

The Buffalo Gnat, *Eusimulium pecuarum* Riley, in Mississippi,
1932

By

G. H. Bradley, Associate Entomologist

Division of Insects Affecting Man and Animals

Bureau of Entomology and Plant Quarantine

United States Department of Agriculture

Table of Contents

Comparison of 1931 Gnat Outbreak with That of 1932	5
Stock Losses:	6
Symptoms of Gnat Poisoning	7
Other Losses	7
Area Affected.....	8
Rivers Producing <i>E. pecuarum</i> in Mississippi.	9
Life History Studies	13
Egg Collections	15
Adult Activities	15
Mating	16
Effect of Gnat Bites on Man	17
Tests with Repellants	18
Experiment No. 2 conclusions.....	20
Tests of Repellants on Working Animals.....	20
Mopping	24
Smokes	25
Summary	25
Dr. George Hirst Bradley	51

Figure 1. Branches raised from the Tallahatchie River near Charleston, Mississippi showing gnat larvae and pupae, March 23, 1932.....	28
Figure 2. Branches raised from the Tallahatchie River near Charleston, Mississippi showing gnat larvae and pupae, March 23, 1932.....	28
Figure 3. Vegetation from river near Charleston, Mississippi showing gnat larvae, March 25, 1932.....	29
Figure 4. Pupal casts and larvae on vegetation. Branches raised from the Tallahatchie River, Charleston, Mississippi.....	29
Figure 5. Dry skins on vegetation. Tallahatchie River near Charleston, Mississippi, March 23, 1932.	30
Figure 6. Pupal skins and pupae killed by drying. Tallahatchie River near Charleston, Mississippi, March 23, 1932.....	30
Figure 7. Gnat larvae on stem, Tallahatchie River, near Charleston, Mississippi, March 23, 1932.	31
Figure 8. Pupal skins on vegetation, Tallahatchie River, Mississippi, March 23, 1932.	31
Figure 9. Tallahatchie River at Mikoma, Mississippi, March 24, 1932.....	32
Figure 10. Tallahatchie River at Swan Lake, Mississippi March 24, 1932.	32
Figure 11. The Yazoo River at Greenwood, Mississippi, above town, March 25, 1932.	33
Figure 12. The Yazoo River at Greenwood, Mississippi, above town, March 25, 1932.	33
Figure 13. The Big Black River, Highway 49 near Flora, Mississippi, March 25, 1932.	34
Figure 14. Big Black River, Highway 80 near Vicksburg, Mississippi, March 25, 1932.....	34
Figure 15. Big Black River, Hwy 49, near Flora, Mississippi, March 25, 1932.	35
Figure 16. The Saline River, near Rison, Arkansas, April 4, 1932.	35
Figure 17. Coldwater River at Marks, Mississippi, March 24, 1932.....	36
Figure 18. Coldwater River at Prichard, Mississippi, March 21, 1932.	36
Figure 19. Coldwater River at Birdie, Mississippi, March 24, 1932.	37
Figure 20. Yocana River at Pope, Mississippi, Hwy 51, March 24, 1932.....	37
Figure 21. Sunflower River at Ruleville, Mississippi, March 25, 1932.	38
Figure 22. Sunflower River at Indianola, Mississippi, March 25, 1932.	38
Figure 23. Yazoo River at Yazoo, Mississippi, March 25, 1932.....	39
Figure 24. Cassidy Bayou, Sumner, Mississippi, March 25, 1932.	39

Figure 25. “Skinned mules”. Effects of tar and grease, Webb, Mississippi, March 24, 1932.	40
Figure 26. Man greasing mules, Mr. Denman’s place, Charleston, Mississippi, March 24, 1932.	40
Figure 27. “Skinned mule” near Crowder, Mississippi, showing effects of tar and grease for black fly control.	41
Figure 28. Cows standing in smoke from fires for protection from gnats, near Charleston, MS April 1, 1932.	41
Figure 29. Animals around smoke, Webb, Mississippi, March 24, 1932.	42
Figure 30. Source of smoke being carried in wagon to repel gnats, Webb, Mississippi, March 24, 1932. .	42
Figure 31. Mules in Mr. Simpson’s lot being protected from gnats by smoke, Webb, Mississippi, February 12, 1932.	43
Figure 32. Breaking stalks (plowing) with smoke can on breaker to repel gnats, Sumner, Mississippi, March 24, 1932.	43
Figure 33. Smoke cans on harness to repel gnats, near Webb, Mississippi, March 24, 1932.	44
Figure 34. Smoker on a plow, Crowder, Mississippi, March 24, 1932.	44
Figure 35. Plow with smoker in a river bottom, Mikoma, Mississippi, March 24, 1932.	45
Figure 36. Children going fishing with smokes to repel gnats, Mikoma, Mississippi, March 24, 1932.	45
Figure 37. Going fishing with smokes in hand, near Charleston, Mississippi, March 24, 1932.	46
Figure 38. Gnats on cow’s udder, Webb, Mississippi, February 12, 1932.	46
Figure 39. Gnats on the face of a mule, near Charleston, Mississippi, March 24, 1932.	47
Figure 40. Chickens eating gnats off of a cow, Charleston, Mississippi, March 24, 1932.	48
Figure 41. Buffalo gnats on udder, near Charleston, Mississippi, March 24, 1932.	48
Figure 42. Chickens eating gnats from a cow, Charleston, Mississippi, March 24, 1932.	49
Figure 43. Barn showing open construction, Charleston, Mississippi, March 23, 1932.	49
Figure 44. Case of shingles in a man who claimed they were gnat bites, Mr. Breeland, Webb, Mississippi, March 23 and 24, 1932.	50
Figure 45. Case of shingles in a man who claimed they were gnat bites, Mr. Breeland, Webb, Mississippi, March 23 and 24, 1932.	50

The past fall and winter were very mild in the areas infested with buffalo gnats. I was told that a few specimens had been seen before Christmas, 1931. They were observed by several persons early in January and were reported as present in abundance about the middle of January. The early outbreak of gnats in 1932 seems to be related to the excessively mild fall and winter. This condition is indicated by the temperature figures for 1931-32 given in Table 1.

Table 1. Mean Temperature and Departure from Normal from September through April for 1930-1931 and for 1931-1932.

Month	1930 - 1931		1931 - 1932	
	Mean ° F	Departure From Normal ° F	Mean ° F	Departure From Normal ° F
September	*77.2	+0.9	79.7 F	+3.9
October	63.6	-1.6	69.5	+4.2
November	55.2	+0.1	69.5	+6.3
December	*46.0	-4.0	55.6	+7.4
January	45.8	-1.2	59.1	+5.6
February	51.8	+2.6	52.7	+9.6
March	51.2	+5.6	--	--
April	62.6	+2.0	--	--

*Vicksburg only.

Comparison of 1931 Gnat Outbreak with That of 1932

In 1931 the gnats appeared suddenly in large swarms around the first of April. In 1932 the gnats were present in increasing abundance from around the first of January on and were definitely on the decline by the latter part of March. This may possibly be explained as follows: In 1931 the winter was cold. There was no flooding of rivers by warm rains. The gnat larvae were not distributed throughout water of great variations in depth and warmth; that is, the larvae were all in like media more or less, as far as temperature of the water was concerned and larval development proceeded uniformly. This caused the adult emergence to occur all at once as did on April 2 and 3 in 1931.

In 1932 the winter was warm. The rivers were flooded with warm rains and also the temperatures of the water, especially near the surface, were raised by having water spread shallowly over large areas. The rivers were very deep. Conditions near the surface of the water were much different than those deep down in the river channel. This gave breeding waters of varying degrees of warmth and gave rise to

ununiform breeding conditions. This caused the gnats to emerge gradually and thus there was no definite outbreak as occurred in 1931. Large numbers of gnats were present continually during January, February, and March, and it is probable that there was an exceptionally large emergence this year. This may be possible because it appears that the gnats are rather indiscriminate in selecting places for oviposition and large numbers of eggs are probably lost through desiccation. In 1931, there being no flood, the waters available for egg decomposition were those which are not subject to going dry in the summer and the egg laying was thus concentrated in favorable places.

Stock Losses:

The conditions occurring this year give weight to the theory that gnats kill mules by poisoning and that when gnats emerge gradually and in increasing numbers as occurred this year, the mules subject to their bites are able to develop a tolerance to the poison. In 1931 the gnats appeared suddenly in large numbers; much stock was lost. In 1932 the gnats appeared gradually and I could only locate two isolated cases in which losses could with any degree of certainty be attributed to gnats, although from conversations I gathered that gnats had never been as abundant as this year. In both of these cases the mules concerned were brought from un-infested to infested territory. These cases are as follows:

On March 5 four mules were driven from Pontotoc (Hill Country) through the Tallahatchie and Coldwater River bottoms where gnats were bad. No grease was applied. Camping for the night at Coahoma, the mules became sick and three of the four died the day following. These three mules gave definite symptoms of gnat poisoning (Dr. Gates, Clarksdale).

On March 25 five mules were brought from Cleveland to Vance and two died the following day with gnat poisoning symptoms (Dr. Gates).

These cases tend to confirm the theory that in gnat infested areas mules gain an immunity to gnat poison as no mules in the areas to which these animals were brought were dying.

In December, 1931, large numbers of mules were removed from the flooded areas west of Charleston, before the gnats became abundant and were driven to hill pastures where few, if any, gnats were present. As the water left the flooded areas these mules were driven back (March 10 to 20) and while gnats were then extremely abundant in this area no mule deaths were heard of.

Symptoms of Gnat Poisoning

The following symptoms of gnat poisoning were given to me by Dr. Gates of Clarksdale. Other veterinarians gave me similar reports. Temperature from 2^o to 5^o subnormal, cold skin, low pulse, swelling of abdomen as in flatulent colic, refusal to eat, some regurgitation from stomach through nose. Symptoms usually develop about four hours after a bad gnat attack and deaths begin in about five hours. About 90% of animals showing bad symptoms die within forty-eight hours. Those seriously affected which survive longer than this period often develop pneumonia; possibly from regurgitation of stomach contents through nose and it's being drawn into lungs. Practically all of these soon die.

I learned of no deaths of cattle directly caused by gnats. Cows are certainly annoyed by them, however, and there is a loss in flesh and amount of milk given. These are caused by the animals staying in barns or around smoke when gnats are bad instead of going out to feed as well as by constant switching.

Hogs are also attacked by gnats and I observed a hog slaughtered at Webb, Mississippi, whose hide was thickly covered with small red patches where gnats had fed. No losses of hogs were reported as due to gnats this year. This area is infested with hog cholera and I learned of no losses of hogs in previous years among cholera vaccinated hogs. It seems that the hog losses attributed to gnats may be caused by cholera.

Other Losses

During some seasons there is a considerable loss of time from field work occasioned by the gnats being so annoying early in the morning and late in the evening that no field work is attempted in the early and late hours. There are probably not many days in the season, however, when this practice is necessary if the work animals are well sprayed or greased.

The commonly used gnat oils are not particularly expensive but their cost combined with the loss in time consumed in applying the grease is probably considerable.

The common practice of giving mules a good greasing causes the animals to become overheated very easily and they cannot be worked steadily without injury.

The losses due to gnats for greases, sprays and loss of time each spring as estimated by various farmers ran from about seventy-five cents to fifteen dollars per head of work stock.

Only few estimates of losses were obtained which savored of anything more than guesses. Mr. Bradford, supervisor of loans for the John Hancock Life Insurance Company, said he could usually count on a five percent loss of stock through death or disability and a twenty percent loss of time during the breaking and planting period which probably would be less than one dollar per animal. These losses occur only during gnat seasons like the present.

Mr. Craig, Greenwood, Mississippi, used a commercial spray exclusively in protecting his mules. He estimated his expense for spray as around one-and-a-half dollars or two gallons of spray per mule per season, and claimed that by careful spraying he lost no time from field work.

Area Affected

In Mississippi buffalo gnats were found to be present in varying numbers from near Vicksburg in the south to Hernando in the north in the area roughly included between Highway No. 51 on the east and the Sunflower River on the west. They were most abundant along the gnat breeding rivers which are the portions of the Coldwater, Yalobushi, Tallahatchie, Yazoo and Big Black Rivers, lying in the Delta Regions. See figures 9 to 20, inclusive.

Although adult gnats were abundant in places along the Sunflower (Fig. 21 and 22) and Quiver Rivers, no larvae or signs of emergence from pupal skins were found in these rivers. These last named rivers appeared similar to those in which gnats were breeding.

Gnats were present in number at Holcomb which is on the edge of the Delta while there were very few at Grenada, ten miles farther east in low hilly country. None had been seen at Graysport, ten miles east of Grenada. North of Graysport, along the Schooner River and five miles east of Bryant, however, they were reported as present in abundance. The Schooner River follows a wide Delta, while the Yalobushi River on which Graysport is situated is in the hills.

Gnats penetrate the hill country from Charleston which is on the edge of the hills to Oakland, nine miles east, but are scarce and are practically unknown a few miles east of Oakland.

In the vicinity of Clarksdale gnats were present as far west as the Mississippi River (Sherard and Farrell). If these gnats were produced in the Coldwater River which is the nearest breeding place located, they must have traveled from twenty to thirty miles.

Gnats were present, and were reported as abundant at times as far west as Blaine, Doddsville, and Ruleville; few were found west of these points.

It would appear that under conditions prevailing this year the gnats penetrate hill country for distances up to ten miles from the Delta and that over Delta country they may fly twenty-five miles or more from their source.

Rivers Producing E. pecuarum in Mississippi.

The gnat breeding rivers have been mentioned previously. A record of collections in these rivers is given in the following table. In addition to these, observations were made in several small hill and delta streams without finding gnat larvae or signs of emergence.

Buffalo gnat larvae breed chiefly in the swift water of the main river channels. They were also found attached to cotton and corn stalks in flooded fields adjacent to rivers through which there was considerable current. They were not found in quiet backwaters. Figures 1 to 8 illustrate the appearance of gnat larvae and pupae in nature. I have pulled up poles extending down 18 to 20 feet below the surface in the swift waters of the Tallahatchie River and found larvae thickly covering them from top to bottom. AN idea of the abundance may be gained from the fact that over six hundred nearly full grown larvae were counted on a three inch twig having a diameter of three-eighths of an inch.

Table 2. River Examinations.

Date 1932	Place (Mississippi)	River	Gnat Larvae	Current	Hill or Delta	Remarks
8-Feb	5 miles SW of Charleston	Tillatobia Creek	None	Slow	Delta	Slow flowing. Short distance to hills
8-Feb	West of Charleston	Canals connecting Yocona to Tallahatchie	Few where water is swift coming through break	Slow	Delta	Yocona River has been dammed and the water forced through canals to the Tallahatchie, i.e., large larvae, pupae, and casts.
8-Feb	West of Charleston	Tallahatchie	Very abundant	Swift	Delta	637 larvae on 3 inch stick 3/8 inch diameter. Large and small debris and vegetation covered with larvae about 3/4 grown. Very few signs of emergence.
13-Feb	8 miles west of Webb	Flowing ditches	None	Swift	Delta	Males and females abundant but no larvae or casts seen. (Shore examined)
14-Feb	Near Ruleville	Sunflower	None	Swift	Delta	Females only seen. No signs of emergence
16-Feb	Near Greenwood	Yazoo	Fairly abundant	Swift	Delta	Many casts. Larvae all 3/4 to large.
16-Feb	5 miles N of Greenwood	Yalobusha	Very abundant	Swift	Delta	Larvae in river and also in flooded cotton and corn fields on stalks. Many larvae not over 1/2 grown 1/2 mile from stream.
16-Feb	5 miles W of Greenwood	Tallahatchie	Very abundant	Swift	Delta	Several examinations along river. Emergence observed.
17-Feb	N of Blaine	Sunflower	None	Fairly swift	Delta	No gnat larvae on vegetation or fish lines. No pupal casts.
26-Feb	W of Ruleville	Sunflower	None	Fairly swift	Delta	6 PM. Favorable night. Still warm. No gnats flying over river.
26-Feb	Near Ruleville	Quiver	None	Slow current	Delta	5 PM. Favorable night for flying. No gnats on river.
28-Feb	Webb	Cassidy Bayou	None	Slow current	Delta	No signs of gnat breeding.
1-Mar	Near Rich	Coldwater	Abundant	Slow current	Delta	Many dead +/- inactive adults on surface. Much striking of surfaces by gnats.
2-Mar	West of Charleston	Tallahatchie	Abundant	Swift	Delta	Estimate fewer than 25% gnats emerged.
3-Mar	Graysport of Grenada	Yalobusha	No pecuarum signs	Fair current	Hills	Pupae and cast skins of a smaller gnat on overhanging vegetation (shore examined)
4-Mar	E of Rich	Coldwater	Few	Fair current	Delta	Many pupal casts
14-Mar	Yazoo City above and below city	Yazoo	No pecuarum signs	Swift	Delta; edge of Hills	Gnat larvae abundant on overhanging willows n water. Center of stream.
14-Mar	Near Flora	Big Black	Abundant	Fairly swift	Delta	Falling water has stranded numbers of pupae.
15-Mar	Near Holcomb	Yalobusha	No pecuarum signs	Swift	Hills	No pecuarum signs, few other gnat pupal casts. No boat available.
18-Mar	Coahoma	Sunflower	None	Slow	Delta	Shore examined. No gnat signs. Few gnats striking water.
19-Mar	Near Charleston	Tallahatchie	About 90% emerged	Swift	Delta	River falling but not fast enough to strand pupae in numbers.
21-Mar	Pritchard	Coldwater	Abundant	Fairly swift	Delta	Many small (75%) grown. Many signs of emergence. Low river may have concentrated larvae.
21-Mar	Coldwater	Coldwater	None	Fairly swift	Hills	Shore examined. No signs of pecuarum.
21-Mar	Pratts Bridge Arkabutla	Coldwater	No pecuarum signs	Fairly swift	Hills	Few gnat larvae and pupal casts. None are pecuarum.
21-Mar	Pritchard to Birdie (3 points) Birdie	Coldwater	Pecuarum signs all alo	Fairly swift	Delta	Shore examined.
22-Mar	Swan Lake	Tallahatchie	Few larvae 90% out	Fairly swift	Delta	Pupal casts cover vegetation and debris.
25-Mar	Swan Lake	Tallahatchie	Apparently nearly all out	Fairly swift	Delta	Pupal casts cover vegetation and debris.

The foregoing data may be briefly summarized by stating that *E. pecuarum* was found breeding in those rivers which rise in the hills, but only in such portions of these rivers as lie in the Delta. No breeding was found in the Sunflower and Quiver Rivers which rise in and whose courses lie wholly in the Delta. The point where the *pecuarum* breeding stops in the Yazoo River between Greenwood and Yazoo City was not determined. Both male and female gnats were found in Yazoo City but no signs of *pecuarum* larvae in the river. The larvae were abundant in the Coldwater River at Prichard which is in the Delta. Five miles upstream (Pratt's Bridge) in the hills, none were found. At Crowder, in the Delta, the Tallahatchie was breeding millions of gnats, but below Batesville, in the hills, no larvae were found. NO *pecuarum* larvae were found in the Yocona at Pope, Mississippi (Hills) and none in the Yalobushi near Holcomb (hills) while farther downstream in the Delta gnat larvae were present.

On April 3 and 4 a trip was made through Arkansas. Adult gnats were reported as abundant near St. Charles but were now greatly diminished. No breeding was found in the White River near Clarendon but a few adult female gnats with well-developed ovaries were taken from the willows overhanging the river. A few gnats were present around Humphreys and farmers reported that gnats had been very abundant earlier in the year. No deaths of animals had been heard of. At Pine Bluff a few gnats were found on the store windows at 9p.m. The County Agent reported that a few gnats were present each year in this area but no losses occurred.

Eighteen miles east of Pine Bluff in the hills, farmers reported the gnats as bad each spring and had been abundant earlier this year before the cold spell early in March. At Rison along the Saline River both male and female gnats were found and a few signs of emergence were seen on vegetation along the shores. South of Camden along the Ouachita River I was informed that there had been no gnats to speak of since the end of February; none were seen on mules.

The presence of gnats in abundance was reported in Arkansas to me, by Mr. Clay Lyle at the following places. His information was from correspondents.

Arkansas	
Bradley	Stamps
Brookland	Stuttgart
Doddridge	Texarkana
Griffithsville	Trumann
Homan	Tyronza
Mayflower	
Louisiana	
<p>On February 19 a trip was made to Monroe, Louisiana. Mr. Strohan, County Agent of Ouachita Parish reported that gnats had been present for some time all over the Parish, and that they usually appear each year but cause little concern. He had received reports of losses of one mule and two cows from an area isolated by floods, but had not checked the reports. He also reported the presence of gnats in the Eastern part of Richland and in several sections of Caldwell Parishes.</p> <p>Reports to Mr. Lyle on February 28 indicated an abundance of gnats at Winnfield and Natchitoches.</p>	
Tennessee	
Reported to Mr. Lyle as abundant at Covington.	

Life History Studies

Record number	Records of Egg Laying by Gnats	
I.	4 Mar	Several females from river (floating) put in four ounce bottle with water and willow twigs. One batch of 250 and 300 eggs laid (not observed laying).
	5 Mar (4 PM)	Eggs on bottom of jar and on slanting willow twig near bottom of bottle. Eggs stick to twig, also to bottom of jar slightly, but easily detached by agitating water.
	10 Mar	Eggs were laid individually, not in any arrangement. Daily observations since laying. No hatching. Eggs were white when laid but were bright yellow next day. Eggs firm and yellow. A few appear white as if moldy; these may have been infertile and never turned yellow. No sign of young larvae.
	10 Apr	Yellow eggs still firm. Examination of "white" ones show them to be without contents: soft. Apparently shell is entire in most cases but some appear broken.
	5 Mar	Willow twig with eggs removed from water.
	10 Apr	Eggs still adhere to stick. Each egg has collapsed on one side.
	8 Mar	+/- Three hundred eggs laid by a female which was collected March 4 on willow in road ditch about three miles from Coldwater River. Female in four ounce bottle with tap water and willow twigs. Eggs laid during night or early morning. Observed at 9 A.M. scattered on bottom of jar in two main groups. Turned yellow soon after deposition.
II.	10 Mar	Bottle covered with gauze and sunk in Coldwater River (8 ft. deep). Observed March 11, 12, and 13. None hatched. Much silt in jar.
	1 Apr	Jar removed from river.
	13 Apr	Examined at Orlando. Eggs still intact.
	10 Mar	Eggs laid by female between 8 and 9 A.M., while she was at the surface of the water with all of the body submerged but wings. Eggs are emitted one to two or three at intervals and sink at once. Wings and legs keep up slight movement but not sufficient for locomotion. Eggs continued to be laid for about one hour, then the female either swam to or accidentally touched a willow stem, walked down it to about one inch below the water surface and laid seven eggs on the twig. She was dead ten minutes later. No exact count of eggs but approximately 350 laid (examined by hand lens). Twigs with eggs stuck thereto taken from the water. These eggs shriveled (April 13). The bottle containing these eggs was placed in Coldwater River the same day as layed, and frequently examined but no traces of larvae found.
III.	1 Apr	Bottle removed from river.
	13 Apr	Bottle examined; eggs intact; not shriveled.

IV.	10 Mar	Observed one female which had been collected from willows near River Mar. 6, laying eggs in four ounce bottle. Female rested on surface of water on feet; body not submerged. While laying the tip of the abdomen was curled beneath the surface of water and eggs layed two or three at a time. The eggs sinking immediately. Egg laying continued from 8:45 to 10 A.M. No effort was made to reach willow stems. Female alive at 12 noon but inactive. Dead at 1 P.M.
	10 Mar	Eggs sank in jar in Coldwater River (about 6 P.M.). Observed daily for several days and no hatching noted. Much silt in jar.
	1 Apr	Bottle removed from River.
	13 Apr	Examined at Orlando. Eggs intact

V.	12 Mar	Six quart fruit jars prepared with water; depth one inch and few willow stalks standing upright in each jar. Five male and five female gnats in each jar (gnats collected by carefully sweeping branches overhanging river. None appeared to be fed.)					
	14 Mar	Several males and females dead in each jar. Many alive and active.					
	18 Mar	Number Alive:					
		Jar 1	Jar 2	Jar 3	Jar 4	Jar 5	Jar 6
		6 females	8 females	3 females	6 females	8 females	10 females
		2 males	1 male	----	7 males	6 males	4 males
	22 Mar	All dead. No eggs in any jar.					
VI.	12 Mar	Collected female on willow at Rich, Mississippi. Single female with large abdomen placed in four ounce jar. Water one inch deep. Willow stem in jar.					
	13 Mar	Female active. No eggs.					
	14 Mar	Female active. No eggs. Resting on water surface.					
	15 Mar	Female dead. 341 eggs laid (counted Orlando, Florida, April 10). Eggs appear viable. None shriveled. Kept in water.					
	10 Apr	Examined. No sign of hatching. Eggs intact.					
VII.	19 Mar	Rich, Mississippi. Caught a number of females from stream of gnats flying up river. 6 P.M. put about a dozen in each of four fruit jars with water and willow stems.					
	20 Mar	Eggs in two jars. All eggs on bottom of jars; none laid in sticks.					
	22 Mar	Eggs in two jars. All eggs on bottom of jars; none laid in sticks.					
	25 Mar	No hatch in any jars. Two of the above jars covered with gauze and sunk on strings in Coldwater River at Rich, Mississippi. Two jars covered with gauze and sunk in Tallahatchie River at Swan Lake.					
	2 Apr	Jars examined. Much silt has drifted in through the gauze. No sign of young larvae. On strings attached to jars at Swan Lake many gnat larvae have attached, several have pupated and in about a dozen adult gnats have emerged (pupal skins found attached to string). This makes it evident that the pupal life may be passed in seven days or less.					

VIII.	29 Mar	Collected 20 pair of mating gnats from side of cotton house at Mr. Russell's place, 2 p.m. Put into fruit jar with water (kept in hotel room). Willow twigs added for resting. Three females showed blood meal; apparently fresh.
	31 Mar	Three with brood alive. 15 females, 18 males dead.
	1 Apr	Two with brood alive. All others dead.
	3 Apr	Two with brood still alive. Put in moist jar to transport to Orlando but gauze on top became loose and females lost. No eggs laid. Ovaries not examined.

Egg Collections

17 Mar	By means of a plankton net towed behind a boat the surface water of the Coldwater River at Rich was strained. This catch was made between six and six-thirty P.M., while the gnats were flying over and striking the water in large numbers. There were also numerous females and males floating on the surface of the water. This catch was subsequently examined and gnat eggs were found.
25 Mar 29 Mar	Catches of surface plankton were made on the Tallahatchie River about 6 P.M. when gnats were active at Swan Lake. Gnat eggs were found in both lots. Vegetation in large amounts was examined along all rivers in which collections were made and gnat eggs were not found except in one case. In a drift in the River at Swan Lake through which there had been considerable current, but which was dry due to falling water, a few scattered eggs were located. These were imbedded in dried algae which was hanging to a wire fence in thin sheets and a very few were found adhering to leaves lying on the ground below this place. It seems likely that these eggs were caught on this vegetation after being laid in the water.

The foregoing observations may be briefly summarized by stating that three hundred or more eggs are laid by a female gnat. After laying she soon dies. The length of time necessary for hatching is unknown, none hatched in water in jars, even when the jars were sunk in rivers. It appears that the eggs are laid on the surface of the rivers and sink. If they come in contact with twigs or debris they may stick thereto. If they become dry they collapse. Eggs were taken from the surface water of rivers by straining it with a plankton net at times when gnats were active over the river. Eggs were found to be very scarce on vegetation along the river.

No very small larvae were noted on sticks and vegetation in the rivers. The pupal stage may be passed in seven days or less.

Adult Activities

Adult gnats emerge below the surface of the water and come to the surface enveloped in a film of air. They may immediately fly to an overhanging branch and rest there awhile or they may rest on the surface

of the water and be carried downstream by the current for a distance before flying. The branches of trees overhanging swift water are often covered by millions of both male and female gnats which I assume are those which have recently emerged and are awaiting a favorable time for flying away. Females taken from these clusters of gnats show no traces of egg development or of blood in the intestine. If these resting gnats are disturbed, both male and female fly out and make a short "dipping flight" over the water before coming to rest again.

On favorable nights, just at dusk swarms of female gnats have been observed flying with the wind up the rivers. At this time the gnats were striking the water surface to such an extent that it appeared like rain falling. A large number of these females were taken and by pressing out the contents of the abdomen it was seen that the intestines of practically all were filled with blood and the ovaries were well developed and contained eggs. In one female the ovaries contained 459 eggs.

Large numbers of gnats, both male and female, are often noticed on the surface of the rivers being carried down by the current. These gnats appear to be dead but if the females are removed and examined it will be noted that some of the females are active and numbers of them have well developed eggs and blood in the abdomen. It is a question whether the females deposit their eggs while resting on the water surface as occurs when they are in captivity or whether they are laying them when they strike the water while in flight. Those females which are taken from the water surface being only exhausted individuals.

I have seen no females depositing eggs on vegetation or debris except in the one case cited previously in which a female in captivity went below the water surface and laid her last few eggs on a twig. Considerable time was spent trying to find individuals in nature walking down vegetation and entering the water for the purpose of laying without result.

Mating

Mating has been observed at practically all hours of the day in many localities both close to and distant up to eight miles from known gnat breeding rivers. The males hover over the ground from 3 to 8 or 10 feet high, not in close swarms as with certain mosquitoes, but more generally distributed. Mating was commonly seen over cotton fields where some females were actively feeding. The black color of the males

and the peculiar way they fly with legs hanging down and the abdomen curled up make them easily distinguishable when in flight.

After coming together in the air, a mating couple fly to the ground or to vegetation or to the side of a building such as a cotton house. I have seen them fly into the car and also fall on the surface of water. Mating females usually show no signs of having fed but several have been taken while mating which showed evidences of having had a fresh blood meal. (out of 20 counted at one time 3 had fed).

The length of time required for a gnat to engorge varies considerably. At a temperature of 68°F and with no breeze to disturb them the following observations were made of gnats biting mules.

Observations of gnats biting mules	
Mule no.	Time to engorge and leave
4	Fully engorged and left in 7 minutes
2	Fully engorged and left in 8 minutes
1	Fully engorged and left in 15 minutes
1	Fully engorged and left in 25 minutes (disturbed by switching)

Effect of Gnat Bites on Man

On February 16 while riding in a boat on the Yazoo River a female gnat alighted on the back of my hand and immediately inserted her proboscis. No pain was felt. She became fully engorged in thirteen minutes and after releasing her hold, blood oozed from the wound for about a minute before clotting. No irritation was felt that day but the following day a sizeable knot similar to a mosquito bite had developed there and there was considerable itching for several days.

During my stay in the gnat country I was bitten dozens of times; chiefly around the wrists, around the neck, under the collar and around the head just below the hat band. Only rarely did a gnat cause any pain while biting. The several days itching which followed was, however, quite annoying. No systemic effects were noted. The greatest number of "bites" I got in one day, however, was only thirteen.

Mr. Breeland of Webb, Mississippi reported that he had been made ill by gnats biting him while plowing. One side of his head and neck was much swollen (see figures 44 and 45), and he was firm in his belief that gnats caused the trouble. Upon calling on the doctor who attended him, however, I was informed that the man was suffering from an ordinary case of shingles and that gnats were not concerned. The patient is, however, unconvinced.

Tests with Repellants

Experiments to ascertain the value of a number of repellent sprays were made. In these tests mules tied to fences and also animals working in the fields were used. The latter method was considered more satisfactory as the animals were ready for spraying when observed; that is, they were caught up and the spray could be immediately applied. Pre-arranging for buffalo gnat spray tests in one locality is unsatisfactory unless one has an abundance of assistance and time on account of the erratic actions of the gnats. They may be abundant when the test is arranged for and then be scarce for several days.

Table 2. Experiment No. 1. Spray Tests, Mr. Craig's Place, Greenwood, Mississippi, February 23, 1932.

Experiment No.	Time	Temp °F	Comments
1	15:40	58	Flying gnats not particularly abundant but a few were biting on each animal.
	16:30		Gnats were flying around, few were alighting, but no biting except on check mule (no. 9).
	17:00		Gnats were alighting on all animals, going down through the hair and returning except on No. 3 and 6 where a few remained to bite. Fewer appear to alight on No. 1 than others
	17:45	54	None were biting on Numbers 1, 2, 4, 5, 7, and 8. Few were biting on Numbers 3, 6, and check.
Nine mules tied to fence about ten feet apart and sprayed as follows:			
Mule no.	Spray used		
1	Kerosene and pine tar		
2	Crankcase oil and pine tar		
3	Mineral oil and wintergreen		
4	Mineral oil and citronella		
5	Mineral oil and pennyroyal		
6	Quin's gnat oil (creosote odor)		
7	Mineral oil and coriander		
8	Mineral oil and fennel		
9	No spray		
Mixing	The sprays were mixed at the rate of one part of the odiferous oil (tar, wintergreen, etc.) to seven parts of the diluting oil (mineral oil, kerosene, etc.). These all mixed readily except the tar and kerosene where heating was necessary.		
Results	Any of these preparations when sprayed on biting gnats cause them to release and fall or fly away.		
Conclusions	The numbers of gnats present during the test were not considered sufficient to give any reliable data on comparative value of the sprays.		

Table 3. Experiment No. 2. Spray Tests, Greenwood, Mississippi, February 24, 1932. In this test twenty-six mules were tied along a fence at ten foot intervals at about 07:00. The gnats did not become numerous enough in my estimation for a satisfactory test, but after noon the sprays were applied.

Mule	Series	Spray	Time applied	Action of Mules					Gnats Biting Mules
				Before	After (minutes)				
	1				30	60	90	150	
1		Cottonseed oil	13:40	s	q	q-	s	s	None
2		Cottonseed oil (7 pt) + Tar (1 pt)	13:40	s	q	q-	s	s	Few
3		Pyrethrum Extract (Nufly)	13:40	s	q+	q+	q	q	None
4		Kerosene (7 pt) + Tar (1 pt)	13:45	s	q+	q+	q-	q-	None
5		Crankcase oil (7 pt) and pine tar (1 pt)	13:45	s	q	q-	s	s	None
6		Mineral oil (7 pt) and wintergreen (1 pt)	13:45	s	q	q-	q	q-	Few
7		Mineral oil (7 pt) and citronella (1 pt)	13:55	s	q-	q-	s	s	Few
8		Mineral oil (7 pt) and pennyroyal (1 pt)	13:55	s	q-	q-	s	s	Few
9		Mineral oil (7 pt) and coreander (1 pt)	13:55	s	q-	q-	s	s	Many
10		Quin's gnat oil (creosote odor)	14:05	±n	q-	q-	s	s-	Many
11		Mineral oil (7 pt) and fennel (1 pt)	14:05	q	q+	q-	q	q	Many
12		Crankcase oil	14:05	s	q+	q+	s	q	Many
13		No spray	N/A	s	s	s	s	s	Many
	2			Before	After (minutes)				
					30	60	90	120	
1		Cottonseed oil	15:20	s-	q-	q	s	q-	Few
2		Cottonseed oil (7 pt) + Tar (1 pt)	15:20	s-	q-	q	s	q-	Few
3		Pyrethrum Extract (Nufly)	15:20	s-	q-	q-	q	q-	None
4		Kerosene (7 pt) + Tar (1 pt)	15:30	s-	q+	q-	q-	q-	None
5		Crankcase oil (7 pt) and pine tar (1 pt)	15:30	n	q-	q-	s	q-	None
6		Mineral oil (7 pt) and wintergreen (1 pt)	15:30	s-	q-	q-	q	q-	Few
7		Mineral oil (7 pt) and citronella (1 pt)	15:40	s	q-	q-	s	q-	Few
8		Mineral oil (7 pt) and pennyroyal (1 pt)	15:40	s	q-	q-	s	q-	Few
9		Mineral oil (7 pt) and coreander (1 pt)	15:40	s	q-	q-	s	q-	Many
10		Quin's gnat oil (creosote odor)	15:45	s	q-	q-	s	q-	Few
11		Mineral oil (7 pt) and fennel (1 pt)	15:45	s	q-	q-	q	q-	Many
12		Crankcase oil	15:45	s	q-	q-	s	q-	Many
13		No spray	N/A	s	s	q-	s	s	Many

s = considerable switching and stamping for gnats

q = quiet

q- = slight switching

q+ = very quiet; no bother

Temperature: 13:40 60 °F; 16:30 57 °F; 18:00 55 °F

Experiment No. 2 conclusions

As was the case in Experiment No. 1, there were not a sufficient number of gnats flying to allow a fair test under field conditions. The actions of the animals appear to be an unreliable basis for judging the effectiveness of the sprays. Some animals with many gnats biting are quieter than those with few biting. In each series of tests the animals sprayed with pyrethrum extract, with kerosene and tar, and with crankcase oil and tar appeared to be best protected.

Tests of Repellants on Working Animals

A number of tests of the sprays as repellants were made at various animals working in the fields. It was difficult to gauge their effectiveness on account of the variations in abundance of the gnats at different places even when in close proximity to one another. There is thus much chance for error in observation. For instance the gnats present around a team while plowing might be very abundant at the point of observation; one hundred yards away they might be estimated as only abundant or few. This condition would consequently effect the numbers of gnats on the mules and a spray credited with being effective for a certain period under very abundant gnat conditions would not appear so if the gnats were uniformly distributed. Table No. 4 illustrates the manner in which the observations were made.

Table 4. Experiment No. 11. Gnat repellent, Mr. Russell's Place, Webb, Mississippi; one team, two mules.

Time	Weather	Flying Gnats	Time between spraying and observation (Min)	Mule 1		Mule 2	
				Spray Applied	Gnats on Mule	Spray Applied	Gnats on Mule
16-Mar-32							
8:30	Partly clear, slight wind	Very abundant	30	Crankcase oil + tar	Few	Crankcase oil + tar	Few
9:00	Partly clear, slight wind	Very abundant	60	0	++	0	++
9:30	Partly clear, slight wind	Very abundant	45	Respray	Few	Respray with above	Few
10:15	Clear, slight wind	Abundant	150	0	Few	0	Few
12:00		Few					
13:00	Clear, slight wind	Few	90	Respray with above	Very few	Respray with above	Very few
14:30	Clear, slight wind	Few	210	0	Few	0	Few
16:30	Clear, slight wind	Few	90	Respray with above	Few	Respray with above	Few
18:00	Clear, slight wind	Fairly abundant					
17-Mar-32							
6:30	Partly clear, still	Abundant	30	Crankcase oil + tar	+		
7:00	Partly clear, still	Abundant	60	Crankcase oil + tar	Few		
8:00	Partly clear, still	Abundant	60	Crankcase oil + tar	Few		
9:00	Partly clear, still	Abundant	60	Crankcase oil + tar	Few		
10:00	Partly clear, still	Abundant	90	Crankcase oil + tar	None		
11:30	Partly clear, still	Abundant		0			
13:00	Partly clear, still	Abundant	60	Mopped with above	0		
14:00			150	0	+		
15:30	Partly clear, still	Abundant	60	Mopped with above	Few		
16:30	Partly clear, still	Abundant	90		Few		
17:00	Partly clear, still	Abundant					

The results of the spray on working animals have been summarized in Table No. 5. While it is believed that this summary gives an indication of the value of the various sprays as gnat repellants, the number of tests is too few to give more than an estimate of the time they are effective under various conditions. The amount of spray applied to each animal varied considerably. Sufficient was applied at each spraying to go over the animal thoroughly and to kill all the attached gnats. With the lighter sprays probably about 25cc was applied per animal. With the heavier sprays the amount per animal was less. In the table the number of spray tests, the variation in time of effectiveness under varying conditions and the average effective time of each spray are given. I had no exact criteria by which to gauge either abundance of gnats or effectiveness of sprays. The abundance is based solely on my opinion. The effectiveness of the spray was judged by the numbers of biting gnats at the time observed. If, when observed there were only a few biting or even if they were numerous in isolated patches the spray was judged to be efficient. When the biting gnats were numerous and general in distribution it was termed ineffective for that period. No consideration was given to the actions of the mules. Some animals will switch and stamp and throw their heads around when troubled by only a very few gnats while others will be quiet while being bitten by thousands of them. The table shows that the sprays containing tar are generally more effective than the others tried, particularly when the gnats were abundant or very abundant. The data given for ineffective periods were obtained when tests were not checked closely enough to estimate the effective period. It is the opinion of the writer that crankcase oil and tar or cottonseed oil and tar (1 gal. oil + 1 pt. tar oil) mixed with equal parts of pyrethrum extract (1 lb. pyrethrum to 1 gal kerosene) makes a satisfactory spray for these pests. The more abundant the gnats the more often the spray must be applied, but the ease with which this light spray is applied and the rapidity with which it cleans the gnats from the mules make it desirable. No observations are at hand on the effect on the mules of the continued application of these materials.

Table 5. Summary of field tests with repellent sprays on working animals.

Spray	Gnat Density														
	Few			Abundant			Very Abundant			Abundant			Very Abundant		
	No.	Time effect		No.	Time effect		No.	Time effect		No.	Time effect		No.	Time effect	
	tests	Range	Ave	tests	Range	Ave	tests	Range	Ave	tests	Range	Ave	tests	Range	Ave
Crankcase oil + tar	6	60-150+	110+	7	30-150		2	30-45	37	2	60-75	67	1	60	60
Crankcase oil + pyrethrum	5	60-150	114+	5	60		7	30-60	37						
Crankcase oil + tar + pyrethrum	3	90-150	110	2	60-150		2	30-45	37				1		60
Cottonseed oil + tar				3	60-150		3	30-45	40	2	30-45	37			
Cottonseed oil + pyrethrum	1	90	90												
Cottonseed oil + tar + pyrethrum	2	45-60	52							1	45	45+			
Pyrethrum extract (Quin's)	4	30-120	60	1	45	45									
Pyrethrum extract (1/2 %/ gal)	2	90-120	105	1	45	45									
Kerosene + tar	4	60-150	100	4	60-90	75	2	30-60	45				1	30	30
Mineral oil + wintergreen	1	90	90	1	60	60				3	30-45	35			
Mineral oil + citronella	7	60-120	85	10	30-60	42				3	30-60	45			
Mineral oil + pennyroyal	7	60-120	85												
Mineral oil + coreander	6	60-120	110	1		60									
Mineral oil + fennel													2	30	30
Quin's gnat oil				3	30-150	50				2	30-75	52			

A sample of light pine oil was obtained after these sprays had been made. It was tried out in a few cases and appeared to be as effective as tar and crankcase oil in repelling gnats and should be given further trials. On March 22 at 1 P.M. when gnats were fairly abundant, one team was sprayed with this material and respray was unnecessary until 4:30. The gnat abundance decreased, however after 2 P.M. and only very few were around. Respraying was not necessary until 4:30 P.M. In another test using two mules plowing separately, one was sprayed with pine oil and one was mopped with crankcase oil and tar. Spray and grease were applied at 7 A.M., at 10 A.M. just before rain stopped the tests there were very few gnats on either mule, although gnats were fairly abundant and troublesome.

Mopping

The general practice in caring for working mules in gnat infested areas is mopping the animals with tar and grease; spraying is practiced very little. The objections to mopping are that it causes the animals to become overheated very easily, lose appetite, and get in poor condition when in heavy work whether sufficient food is supplied or not. It also blisters the skin and causes the hair to fall out besides being disagreeable to us and wasteful of material. (See Figures 25, 26 and 27). Its advantages over spraying lie in the fact that it protects the animal for a longer period, and is more adapted to use by inefficient or careless drivers who do not want to be bothered by watching the mules and by periodic sprayings and who usually ruin a spray gun as soon as the manager is out of sight. Many farmers, however, claim that by judicious use of the mop no injury to animals need result. The general practice when mopping mules is to put a daub here and there on the mules when they are taken to the field. If the gnats are abundant the places not mopped become covered with gnats and the process must be repeated, covering those spots not thoroughly greased at first. The hide of the animal thus gradually becomes soaked with grease and tar. Observations on the effectiveness of greases in repelling gnats applied by mopping showed them to be effective for a longer period than when applied by spraying, and were it not for the harmful effect on the animal of the grease coating, it would certainly be more advantageous than spraying on days when the gnats are very abundant.

Smokes

The building of smokes or smudges to repel gnats is commonly practiced in gnat infested communities and it was observed that gnats do not become abundant around smoke. The animals know the efficiency of smokes in keeping the pests away and congregate around them for protection. When a gnat covered animal goes into a smoke the gnats gradually release as they become engorged and as there are few flying in the vicinity it is not quickly reinfested. Smudges are made of any material which will smoulder such as damp wood, partially dried dung, cotton seed, old sacks, etc. When the smoke is thin and gnats abundant animals have been seen to get so close to the fire as to burn the hide. The placing of smudges in metal containers near the door in barns so that the wind fills the interior with smoke is of advantage when the barn is poorly built, or when large numbers of gnats are being brought in on mules. The common type of barn (see Figure 42 and 43) in use in the infested areas is not such that gnats could readily be excluded by darkness. The barnyard smoke, however, seems to be fairly efficient in keeping the gnats away from stock which is not in harness. See Figures 28, 29 and 31.

Smoke pots made by putting smoldering material in tin cans and tying them to plows, wagon poles, harness, stalk cutters, etc., are commonly seen (See Figures 30 to 35). These pots are also carried along the road by pedestrians and are indispensable part of fishing equipment. (see Figures 36 and 37).

Chickens are an aid in ridding animals of gnats. It is a common sight to see them hovering around animals and picking the gnats off as they alight. (See Figures 40 and 42).

Clipping of mules to aid in keeping them free from gnats is often recommended but I saw no clipped mules in the gnat infested regions. I believe, however, that there is some basis for the statement as gnats do not stick to slick haired animals as readily as to shaggy ones.

Summary

Buffalo gnats (*E. pecuarum* Riley) were present in abundance around the middle of January and were on the decline by the end of March in the gnat infested areas of Mississippi, which are roughly, the Delta regions and a fringe of adjacent hill country extending north from Vicksburg to the Tennessee line, lying between Highway 51 on the east and the Sunflower River on the west. They were also reported as abundant during January and February at several points in Arkansas and Louisiana.

Under conditions present this year the gnats may fly twenty to thirty miles from their breeding place over delta land, and may penetrate low hill country for ten miles.

Only isolated cases of stock deaths due to gnats were reported although the gnats were at times exceedingly abundant.

Gnat larvae were found to be breeding abundantly in the portions of the Yazoo, Tallahatchie, Yocona, Yalobushi, Coldwater and Big Black Rivers which lie in the delta. None were found in the portions of these rivers lying in the hill sections. No breeding was found in the Sunflower and Quiver Rivers which are entirely delta streams.

In captivity female gnats lay their eggs while resting on the surface of the water, the eggs sinking at once. Eggs laid early in March had not hatched up to the first of April. Eggs were kept in still water and in bottles covered with gauze and submerged in the rivers. No very small larvae were found in the river examinations.

Eggs were seined from rivers by drawing a plankton net through the water at times when gnats were active.

Gravid females usually show evidences of having had a blood meal. They are very active late in the afternoon over rivers, where they were observed flying over and striking the surface of the water in large numbers. Many more or less inactive females were found floating on the surface of the water with well-developed ovaries.

No females were seen to lay eggs on vegetation except one in captivity which laid the last 6 or 7 of a batch of 350 on a willow twig about an inch below the surface of the water.

Mating was observed at various times during the day at points up to 8 miles from breeding places. Females may mate either before or after feeding.

Female gnats become engorged and leave their host in from 7 to 25 minutes.

Field tests with sprays indicated the value of pine tar mixed with crankcase or cottonseed oil as gnat repellants. Crankcase oil or crankcase oil and tar mixed with 50% of pyrethrum extract also gave good results. The number of spraying necessary to protect animals depends on the abundance of the gnats.

Mopping repellants on animals increases the effective period if the mopping is thorough. This treatment, however, weakens mules; causing blistering and shedding of hair.

Repelling gnats by means of smokes or smudges is effective in caring for animals not in harness.



Figure 1. Branches raised from the Tallahatchie River near Charleston, Mississippi showing gnat larvae and pupae, March 23, 1932.



Figure 2. Branches raised from the Tallahatchie River near Charleston, Mississippi showing gnat larvae and pupae, March 23, 1932.



Figure 3. Vegetation from river near Charleston, Mississippi showing gnat larvae, March 25, 1932.



Figure 4. Pupal casts and larvae on vegetation. Branches raised from the Tallahatchie River, Charleston, Mississippi.



Figure 5. Dry skins on vegetation. Tallahatchie River near Charleston, Mississippi, March 23, 1932.



Figure 6. Pupal skins and pupae killed by drying. Tallahatchie River near Charleston, Mississippi, March 23, 1932.



Figure 7. Gnat larvae on stem, Tallahatchie River, near Charleston, Mississippi, March 23, 1932.



Figure 8. Pupal skins on vegetation, Tallahatchie River, Mississippi, March 23, 1932.



Figure 9. Tallahatchie River at Mikoma, Mississippi, March 24, 1932.



Figure 10. Tallahatchie River at Swan Lake, Mississippi March 24, 1932.



Figure 11. The Yazoo River at Greenwood, Mississippi, above town, March 25, 1932.



Figure 12. The Yazoo River at Greenwood, Mississippi, above town, March 25, 1932.



Figure 13. The Big Black River, Highway 49 near Flora, Mississippi, March 25, 1932.



Figure 14. Big Black River, Highway 80 near Vicksburg, Mississippi, March 25, 1932.



Figure 15. Big Black River, Hwy 49, near Flora, Mississippi, March 25, 1932.



Figure 16. The Saline River, near Rison, Arkansas, April 4, 1932.



Figure 17. Coldwater River at Marks, Mississippi, March 24, 1932.



Figure 18. Coldwater River at Prichard, Mississippi, March 21, 1932.



Figure 19. Coldwater River at Birdie, Mississippi, March 24, 1932.



Figure 20. Yocana River at Pope, Mississippi, Hwy 51, March 24, 1932.



Figure 21. Sunflower River at Ruleville, Mississippi, March 25, 1932.



Figure 22. Sunflower River at Indianola, Mississippi, March 25, 1932.



Figure 23. Yazoo River at Yazoo, Mississippi, March 25, 1932.



Figure 24. Cassidy Bayou, Sumner, Mississippi, March 25, 1932.



Figure 25. “Skinned mules”. Effects of tar and grease, Webb, Mississippi, March 24, 1932.



Figure 26. Man greasing mules, Mr. Denman's place, Charleston, Mississippi, March 24, 1932.



Figure 27. “Skinned mule” near Crowder, Mississippi, showing effects of tar and grease for black fly control.



Figure 28. Cows standing in smoke from fires for protection from gnats, near Charleston, MS April 1, 1932.



Figure 29. Animals around smoke, Webb, Mississippi, March 24,1932.



Figure 30. Source of smoke being carried in wagon to repel gnats, Webb, Mississippi, March 24,1932.



Figure 31. Mules in Mr. Simpson's lot being protected from gnats by smoke, Webb, Mississippi, February 12, 1932.



Figure 32. Breaking stalks (plowing) with smoke can on breaker to repel gnats, Sumner, Mississippi, March 24, 1932.



Figure 33. Smoke cans on harness to repel gnats, near Webb, Mississippi, March 24, 1932.



Figure 34. Smoker on a plow, Crowder, Mississippi, March 24, 1932.



Figure 35. Plow with smoker in a river bottom, Mikoma, Mississippi, March 24, 1932.



Figure 36. Children going fishing with smokes to repel gnats, Mikoma, Mississippi, March 24, 1932.



Figure 37. Going fishing with smokes in hand, near Charleston, Mississippi, March 24, 1932.



Figure 38. Gnats on cow's udder, Webb, Mississippi, February 12, 1932.



Figure 39. Gnats on the face of a mule, near Charleston, Mississippi, March 24, 1932.



Figure 40. Chickens eating gnats off of a cow, Charleston, Mississippi, March 24,1932..



Figure 41. Buffalo gnats on udder, near Charleston, Mississippi, March 24,1932.



Figure 42. Chickens eating gnats from a cow, Charleston, Mississippi, March 24, 1932.



Figure 43. Barn showing open construction, Charleston, Mississippi, March 23, 1932.

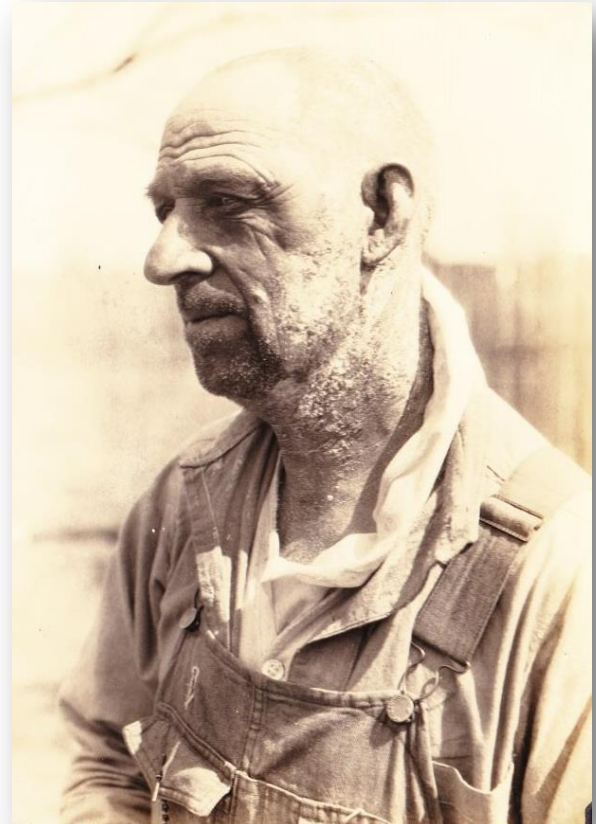


Figure 44. Case of shingles in a man who claimed they were gnat bites, Mr. Breeland, Webb, Mississippi, March 23 and 24, 1932.

Figure 45. Case of shingles in a man who claimed they were gnat bites, Mr. Breeland, Webb, Mississippi, March 23 and 24, 1932.

Dr. George Hirst Bradley

Madison Parish, Louisiana

From Tallulah Madison Journal, October 20, 1983

Services for Dr. George H. Bradley, 90, will be at 11 a.m. at Crothers Funeral Home in Tallulah with the Reverend Miller officiating. Burial will be in Silver Cross Cemetery in Tallulah. Dr. Bradley died Monday after a brief illness. He was a native of Patch Grove, Wisconsin and had lived many years in Rome. He obtained his Bachelor of Science degree in biology from Cornell University in 1916 and his PhD in medical entomology from Cornell University in 1949. Bradley wrote this dissertation later in Life (born 1893). He was head of the Entomology Division, Office of Malaria Control, Public Health Service during W.W.II; and later Chief Entomologist with the CDC in Atlanta. Dr. Bradley was a former resident of Madison Parish. Dr. Bradley was a retired veteran public health service office for the Center of Disease Control in Atlanta during World War II. He was past president of the National Malaria Society, a U.S. Delegate to the Eighth International Congress on Entomology at Stockholm, Sweden, in 1948 and a U.S. delegate to the First Inter-American Congress of Tropical Medicine and Hygiene in Havana, Cuba, in 1953. Dr. Bradley was a veteran of World War I and a member of the American Legion. The first and only Dr. Thomas J. Headlee Memorial Award was given to George H. Bradley by the American Mosquito Control Association in 1968.

Survivors include his wife, Nancy McMurray Bradley of Rome; two sons, George H. Bradley Jr. of Albuquerque, New Mexico, and John B. Bradley of Natchitoches; one brother, C. R. Bradley of St. Petersburg, Florida; one sister, Mrs. Marguerite Torty of Augusta Georgia; nine grandchildren and three great-grandchildren.