A taxonomic study of the adult mosquitoes of Utah county with notes on the biology and distribution of the more common species 1946-1947

Cluff E. Hopla

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A TAXONOMIC STUDY OF THE ADULT MOSQUITOES
OF UTAH COUNTY WITH NOTES ON THE BIOLOGY AND
DISTRIBUTION OF THE MORE COMMON SPECIES
1946-1947

A THESIS SUBMITTED TO
THE DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY
OF
BRIGHAM YOUNG UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE
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BY
CLUFF E. HOPFA
1947
This Thesis by Cluff E. Hopla is accepted in its present form by the Department of Zoology and Entomology as satisfying the Thesis requirement for the degree of Master of Science.

May, 1947

Signed

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INTRODUCTION

In Utah County, information has been lacking concerning the taxonomy and distribution of mosquitoes. With the knowledge of this condition, it is felt that information can be presented which will be of value both to the science of Entomology and the area concerned.

During the past years which were occupied by the war, the mosquito population and distribution of many areas throughout the United States has been extensively studied. This study was due to knowledge of the transmission of malaria by the Anopheles mosquitoes. Due to the lack of endemic malaria within Utah, this area was "passed over." From an economic standpoint alone, it is felt that a study of this type will prove to be of considerable value. Except for the fine work completed by Dr. Don M. Rees* no other work worthy of note has been done which relates to the mosquito fauna of Utah. However, excellent as this work may be, it does not cover the mosquitoes of Utah County except for occasional records.

Acknowledgements

I am indebted to Dr. Vasco M. Tanner for assistance and guidance; whose encouragement and interest has helped in so many ways to complete this problem. I appreciate sincerely the suggestions and help of Dr. D. Elden Beck, without whose help, much of the photography used for illustration would not have been possible.

The help received from Dr. Don M. Ras, both in suggestions and loan of material has made this problem more complete than it otherwise would have been.

Dr. C. Lynn Hayward and Dr. Bertrand F. Harrison have been most helpful with advice and suggestions during the course of this study - to them I extend my sincere gratitude.

To James Bee, Herbert H. Frost, and Lowell S. Miller, I wish to thank them for their associations and help, not only in this problem, but also other graduate studies. I am indebted to Miss Myrtle Hancock for her assistance and excellent cooperation in the typing of this thesis.

Objectives

The purpose of this study is threefold: First, to make a study of the classification of as many adult mosquitoes of Utah County as possible; second, to study the distribution and biology of some of the more common species; and third, it is hoped that through a study of the above, to obtain objective
information which will be of value to the area concerned from an economic, as well as medical, standpoint.

Description of Area

The topography of Utah County, Fig. (1), has many unique aspects. The eastern part of the county is mountainous (Wasatch Range). The drainage from these mountains, for the most part, runs into Utah Lake, which is situated near the center of the county.

Between the Wasatch Mountains and Utah Lake, a relatively flat, agricultural area is found, which, for the most part, is under irrigated cultivation. Bordering the east shore line of the lake itself are marshlands, of which much is flooded in the early spring as the lake rises to higher levels after the previous season’s depletion. The western shore of the lake rises abruptly into a mountain range (Lake Mountains), which also forms the eastern boundary of Cedar Valley.

Cedar Valley is a relatively dry area, being desert-like in all aspects. Springs at Cedar Fort and Fairfield run into the desert area during the late fall to early spring, forming shallow bodies of water in the natural depressions of the valley floor. The west side of Cedar Valley is bounded by the Oquirrh Range, which also forms part of the southern boundary of the County.
Fig. (1). The area and topography of Utah County, Utah.
Procedure

To obtain the adult mosquitoes for the taxonomic study, whenever possible, the larval stages were collected, transported to the laboratory for rearing, and the adults then collected as they emerged from the pupal stage. There are numerous advantages for this procedure, as one is able to note definitely the breeding habitats, and better adult specimens without damaged scale and bristle patterns are thus obtained.

The following technique was employed: Upon collecting the mosquito larvae in the field, each collection was given a number. After returning to the laboratory, fourth instar larvae were individually isolated into small medicine glasses. When the larval skin was shed upon transforming to the pupal stage, it was placed ventral view up, under a dissecting microscope and stretched to its original length, and placed in a small vial containing 80% ethyl alcohol. A label giving its collection and decimal numbers, locality and other important data was also placed in the vial.

The pupa from the respective "cast skin" was placed, at this time, in a small vial or bottle, cotton stoppered, containing water approximately one inch in depth (Fig. 2), and given the same number as its respective skin. When the adult
Fig. (2). Bottle used in isolation technique.

Fig. (3). Use of a wide-mouthed pint jar, paper cone and lamp chimney in "mass" rearing of adults.
mosquito emerged from the pupal case, it was transferred to a dry cotton-stoppered vial to harden. The pupa case was then transferred to the same vial as the stretched skin. After allowing the adult to harden in the dry vial for approximately twenty-four hours, it was killed by adding a few drops of chloroform to the cotton stopper and then pinned. This pinned specimen was given the same number as the stored larval and pupal case in the vial. When the genitalia of the male was removed from the pinned specimen for mounting on a slide, the slide under preparation was given the same number as the respective male it was taken from. If some species proved too difficult to raise by the isolation technique, a number of pupae were placed in a wide-mouthed pint jar, as illustrated in Fig. (3). The capturing of adult mosquitoes in nature was accomplished by allowing females to settle on the collector, by taking engorged females from animals in the vicinity; by a light-weight insect net, and by a New Jersey Light Trap. The mosquitoes were killed in a chloroform tube Fig. (4). An aspirator tube, Fig. (5) was also used in collecting adults.

Preparation of Male Genitalia

For specific determination and relationship studies between the various species of mosquitoes, a study of the male genitalia is perhaps one of the most accurate and valuable methods that can be used.
Fig. (5). Aspirator tube.

Fig. (4). Chloroform tube.
To prepare the male genitalia for study, clip off the apical end of the abdomen between the fifth and sixth abdominal segments and place in a small casserole (size O0O) containing 95% ethyl alcohol. This moistens the genitalia, and upon being transferred to a solution of KOH, the genitalia will then sink to the bottom, lessening the danger of it remaining in a floating condition at the surface.

After standing in the alcohol for a few minutes, pipette the alcohol off and replace with a 10% solution of KOH. Heat the KOH to boiling, cool and transfer the genitalia to a container of suitable type, containing distilled water, and allow to rinse for several minutes. After being thoroughly rinsed, transfer the genitalia with a drop of water, to a depression slide, and place in position under a dissecting microscope. If it is desirable after this examination, the genitalia may be placed in a small vial containing 80% alcohol. However, if a permanent preparation of the genitalia is desired, the following steps may be followed:

Dissect off the extra abdominal segments. If this is done in water, the genitalia is then transferred directly to polyvinyl alcohol (Elvanol-90A-25) mounting medium to apply a cover slip. This same procedure may also be used with chloral gum; however, chloral gum crystalizes within a few years and the genitalia must be remounted.
Carpenter et al* have used creosote balsam method in the following manner, with excellent success:

"Transfer the specimen from the rinse water to 80% and 95% alcohol for 5 minutes each, and in absolute for 30 seconds; then transfer to a clean slide on which has been placed a drop of the creosote-balsam medium."

If Canada balsam, or an equivalent method is used, a three to five minute period between the absolute alcohol and the final mounting medium should be introduced. Otherwise, the steps are the same as for the Creosote-balsam technique.

From personal experience, the polyvinyl alcohol medium is preferred, as it saves time and prevents extra handling, thus eliminating to a minimum the danger of damaging the specimen.

The genitalia of Culex have stout basistyles, which should be dissected partially loose at their bases and laid flat upon the slide. This eliminates the necessity for blocking up the cover slip. The anal lobe and ninth tergite in the Anophelines often obscures the useful characters of the mesosome. In the event that they do, the anal lobe and ninth tergite should be dissected away, thus allowing the leaflets of the mesosome to straighten out and be easily seen. At times it is necessary to dissect the individual structures of the genitalia separately and mount in their morphological order on a clean slide. This dissection can be performed by using minuten-nalden pins inserted

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into glass rods. Komp* describes in great detail, an excellent method for this type of dissection.

TAXONOMY

Adult Characters used in Identification

The body of an adult mosquito, Fig. (6), is divided into three distinct regions; the head, thorax, and abdomen, all possessing characters of variable usefulness in classification.

The head of a mosquito is more or less spherical in shape and is joined to the thorax by a narrow membraneous connection. The dorsal part of the head, posterior to the eyes, is termed the **occiput** and the area extending anteriorly between the eyes, the **vertex**. The area between the base of the antennae and the anterior margin of the vertex is called the **frons**. Scales and bristles of different types and colors make up the vestiture of the occiput and vertex and are used a good deal in classification. The mouth parts are composed into an elongated proboscis, the individual parts of which are not known to have any specific taxonomic value. Anterior to the frons is the **clypeus**, usually nude and of little or no taxonomic value in this problem.

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Fig. (6). Generalized diagram of a female mosquito.
The fifteen segmented antennae, arising on each side of the frons between the eyes, are used in separating males from females, which is illustrated in Fig. (7) and (8). The maxillary palps are five-segmented (the first segment is very short and difficult to discern) and originate at the anterior margin of the head below the eyes. As stated by Carpenter, et al*

"They are important to the taxonomist, not only because they may bear rings or patches of scales of contrasting color, but also because of sexual modification and striking variations in some genera, subgenera, and species. In Culicines, the palpi of the female are more or less straight, much shorter than the proboscis, and usually smooth-scaled. The male Culicines usually have densely-haired palpi longer than the proboscis, each with the last two segments angled upward and tapered to a point. These long, bushy palpi, together with the bushy antennae, usually make it comparatively easy to distinguish the sex with the naked eye. In the Anopheline, the palpi of the females are straight and about as long or longer than the proboscis and usually less conspicuously haired than those of Culicines. The last two segments of each are somewhat flattened, angled upward, and rounded at the tip."

Thorax:

The thorax consists of three fused segments, the prothorax, the mesothorax, and the metathorax. The areas and bristles of importance are illustrated in Fig. (9). The prothorax consists of the anterior pronotum, the posterior pronotum, spiracular area; the propleura, and the prosternum. The setae known as the spiracular bristles arise from the spiracular area in Culiseta, but are absent in Aedes and Culex.

A. Female *Anopheles*  

B. Male *Anopheles*

Fig. (7). Heads and appendages of mosquitoes.
A. Female Culicine.  

B. Male Culicine.

Fig. (8). Heads and appendages of mosquitoes.
Fig. (9). Pleural chaetotaxy of an adult generalized mosquito.
The mesothorax is the largest portion of the thorax and bears many structures of prime importance. The mesothorax is divided into two areas. The dorsal area designated as the mesonotum, and the lateral areas or sides as the pleurae.

The mesonotum consists of the scutum, which takes up the larger part of the mesonotum; the paratergite, the scutellum, and the postnotum. The vestiture of the scutum is very important in specific classification. Its divisions are illustrated in Fig. (10).

The pleural plates of the mesothorax consist of the following important areas; the post-spiracular area; the sub-spiracular area; the sternopleura; the prealar area; and the prealar knob anterior to the wing base; the mesepimeron; and the meron.

The genus *Aedes* is separated from the other two genera of *Culicini* in this area by the presence of post-spiracular bristles, while *Culex* and *Culiseta* lack this particular group of bristles. The number of bristles on the lower mesepimeron are used extensively in the specific classification of *Aedes*.

**Metathorax:**

The metathorax is much reduced. It consists of the following divisions: the metameron, the metapleuron. However, it was of no taxonomic interest for the purpose of this problem.
Fig. (11). Generalized wing of an adult mosquito.

Fig. (10). Mesonotum of a mosquito.

AC - acrostichal bristles.
AP - anterior pronotal lobe.
DC - dorso-central bristles.
PsS - prescutellar space.
Sc - scutellum.
S - scoum.
SuA - supra-alar bristles.
Legs:
Each leg is made up of a coxa, trochanter, femur, tibia, and a five-segmented tarsus. The scale patterns of the femur and tibia are used extensively in specific determinations. The tarsal segment attached to the tibia is the longest segment of the tarsus. The breadth, and color of the bands, presence or absence of bands, on all segments of the tarsi are used a great deal in taxonomy. The fifth or terminal segment of the tarsus of each leg bears a pair of small claws, and arising near the base in a lateral aspect are a pair of small pulvilli which are diagnostic for the genus Culex. However, due to the difficulty in observing these small pads, they are not extensively used in taxonomic studies.

Wings:
The wings originate from the mesothoracic segment, scalarion and type of venation distinctly separate them from all other Diptera. Fig. (11) shows a typical wing. The nomenclature of the venation used in this problem is essentially that of Ross and Roberts*. The wing venation by Comstock and Needham is used so rarely by culicidologists that it is not mentioned here.

Abdomen:
The abdomen consists of ten segments, the first eight of which are easily observed. From a phylogenetic concept, the

Fig. (12). Diagram of male genitalia of Culex; B-P, basal plate; Bs, basistyle; Ds-C, claw of dististyle; IX-S, ninth sternite; IX-T, ninth tergite; IXT-L, lobe of ninth tergite; Mes, mesosome; Mes-DA, dorsal arm of mesosome; Mes-T, lateral teeth of mesosome; Mes-VA, ventral arm of mesosome; S-L, subapical lobe; SL-A, appendages of subapical lobe; X-S, tenth sternite; XS-BA, basal arm of tenth sternite; crown of tenth sternite; XS-DA, dorsal arm of tenth sternite.
ninth and tenth segments of both males and females have undergone great modification for carrying out the sexual functions. The modification of the genital segments of the male are discussed under male genitalia.

Genitalia:

The abdominal terminal segments of the male genitalia have undergone great modification, thus showing a great variety of structures which are of great value in taxonomic studies. The terminology is essentially the same as that used by Ross and Roberts with some modifications.

The male genitalia, Figs. (12), (13), and (14), of the Culicinae undergoes a rotation of 180° a short time after the adult emerges so that the structures which were dorsal become ventral. In referring to the structures of the male genitalia, the original positions before rotation are used; i.e., the structures which become ventral due to the rotation are actually considered to be dorsal.

The modification of certain structures, the presence or absence of the various structures of the genitalia constitute the basis of taxonomic characters used in the male. The morphological characters found in the male genitalia* are the ninth

* Carpenter includes the eighth abdominal segment, and used the term "termenalia" to cover the terminal abdominal segments. This segment is usually unmodified, and is of little importance. For this reason, it is omitted from this study.
Fig. (13). Diagram of male genitalia of Aedes. A-L, apical lobe; A-M, anal membrane; B-L, basal lobe; B-F, basal plate; Bs, basistyle; Cl-F, filament of claspette; Cl-S, stem of claspette; Ds, dististyle; Ds-C, claw of dististyle; Ib-F, interbasal fold, IX-T, ninth tergite; IXT-L, lobe of ninth tergite; Mes, Mesosome; Pm, paramere; X-S, tenth sternite; XS-DA, dorsal arm of tenth sternite.
abdominal segment; (sternite and tergite) proctiger, mesosome, and the supporting structures, the basistyles, dististyles, and claspettes.

Ninth Segment:

The sternite (IX-S) of the ninth abdominal segment is unmodified in the mosquitoes of Utah County, and therefore, is of little or no value. The ninth tergite (IX-T) is born submedially at the base of the genitalia, and has lobes on its transverse band which are often of importance in specific characters.

Proctiger:

The proctiger is composed of the tenth abdominal segment, and varies a great deal among the different genera of mosquitoes. The tenth sternite (X-S) is the stronger developed structure and forms a pair of dark sclerotized supports for the anal membrane (AM) in some of the genera of this region. This is well illustrated in genera Aedes, Fig. (13), and Culiseta. From this study, the anal membrane appears to be absent from Anopheles. Fig.(14), which has an unsupported anal lobe (An-L). In many cases the tenth sternite is crowned with a tuft of bristles or hairs, and is of most importance in separating the species of the genus Culex.

Mesosome:

Mesosome (Més) is a chitinous structure, tubelike in appearance which surrounds the penial apparatus. The mesosome is located ventrally from the proctiger and is held in position by
Fig. (14). Diagram of male genitalia of Anopheles. An-L, anal lobe; Bs, basistyle; Cl-Dl, dorsal lobe of claspette; Cl-Vl, ventral lobe of claspette; Ds, dististyle; Ds-C, claw of dististyle; I-S, internal spine; IX-S, ninth sternite, IX-T, ninth tergite; Mes, mesosome; Mes-L, leaflets of mesosome; P-S, parabasal spines.
two supporting structures, the parameres (PM) and basal plates (BP). These two structures in turn articulate with the basal processes of the tenth sternite, and the mesosome. The mesosome exhibits some of the most well-marked and reliable characters for generic and subgeneric divisions. The variations of this structure are well illustrated in the Anopheles where the mesosome is modified into a long, slender tube with leaflets attached to its apical end, and in Culex, by hairy, complexly-toothed plates.

Basistyles (Bs):

The basistyles are a pair of large hollow structures arising from the ninth sternite. Because of their location, the individual structure is referred to as a side piece by Matheson* and Rees†. For the mosquitoes of this area, the basistyles always possess either scales, setae or both, and may or may not give use to basal, subapical or apical lobes.

The Basal Lobe (BL) is present in both Culiseta and Aedes. In Aedes, however, it is much better developed. The apical lobe (AL) is frequently present in Aedes, and Culiseta, but it is much better developed, when it does occur, in Aedes. The apical lobe becomes a subapical lobe (SL) in Culex * and bears important

‡ Carpenter, et al, 1946, states that the subapical lobe of Culex is "probably homologous with the basal lobe of Aedes." Matheson, 1944, however, states, "the apical lobe is now distinctly subapical." From the observations of this study, I am inclined to agree with the latter.
spines, filaments and spatulate-like appendages. The basal lobe is absent in Culex and is represented in Anopheles by the parabasal spines (PS).

**Dististyle (Ds):**

The dististyle is an articulated appendage attached to the apical portion of the basistyle and bears an articulated claw (Ds-C) at or near its apical area, in all cases among the mosquitoes of this area. The variation of shapes, vestiture, place of origin on the basistyle and the dististyle are very important characters. The origin and type of claw cannot be disputed in importance as regards the various genera, the species within the genera. In Anopheles the dististyle is curved, slender and rather long. In Aedes, it is usually somewhat more broad medi ally, and more or less pilose.

**Claspers:**

From each side of the interbasal fold (Ib-F), membranous connections between the bases of the basistyles a pair of small structures may appear, termed the claspers (Cl). The claspers are ventral to the mesosome. In Anopheles, the claspers are represented by a pair of bilobed, spined, rather fleshy structures, which are incompletely divided into an outer or dorsal lobe (Cl-DL), and an inner or ventral lobe (Cl-VL). The well fedined stem (Cl-S) and its distal filament (Cl-F) of Aedes apparently corresponds to the ventral lobe of Anopheles. The characters of the claspers are usually well defined, reliable, and easy to use.
Fig. (15). Diagram showing the rounded scutellum of Anopheline and the trilobed scutellum of Culicine.
KEY TO THE ADULT CULICINAE OF UTAH COUNTY

Key to the Genera

Adult Females

1. Palpi short, never as long as proboscis. Scutellum trilobed -------------------------------------- 2

Palpi long, equal in length to the proboscis. Scutellum rounded, never trilobed ---------------------- Anopheles

2. Terminal segments of abdomen rounded or blunt; Post spiracular area void of bristles --------------------------------------------- 3

Terminal segments of abdomen pointed, post spiracular area always clothed with long bristles -------------------------- Aedes

3. Spiracular bristles present; cross-veins of wing tending to be in line. Large species ------------------------------- Culiseta

Spiracular bristles absent, cross-veins of wings not tending to be in line. Moderate to small mosquitoes ---------------- Culex

Key to the Genera Using Structures of the Male Genitalia

1. Mesosome never bearing leaflets on its apical portion------ 2

Mesosome always bearing leaflets on the apical portion -------------------------------- Anopheles

2. Interbasal fold never giving rise to elongated structures termed claspettes ------------------------------------------ 3

Interbasal fold bearing claspettes -------------------------------- Aedes

3. Tenth sternite possessing a crown consisting of an armature of spines or comb-like teeth. Subapical lobe present -- Culex

Tenth sternite never possessing a crown bearing an armature of spines or comb-like teeth. Subapical lobe absent ----------------- Culiseta
Genus *Aedes* Meigen


The genus *Aedes* is characterized by the presence of post spiracular bristles. Absence of spiracular bristles and pulvilli absent or hair-like. Alar squama with fringe of hair complete. Antennae of the males always densely plumose with the last two segments being elongated. In the female the whorls are not dense, and all the segments are of equal length. The palpi of the male are usually as long as proboscis. However, in one species for the area the palpi are short. Prealar, sternopleural, and upper mesepimeral bristles are present, usually numerous. The lower mesepimeral bristles may or may not be present.

Key to Sub Genera of *Aedes* in Utah County Based on Male Characters

1. Palpi equal in length to the proboscis or longer

Palpi short, never reaching half the length of proboscis

*Aedes* Meigen

* This genus contains a great number of synonyms. Only those of importance are listed here.
2. Claspette with apex capitate, bearing a dense crown of spines; filament of claspette absent — Aedemorphus

Claspette with apex not capitate, never bearing a dense crown of spines; filament of claspette present — Ochlerotatus

Key to Species of Aedes using Female Characters

1. Some or all of tarsal segments ringed with white ————2

Tarsal segment never ringed with white ————7

2. Tarsal segment with white bands on both basal and apical ends of the segments ————3

Tarsal segments banded with white scales on basal portion of the segment only ————4

3. Wing scales uniformly mottled with black and white — campestris

Wing scales not uniformly mottled; black scales very predominant on third vein — dorsalis

4. Lower mesepimeral bristles present ————5

Lower mesepimeral bristles absent — vexans

5. Proboscis of female not banded with white ————6

Proboscis of female with white band near the middle — nigrumaculatus

6. Torus with white scales on dorsal half ———— fitichii

Torus without white scales on dorsal half — increpitus

7. Abdomen with broad basal bands of white scales forming a dorsal median white line on thorax. Wing scales coarse and large ———— niphadopsis

White basal scales of the abdominal segments not forming a medial white line ————8

8. Lower mesepimeral bristles absent ————9
Lower mesepimeral bristles present 10

9. Abdomen without a lateral white line sticticus
   Abdomen with a lateral white line cinereus

10. Mesonotum uniformly colored, usually without distinct lines or stripes cataphylla
    Mesonotum not uniformly colored; with distinct lines or stripes 11

11. Hypostigial spot of few to many white scales pullatus
    Hypostigial spot of scales entirely absent communis

Key to Males

1. Dystistyle articulated at the apex of basistyle cinereus
   Dystistyle articulated before the apex of the basistyle, furcate at base cinereus

2. Claspette, capitate, crowned with setae, filament absent vexans
   Claspette not capitate, never crowned with setae, filament present

3. Basistyle with both apical and basal lobes present increpitus
   Basistyle with apical lobe absent, basal lobe present nigromaculis

4. Basal lobe flat, elongate towards apical lobe increpitus
   Basal lobe not flat, not elongate towards apical lobe 5

5. Stem of claspette severely angulate near the middle, knee-like pallatus
   Stem of claspette not angulate or knee-like near the middle 6
6. Apical lobe with a group of stout, long hairs arising near its base; basal lobe conical ——cataphylla

Apical lobe without a group of stout, long hairs arising near its base; basal lobe may be of various shapes ——7

7. Filament of claspette as long or longer than the stem ——8

Filament of claspette not as long as the stem ——9

8. Lobes of the ninth tergite short; each bearing four or five short, stout spines ——stictious

Lobes of the ninth tergite large, closely approximate and stout; each lobe bearing eight to twelve stout spines ——niphadopsis

9. Filament of claspette distinctly notched at its base ——fitchii

Filament of claspette not distinctly notched at base ——10

10. Basal lobe semi-detached, with two stout spines. The larger spine arising near the base of the lobe, the shorter one more distal ——dorsalis

Basal lobe not semi-detached, with only one prominent spine ——11

11. Claspette stem with several large subapical setae. Apical lobe short, not produced finger-like ——campestris

Claspette without large subapical setae, apical lobe long, clothed with long setae on the dorsal surface ——communis
Genus ANOPHELES* Meigen


The genus Anopheles is characterized by the presence of long palpi in both sexes. The last two segments of the male are club shaped. Scutellum arcuate. Scutellum and abdomen without bristles, vestiture composed of hairs. Legs long and slender; pulvilli are absent. Male genitalia without apical lobes, or claspettes. Mesosome modified to a long, slender tube bearing leaflets on the apical end, (sub-genus Anopheles).

Key to the Species of Anopheles in Utah County using female characters

1. Mesonotum with a pale pruinose stripe, fading out anteriorly ------------ freeborni

Mesonotum without a distinct stripe, uniformly colored -------
---------- quadramaculatus

Key to the Species of Anopheles in Utah County using male characters

1. Lobes of the ninth tergite long, narrow, and rounded apically ---------------- freeborni

Lobes of the ninth tergite short, stout, and expanded at the apices ---------------- quadramaculatus

* Dyar in 1922 lists thirty-seven synonyms for this genus. Only those of importance are listed here.
Genus CULEX* Linnaeus


The genus Culex is characterized by the absence of spiracular bristles, post spiracular bristles, and the lower mesepimerals either lacking or reduced to one bristle. Pulvilli well developed and pad-like. Alar squama with complete fringe of hairs.

Key to the Species of Culex in Utah County using Female Characters

1. Proboscis ringed with white -------------------------tarsalis
   Proboscis never ringed with white ---------------------------2
2. Mesonotum vestiture of light-red, hair-like scales --erythrothorax
   Mesonotum vestiture golden; scales normal -----------------pipiens

Key to the Species of Culex in Utah County using Male Characters

1. Subapical lobe with eight appendages ------------------pipiens
   Subapical lobe with less than eight appendages -----------2
2. Subapical lobe with five appendages ------------------tarsalis
   Subapical lobe with six appendages ------------------erythrothorax

The genus *Culiseta* is characterized by spiracular bristles, with post-spiracular bristles absent. The second marginal cell over half as long as its petiole. Postnotum nude and the presence of postpronotal bristles characterize this genus. Usually they are large species, being considerably larger than the other mosquitoes of this region.

Key to the species of *Culiseta* in Utah County using

**Female Characters.**

1. Segments of the tarsi, especially those of the hind leg,
   1. banded with white ------------------------------- *incidens*
   2. Segments of the tarsi never banded with white ---------------2

2. Cross veins of wing with scales, wing scales and legs sprinkled with white scales ------------------------------- *inornatus*
   3. Cross veins without scales. Wings and legs usually not sprinkles with pale scales. ------------------------------- *impatiens*

Key to the species of *Culiseta* in Utah County using

**Male Characters**

1. Basistyle with apical lobe, spines of ninth tergite heavily chitinized -------------------------------2
Basistyle without apical lobe ---------------------- *inornatus*

2. Ventral of the eighth abdominal segment bearing fifteen to twenty strong setae, at least ---------------------- *impatiens*

Ventral lobe of the eighth abdominal segment never bearing more than eight strong setae, usually between five and eight ---------------------- *incidens*
DESCRIPTION OF SPECIES

Sub Genus Aedes

Aedes (Aedes) Cinereus Meigen


Female: Vestiture of mesonotum of reddish-brown scales. Lower mesepimeral bristles absent. Abdomen with either narrow partial or complete band, or with bands lacking. The lateral spots joined to form white line. Wing scales dark; coxa of front leg with white scales at top and a central patch of brown scales on the anterior surface.

Male: Palpi short as in the female; basistyle twice as long as wide, densely-haired on apex. Dististyle articulated before apex of basistyle, furcate at base. Apical lobe absent. Claspette modified; stem divided into two slender branches, the outer branch running along the basistyle, bearing two stout spines at apex. Inner branch shorter, ending in a stout spine with two smaller spines before the apex. Fig. (16).
Fig. (16). Aedes (Aedes) cinereus Meigen
Subgenus *AEDIMORPHUS* Theobald

*Aedes (A.) vexans* (Meigen)

**Female:** Occiput with patch of flat black scales bordering top edge of white lateral patch. Mesonotum clothed with bronzy-brown scales, paler at the base of the wings and around the antescutellar. Lower mesepimeral bristles absent. Abdomen with broad basal white bands which are centrally indented. Tarsal segments with narrow, basal white bands.

**Male:** Dististyle gradually expanding to apex, furcate; basistyle lacking both apical and basal lobes; twice as long as wide. Claspette without filament, capitate, crowned with short spines. Mesosome small and heavily chitinized; apex gnarled, more broad than base. Fig. (17).
Fig. (17). *Aedes (A.) vexans* (Meigen)
Subgenus OCHLEROTATUS Lynoh Arribalzaga

*Aedes* (O.) *campestris* Dyar and Knab


**Female:** Mesonotum yellowish-scaled with an undivided, broad, brown median line or strip. Tarsi ringed with white on both basal and apical ends. Wing uniformly mixed with black and white scales. This species is separated from *Aedes dorsalis* in that the latter has the third vein entirely, or at least predominantly, dark-scaled.

**Male:** Basistyle over twice as long as wide. Apical lobe small, rounded, and covered with long setae. Basal lobe rounded, convex, with a single large spine on the outer margin at the base with many small spines surrounding it; lobe densely covered with setae. Claspette stem with several long, apical setae; filament slightly expanded in the middle.

Fig. (18).
Fig. (18). *Aedes* (O.) *campestris* Dyar & Knab
Aedes (O.) cataphylla Dyar


Female: Integument of torus dark-brown or black on outer side. Sides of mesonotum gray around sides, middle with golden brown scales. Scutellum with pale yellow scales. Abdomen black with broad basal segmental white bands. Legs black with a mixture of pale scales; the tarsal segments almost completely black. White spot at the base of costa. Lower mesepimeral bristles variable.

Male: Basistyle more than twice as long as wide; apical lobe produced long and finger-like with two short spines on its dorsal area. Basal lobe more or less conical, with one stout spine on its margin and numerous stout setae. Claspette long, stem sickle-shaped, curving outward; filament broadly expanded in middle, pointed at its apex. Fig. (19).
Fig. (19). Aedes (O.) cataphylla Dyar
Aedes (O.) communis (De Geer)

Culex lazarensis Felt and Young, Science, n.s. vol. 20, p. 312, 1904.

Female: Mesonotum dull-yellow or gray scaled with a narrow, pale median line, separating paired darkbrown lines, and with posterior brown half-lines. Coloration variable. Abdomen dark-brown with basal white bands. Wings dark-scaled with a patch of two to many pale scales at base of costa. Femora partially pale scaled, legs otherwise dark.

Male: Filament of claspette shorter than the stem. Apical lobe prominent, clothed with long setae on the dorsal surface; very noticeable on the anterior end of the lobe. Basal lobe small, quadrilateral, somewhat detached at the base. Apical margin with a row of recurved spines, and a single stout spine arises near the base. Fig. (20).
Fig. (20). *Aedes* (O.) *communis* (De Geer)
Aedes (O.) dorsalis Meigen

Culex onondagensis Felt, Bull. 79, N. Y. State Mus., p. 278, 1904.

Female: Mesonotum creamy yellow, a diffused brown stripe in the middle of variable width and pattern; brown stripe on the lateral margins. Wing scales intermixed with white and black, vein three predominantly dark-scaled. Abdomen with white or yellowish scales apically, basally and dorsally on the segments reducing the black to paired quadrature spots; the quadrature spots becoming smaller as they proceed posteriorly, at times tergal region of abdomen may be completely yellow-scaled with the exception of one or two dark scales.

Male: Apical lobe short, rounded with long setae; basal lobe constricted at base and expanded apically with two stout spines on the margin. Claspette with a short spined stem with a slight constriction at the apex which bears two long setae and usually one shorter one; filament short, expanded beyond the middle, slightly shorter than the stem, ending in a recurved point. Fig. (21).
Fig. (21). Aedes (O.) dorsalis Meigen
Aedes (O.) fitchii (Felt and Young)


**Female**: Occiput yellowish-white with a dark part on each side. Mesonotum dark brown with a broad median line of light brown scales, or mottled with no distinct pattern. Wing scales evenly intermixed with black and white scales. Abdomen with broad, white basal bands; venter mostly pale-scaled. Tarsi with broad, basal white bands.

**Male**: Basistyle nearly three times as long as wide; apical lobe large, covered with stout setae; basal lobe prominent, bearing short and long setae which have the appearance of spines. Basal lobe triangular, clothed with numerous setae and one stout spine. Filament of claspspete distinctly notched at base. Fig. (22).
Fig. (22). *Aedes (O.) fitchii* (Felt & Young)
**Aedes (O.) inoreptus Dyar**


Female: Torus without white scales on the dorsal half. Halpbus without hairs on a narrow strip bordering the scale on the inner ventral edge of the apical segment, or with hairs near the apex of this strip only. Mesonotum (pattern very variable) gray, usually a narrow, median white line and at each side a narrow white line extending back on each side of antescutellar space. Abdomen black, broad basal segmental white bands widening at the sides. Wing scales dark, intermixed with white scales along costal margin. Legs black with many white scales; tarsi with white bands basally, most evident on hind tarsi.

Male: Basistyle two and one-half times as long as wide, with long hairs and scales on outer side. Apical lobe distinct, bluntly pointed with a few small setae. Basal lobe represented by a flat, rugose area bearing short setae. Claspette with a cylindrical stem longer than the filament. Filament expanded at the middle with an angular, tooth-like projection at its base. Fig. (23).

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Rees (1942) separated *Aedes stimulans* from *A. inoreptus* on the number of lower mesepimeral bristles. From the observations of this study it is known that the lower mesepimeral bristles as used by Rees would overlap for the species concerned. Approximately fifty per cent of the *A. inoreptus* examined during the course of this study showed a range of from 2-5 lower mesepimeral bristles. According to Rees *A. inoreptus* has two such bristles. In discussing this matter with Dr. Rees, he feels the separation by this basis to be of doubtful value. Further investigation by Mr. Fred Harmston and the author of the material in the University of Utah Collection indicates that the genitalia ascribed to *A. stimulans* appear to be *A. inoreptus*. In view of this information it would seem evident that the records of *A. stimulans* at the present time in Utah County and the State of Utah are erroneous.
Fig. (23). Aedes (O.) increpitus Dyar
Aedes (O.) nigromaculis (Ludlow)


Female: Proboscis singed with white medially, (this character is sufficient to separate this species from all other Aedes known so far in Utah County.) Mesonotum with a variable stripe of yellow scales; the lateral spots usually continuous with the brown sides. Abdomen black with basal segmental white bands and a median stripe of light yellow scales. Wing scales pale and dark, the dark scales predominating. Femora and tibiae partially pale-scaled; tarsi black with basal white bands. The last segment of the hind tarsus rarely all white.

Male: Basistyle twice as long as wide; apical lobe absent; basal lobe consists of a small flattened area with numerous, short, stout, setae. Claspette with a strong seta near outer end; filament narrow, as long as stem. Fig. (24).
Fig. (24). *Aedes (Q.) nigromaculis* (Ludlow)
Aedes (O.) miphadopsis Dyar and Knab


Female: Mesonotum vestiture gray, white-scaled around the margins, dark brown centrally, paired narrow dark line and white spots distinguishable posteriorly on a few specimens. Abdomen black with wide segmental, basal bands and scattered scales, forming a more or less well-developed median line; sometime the abdomen nearly all white. Wing scales large, coarse predominately black intermixed with white, especially on costa, first vein and bordering the veins first basal cell.

Male: Basistyle approximately three times as long as wide. Apical lobe elongated, conical, with a few outwardly-directed short setae. Basal lobe very small, bearing single, long marginal spine. Claspette with filament longer than stem, filament expanded in the middle. Lobes of the ninth tergite large, closely approximate and stout, each lobe bearing eight to twelve stout spines. Fig. (25).
Fig. (25). *Aedes (O.) niphadopsis* Dyar & Knab
Aedes (O.) pullatus (Coquillett)


Female: Torus with integument of outer side black to dark-brown. Mesonotum with yellowish-brown scales; a narrow bare median line parallel stripes of brown scales, each stripe bordered by a broader stripe with a few dark scales; with or without narrow, bare, curved posterior half line. Abdomen dark with broad basal segmental bands. Wing scales narrow, dark. Tarsi solid dark, without bands.

Male: Basistyle three times as long as wide; apical lobe prominent, numerous hairs on ventral surface; basal lobe small, with a large spine, at the apex of a small projection two short curved spines. Claspette with a long, stout stem, angled in the middle; the basal portion of the stem before the angle, stout and densely setose; beyond angle, stem slender and less setose; filament expanded before the middle and tapering to the apex. Fig. (26).
Fig. (26). Aedes (O.) pullatus (Coquillet)
Aedes (O.) sticticus (Meigen)


**Female:** Mesonotum yellowish-gray with two golden-brown stripes and posterior half-lines; the anterior stripes separated by a narrow median line of pale scales which is sometimes indistinct or absent. Lower mesepimeral bristles absent. Abdomen black with basal white bands widening at the sides. Wing scales dark, with or without a patch of pale scales on the base of the costa. Legs dark, occasionally with a scattering of pale scales; tarsi not banded.

**Male:** Basistyle approximately three times as long as broad; apical lobe long, rounded at the apex covered with short setae. Basal lobe prominent, conical, clothed with setae, a long, stout marginal spine surrounded by a tuft. Claspette stem stout, reduced near apex with a stout setae on the inner side at the place of constriction; filament short, expanded in middle. Dististyle short, slightly swollen in middle. Fig. (27).
Fig. (27). Aedes (O.) sticticus (Meigen)
Genus ANOPHELES Meigen

**Anopheles (Anopheles) maculipennis freeborni** Aitken* ¹


**Female:** Proboscis slender, dark brown to black. Palpi clothed with appressed brown to black scales. Mesonotum with a broad, grayish, pruinose, median stripe, the sides brown. Abdomen brown, the median area darker, clothed with numerous short, yellow hairs. Wing scales unicolored, thicker in area, thus producing dark spots. Apical end of femur and tibia may be tipped with pale white scales.

**Male:** Basistyle approximately one and a half times as long as wide at the base. Apical lobe absent, internal spine located just beyond the middle of the basistyle and directly inward. Dorsal lobe of claspette contains three stout spines in all the specimens examined in this study. Lobes of the ninth tergite long and rather sharply pointed. Fig. (28).


¹ Records of Anopheles quadrimaculatus say were reported from Utah County, Sept., 1910 by Dyar. Since this species has never been collected in this area since then, it seems evident that Anopheles maculipennis freeborni was confused with this species as these two species are inseparable in the larvae or adult females. Separation at the present time depends upon the characters of the dorsal lobe of the claspette. In A. quadrimaculatus, the dorsal lobe of the claspette bears two spines.
Fig. (28). *Anopheles (Anopheles) maculipennis freeborni* Aitken
Culex (C.) erythrothorax Dyar


Female: Medium sized reddish-brown mosquito. Mesonotum vestiture of fine, hair-like golden-red scales; scales on scutellum and on antescutellar space paler. Pleura and coxae reddish-brown.
Abdomen brownish-black with irregular, basal bands composed of light yellow scales. Tarsi unbanded.

Male: Medium-sized basistyle more than twice as long as wide at the base, base deeply hollowed. Subapical lobe bears three rods, a leaf, a filament, and a small seta. Tenth sternite pointed, clothed, with a dense mass of pointed spines, ventral arm of mesosome elongate, pointed, without teeth; dorsal plate stout with five or six teeth and a basal one directed cephalad.

Fig. (29).
Fig. (29). *Culex (C.) erythrothorax* Dyar
Culex (C.) pipiens Linnaeus*


Female: Medium-sized species. Scutum brown, covered with golden lanceolate scales. Abdominal bands broadly joined to the lateral basal white patches. Tarsi unbanded. Wing scales narrow and hair-like, entirely dark.

Male: Basistyle more than twice as long as wide at base. Subapical lobe bearing eight processes, a seta, a leaf, a flattened seta, two setae and three rods. Tenth sternite ending distally in a crown of rather stout spines. Mesosome is a paired structure joined at base. The ventral arm of each plate large, wing-like, curved outwardly, and tapered to a point; dorsal arm of each half long, slender, straight and usually bluntly rounded at the tip, directed posterio-laterally and obliquely crossing over the lateral extension of the ventral arm. Lobes of the ninth tergite widely separated, each bearing numerous setae. Fig. (30).

Fig. (30). *Culex (C.) pipiens* Linnaeus
Culex (C.) tarsalis Coquillett

Culex willistoni Giles, Handb. Gnats or Mosq., p. 281, 1900.

Female: A medium-sized mosquito, the mesonotum bronzy-brown scaled, frequently ornamented with narrow silvery-white line each side of the posterior portion, running back to the scutellum. The abdomen is black to brown, with moderate basal segmental white bands, venter white-scaled, with "v" lines of dark brown scales. Proboscis dark, with a white ring near the middle. Legs brown, the femora with narrow white lines on both the dorsal and ventral surface. Tarsi with apical and basal white bands.

Male: Coloration similar to that of the female, but with some abdominal white scaling more extensive. Ninth tergite slightly raised, separated by about the width of one lobe, each bearing several setae. Tenth sternite crowned with numerous short spines, the outer bristles blunt, the inner ones sharply pointed. Mesosome divided, each half heavily solerotized, platelike. Each plate basally with a long, pointed dorsal arm, directed posteriorly and nearly reaching the crown of the tenth sternite, the ventral arm is located apically on the plate, curved outward and nearing the crown of the tenth sternite in length, arising laterally near the base of the ventral arm are several stout pointed teeth.

Fig. (31).
Fig. (31). Culex (C.) tarsalis Coquillet
Fig. (31b) Culex tarsalis tenth sternite and mesosome.
Genus CULISETA Felt

Culiseta (Culiseta) inornata (Williston)

Culex magnipennis Felt, Bull. 79, N. Y. State Mus., p. 278, 1904.

Female: A very large brown mosquito with the proboscis and palpi brown. Mesonotum with two pale, slightly impressed lines, and a posterior, bare stripe each side of the antescutellar space. Vestiture of narrow, curved, golden-brown scales intermixed with pale yellow scales. Abdomen brownish-black with broad basal bands of rather white scales. Wing scales dark brown, intermixed with white scales along the costal area. Legs dark brown, intermixed with white scales. Tarsi not banded.

Male: Apical lobes absent, basal lobes well represented. Lobes of the ninth tergite dome-like with heavily chitinized, dark, stout spines. Mesosome elongate, broadened at the base, open along the ventral and dorsal sides. Basistyles stout, and conical. Fig. (32).
Fig. (32). Culiseta (Culiseta) inornata (Williston)
**Culiseta (C.) impatiens (Walker)**


**Female:** A very large dark brown mosquito. Proboscis and palpi black. Mesonotum with two broad impressed lighter brown lines, the vestiture sparse, forming frosted yellow line on each side posteriorly. Abdomen black with basal white bands, venter almost completely white. Wings and legs not sprinkled with white scales; cross veins not scaled. Femora white tipped.

**Male:** Basistyle stout. Apical lobe prominent, strongly chitinized, and densely clothed with hairs and two or three more thick ones which almost have the appearance of spines. Basal lobe large, expanded, setose, with a stout hair at the apex. The apical ventral portion of the eighth abdominal segment bears on its median area a row of fifteen to twenty short, stout spines.

*Rees (1942) lists this species as "fairly common". During the course of this study only 3 females were collected. In the examination of the *Culiseta* impatiens in the University of Utah collection, a number of the specimens taken in Aspen Grove and Provo Canyon exhibited cross veins with scales. The wings with white scales intermixed along the costal margin, and legs also exhibited the sprinkling of white scales. In that these characters are to separate *Culiseta inornata* from *C. impatiens*, it seems evident there has been some confusion in classifying these two species.*
Fig. (33). *Culiseta (C.) impatiens* (Walker)
**Culiseta (C.) incidens (Thomson)**


**Female:** A large dark mosquito with spotted wings. Mesonotum with uniform pattern, without impressed line. Vestiture dark, mixed with yellow-white scales which form diffuse longitudinal lines and a spot on each side. Abdomen black, with basal segmental white bands. Femora tipped with white, also in the specimens for this area. I have found, in addition, a sub-apical patch of scales on the dorsal surface of the femur. Some tarsal segments marked with very narrow basal white bands.

**Wings spotted.**

**Male:** Basistyle more than twice as long as wide. Apical and basal lobes present; apical lobe bearing a narrow ligulate, along spine and a number of setae, basal lobe sharply conical, bearing two approximate, stout spines on the apex. Lobes of the ninth tergite short, chitinized and each bearing a row of long setae. Eighth abdominal segment bears a group of from five to eight short, stout spines on the median ventral margin.

*Fig. (34).*
Fig. (34). *Culiseta (C.) incidens* (Thomson)
BIOLOGY AND DISTRIBUTION OF SOME OF THE COMMON SPECIES OF MOSQUITOES IN UTAH COUNTY

As indicated by the taxonomic study, Utah County is represented by four genera of mosquitoes. These genera vary widely in their biology and distribution as they relate to each other and to various species within each genus.

Laying Habits:

_Culex_ and _Culiseta_ deposit their eggs in small, boat-shaped rafts on the surface of the water. The deposition of eggs occurs usually in the late spring (_Culiseta_ at times is found earlier) through the late summer producing several _broods_ per season. _Anopheles_ lays the eggs singly, from early to late summer. _Aedes_ deposits the eggs individually in moist places which later fill with water, or around the edges of the breeding area on the grass and other vegetation. _Aedes_ eggs must undergo a period of desiccation after being laid before becoming viable. Mail* and many other workers have found that the egg of the mountain species of this genus must also undergo a prolonged period of exposure to sub-zero temperatures in addition to the desiccation period. Due to this specialization, the mountain species of _Aedes_ produce but one _brood_ per year. The eggs of _Aedes_ can withstand long periods of unfavorable circumstances. Rees¹ has shown that the eggs of _Aedes_

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dorsalis are viable after three years of desiccation.

Hibernation:

All the species of Anopheles, Culex and Culiseta of this area pass the winter as fertilized females.* These hibernating forms emerge at variable times during the spring of the year. All the species of Aedes pass the winter in the egg stage which were laid during the previous summer.

Mating Habits:

Numerous observations were made of Culiseta inornata in the laboratory. Within twenty-four hours after they emerged from the pupal case, males and females were observed in copulation. The specimens observed in the process of copulation remained in tandem for usually two hours. However, one pair was observed which remained in copulation for six hours. The females would occasionally fly about in the rearing bottle, pulling the males behind them. Males of Aedes increpitus were observed (May 2, 1946) hovering approximately seven to eight feet above the ground over low shrubs. Females would dart into the "cloud" of males and come out in tandem with a male.

Time of activity:

Species of Aedes and Culex are active during most times of the day from early sunrise to late in the evening. Anopheles have never been observed before dusk unless the weather was extremely cloudy.

Food Habits:

The species of *Aedes*, *Anopheles* and *Culex* feed with avidity on man and other mammals. *Culiseta* will feed occasionally on man, but prefers a blood meal from other mammals. The food habits of mosquitoes have caused much discussion as to the effect they produce upon egg production. In the laboratory various workers* have been able to produce viable eggs from certain species without a blood meal. However, it has been found that in those cases where fertile eggs were obtained without a blood meal, the colony could not maintain itself over a long period of time. This information indicates that in nature a blood meal is required before fertile eggs can be laid which have the possibility to reproduce generation after generation.

During February of this year (1947) one hundred female specimens of *Anopheles maculipennis freeborni* were collected in hibernation, fifty specimens being placed in each of two containers. The mosquitoes in container one were fed on boiled raisens and the mosquitoes in container two being allowed to feed on the writer's arm at intervals of three days. After one week, no eggs were received from either group. The mosquitoes in container two were given another blood meal and then placed individually in half-pint jars with wet filter paper on the bottom of each respective jar. Three days after this isolation,

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* Trembly, Helen S., personal communication.
two females had oviposited. Thus within nine days and three
blood meals, the first eggs were obtained. By the sixteenth day,
and the fifth blood meal since capture, twenty-five, or fifty per
cent of the "blood feeders", had laid eggs. Further attempts to
induce the remaining mosquitoes of this group to lay eggs failed.

Counting the total number of eggs laid by each female, it
was determined that average number per female which laid eggs was
thirty-nine. Within forty-eight hours after deposition, approxi-
mately 87.5% of the eggs hatched.

By the sixteenth day, the mosquitoes from container one had
laid no eggs. At this time, they were allowed to have their first
blood meal; on the eighteenth day they were allowed a second blood
meal, and on the nineteenth day, approximately one hundred eggs
were found in the container; of which 60% hatched within forty-
eight hours. During the next twenty-four hours the mosquitoes
died, due to the inability to control the temperature. From this
data, it would seem that a blood meal is required before Anopheles
maculipennis freeborni Atiken will lay viable eggs.

**DISTRIBUTION**

*Aedes (A.) cinereus* Meigen


The one collection of *Aedes cinereus* in Pole Canyon con-
sisted of two females captured by sweeping the grass. The
elevation was approximately 7000 ft. This species is evidently
rare in Utah County, and thus is of no importance, especially
since it produces one brood per season.

_Aedes (A.) vexans (Meigen)_

6-15-30 Springville, Utah (Rees)
5-14-46 Hobble Creek Canyon, Ut. Co., Ut.
6-21-46 Provo City, Utah Co., Ut.
8-13-46 Provo City, Utah Co., Ut.
8-26-46 West Fields, Springville, Ut.
8-29-46 West Fields, Springville, Ut.

_Aedes vexans_ is a common species, occurring throughout the valley floor in clear water pools of a temporary nature. The many instances the pools were formed by irrigation water. In the light trap collections from the middle of July until the end of September, 1946, this species ranked second to _Culex tarsalis_ for the greatest number collected. This species is one of the most abundant mosquitoes in Utah County, and during the latter part of the summer, is of major importance as a pest mosquito. During the summer, in field observations, this species exhibited the ability to complete the cycle from egg to adult within six days.

_Aedes (O.) campestris_ Dyar

4-17-47, Springville, Ut. Co., Ut.

_Aedes campestris_ is found in the valley and foot-hill regions of Utah County. It is very often found in association with _Aedes dorsalis_. One brood per year is produced, usually in the early spring.

This species has never been taken in sufficient numbers to
constitute a pest condition of any importance.

**Aedes (O.) cataphylla** Dyar

4-16-47, Left hand fork, Hobble Creek Canyon, Ut. Co., Ut.

*Aedes* cataphylla is considered as a mountain species and produces but one brood per year. According to Rees*, this species is never found below 7,500 feet in heavily timbered areas. The collection at Oak Springs was at valley level in an open grass pasture, fully exposed to the sun, in association with larvae of *Aedes* increpitus.

**Aedes (O.) communis** (De Geer)


This species was collected near Balsam Park at an elevation of approximately 6,000 feet in a densely wooded area, and was associated with *Aedes* increpitus and *Aedes* fitchii. In that it has never been collected in any abundance in the County before, it would not seem to be of any great importance as a pest, especially since it produces only one brood per season.

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Fig. (35).

Aedes cinereus 
Aedes vexans 
Aedes campestris
Aedes cataphylla
Aedes (O.) dorsalis (Meigen)

4-25-46 Rock Island, Utah Lake, Ut. Co., Ut.
5-8-46 Goshen, Ut. Co., Ut.
7-14-46 Provo, Ut. Co., Utah.
4-17-47 Springville, Ut. Co., Utah.
4-17-47 Mouth of Provo River, Ut. Co., Utah.

Aedes dorsalis is one of the most abundant mosquitoes at lower elevations within the county, and is also one of the earliest forms to appear in the spring. This species produces numerous broods throughout the season. In one area which was flooded with irrigation water every two weeks throughout the summer, six broods were observed.

The larvae of Aedes dorsalis has been collected in many different types of aquatic environments. These habitats range from clear irrigation water to pools of water in which the alkali content was very concentrated, giving the water a white color.

A. dorsalis attacks man and other mammals with great vigor. With the tremendous numbers of this species occurring in the area between the present cities and the lake region, development of this area will be slow until proper control methods have been instituted.
Aedes (O.) fitchii (Felt)

4-16-46 Big Hollow, Mapleton, Utah
4-18-47 Left hand fork, Hobble Creek Canyon, Utah Co., Ut.

Aedes fitchii is usually considered to inhabit the mountains at lower levels in the more densely wooded sections. This species was found in larval associations with A. increpitus and A. pullatus. This species produces but one brood per year, and will attack man and other mammals in its habitat. However, it has never been found in any considerable numbers and for this reason, is of no importance in Utah County.

Aedes (O.) increpitus Dyar

4-16-46 Big Hollow, Mapleton, Ut. Co., Ut.
5-12-46 Oak Springs, Mapleton, Ut. Co., Ut.
5-12-46 Maple Canyon, Mapleton, Ut. Co., Ut.
2-26-47 Big Hollow, Mapleton, Ut. Co., Ut.
3-16-47 Big Hollow, Mapleton, Ut. Co., Ut.
4-12-47 South fork, Provo Canyon, Ut. Co., Ut.
4-16-47 Big Hollow, Mapleton, Ut. Co., Ut.
4-18-47 Left hand fork, Hobble Creek Canyon, Ut. Co., Ut.

Aedes increpitus produces one brood per year and is found in great abundance in the mountains at low levels, although at times it may extend into the valley. This species is one of the most important pest mosquitoes in the areas where it occurs in Utah County. The larvae have been collected during the first part
of February when ice covered the surface to a depth of one-quarter of an inch. A. incruptus attacks man with vigor, and apparently is long-lived as two females were collected July 15, 1947 in a light trap two miles from any known breeding area for this species. This mosquito is of considerable annoyance to summer resorts in the lower mountain elevations.

*Aedes (Q.) nigromaculis* (Ludlow)

7-14-46, Big Hollow, Mapleton, Ut. Co., Utah.

One specimen of *Aedes nigromaculis* was collected at the above area. According to Rees, this species produces a number of broods, throughout the season, in the main valleys. Due to the rarity of this mosquito it is not of importance in this area.

*Aedes (Q. niphadopsis* Dyar

4-20-47 Chimney Rock Pass, Ut. Co., Utah (Lowell S. Miller)

*Aedes niphadopsis* produces but one brood per year. The breeding habitats usually being found in small bodies of water in the foot-hill regions of the mountains. Apparently this species may breed in very arid situations as the adult mosquitoes have been collected in great numbers where little or no water is found. It is a vicious biter, attacking at any time during the day. *A. niphadopsis* was found resting in Juniper trees and on the sagebrush *Artemisia*. *A. niphadopsis* is of serious importance in the
Fig. (36).

Aedes communis

Aedes dorsalis

Aedes fitchii

Aedes increpitus

Aedes pallipes produces eggs where it occurs.

Aedes pallipes produces eggs in the mountains at elevations above 8,000 feet, however, it is occasionally found in the valleys.

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areas where it occurs.

**Aedes (O.) pullatus (Coquillett)**

- 6-30-35 Payson Canyon, Ut. Co., Ut.
- 4-18-47 Left hand fork, Hobble Creek Canyon, Ut. Co., Ut.
- 4-26-47 Payson Canyon, Ut. Co., Ut.

*Aedes pullatus* produces but one brood per year, usually in the mountains at elevations approximately 7,000 feet. However, it is occasionally found at the low mountain elevations.

This species was found in association with *A. incropitus* and *A. fitchii*. In the high mountain areas where it does occur, this species is considered to be a serious pest for approximately three weeks.

**Aedes (O.) sticticus (Meigen)**

- 4-30-35 Ironton, Ut. Co., Utah.

*Aedes sticticus* supposedly occurs in the mountains along the margins of the larger streams according to Rees.* This species was never collected by the author.

**Anopheles (A.) maculipennis freeborni Aitken**

- 3-12-46 Springville, Ut. Col, Ut.

Fig. (37).

Aedes nigromaculis = 1
Aedes niphadopsis = 2
Aedes pullatus = 3
Aedes sticticus = 4
Anopheles maculipennis freeborni produces numerous broods from June until the latter part of September if weather conditions are favorable. This species breeds in throughout the valley in clear water pools of a more or less permanent nature. When colder weather sets in, it is found in abundance in basements, cellars, barns and other similar establishments as the cooler weather progresses. The adults are found in hibernation in the fruit cellars in close approximation to the mountains in great numbers. Usually they are found attached to old spider webs. Within this region A. m. freeborni is of importance as a pest mosquito. Due to the short season, and the hot dry period during the middle of the summer, which inactivates the adults a good deal, this species possibly never will be of importance as a malarial vector in this area. It is found in greatest numbers during the first part of September.
Anopheles maculipennis freeborni

This species is of importance in large numbers.
Culex (C.) erythrothorax Dyar

8-10-46 Springville, Ut. Co., Utah.
9-12-46 Springville, Ut. Co., Utah.

Culex erythrothorax was collected by means of a light trap, in which it never was found, except as an occasional specimen. This species is not of importance as it was never encountered in large numbers.

Culex (C.) pipiens Linnaeus

9-16-46 Springville, Utah Co., Utah.

Culex pipiens was collected in the light trap as was C. erythrothorax. This species has never been found in the county by other methods of collection. Due to the few times it was encountered, it is not considered to be of importance in this area.

Culex (C.) tarsalis (Coquillett)

4-16-46 Big Hollow, Mapleton, Utah Co., Utah
5-13-46 Vivian Park, Provo Canyon, Ut. Co., Utah
6-22-46 Hobble Creek Canyon, Ut. Co., Ut.
6-29-46 Left hand fork, Hobble Creek Canyon, Ut. Co., Ut.
7-14-46 Big Hollow, Mapleton, Ut. Co., Ut.
Fig. (39).

Culex erythorhorax

Culex pipiens

Culex tarsalis
Culex tarsalis produces many broods per season throughout Utah Valley and in the mountains up to 7,500 feet. This is perhaps one of the most abundant species found in Utah County, and can adjust to many different types of breeding habitats. The larvae have been found in association with *Aedes dorsalis*, *Culiseta incidens*, *C. inornata*, and *Anopheles freeborni*.

*Culex tarsalis* has been found naturally infected with *St. Louis encephalitis* and the western strain of equine encephalomyelitis*. In view of this and its great numbers, and range of habitats, this is perhaps the most important mosquito in the valley, both from an economic as well as a medical point of view.

*Culiseta (C.) impatiens* (Walker)


*Culiseta impatiens* is not of any importance in this area, as it was encountered only occasionally in the mountains at elevations of approximately 7,000 ft.

*Culiseta (C.) incidens* (Thomson)

5-18-46 Head of Pole Canyon, Ut. Co., Ut. 8000 ft.
6-29-46 Left hand fork, Hobble Creek Canyon, Ut. Co., Ut.

Fig. (40).

Culiseta impatiens
Culiseta incidunt
Culiseta inornata
any other time in this study. *Culiseta inornata* is of considerable importance as a pest of domesticated livestock.

**SUMMARY**

During the course of this problem, it is felt that the following information has been presented to substantiate the objectives presented in the beginning of this thesis.

From the taxonomic study it was found that four genera of mosquitoes was present in Utah County, with a total of nineteen species, twelve of which were *Aedes*, three *Culex*, three *Culiseta*, and one *Anopheles*. Eleven of these species are new records for the County, which are listed as follows: *Aedes campestris*, *Aedes cataphylla*, *Aedes cinereus*, *Aedes communis*, *Aedes fitchii*, *Aedes increpitis*, *Aedes nigromaculis*, *Culex erythrothorax*, *Culex pipiens*, *Culiseta impatiens*, *Culiseta incidens*. Taxonomic keys have been constructed for the genera of mosquitoes of Utah County and for the three sub-genera of the genus *Aedes*. No taxonomic keys were made for the sub-genera of *Anopheles*, *Culex* and *Culiseta*, as each genus was represented by one sub-genus. Taxonomic keys were made for the species of each genus, using both male and female characters. Throughout this phase of the study, emphasis was placed on the male genitalia, of which an illustration is presented of each species.

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In the distribution study, records were extended for all species previously reported by other workers. With the exception of one species, the above mosquitoes listed as new for the County conformed in distribution with records from other areas. *Aedes cataphylla* was taken at 4,500 feet in an open grass pasture. Rees* lists this species as usually occurring above 7,500 feet in the wooded sections of the mountains.

From the data presented by the experiment with *Anopheles maculipennis freeborni*, it seems evident that this species must have a blood meal before it can be induced to oviposit.

Mating habits of *Aedes increpitus* was observed in the field. Observations were also made of *Culiseta inornata* in the laboratory.

From the medical and economic standpoint, the evidence presented in this study suggests that the economic standpoint is more important than a medical one. Many areas within the county will not be developed until adequate mosquito control measures are instituted.

*Culex tarsalis* is the most important mosquito in Utah County from an economic as well as a medical viewpoint.

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