ECOLOGICAL OBSERVATIONS ON THE MOSQUITOES OF CENTRAL ALASKA

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Increased military interest in the Arctic and subarctic regions has necessitated studies of the biting insect pests and their control. During the 1947 season, a study was started in the central Alaska area by the Alaska Insect Control Project. The project was supervised by B. V. Travis of the Orlando, Fla., laboratory of the U. S. Bureau of Entomology and Plant Quarantine and recommended by the Army Committee for Insect and Rodent Control. The ecological observations of the Biology Section on mosquitoes are presented for the period 5 May to 24 August 1947. The study was made in central Alaska from Anchorage to Fairbanks and Circle, and from there to Tok and Valdez along the highways and railroads. Special trips were made to Nome, Mt. McKinley National Park, and Adak in the Aleutian Islands. About 200 widely separated stations were established in different types of habitats, but the only intensively studied area was near Anchorage.

The collections and observations were made by the author and all other members of the project. The determinations were made or confirmed by Dr. Alan Stone, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. The ecological observations are preliminary and represent one season during which there was less rainfall than usual.

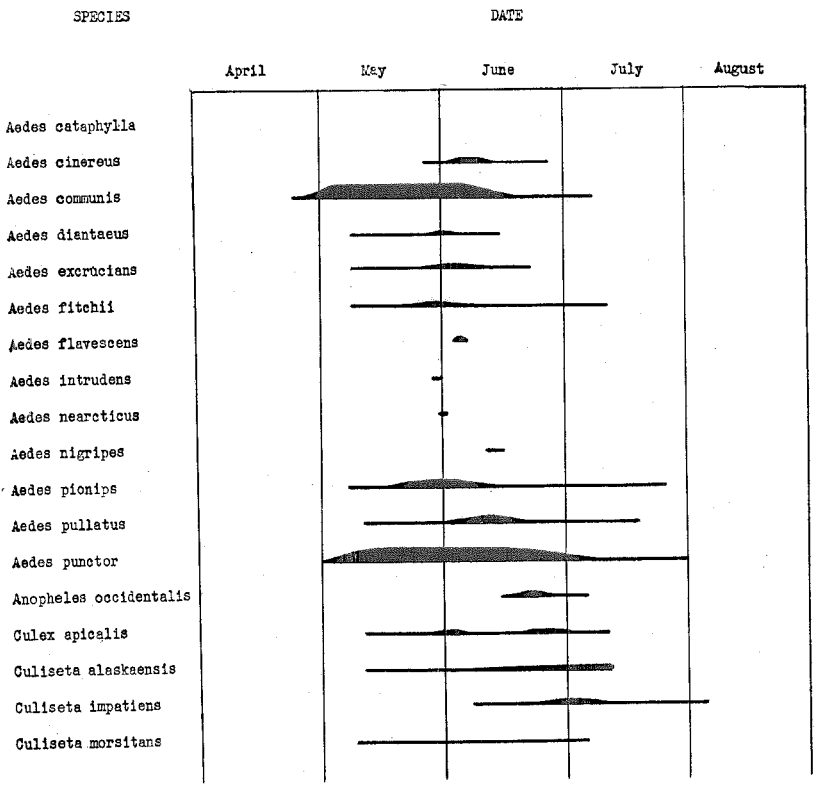
RESULTS

Eighteen species of mosquitoes were found in the central Alaska region in the 1947 season. The most abundant species were *Aedes punctor, A. communis, A. pionips, Culiseta alaskaensis* and *C. impatiens.* In the coastal marshes *A. flavescens* was locally abundant. Species that were fairly common and widespread were *A. diantaeus, A. excrucians, A. fitchii,* and *A. cinerus.* Species typical of the Arctic tundra extended south into the southern interior of Alaska only near the timberline in the mountain ranges, at elevations above 2,000 feet. These relatively rare northern species were *A. cataphylla, A. intrudens, A. nearcticus,* and *A. nigripes. A. pullatus,* which was not so rare, extended to sea level in the mountainous regions. Southern species that appeared to be near their northern limits of distribution were found near sea level and in larger river valleys. These species included *Culex apicalis, Culiseta morsitans,* and *Anopheles occidentalis.*

A somewhat indistinct succession of species took place throughout the larval breeding season and can be classified into four groups. The first group was composed of *Aedes communis* and *A. punctor,* which developed in very cold water. These species preceded or developed along with group 2, which was composed of *A. pionips, A. excrucians, A. fitchii, A. diantaeus, Culiseta morsitans, C. alaskaensis, Culex apicalis,* and perhaps *A. pullatus.* These appeared to require warmer temperatures and in some cases were found in habitats which did not thaw until later than those occupied by group 1. Group 3 was composed of the northern *A. intrudens, A. nearcticus, A. nigripes,* and probably *A. cataphylla* (larvae not found), which occur in the mountains. *A. cinereus* and the coastal salt marsh species *A. flavescens* were also in this group. The fourth group included *Culiseta impatiens* and *Anopheles occidentalis.* The exact dates of occurrence of each of the species of larvae and an indication of the relative abundance of each species are presented in Fig. 1.

It appears that with the *Aedes* there is only one brood each season. Larvae of *Anopheles, Culiseta,* and *Culex* matured throughout the last part of the season, but it is thought that only one brood was represented.

FIG. 1. Seasonal occurrence of mosquito larvae in Alaska, 1947



LARVAL HABITATS

The total area in which mosquitoes were produced was very extensive and widely distributed. The water in the breeding areas was derived in large part from melting snow, ice, and permafrost. The 1947 season was very dry, with a total rainfall of 1.61 inches in the Anchorage region during April–June. This was a deficit of 0.41 inches from the normal. The number of breeding places containing water was greatly reduced and many mosquito larvae died before finishing their development. Discoloration and turbidity due to suspended organic material increased in habitats in which the water was greatly reduced.

The water temperatures in early May varied from 33° to 48° F., and active larvae were found at the edge of or below ice ledges, in water temperature of 33°. The temperatures gradually increased in most habitats but remained low in seepage pools, bogs, and shaded areas underlaid with permafrost. Later in the summer, water temperatures were recorded as high as 71°, with averages as high as 68°. Some open shallow pools heated very rapidly, and the species succession was shortened. The species succession in very cold bogs rarely went past the early *Aedes punctor, A. communis* group.

The water in most habitats was rela-

tively acid early in the season with a pH of 6.0 or less. In late July and August, the pH of many habitats increased to over 7.2, and most of the waters tested were relatively alkaline. Unfortunately during the month of May, Nitrazine and Alkacid indicator papers were used in the field and these proved to be unreliable in testing cold water, so that these field pH values were discarded unless rechecked by phenol red or brom thymol blue indicators.

The many different kinds of habitat that produced mosquito larvae were classified into eight main types. The species of mosquitoes breeding in each habitat are shown in Table 1. The habitat types are briefly described below, with the predominant or characteristic vegetation.

TABLE 1. Larval habitats of Alaskan mosquitoes, 1947.

Species	Habitats							
	Climax spruce forest	Sphagnum-heath bog	Carex marsh	Myrica-Carex coastal marsh	Salt marsh (brackish)	Permanent pond	Excavations, wheel tracks	Snow melt, cold seepage pools
Aedes cataphylla								
Aedes cinereus		x	x					
Aedes communis	x	x	x	x	x		x	x
Aedes diantaeus		x	x					
Aedes excrucians		x	x	x			x	x
Aedes fitchii			x				x	
Aedes flavescens					x			
Aedes intrudens			x					x
Aedes nearcticus								x
Aedes nigripes								x
Aedes pionips			x				x	x
Aedes pullatus							x	x
Aedes punctor	x	x	x	x	x		x	x
Anopheles occidentalis						x		
Culex apicalis						x		
Culiseta alaskaensis			x	x		x		
Culiseta impatiens		x		x			x	
Culiseta morsitans			x			x		

1. Snow melt and cold seepage pools—includes the cold water in depressions and at the bases of snow banks, pools at the bases of cliffs, spring pools, and seepages. The water was clear, about neutral, cold, and usually with little or no vegetation.

2. Excavations, wheel tracks—includes all new artificial and natural depressions as gravel and borrow pits, roadside ditches, caterpillar and wheel tracks, recent oxbow lakes, and washed out places. The water was turbid to clear, variable in pH and temperature, usually with little or no vegetation.

3. Salt marsh (brackish). The water was clear to turbid, brackish, pH 7.0 to 7.8, temperature variable, and the vegetation *Triglochin maritima, Salicornia, Carex,* and other plants.

4. *Myrica-Carex* coastal marsh—area characteristic of coastal marshes, especially at the base of hills with cold fresh seepage water. The water was shallow, clear, slightly alkaline, cold, and the vegetation *Myrica gale, Carex* spp., and moss.

5. Permanent pond—pools usually deep, with variable temperature, often alkaline and clear to stained water. The vegetation included *Lemna minor, L. trisulca, Ranunculus purshii, Nymphaea, Utricularia,* etc., as floating aquatics and various emergent aquatics along the shore.

6. *Carex* marsh—an inclusive type containing areas populated predominantly with species of *Carex* and other plants as *Calamagrostis, Eriophorum, Equisetum,* etc. The water was usually shallow, clear, variable in pH and temperature.

7. Black spruce-sphagnum, heath bog—this includes all of the many and variable types of bogs. The important plants were *Picea mariana, Larix laricina, Betula glandulosa, Ledum groenlandicum, Andromeda polifolia, Potentilla fruticosa, P. palustre, Carex* spp. and *Sphagnum* spp. The bogs with permafrost near the surface usually had clear cold water, while the other bogs had dark-stained, often warmer water.

8. White spruce climax forest—the limited breeding places were holes and low

places containing cool water, clear to stained, with variable pH, often acid. The predominant vegetation was *Picea glauca, Betula papyrifera,* with many shrubs and herbs, often with a sphagnum ground cover.

The species associations of mosquito larvae are shown in Table 2. The numbers represent the number of times two species occurred together in the same habitat.

of mosquito larvae from May 16 to June 15. It occurred in the warmer habitats from Fairbanks to Anchorage and was most common in vernal temporary ponds containing *Carex* and other emergent vegetation. The algae were found on the gills of *Aedes fitchii, A. diantaeus, A. punctor, A. pionips,* and *A. excrucians,* and in some pools 10 per cent were found with algae. No observations were made on the effect of the algae on the mosquito

TABLE 2. Larval associations of Alaskan mosquitoes, 1947.

Species	*Aedes cinereus*	*Aedes communis*	*Aedes diantaeus*	*Aedes excrucians*	*Aedes fitchii*	*Aedes flavescens*	*Aedes intrudens*	*Aedes nearcticus*	*Aedes nigripes*	*Aedes pionips*	*Aedes pullatus*	*Aedes punctor*	*Anopheles occidentalis*	*Culex apicalis*	*Culiseta alaskaensis*	*Culiseta impatiens*	*Culiseta morsitans*
Aedes cinereus	x		4	2	2		1			1	1	5					5
Aedes communis		x	6	7	3		1			31	5	62		1	1		2
Aedes diantaeus			x	8	4		2			4	1	12					4
Aedes excrucians				x	8		2			5	3	17			2		3
Aedes fitchii					x					1		5					1
Aedes flavescens						x						1			1	1	
Aedes intrudens							x					3					
Aedes nearcticus								x				1					
Aedes nigripes									x		1	2					
Aedes pionips										x	4	35			1		2
Aedes pullatus											x	13		1	1		2
Aedes punctor												x	1	1	11	9	8
Anopheles occidentalis													x	3	3	1	
Culex apicalis														x	4	1	
Culiseta alaskaensis															x	12	3
Culiseta impatiens																x	2
Culiseta morsitans																	x

NATURAL CONTROL

The drying of the breeding places before adults emerged greatly reduced the mosquito population during this season. Predacious Chaoborinae were locally abundant and, of these, the genera *Mochlonyx* and *Chaoborus* were the most common. *Eucorethra underwoodi* was occasionally found. Other types of predacious insects were more common in the latter part of the breeding season.

A green alga was found on the gills larvae, and a number of affected larvae were observed to pupate normally.

A stalked protozoan, *Intranstylum invaginatum* (Stokes), of the order Peritricha was found on the larvae of *Aedes punctor.* These *Vorticella*-like protozoans were visible on the outside of the anal gills and on all parts of the larvae, especially on the sides and dorsal surface. They were white when alive and were easily seen on the larvae in the water. There were also many delicate filaments

of sulphur bacteria on the larvae. Larvae covered by the protozoans and bacteria were full-sized fourth instar but they moved more slowly than unaffected larvae. The final effect on the larvae was not determined. The protozoan was found on larvae in cold bogs in the Anchorage area in late July and early August. The water temperature of the bogs varied from 38° to 45° F.

NOTES ON SPECIES

Aedes cataphylla Dyar.—No larvae of this species were collected, but adults of what appeared to be this species were taken in an alpine meadow at 2,400 feet in Thompson Pass near Valdez, and in the tundra close to sea level at Nome.

Aedes cinereus Mg.—Larvae of this species were found from Circle to Anchorage at elevations under 1,800 feet in sphagnum-heath bogs, in *Carex* and grass marshes, and in the emergent vegetation at the margins of lakes, permanent pools and abandoned gold prospect holes. Only occasional specimens were collected in eight widely separated localities.

The adults were observed biting in a few well-forested localities.

Aedes communis (Deg.)—Larvae of this abundant species were found throughout the area studied from coastal areas at sea level to above timber line at elevations above 3,500 feet. They were found in bodies of water of all sizes and types, but were most abundant in shallow depressions, either open or shaded. The heaviest breeding areas, up to 300 per dip, were vernal ponds which dried up early in the summer. The larvae withstood sudden changes in the environment and were the easiest to rear in the laboratory. This species was one of the earliest to appear in the spring. Larvae were found active at water temperatures of 33° F. with permafrost below and a thin layer of surface ice above. The larvae were nearly always found in open water and did not hide in the vegetation.

Adults were quite common pests in wooded areas throughout the summer during the daytime, and they came into the open in the evening. A female that fed on a human laid 67 eggs, and dissection did not reveal any more in the ovaries.

Aedes diantaeus H. D. & K.—Larvae were collected from Fairbanks to Anchorage in 14 widely separated areas in open sphagnum-heath bogs, temporary vernal pools, depressions containing *Carex*, grass, or *Equisetum*, and at the margins of permanent pools. They were usually closely associated with submerged emergent vegetation. The water was usually acid, averaging pH 6.2.

Aedes excrucians (Walk.).—Larvae were collected in 24 widely separated places throughout the area but were never numerous. They occurred in *Carex* swamps, coastal marshes, grass marshes, and in many types of excavations. They were found in both temporary and semi-permanent pools but were most common in temporary vernal pools with a small amount of emergent vegetation. The habitats were nearly always open with little or no shade. The larvae were sometimes found in the same places as *A. fitchii* and had similar habits, although they did not swim as fast and were easier to dip.

Aedes fitchii (F. & Y.).—Larvae in small numbers were found in 11 different places from Fairbanks to Anchorage. They bred in open unshaded places such as excavations and borrow pits, with no vegetation or only early pioneer species, and temporary vernal ponds with a small amount of emergent vegetation, open *Carex* swamps and some grass marshes. The bottoms of the habitats were usually bare mud or gravel with little accumulation of organic debris. Most of the breeding places were shallow temporary pools filled with snow or ice melt or early spring rains. The larvae were difficult to catch, since they swam rapidly to the bottom when disturbed, and remained there for long periods of time.

Aedes flavescens (Muell.).—Larvae were found only in open and unshaded coastal flood plains near Anchorage. The characteristic vegetation in the breeding places was *Triglochin maritima* and some *Carex*. The water was shallow with scattered deeper holes, often brackish.

The adults were fairly common locally

in the open coastal marshes near Anchorage, but were not found in the woods or areas adjacent to these marshes. The biting rate of this species was seldom more than five per minute, but 20 per minute was observed on one occasion. Biting occurred throughout the day on warm, still days.

Aedes intrudens Dyar.—A northern and relatively rare species found near Fairbanks and in five localities at elevations of 1,600 to 2,800 feet. The typical habitat of this species was *Carex* swamps containing deep water, semi-permanent pools and the margins of small lakes.

Aedes nearcticus Dyar.—Larvae were collected only once in a pool at the base of a snow bank, at an elevation of 3,000 feet, in the Alaska range near Black Rapids. The main vegetation in the depression was *Carex, Salix reticulata,* and various small heaths and moss.

Aedes nigripes (Zett.).—This species was found only in two localities in the Alaska and Chugach mountains at above 2,400 feet. Larvae were found in clear water in a snow melt pool below a glacier and in an icy pool in an alpine meadow. No vegetation occurred in the glacial pool and a mat of dead *Carex* with a few willows was found in the other. There were fourth instar larvae in the middle of the pool and smaller ones near the edges.

Aedes pionips Dyar.—This was one of the most abundant and widespread species from sea level to about 3,000 feet. The larvae occurred in excavations, such as roadside ditches, gravel pits, blast holes, and seepage pools from gold mines. They were particularly abundant in the tracks made by caterpillar tractors and sleds which had been driven through bogs and spruce forests. About 60 areas were examined containing "cat" tracks made during the past 5 years, and most of these contained populations from about 10 up to 300 larvae per dip. Larvae were taken also in vernal ponds, depressions in bogs, in oxbow lakes, and pools under rock ledges. This species is a pioneer in new habitats. The breeding pools were usually temporary or semi-permanent and they varied in size from shallow moose tracks to extensive and deep ponds. The pools were shaded and unshaded, the amount of light not appearing to affect the populations. The larvae were disturbed readily and descended to the bottom rapidly where they wriggled along the bottom of the pool and remained for longer periods of time than usual.

Aedes pullatus (Coq.).—Alpine meadows above the timber line in the higher mountain passes appeared to be the most typical breeding places of *A. pullatus* in interior Alaska, but the larvae were found down to sea level. They were collected at 20 localities, mostly above 2,000 feet, and were found in snow melt pools, seepage areas, holes in stream beds, below a rock ledge and in other habitats. The populations averaged about 5 per dip, but up to 200 per dip were observed. The larvae occurred usually in clear water in small pools in open and unshaded locations. They were readily disturbed and descended to the bottom. The larger larvae were observed toward the center of the pool and the earlier instars in the shallower water at the margin.

Aedes punctor (Kirby).—This was the most abundant species of mosquito found in central Alaska. It occurred in nearly all localities studied and was locally abundant from sea level to 3,500 feet elevation. The characteristic larval habitats were those that remained cold during the season from subsurface permafrost ice. Larvae were collected most frequently in the black spruce-sphagnum moss-heath bogs and in the *Myrica* and *Carex* coastal marshes. They were also found in *Calamagrostis* marshes, snow melt and cold seepage pools, permanent pools, excavations and wheel tracks, and in white spruce-birch climax forests. Although this is an early spring species, it was found during June and July in depressions in cold bogs. The habitats were usually open and unshaded. In many places high populations of 100 to 300 larvae per dip were encountered. It was collected more than 180 times and was found associated at least once with each of the other species. Larvae were commonly found in brackish coastal marshes, some of which had an

odor of H_2S and contained a sulfur-like material. Many were encrusted with a whitish yellow substance similar to that deposited on objects in the bottom of the depressions. Larvae were active at 33° F. in water with permafrost ice below and thin surface ice above. They were often absent or uncommon in bogs that warmed up or dried out rapidly. The developmental period was quite long in many cases and larvae appeared to remain the same size for over a month in cold bogs. The larvae descended to the bottom of the pool when disturbed and often remained longer than *A. communis* larvae, with which they were frequently found.

The adults appeared in early June and became more abundant in July. They were abundant in the spruce woods during the daytime, but were commonly encountered in open areas in the evening. Biting occurred throughout the day and was heaviest from 6:00 p.m. to 11:00 p.m. Biting rates of 25 per minute of a mixed population of *Aedes punctor* and *A. communis* were found in a few areas and swarms of about 200 females were observed in a few places. Light breezes greatly reduced the biting rates and activity of the adults. Due to the difficulty of adult determinations, the observations of their behavior were limited.

Wild females collected after a blood meal were kept in glass tubes with moistened cellucotton and provided with a raisin for food. The first eggs were laid on the fifth day and the highest numbers were laid on the sixth day. The egg-laying records are given below for four females:

Eggs laid	Mature eggs dissected from female	Total
54	89	143
7	20	27
42	11	53
15	41	56

These females died before depositing all of the eggs. Thirty-three additional females which had not laid eggs were dissected, and they contained from 3 to 131 eggs, averaging 48.

Anopheles occidentalis D. & K.—These larvae were found in permanent pools, old ponds, and at the margins of lakes. They were always associated with floating or partly submerged plants, such as *Lemna minor, Lemna trisulca, Ranunculus purshii, Utricularia,* etc. The breeding places were usually unshaded. Larvae were collected in six widely distributed localities from Circle to Anchorage along the coast and near river valleys, never at higher altitudes. The populations rarely exceeded about one larva per dip. The water in which the larvae were found was clear and alkaline, ranging from 7.4 to 7.8. The temperature varied from 60° to 68° F.

On May 7 about 15 females were collected as they attempted to bite. Although this species was not very aggressive, biting was observed throughout the day until 10:00 p.m., and at temperatures as low as 44° F. Cast pupal skins were observed in July, but the only adults (about 30) were seen during the month of May.

Culex apicalis Adams.—Permanent pools and ponds containing vegetation, such as *Lemna* spp., *Ranunculus purshii, Scirpus validus,* etc., were the characteristic habitats for the larvae of this species. They were found in 10 localities from Fairbanks to Anchorage usually near sea level along the coast or in river valleys at comparatively low altitudes. The larvae were usually found among floating vegetation in the same habitats as *Anopheles occidentalis.* Overwintered females were observed resting on moist logs, stumps, and vegetation near small permanent ponds throughout the month of May. They made no attempt to bite humans. In the ponds where the females were observed a number of frogs *Rana cantabrigensis latiremis* were collected.

Culiseta alaskaensis (Lud.).—Larvae of this species were collected in 25 widespread localities from sea level to 2,500 feet. They were fairly abundant locally in *Carex* swamps, and in the *Carex* and grass at the edge of small pools and ponds. They were abundant in the small pools among *Carex* and *Myrica* in coastal marshes. Larvae were collected in a bog, in a permanent pond containing duckweed and in a small pool containing decaying logs. They were found in

shallow or deep pools and marshes of various sizes. The breeding places were usually open and unshaded. All instars of larvae were found from May 11 to July 10. The overwintered females were common and bit readily from the latter part of April until the middle of June. No males were collected in the spring. The adults became more abundant again in late July and August but did not bite much at that time. Biting was more common on the upper parts of the body, especially on darker areas of the skin and at the hair line. The females were most aggressive during the long crepuscular periods, although they would bite throughout the day. Biting was observed in winds of 10 miles per hour on the leeward side of subjects, and at air temperatures as low as 44° F. The adults were commonest in spruce woods, especially early in the season. They also occurred in open areas and could be found biting in almost any habitat, including the inside of buildings. Biting rates of 5 to 20 per minute were observed in a few localities. Egg rafts were observed as late as July 3.

Culiseta impatiens (Walk.).—Larvae were collected from 18 widespread localities from Circle to Anchorage and Valdez, and at sea level to 1,500 feet elevation, but adults were collected at higher altitudes. The larvae were taken in the same habitats as *C. alaskaensis* and, in addition, were found in muddy turbid water of road ruts and excavation ditches.

The habits of the adults were similar to those of *C. alaskaensis*. When they were found together *C. alaskaensis* was usually more common. The biting habits of the two species were similar, but *C. impatiens* appeared more nervous and did not bite as readily as *C. alaskaensis*. No high biting rates of this species were observed. The females were active and biting at 44° F. air temperature during the first week of May. No males were collected early in the season. A wild female which was caught and fed on human blood died without laying eggs. Dissection revealed 144 eggs which appeared well formed and nearly mature.

Culiseta morsitans (Theob.).—This mosquito was found only in the larval stage, in temporary *Carex* marshes, lake margins, coastal marshes, and in bogs. In all collections, *Carex* was found to be the most important vegetative type associated with this species. The larvae were always found in unshaded open, temporary or permanent clear water. The larvae were uncommon in collections, only 41 being collected, and 16 of these came from one pool. They were found among the *Carex* plants and were rarely seen at the surface.

SUMMARY

A preliminary ecological survey of the mosquitoes of central Alaska was made during the period May through August, 1947.

Eighteen species of mosquitoes were found, of which *Aedes punctor, A. communis, A. pionips, Culiseta alaskaensis* and *C. impatiens* were the most abundant. An indistinct succession of species took place throughout the larval breeding season, and only one brood was observed for each species. The observed larval associations are presented.

The total area in which mosquitoes are produced is very extensive and includes many different types of habitat, with relatively low populations (this season) per unit area. This makes control operations difficult. The larval habitats were classified into eight main categories based upon kind of depression or pool, water source and type, and vegetation type. Most larval habitats were relatively cold and acid early in the season, but usually became warmer and often more alkaline.

Drying of breeding places due to the unusually dry season greatly reduced the mosquito population this season and curtailed adult studies. Predacious Chaoborinae were locally abundant, and a green alga was found on the gills of some mosquito larvae. A stalked *Vorticella*-like protozoan and filamentous sulfur bacteria were found on *Aedes punctor*.

Observations on the distribution, abundance, dates of breeding period, habitat, and other ecological data are presented for each species. Limited information on the habits of some adults is included.