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On the Distribution of *Anopheles*
albimanus and Its Occurrence
in the United States

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ON THE DISTRIBUTION OF *ANOPHELES*
ALBIMANUS AND ITS OCCURRENCE
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Anopheles albimanus Wiedeman is considered to be by far the most important anopheline species in the Caribbean region, being the predominant form in many parts of the area and a highly effective vector of malaria. While preferring fresh water breeding places, open to the sunlight, it is also versatile in its habits, since it may develop freely in brackish or salt water and in quite a wide variety of situations. The unfortunate results of its introduction into new territory has been demonstrated in Barbados, where, as reported by Seagar¹⁵ (1928), it was found for the first time in 1927, accompanied by a severe outbreak of malaria. According to this report, the island had previously been entirely free of anophelines and of malaria infection.

This species has been reported from several points in the extreme southern part of the United States and appears to be established at present in the Brownsville, Texas, area. Because the northern limits of its natural range lie close to our southern borders, an inquiry into the possibility of its establishment in other parts of the South is pertinent. As a preliminary to such an inquiry, it seems worth while to consider briefly the records of its present distribution and their possible application to this question. I am taking the opportunity also to include a few original notes by Dr. George N. MacDonell on the occurrence of the species at Key West, Florida, in 1904.

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†From the Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

REPORTED OCCURRENCES IN THE UNITED STATES

For the State of Texas, Dyar⁶ first reported the species in 1928, from the Rio Grande Valley. Specimens (20 in all) upon which this record was probably based were recently examined in the United States National Museum. They are labeled from Brownsville, McAllen and Pharr, Texas, and were collected during October and November, 1923, by R. L. Turner. Another specimen in the collection is labeled "Brownsville, on plane, 8. x. 34." Kumm (1929) gives locality records for Brownsville, Harlingen and Rio Hondo, which are reported from a personal communication from R. L. Turner with the statement that the species had not been taken outside of Hildago and Cameron Counties (in the extreme southern tip of the State). Dr. F. C. Bishopp has given me records of two specimens collected at Brownsville and one in Cameron County in January, 1934.

A reported occurrence in Louisiana is based upon a statement by Beyer⁵ (1923) that *albimanus* had been taken time and again along the docks at New Orleans and about fruit vessels from Central and South America. In the absence of specimen material for definite identification, however, this must be regarded as a very questionable record. Howard¹¹ (1907) stated that *Anopheles argyrotarsis* had been taken in New Orleans, but the record was not repeated in later references to mosquitoes and was probably dropped as a doubtful identification.

In Florida, Gardner⁹ (1904) reported very briefly the collection of *Anopheles albipes* by Mr. (now Dr.) George N. MacDonell at Key West, the identification having been confirmed by the Bureau of Entomology, United States Department of Agriculture. The specimens furnished at that time were later determined as *Anopheles albimanus* and were recorded under this name by Howard, Dyar, and Knab (1917) and by Dyar (1922), although the credit for the collection was given in error to Dr. Gardner instead of Dr. MacDonell.* Two of the specimens are still in the National Museum collection at Washington. While no further report of this occurrence has been published, some of the original notes and correspondence, copies of which have recently been furnished the writer by Dr. MacDonell, are of interest and are referred to here with his permission. The notes show that the first specimen was collected in a residence on July 29, 1904, and identified by him as *Anopheles argyrotarsis* subspecies *albipes* (a name later recognized as a synonym of *albimanus*). An intensive search was initiated immediately and continued until August 20, by

*Gardner stated that sole credit belonged to Mr. MacDonell, and the unintentional error on the part of the authors mentioned should be corrected in future references.

which time the number of adults obtained had reached a total of 131 (2 males and 129 females). Most of these were taken in stables within a single city block, although a few in addition to the first specimen were found in residences. The breeding place could not be discovered. Dr. MacDonell suggested that the captured adults were the progeny of a single female, possibly brought by vessel from Vera Cruz, Mexico. Assuming that the number of males produced was equal to the number of females, the total would indicate either that two or more batches of eggs had been deposited by the one female or that more than one female was involved.

The species has not again been reported from the area and was apparently completely eliminated. Dr. MacDonell has also called my attention to the fact that this was probably the first occurrence of any species of *Anopheles* at Key West. He quotes from a published statement by Surgeon R. D. Murray in 1902 to the effect that search for *Anopheles* during the previous two and a half years had assured him that none was present. From my personal observation, breeding conditions on the Key do not appear to be very favorable for the perpetuation of anophelines.

Another record for Florida is furnished by Griffiths¹⁰ (1931), who reported taking the species in Miami during the routine inspection of airplanes arriving from Southern ports. The route of the airplane or whether more than one specimen was found was not recorded.

TROPICAL DISTRIBUTION

Howard, Dyar, and Knab (1917) gave the distribution of *albimanus* as "Continental America from Mexico to Ecuador and the Greater Antilles; southern Florida." The present known distribution is still within the same general region, although a number of areas have been added to the list as given. These include Colombia, Venezuela, and several places in the Lesser Antilles (Guadalupe, Barbados, Trinidad, and so on). The species has been reported from Brazil, but in the light of more exact identification all of the reports for that country are now believed to refer to other species (Cf. Root,¹⁴ 1926, and others). Root (ibid) mentions it as probably extending into Argentina, although this was evidently not based on specimen records, and none of the recent authors include it in the list of anophelines found there. Apparently, therefore, the species has not been found south of the equator except in Ecuador.

The record for Ecuador is based upon its collection at Guayaquil by F. Campos⁴ and the *albimanus* material in the National Museum collection contains one undated lot of specimens from him. A recent examination by Dr. Alan Stone and the writer of the male genitalia of

Colombia
Venez.
Ecuador
Cent Amer.
Greater Antilles
some Lesser "
Not believed to occur in Braz.

two of the specimens from this lot confirms the identification. Other than this, little information is available as to the occurrence there of this species. A later shipment of material to Washington did not contain specimens of *albimanus*, according to Dyar (1925). Campos⁵ (1921) included it in one list of the mosquitoes of Ecuador, but omits it in a later list (1925). In the later article he states that *A. tarsimaculatus* (which is very similar in appearance to *albimanus*) is the chief species throughout the year in the vicinity of Guayaquil. Specimens collected in Ecuador in March, 1936, by Dr. Henry Hanson were forwarded to the Bureau of Entomology and Plant Quarantine and identified by Dr. Alan Stone as *A. albimanus*. One of the lots had been taken in a hotel room in Guayaquil and one in a bed net at Daule on the Daule River. In a personal communication to the present writer, Dr. Hanson mentioned that *albimanus* was the principal anopheline observed by him.

For Colombia and Venezuela, the records of *albimanus* seem to be limited to the northern coast. With reference to the latter country, Benarroch² (1934) states that it is common on this coast, but does not extend very far inland. It is said to be the principal carrier of malaria in the coastal areas of both countries.

The species was reported from Trinidad by Beattie¹ (1932), although the prevalent anopheline there was found to be *A. tarsimaculatus*. De Verteuil¹⁶ (1931) did not record *albimanus* during a year's survey in western Trinidad (including Port of Spain), so its occurrence must be very limited in the island. Moreover, Trinidad appears to be the farthest extension of the species in a southeasterly direction, as I find no authentic record for the Guianas and, as stated previously, the Brazilian reports are thought to have been in error.

From a perusal of the literature the chief characteristics of the local distribution of *albimanus* are shown to be a warm damp climate and low altitudes. Except in Trinidad and Ecuador, it is usually the predominant anopheline in the coastal areas and lowlands throughout its range, but it is replaced by other species in dry climates and at higher elevations. The latitude most favorable for its existence, judged on the basis of prevalence, extends from central Mexico to Panama and the northern coast of South America, or from about 24° to 8° north latitude. It has been found as far north as 26° (southern Texas) and south to about 3° south latitude (south-central Ecuador). Its effective range is practically limited at the present time to the Caribbean and Mexican regions.

CLIMATIC LIMITATIONS IN THE UNITED STATES

The distribution records for *albimanus* show that the

only places where it has approached the temperate zone are in northeastern Mexico and southern Texas. The situation in northeastern Mexico, however, is of little assistance in determining the low temperature limitations to its dispersion, since the climate is probably too dry to favor its extension inland, irrespective of temperature. This restricts the inquiry to the Texas records as a source of information in this connection, and the conditions there may be briefly compared with those of other sections of the United States.

The normal rainfall rate in the Brownsville area would seem to be unfavorably low for *albimanus* (less than 30 inches annually), but irrigation and coastal marshes presumably supply the required conditions for the limited amount of breeding. The Weather Bureau records show the normal annual mean temperature for Brownsville to be 73.1° F., with an average monthly mean for December and January of 60.5°. At Corpus Christi, approximately 100 miles farther up the coast, where the species has not been reported, the annual mean is 70.4° and the average for December and January is 56.9°. The conditions in the Brownsville area are assumed to represent the minimum climatic requirements for the species, and temperatures corresponding to those found there are not encountered elsewhere in the United States except in peninsular Florida. A comparison of the Texas localities with the most southerly coastal stations in Louisiana and California and with several sections of Florida is shown in *Table 1*.

As may be noted from the table, only the extreme southern section of the Florida east coast exceeds in temperature the 73° annual mean of Brownsville and Harlingen, although the west coast average is but slightly less, and three of the six stations (St. Petersburg, Punta Gorda and Ft. Myers) are above that figure. The annual means in Florida, however, are reduced several degrees as compared with Texas by the lower summer temperatures, and on the basis of the coldest weather in the year, which is more likely to be the determining factor, we find that a large portion of the coastal area has December and January averages above 60°. This section extends from Daytona on the east coast to Tarpon Springs on the west coast, while all the stations on the lower east coast, from Ft. Pierce to Homestead, have averages above 65°. The rainfall in Florida would also appear to be much more favorable than at Brownsville.

Judging from this comparison, climatic conditions in a considerable section of Florida, perhaps as far north as the twenty-eighth parallel, might prove to be more or less favorable for the existence of *albimanus*. Further evidence that would tend to support this view is to

Table 1
 NORMAL MEAN TEMPERATURE AND RAINFALL AT SE-
 LECTED STATIONS IN THE EXTREME SOUTH-
 ERN PART OF THE UNITED STATES

	Temperature		Rainfall
	Dec.-Jan. Average	Annual Mean	Annual Mean
	°F.	°F.	Inches
Brownsville, Texas	60.5	73.1	27.4
Harlingen, Texas	59.9	73.4	26.4
Corpus Christi, Texas	56.5	70.6	26.4
San Diego, California	55.1	61.0	10.3
Burrwood, Louisiana	57.4	70.2	52.8
New Orleans, Louisiana	54.8	69.4	57.5
Florida west coast:			
Tarpon Springs to Fort Myers (6)*	62.3	72.5	51.4
Florida east coast:			
Fernandina to St. Augu- tine (3)	56.1	69.1	49.1
Daytona to Merritt Island (4)	60.9	71.2	50.0
Ft. Pierce to Homestead (7)	67.1	74.4	58.7

*The numbers of stations from which the records were averaged are shown in parentheses.

be found in the distribution of four tropical species of mosquitoes that already are found in southern Florida. These species are *Deinocerites cancer* Theobald, *Mansonia titillans* Walker, *Wyeomyia mitchellii* Theobald, and *Wyeomyia vanduzeei* Dyar and Knab, the last three of which have been taken as far north as Orlando (about 28°30') and have been found in comparative abundance between latitudes 28 and 27. The fourth species, *D. cancer*, has been taken as far north as Vero Beach. Like *A. albimanus*, three of these species are also normally restricted to the Caribbean area.

While this rather meager evidence by no means proves that *albimanus* could propagate actively in southern Florida, if introduced, it is sufficiently suggestive to indicate a possible danger and the need for further study of the climatic and other factors affecting its distribution. Attention may be called to the fact that the southern half of Florida at present is largely free of malaria, due no doubt to the fact that the prevalent anopheline, *A. crucians*, is of little importance in the transmission of the disease. The introduction and establishment of an effective vector in this area, therefore, would be particularly unfortunate.

REFERENCES

1. Beattie, Mary V. F.: The Physico-Chemical Factors of Water in Relation to Mosquito Breeding in Trinidad. *Bull. Ent. Res.*, **23**:477-496, 1932.
2. Benarroch, E. I.: Estudios relativos al paludismo en Venezuela. Observaciones Acerca de los Zancudos Transmisores. 15 pp. Caracas, Venezuela, 1934. (Quoted in *Rev. App. Ent.*, B, **22**:239, 1934.)
3. Beyer, Geo. E.: The Mosquitoes of Louisiana. *Quart. Bull. La. State Board of Health*, **14**:54-84, 1923.
4. Campos, F.: Estudios Sobre la Fauna Entomologica del Ecuador. 2° Dipteros Nematoceros: Fam. Culicidae (Mosquitos). *Rev. Col. Nac. Vicente Rocafuerte, Guayaquil, Ecuador*, No. 5, pp. 20-30, 1921. (Quoted by Dyar, 1925.)
5. Campos, F.: Estudios Biologicos Sobre los Mosquitos de Guayaquil y Alrededores. *Rev. Col. Nac. Vicente Rocafuerte*, 7 (21-22):3-49. Guayaquil, Ecuador, 1925. (Quoted by *Rev. App. Ent.*, B, **14**:152, 1926.)
6. Dyar, Harrison G.: The Mosquitoes of the United States. *Proc. U. S. Nat. Mus.*, **62**:119, 1922.
7. Dyar, H. G.: Some Mosquitoes from Ecuador. *Ins. Ins. Mens.*, **13**:27-31, 1925.
8. Dyar, Harrison G.: The Mosquitoes of the Americas, 616 pp, Washington, D. C., 1928.
9. Gardner, C. H.: *Anopheles* Mosquitoes Found at Key West, Fla. *Pub. Health Reports*, **19**:1651, 1904.
10. Griffiths, T. H.D.; and J. J.: Mosquitoes Transported by Airplanes. *Public Health Reports*, **46**:2775-2782, 1931.
11. Howard, L. O.: Mosquitoes. *Osler's Mod. Medicine*, **1**:370-391, 1907. (Quoted by Howard, Dyar, and Knab, 1917.)
12. Howard, Leland, O.; Dyar, Harrison G.; and Knab, Frederick: Mosquitoes of North and Central America and the West Indies. **4**:525-1064, 1917; Washington, D. C.
13. Kumm, Henry W.: The Geographical Distribution of the Malaria Carrying Mosquitoes. *Amer. Jour. Hyg., Monographic Series No. 10*, 178 pp., 1929.
14. Root, Francis Metcalf: Studies on Brazilian Mosquitoes. I. The Anophelines of the *Nyssorhynchus* Group. *Amer. Jour. Hyg.*, **6**:684-717, 1926.
15. Seagar, E. A.: Malaria in Barbadoes. *Trop. Agri.*, **5**:48-50, 1928. (Quoted in *Rev. App. Ent.*, B., **16**:119, 1928.)
16. Verteuil, E. de: Malaria Survey. *Counc. Pap. Legis. Counc. Trinidad and Tobago*, No. 97. Port of Spain, 32 pp., 1931. (Quoted in *Rev. App. Ent.*, B, **20**:267, 1932.)

DISCUSSION (Abstract)

Dr. George N. MacDonell, Miami, Fla.—Referring to the original collection of *Anopheles albimamus* at Key West in 1904, a page from my note book, written at that time, records the happenings in chronological order as follows:

"July 29, 1904.—Captured first specimen (583) in lighted room at 10:00 p. m. Identified as *Anopheles argyrotarsis* subspecies *albipes*, female. Window of room open to east wind which was blowing across a fresh water pond 350 yards distant.

"July 30.—Captured second specimen (593) in Seminary stable and notified Dr. Maloney, local Health Officer.

"August 1.—Captured three specimens (594-596), one in my bedroom at 9:00 p. m. and one in Mr. W. Morton's stable. Searched surrounding ponds hut found no larvae.

"August 2.—Captured three specimens (597-599) in the Morton stable. Sent by mail two specimens to Dr. L. O. Howard, Bureau of Entomology and two specimens to Dr. H. F. Harris, Secretary Georgia Board of Health, a former instructor and personal friend

After mailing letter and specimens to Dr. Howard, I showed specimens to Dr. Fogarty, practicing physician, Dr. Plummer, in charge of the Key West Naval Station, Dr. Gardner, P.A. Surgeon in charge of Marine Hospital, Mr. Stier, Clerk and Paymaster of Marine Hospital, and Dr. Barnes, Contract Surgeon, Marine Hospital.

"August 3.—Captured twelve specimens in Morton's stable. Gave several specimens each to Dr. J. Y. Porter, State Health Officer of Florida, Drs. Plummer, Fogarty and Maloney. Many of mosquitoes filled with blood. Searched several ponds but found no larvae."

I continued finding specimens until August 20, after which time I had to leave Key West. In all, I found 131 *Anopheles albimanus*, of which only two were males. All were found practically within the range of a city block and were probably the hatch from eggs laid by the first mosquito arriving in Key West. My search was so intensive and thorough, combing every possible hiding place, that I have reason to believe that I exterminated the breed. At any rate, no more were found, although Dr. Plummer told me he searched diligently. None have been reported from Key West since then.

In so doing, I probably checked what might otherwise have been an invasion of the Keys and the mainland by the chief vector of malaria in the West Indies. Thus, as a medical student, I performed what is probably my best contribution to preventive public health work.

Dr. D. P. Curry, Ancon, Canal Zone.—The distribution of *albimanus* is an interesting and perplexing problem. It is, of course ubiquitous in the Canal Zone where fresh water and sunlight abound, but its presence in salt water of any high degree of salinity is usually accidental, generally occurring where a high tide has invaded a fresh water breeding place. In the large brackish swamps of the Atlantic side its place is taken by *tarsimaculatus*.

Why *albimanus* has not invaded the Lesser Antilles and the coastal region of South America beyond La Guaira has been discussed frequently, without seemingly adequate explanation. It has been doubted if it was really the species that caused the recent epidemic of malaria in Barbados and I do not know whether larval or genitalic identifications were made. The reports of *albimanus* from Trinidad are also uncertain. For some years de Verteuil has been sending specimens to Edwards and to me and I know of no specimens of the species having been taken there in recent years. Nor does de Verteuil report it in his annual reports.

A most interesting problem here is the dispersal of breeding of the two species, *albitarsis* and *albimanus*, in the inlets of Gatun Lake. Until recently *albitarsis* bred only in the southwestern part of the lake, the larvae sometimes being collected 200 or more at a dip, in the proportion of 20 *albitarsis* to one *albimanus*; whereas in almost similar locations in the northeastern area, *albimanus* alone were collected in the same great numbers. A few weeks ago, however, we took a single larva of *albitarsis* (from which an adult male was bred) in the Gatun River inlet of the northeast section. At the same time about 40 *albimanus* larvae were collected.

Mr. W. H. W. Komp, United States Public Health Service, Ancon, Canal Zone.—I visited the island of Trinidad during the past summer, and had the pleasure of going over most of the island with Dr. Eric de Verteuil and Prof. F. W. Ulrich. We did not find *albimanus*, and de Verteuil believes, on the basis of many collections and long-continued observations, that it does not occur there. It was not found by me during two visits, a year apart, to eastern Venezuela, near the mouth of the San Juan River, of the Orinoco drainage. Dr. Rolla Hill reports it from the region around Maracay, Venezuela, at altitudes of about 2,000 feet. It has also recently been reported from Guatemala City, at 4,500 feet, by Dr. Romeo de Leon. *Albimanus* occurs well up the Magdalena River in Colombia, and also occurs in Guayaquil, Ecuador, as I proved by the examination of males from this locality. C. H. T. Townsend reports it from Rio Tapajos, Brazil, but I have seen his material so labeled in the U. S. National Museum, and it is *bachmanni* Petrocchi.

Townsend's "albimanus"
from Tapajos =
bachmanni.

Dr. F. W. Edwards, of the British Museum, has written me as follows concerning Miss Beattie's record of *albimanus* from Trinidad: "In regard to *Anopheles albimanus* in Trinidad, I think some mistake must have been made either by me or by Miss Beattie. There are no specimens from the Island in our collection, and I expect the determination was in error for *albitarsis*." So the eastern limit of *albimanus* along the northern coast of South America seems to be the Lake Valencia region in Venezuela.

Regarding its reported connection with the epidemic of malaria in Barbadoes in 1927, I made many inquiries while in Trinidad to determine whether any *Anopheles* material collected during the outbreak was still extant. None could be found, and de Verteuil informed me that when Seagar, who is a medical man, not an entomologist, was questioned concerning his diagnosis of the species, he freely confessed that the mosquito he found in Barbadoes might have been *tarsimaculatus*, not *albimanus*. Mr. L. B. Assang, Chief Sanitary Inspector of the malaria survey of Trinidad, who visited Barbadoes at the time of the epidemic, told me that he believes the mosquito involved was *tarsimaculatus*, on the basis of his later knowledge of this species in Trinidad. In the absence of direct evidence of the presence of *albimanus* in either Trinidad or Barbadoes, I believe we are safe in assuming that the mosquito found there is not *albimanus*, but really *tarsimaculatus*.

One of the mysteries of Anopheline distribution is the fact that *albimanus* occurs with *Anopheles darlingi* in north central Venezuela, but apparently does not extend down the eastern coast, while *darlingi* apparently does not extend farther west, and has never been found in the Canal Zone.