly laid out that reprints with the plates could not be made and the legends were missing.

had to be hauled away. Raccoons are good swimmers and they certainly did not come from the surrounding nearby marsh-land. Horn Island, which lies eight miles offshore, was either completely or nearly submerged during this storm. The most reasonable assumption is that these coons were drowned in Mississippi Sound, after being washed off of Horn Island and their bodies were finally blown onto the mainland shore.

Hurricane Camille—17-18 August 1969

This has been publicized variously as the worst storm that ever struck North America, or as the worst that has come ashore in this country in 143 years. Old, indefinite accounts indicate that something like this struck Florida in the 1700s. It is quite certain that Camille was the most powerful hurricane that has struck a well-populated shore of the United States. The weather planes flying through it clocked the winds at 218 mph and recorded the lowest natural barometric pressure that has ever been read (26.01 inches).

The "Big House," an old landmark of the Laboratory and of the coast, was splintered and even the brick pillars upon which it stood were washed away.

We have no way of quantifying the destruction of animals, except to say that the clean-up agency, the 43rd Battalion, Corps of Engineers, U. S. Army, reported removing 28 tons of animals from the beach between Biloxi and Gulfport on August 22-24. Most of these animals were dogs and cats, but some horses and cattle were mixed in. After the storm many dogs were homeless and many were systematically shot because they were starving.

Following the storm, the writer was waked up by a bird singing lustily just outside his window; this was the only bird seen for about a week. An unknown number of wild animals, birds, dogs and other life including human beings lost their lives in the storm; after about three days, the odor of decaying animals was noticed in the atmosphere and lasted about a week before it gradually went away.

The bird population and the squirrel population virtually disappeared but both came back after a few weeks time, most noticeably the jaybirds and a few gray squirrels (*Sciurus carolinensis*). The birds disappeared again, probably because they could find nothing to eat. This was certainly true of the squirrels and they were reduced to gnawing the bark off of felled water oaks (Gunter and Eleuterius 1971).

When the storm struck, the seeds of various nut trees—chiefly the hickory, black walnut, and thousands of pecans which are planted in this area—were just beginning to mature. Many of these were blown

down and approximately half of the foliage of those remaining was denuded by breakage of the limbs. The same thing was true of oaks and acorns. Additionally, the nuts themselves were beaten off the trees that remained standing. Presumably for that reason the Eastern Gray Squirrel, which was quite common, had not returned in its former numbers by April 1970. Before the storm it was quite common to see as many as eight of these at one time in a relatively small area of trees in the senior author's front yard. After the storm, he saw none for one week and then he saw a lone squirrel. The squirrel population apparently increased in about three weeks to a month after the storm, then declined again. This observation would bear out the supposition that squirrels moving in from other areas could not find sufficient food and moved out again. The same thing apparently was true of the jaybirds.

There was a decided diminution in the number of birds which came to feeder stations during the following winter. For instance, dozens of birds and sometimes a few hundred in one afternoon formerly fed at a home facing the beach just to the side of the Laboratory grounds. The most numerous species, sometimes present in the dozens at a time, was the Savannah Sparrow. During the past winter only three or four have appeared at a time. The owner, before Camille, had to keep watch on the Starlings and jaybirds because they disturbed and ran off the others, but has had no trouble since the storm. General observations show that the Brown Thrashers, the jaybirds and the Cardinals are present in very diminished numbers even today (April 1970).

These facts have been noticed by other people and recorded, especially in *The Dixie Guide* by Mr. Clayton Rand who has gone through three bad hurricanes at his home in Gulfport. Mr. Rand has mentioned in his paper several times, the last being February and March 1970, that during former hurricanes there were many snakes and frogs everywhere in the area and that the mosquitoes were quite bad. He has remarked three times in his monthly newspaper that there was a great absence of life following Camille, even of the birds.

To the senior writer, however, the most amazing thing has been the disappearance of the ants up until this time (April 1970). The black carpenter ant and the Argentine fire ant and several other smaller species were quite common in his yard. Apparently they all succumbed to the storm, except for a minute yellow species that goes by the name of sugar ant, which has been seen one time. Bread and other foods set out for dogs and cats were formerly covered with ants in a matter of minutes; but, even this long after the storm, they may remain untouched by ants for days. We do not know the extent of destruction of the Argentine fire ant, but locally they are gone.

It is to be expected that termites and termite feeding animals and

possibly woodpeckers would increase greatly in numbers due to the thousands and thousands of felled trees and rotting timber, a good bit of which, after having had the top broken off, is still upright.

Damages to the Flora on the Mississippi Coast

There are very few reports of the effects of hurricanes, typhoons, or cyclones (tornadoes) on coastal vegetation. Sauer (1962) reported the effects of cyclones on the coastal vegetation of a tropical island (Mauritius) in the Indian Ocean. Chamberlain (1959) and the U. S. Department of Agriculture (1960) reported some of the effects of Hurricane Audrey on the vegetation of south Louisiana. Previous hurricanes which struck the Mississippi coast inflicted minor damage to the vegetation; one of the worst of these storms known to the junior author occurred in 1947.

The "eye" or center of Hurricane Camille came ashore in the Pass Christian-Bay St. Louis area and the path was well marked by the effects of the storm on vegetation. The most apparent and obvious effect was the destruction of the trees. In Jackson County most of the trees blown down were oriented with the tops pointing toward the northwest. In Harrison County near Gulfport, the trees became oriented with the tops pointing toward the west-northwest and in the Pass Christian-Bay St. Louis area, they were oriented in an east-west direction, but some tree tops pointed eastward and some pointed to the west and the trees were nearly parallel in alignment (Figs. 1 and 2). The paradoxical alignment was apparently a result of the initial winds from the east, followed after the "eye" passed over the area, by winds from the west. Trees west of Bay St. Louis near Pearl River were oriented with the tops toward the east-northeast and near Slidell, Louisiana, they were down in a northeast direction.

The intensity of winds from Hurricane Camille could be seen in the number of trees felled, the number increasing as the wind velocity increased toward the path of the "eye." In fact, without referring to other data, one could determine the storm's path by observing the east-west direction in which the trees were blown down and by the gradual increase in the numbers of trees destroyed as the center of the path was approached.

Tornadoes or extremely turbulent winds ripped through many areas on the periphery of the hurricane and the paths of their "touch downs" were well documented in the vegetation. In Magnolia State Park, which almost adjoins the Laboratory property, there is one area 50 feet wide and 17 tree lengths long, which the second author attributed to these tornadic gusts.

The junior author conducted two vegetational surveys to compare the intensity of damage to areas on the periphery of Hurricane Ca-

mille with areas nearer the center. In Jackson County, these surveys showed that in one tract, 4% of the trees were blown down and 10% were damaged to the point that survival was in question. The plant community was dominated by *Quercus nigra* (water oak) with *Pinus elliotii* (slash pine), *Carya glabra* (hickory) and *Quercus rubra* (red oak) being the subdominant species. This 40-acre tract in Magnolia State Park was approximately 22 feet above sea level. Destroyed trees in decreasing order were: red oak, slash pine, water oak, and hickory. It was noted that the heart wood (xylem) of the red oaks had been weakened by pathogenic attack and were rotted. Less than 10% of the pines destroyed were uprooted; they were twisted or broken off at heights ranging from 5 to 20 feet above the ground. The large tap-root characteristic of the pines apparently held the trees up; they were not blown down easily, but could be broken. Other trees blown down in adjacent plant communities were *Magnolia grandiflora* (magnolia), *Nyssa biflora* (black gum), *Liquidambar styraciflora* (sweet gum), and *Lireodendrum tulipera* (tulip tree or yellow poplar).

Another survey was conducted on 87 acres of forested land north of Pass Christian in Harrison County, bordering the Wolf River and Red Creek Road. Approximately 10 acres here was bottomland forest along the river and adjacent low-lying drainage areas. The rest of the land was approximately 25 feet above sea level and covered with *Pinus elliotii* (slash), *Pinus taeda* (loblolly) and *Pinus palustris* (longleaf) in various stages of growth. The owner considered the area a game reserve and left it undisturbed. Results of a sample showed that approximately 70% of the bottomland species were blown down. The species were *Magnolia virginiana* (sweet bay) *Liquidambar styraciflora* (sweet gum), *Taxodium distichum* (bald cypress), *Acer rubrum* (red maple), and the area was dominated by *Quercus nigra* (water oak). Ninety per cent of the trees in the low-lying area had diameters greater than 24 inches at breast height and there were between 100 and 150 trees per acre. An estimated total of 201,000 board feet of hardwood timber was lost.

Approximately 10,000 slash, loblolly, and longleaf pine trees with diameters greater than 10 inches were present on the higher sites and there were only 300 of these trees that were not damaged, i.e. 97% were destroyed. Many of those standing were not expected to survive due to lack of limbs, missing tops or split trunks. A total of 607,600 board feet of pine was estimated as lost. Many young trees were crushed by the falling trees, and other understory plants and habitats for wildlife were destroyed. At the time of the survey (March 1970), beetles, especially *Ips avulsus*, *Ips grandicollis*, and *Ips calligraphus*, had infested many of the downed trees and rot had begun. The specific names of the beetles were furnished by Dr. Virgil Smith, entomologist, U. S. Forest Service, Gulfport, Mississippi. Twisted and split saw logs could not be salvaged for use. Paper wood operations were expected to

be hindered by the tangled mass of trees. Practically all of the pine trees were second growth and ranged from 16 to 68 years old. The water oaks and other hardwoods were much older, ranging from 100 to 125 years.

These two tracts simply show by comparison that the most damage to the vegetation was caused by winds occurring near the center of Hurricane Camille's path.

Another observation was the destruction of *Quercus virginiana* (live oak) along the beach front from Biloxi to Pass Christian. Approximately 25,000 live oaks were growing along the beach before Camille and one-fourth were destroyed by wind and water and one-half were damaged. Those trees nearest the beach were partially inundated and the roots eroded by wave action. The immediate beating action of wind and the physiological "drought" resulting from the salt spray reduced these evergreens to bare branches (Figs. 3 and 4).

Many slash and longleaf pines may have been killed as a result of the inundation of low-lying areas near the mouth of the Wolf and Jourdan Rivers. The trees are dead but standing; however, this could be the result of other, internal damage since many trees on the barrier islands were covered by salt water and survived. This observation needs further study.

The Corps of Engineers, U. S. Army, estimated that a total of 1.2 million board feet of saw timber and one million cords of pulpwood in Mississippi were lost. On the Mississippi Test Facility in Hancock County, an estimated 6,000 cords of pulpwood were damaged and only 60% of the downed trees could be salvaged for lumber. It has been reported that a total of 290 million cubic feet of pine alone was lost in South Mississippi (Van Hooser and Hedlund 1969).

The barrier islands presented a pattern of destruction similar to that on the mainland. Petit Bois Island was affected relatively little but there was a gradual increase in damage on the islands to the west. Horn Island was heavily eroded on the outside beaches. The marsh vegetation was pushed down and pressed to the soil surface by the water as it passed over the island (Figs. 5 and 6). Ship Island was cut into three pieces and more than one-third of the vegetation, most of which was herbaceous, was removed. Cat Island was heavily damaged. Large oaks were uprooted by wave action and many pines were broken by the wind. Large sand dunes were leveled, the sand redistributed over much of the adjacent low-lying marsh. Tons of plant materials swept from the Louisiana marshes and the barrier islands were deposited on the mainland in large windrows.

Marshlands were affected insignificantly because the water covered them early in the hurricane and they were not exposed to the terrific beating of wind and wave that occurred later. *Spartina alter-*

niflora (smooth cord grass) flowered on schedule (September through November). Shrubs found along the periphery of marshes, where they formed thickets, acted as baffles and protected trees and, in some cases, homes. Many upland understory areas were denuded of herbaceous and woody shrubs where they were located near water.

The botanical regime of South Mississippi was disturbed by Hurricane Camille of August 1969, probably to a greater extent than by any other hurricane in the history of Mississippi, and the greatest influence on the terrestrial vegetation was the destruction of the trees.



Figure 1. Heavily damaged pine stand in Hancock County showing parallel but opposite direction alignment of fallen trees. Note direction in which standing trees are leaning.



Figure 2. Heavily damaged pine stand illustrating parallel but opposite direction alignment of fallen trees. This effect was caused by passage of the "eye" of Hurricane Camille through Bay St. Louis-Pass Christian area.



Figure 3. Damaged live oaks (*Quercus virginiana*) along Highway 90 near Long Beach, Mississippi.

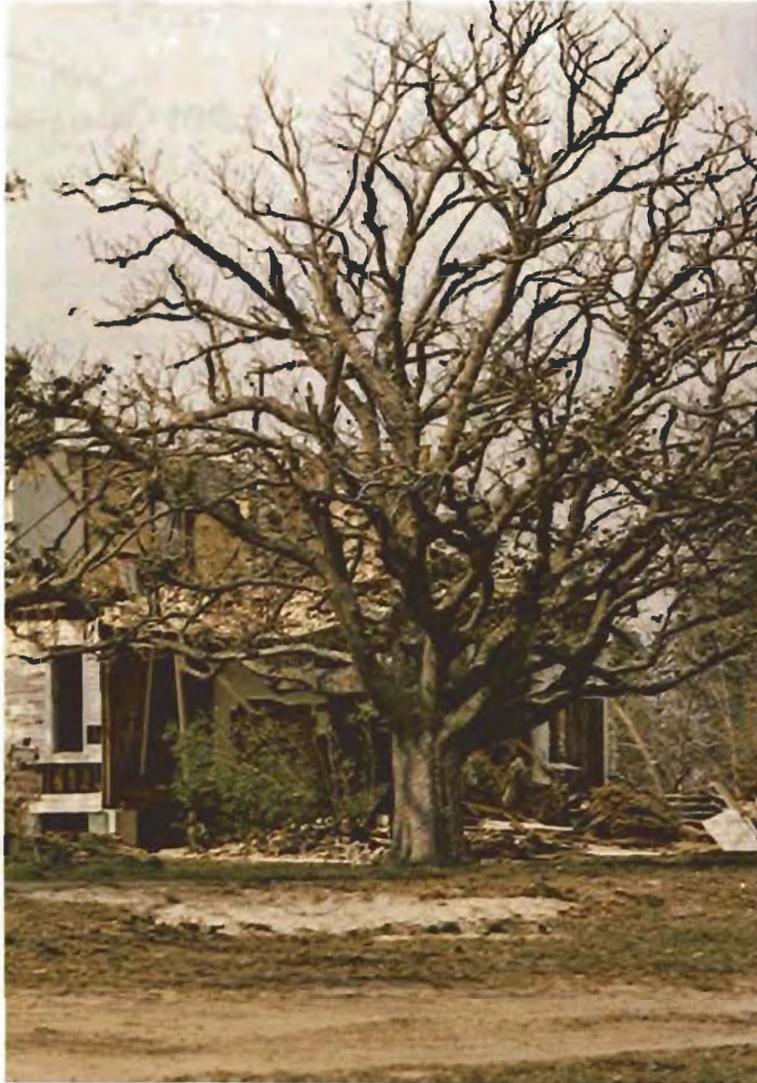


Figure 4. Damaged home and live oak (*Quercus virginiana*) along Highway 90 and open waters of Mississippi Sound at Long Beach, Mississippi.



Figure 5. Marsh near the south beach of Horn Island. Altitude approximately 1,500 feet.

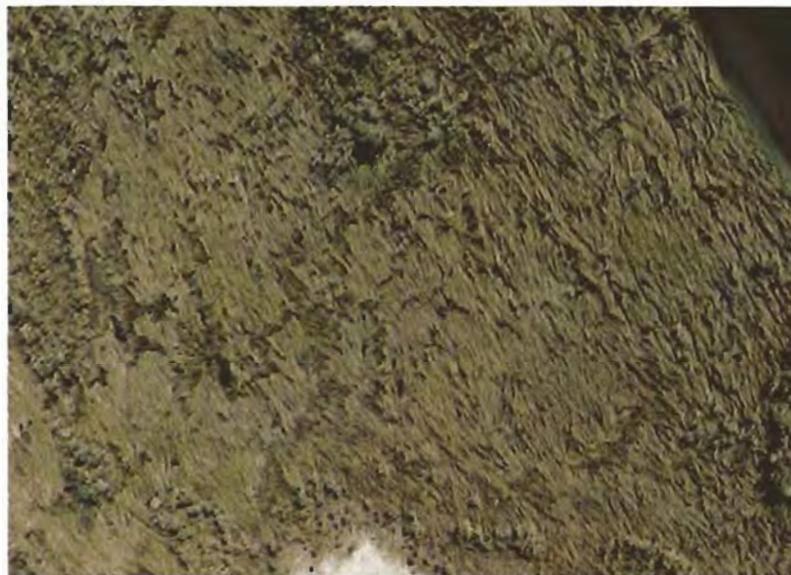


Figure 6. Low altitude view (600 feet) of same marsh shown in Figure 5. Note flattened plants of *Juncus roemerianus* and *Spartina alterniflora* as a result of wave action across island.

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