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

by
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INTRODUCTION

There have been very few articles concerning the effects of hur-
cricanes 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 stud-
ies 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 record-
ing.

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 hun-
dreds 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, Pro-
cyon 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 re-
prints with the plates could not be made and the legends were missing.
had to be hauled away. Raccoons are good swimmers and they cer-
tainly 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 main-
land 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 baro-
metric 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, ex-
cept 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 atmos-
phere and lasted about a week before it gradually went away.

The bird population and the squirrel population virtually disap-
peared 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 for-
mer 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 for-
merly fed at a home facing the beach just to the side of the Labora-
tory 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 dis-
turbed 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, espe-
cially in The Dixie Guide by Mr. Clayton Rand who has gone through
three bad hurricanes at his home in Gulfport. Mr. Rand has men-
tioned 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 de-
struction 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 elliottii* (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 *Liriodendron 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 elliottii* (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 dam-
age 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. Ap-
proximately 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 in-
undated 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 pulp-
wood in Mississippi were lost. On the Mississippi Test Facility in Han-
cock 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 dam-
aged. Large oaks were uprooted by wave action and many pines were
broken by the wind. Large sand dunes were leveled, the sand redis-
tributed 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 cov-
ered 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.
HURRICANE EFFECTS ON BIOTA

LITERATURE CITED


