VII. Mosquitos — Culicidae

1. PARASITES

VIRUSES

Polyhedrosis virus ?

Aedes sierrensis and *Anopheles freeborni* (inclusion bodies similar in appearance to those described below) (Kellen, Clark & Lindegren, 1963).

Culex tarsalis (larvae variously distorted, developing adult structures partially destroyed or malformed; death occurs in 4th instar, which exhibits shiny black cuticular spots and intranuclear tetragonal inclusion bodies; laboratory transmission achieved) (Kellen, 1961; Kellen, Clark & Lindegren, 1963).

Culicines and anophelines (Del Guercio, 1926, 1929).

Virus with nonpolyhedral inclusion bodies ?

Anopheles subpictus (intranuclear inclusions occur in the midgut of the larvae) (Das Gupta & Ray, 1954, 1957).

Entomococcus [1] *anopheliperda*

Anopheles sp.; *Culex* sp. (Del Guercio, 1929).

E. berlesianus

Anopheles hyrcanus; *A. superpictus*; *Culex* sp. (will infect from egg to adult) (Del Guercio, 1929).

RICKETTSIAE

Rickettsia culicis

Culex pipiens fatigans (appears as small granules 0.6 μ in diameter or bipolar rods 1 μ in length; there is destruction of stomach epithelial cells in the adult mosquito) (Brumpt, 1938b).

Rickettsia sp.

Aedes aegypti (masses of rickettsiae in lumen and epithelial cells of hind gut of adult) (Sellards & Siler, 1928)

A. aegypti (Moutoussis, 1929).

Culex pipiens (in oesophageal diverticula) (Nöller, 1920).

C. pipiens fatigans (rickettsiae present are probably symbiotic) (Micks et al., 1961).

Wolbachia pipientis

Small and large coccoids and thin rods are present; the gonads of both sexes and occasionally the cells of the Malpighian tubules of adults are infected; there is limited pathological damage. The rickettsiae are transmitted via the eggs.

Culex pipiens (Hertig, 1936; Hertig & Wolbach, 1924).

C. pipiens; *C. pipiens molestus* (Bates, 1949).

C. pipiens molestus (=*C. autogenicus*) (Callot, 1950).

BACTERIA OTHER THAN SPIROCHAETALES

Bacteria affect mosquitos in a number of ways. Some (e.g., *Pseudomonas aeruginosa*) cause mortality or damage in the larval stage by their adventitious presence in very large numbers and the production of toxic substances. Others cause a scum at the water surface that results in the death of immature mosquitos (Ejercito, 1935). A few species (e.g., *Leptothrix buccalis*) are said to be true pathogens and to cause the host's death, but there are more records concerning apparently harmless species or symbiotes. Much more work needs to be done before the effects of bacteria on mosquitos can be properly assessed.

Bacillus cereus

Aedes aegypti (causes surface scum and death of larvae) (Jenkins, 1960).

Bacillus (of Loutraz)

Anopheles claviger (=*A. bifurcatus*) (5%-79% infected); *A. maculipennis* (very virulent for larvae) (Garin, 1918).

B. subtilis

Anopheles maculipennis (caused " epidemic " in hibernating mosquitos) (Eugling, 1921).

Culex sp. (died in 2nd instar, or before, when cultured in bacterial media; a toxic substance may have been given off by large numbers of the bacteria (Hinman, 1930).

B. thuringiensis

Aedes aegypti (large quantities required for control) (Liles & Dunn, 1959).

[1] Although *Entomococcus* has been claimed to be a polyhedral virus, it seems likely that it is either another organism or an artefact (Steinhaus, 1949b). Del Guercio (1929) claimed that it is a parasite which occurs only in mosquitos, that its species can infect any stage from egg to adult, and that they destroy *Plasmodium* in these insects. *E. anopheliperda* may also have been observed by Grassi.

Bacillus thuringiensis (continued)

Aedes nigromaculis; *Culex tarsalis* (Kellen & Lewallen, 1960).

Bacterium acidophilus stegomyiae

Aedes aegypti (larvae) (Jettmar, 1947; Legendre, 1910).

Bacterium (near *Leptothrix*)

Anopheles maculipennis (in coelom of larvae and pupae) (Jettmar, 1947).

Eberth's bacillus

Aedes mariae (=*A. zammitti*) (Theobald, 1903).

Culiseta longiareolata (Pringault, 1921b).

Escherichia coli

Culex sp. (died in 2nd instar, or before, when cultured in bacterial media; a toxic substance may have been given off by large numbers of the bacteria (Hinman, 1930).

Flavobacterium esteroaromaticum

Aedes aegypti (presence of large number in rearing medium causes death of larvae) (Jenkins, 1960).

Leptothrix buccalis

Anopheles maculipennis (infects larvae, passes into pupae, and destroys adult soon after emergence) (Keilin, 1921; Perroncito, 1900).

Micrococcus melitensis

Aedes mariae (=*A. zammitti*) (Theobald, 1903).

Culiseta longiareolata (Pringault, 1921b).

Pseudomonas aeruginosa

Toxic products of this organism rapidly killed mosquito larvae (Rozeboom, 1935).

Pseudomonas fluorescens

Anopheles maculipennis larvae killed (Rahmanova, 1937).

Culex sp. (died in 2nd instar, or before, when cultured in bacterial media; a toxic substance may have been given off by large numbers of the bacteria) (Hinman, 1930).

Serratia marcescens (=*Bacterium prodigiosum*)

Culex apicalis (Boženko, 1936).

Siderocapsa treubi

Larval epibionts on several species of mosquito; no lethal or other effects reported (Laird, 1959b).

Sphaerotilus dichotomus and *S. natans*

Larval epibionts on many species of mosquito; among the combination of factors causing larval mortalities in nature in heavily polluted situations (Laird, 1959b).

Staphylococcus albus

Culex sp. (died in 2nd instar, or before, when cultured in bacterial media; a toxic substance may have been given off by large numbers of the bacteria) (Hinman, 1930).

Streptococcus margaritaceus

Larval epibionts; no lethal or other effects reported (Laird, 1959b).

Sulfur and iron bacteria

Aedes punctor (occurred as larval ectophytes; caused neither damage nor mortality) (Jenkins & Knight, 1950).

Penetrate larval cuticle and infest epithelial chitin-producing cells, causing death before pupation) (Jettmar, 1947; see also Laird, 1959b).

Zoogloea ramigera

Larval epibionts; among the combination of factors causing larval mortalities in nature in heavily polluted situations (Laird, 1959b).

SPIROCHAETALES

Spirochaetes of species not known to be transmissible to vertebrates have been found in a number of species of mosquito, but no pathological damage of significance has been reported. In this connexion, though, it might be noted that a spirochaete causing production of all-female progeny occurs in several closely related species of *Drosophila*, suggesting interesting control possibilities (Malogolowkin, Carvalho & da Paz, 1960).

Borrelia culicis

Anopheles hyrcanus; *A. kochi*; *Culex fuscanus*; *C. gelidus*; *C. mimulus*; *C. tritaeniorhynchus summorosus* (Laird, 1959b).

Anopheles labranchiae atroparvus; *Anopheles* sp. (in larvae; in salivary glands of females—no harmful effects) (Sinton & Shute, 1939).

Anopheles maculipennis (larvae) (Sergent & Sergent, 1906).

Culex sp. (gut of larvae and Malpighian tubules of adults) (Jaffé, 1907).

Culex sp. (Malpighian tubules of adults) (Christophers, 1952).

Borrelia sp.

Aedes aegypti (Noc & Stévenel, 1913).

Anopheles funestus (Masseguin & Palinacci, 1954).

Culex nebulosus (Taylor, 1930).

Culex pipiens (Schaudinn, 1904).

C. pipiens (adults); *Culiseta longiareolata* (=*C. spathipalpis*) (larvae and pupae) (Sinton & Shute, 1939).

C. pipiens fatigans (adults) (Christophers, 1952).

FUNGI

(1) PHYCOMYCETES

BLASTOCLADIALES

Coelomomyces

Fungus with (usually) oval sporangia 18μ-127μ long and 10μ-65μ in diameter surrounded by a thick yellowish wall. The mycelium apparently lacks a true cell wall, the non-septate hyphae being rather easily overlooked in early infections prior to sporangium formation. Infection may become evident in 1st-instar larvae, and sporangia attain full development in 3rd and 4th instars. Infected larvae rarely develop into adult mosquitos and nearly always die before pupation. Egg development is inhibited in parasitized adult females.

Coelomomyces africanus

See Laird (1956a, 1959b) and van Thiel (1954).

Anopheles funestus (Africa); *A. gambiae* (Africa) (=*A. costalis*) (Haddow, 1942a; Walker, 1938).

Anopheles hancocki (stated to appear identical to Walker's type 2) (Africa) (Lewis, 1956).

Anopheles squamosus (Madagascar) (Couch & Umphlett, 1963).

C. anophelesicus (=*C. anophelesica*)

Anopheles annularis (India); *A. subpictus* (India); *A. vagus* (India); *A. varuna* (India) (Iyengar, 1935, 1962).

C. ascariformis [1] (includes Walker's type 4)

Anopheles gambiae (Africa) (van Thiel, 1954; Walker, 1938).

Anopheles tesselatus (Philippine Islands, from a record of Manalang, 1930) (van Thiel, 1954).

C. bisymmetricus

Anopheles crucians (USA) (Couch & Dodge, 1947).

C. cairnsensis

Anopheles farauti (Australia) (Laird, 1956a).

C. cribrosus (includes Muspratt's type b)

Anopheles crucians (USA); *A. punctipennis* (USA) (Couch & Dodge, 1947).

Culex fraudatrix (North Borneo) (Laird, 1959b).

Culex tritaeniorhynchus summorosus (North Borneo, Singapore) (Laird, 1959a,b).

C. dodgei

Anopheles crucians (USA) (Couch, 1945; Couch & Dodge, 1947).

C. finlayae

Aedes (*Finlaya*) *notoscriptus* (Australia) (Laird, 1959b).

C. grassei

Anopheles gambiae (North Chad, Africa) (Rioux & Pech, 1960).

C. indicus (=*C. indiana*) (includes Muspratt's type a)

Aedomyia catastica (Australia); *Anopheles farauti* (Australia) (Laird, 1956a).

Anopheles aconitus (India); *A. annularis* (India); *A. barbirostris* (India); *A. jamesii* (India); *A. nigerrimus* (India); *A. ramsayi* (India); *A. subpictus* (India); *A. varuna* (India) (Iyengar, 1935, 1962).

Anopheles funestus (Africa); *A. gambiae* (Africa); *A. rivulorum* (Africa); *A. rufipes* (Africa); *A. squamosus* (Africa) (=*A. pretoriensis*); *Culex simpsoni* (Africa) (Muspratt, 1946a,b).

Anopheles farauti (Australia); *A. subpictus* (Cambodia) (Laird, 1959b).

Anopheles vagus (India) (Couch & Umphlett, 1963).

C. keilini

Anopheles crucians (USA) (Couch & Dodge, 1947).

C. lativittatus

Anopheles crucians (USA) (Couch & Dodge, 1947).

Anopheles earlei (USA) (Laird, 1961).

C. macleayae

Aedes (*Macleaya*) sp. (Australia) (Laird, 1959c).

C. pentangulatus

Culex erraticus (USA) (Couch, 1945; Couch & Umphlett, 1963).

C. psorophorae [2]

Aedes taeniorhynchus (USA) (Lum, 1960, 1963).

Aedes vexans (USA) (Couch & Dodge, 1947; Laird, 1961); (Czechoslovakia) (Weiser & Varra, 1964).

Culiseta inornata (USA) (Couch & Dodge, 1947).

Culiseta inornata (Canada) (Shemanchuk, 1959).

Culiseta morsitans (USA) (Laird, 1961).

Psorophora ciliata (USA) (Couch, 1945; Laird, 1961).

[1] Professor J. N. Couch (personal communication), like Laird (1959c), considers this species of doubtful status. It is impossible to tell from the information given by Manalang (1930) whether the sporangia he found bore longitudinal ornamentation of the *indiana* or *lativittatus* type, but in any case they were very distinct from the "type 4" of Walker (1938). It is suggested by Professor Couch that the latter—material from Malayan *Anopheles kochi* sent to him by Walker in 1953—and the North Borneo and Singapore material referred by Laird (1959a,b) to *C. cribrosus* (see above), may all belong to an as yet undescribed species only superficially resembling *cribrosus*.

[2] Couch (1963) gives additional but queried host records, and indicates that re-examination of material from the range of certain hosts for *C. psorophorae* reveals that this species exists in a number of distinct varieties.

Coelomyces psorophorae (continued)

Psophora howardii (USA) (Couch & Umphlett, 1963; Couch & Dodge, 1947; Lum, 1960, 1963).

C. punctatus

Anopheles crucians (USA); *A. quadrimaculatus* (USA) (Couch & Dodge, 1947).

C. quadrangulatus

Anopheles crucians (USA) (Couch, 1945, 1960; Couch & Dodge, 1947).

Anopheles georgianus (USA); *A. punctipennis* (USA); *A. quadrimaculatus* (USA) (Couch & Dodge, 1947).

Anopheles walkeri (USA) (Laird, 1961).

Anopheles sp. (Couch, 1945).

C. quadrangulatus var. *irregularis*

Anopheles punctipennis (USA) (Couch & Dodge, 1947).

C. quadrangulatus var. *lamborni*

Aedes albopictus (Malaya) [1] (Couch & Dodge, 1947).

C. quadrangulatus var. *parvus*

Culex tritaeniorhynchus var. *summorosus* (Singapore) (Laird, 1959a,b).

C. raffaelei

Anopheles claviger (Coluzzi & Rioux, 1962).

C. sculptosporus

Anopheles crucians (USA); *A. punctipennis* (USA) (Couch & Dodge, 1947).

Anopheles walkeri (USA) (Laird, 1961).

C. solomonis

Anopheles punctulatus (Solomon Islands) (Laird, 1961).

C. stegomyiae

Aedes aegypti (Singapore); *A. albopictus* (Singapore) (Laird, 1959a).

Aedes albopictus (Malaya) (Keilin, 1921c, 1927).

Aedes polynesiensis (introduced from Singapore to Tokelau Islands, South Pacific) (Laird, 1959b, 1960).

Aedes scutellaris (Solomon Islands) (Laird, 1956).

Armigeres obturbans (Singapore) (Laird, 1959b).

C. stegomyiae var. *rotumae*

Aedes (*scutellaris* complex—subsequently described as *Aedes rotumae* Belkin) (Rotuma Island, near Fiji) (Laird, 1959b).

[1] Host originally misidentified as *Stegomyia scutellaris* (see Steinhaus, 1946; Laird, 1959b).

C. tasmaniensis

Aedes australis (Tasmania) (Laird, 1956b, 1959b).

C. uranotaeniae

Uranotaenia sapphirina (USA) (Couch, 1945).

C. walkeri (includes Walker's type 1)

Anopheles funestus (Africa); *A. gambiae* (Africa) (Walker, 1938).

A. tesselatus (Java) (ovary of adult) (van Thiel, 1954).

Uncertain *Coelomomyces*

Aedes cinereus (France); *A. vexans* (France) (Eckstein, 1922).[2]

Aedes scatophagoides (" type c ") (Northern Rhodesia) (Muspratt, 1946a,b).[2]

Aedes simpsoni (Africa) (Haddow, 1948).

Aedes (*Mucidus*) sp. (Africa) (De Meillon & Muspratt, 1943).

Anopheles crucians (USA) (Couch & Dodge, 1947).

Anopheles funestus (Africa); *A. gambiae* (Africa) (Gibbins, 1932).

Anopheles maculipennis (Croatia) (Chorine & Baranoff, 1929).[3]

Anopheles sinensis (China) (Feng, 1933).[4]

Culex pipiens fatigans (New Caledonia) (Lacour & Rageau, 1957).

C. pipiens fatigans (Malaya) (Thompson, 1924).

Culex tritaeniorhynchus (China) (Feng, 1933).[4]

ENTOMOPHTHORALES

Mosquitos become infected by the cuticular route, and the parasite develops rapidly. Internal structures of the adult mosquito become liquefied and replaced by the fungus, death supervening.

Entomophthora conglomerata (=*Empusa conglomerata, Empusa thaxteri*)

Aedes communis (=*Culex nemorosus*) (Lakon, 1919; Sorokin, 1877).

Culex pipiens (105 infected adults killed); *Culiseta annulata* (adults killed) (Brumpt, 1941; Lakon, 1919).

Culex sp. (larvae and adults) (Thaxter, 1888).

E. culicis (=*Entomophthora rimosa, Lamia culicis, Empusa culicis, Saprolegnia minor*)

Aedes detritus (adult females) (Marshall, 1938).

[2] Possibly varieties of *Coelomomyces psorophorae* (Couch, 1963).

[3] Or *Saprolegnia* ?

[4] For discussion, see Laird (1956) and Couch & Umphlett (1953).

Entomophthora culicis (continued)

Anopheles hispaniola; *A. maculipennis* (López-Neyra & Guardiola Mira, 1938).

Culex pipiens (Braun, 1855; López-Neyra & Guardiola Mira, 1938; Marshall, 1938; Speer, 1927).

Culex sp. (Nowakowski, 1883; Thaxter, 1888).

Culex sp. (adults) (Christophers, 1952).

E. gracilis

On mosquitos (Lakon, 1919; Picard, 1914; Thaxter, 1888).

E. henrici

Culex pipiens (isolated in nature and then grown on dead insect) (Brumpt, 1941; Molliard, 1918).

E. papilliata (=*Lamia apiculata*)

On adults (Lakon, 1919; Marshall, 1952).

E. rhizospora

A highly lethal epizootic in mosquitos occurred in Michigan in 1902; the adults were greyish white (Brumpt, 1941; Howard, Dyar & Knab, 1912).

E. schroeteri (=*E. rimosa* Schroeter not Sorokin)

On mosquitos (Brumpt, 1941; Schröter, 1886).

E. sphaerosperma (=*Tarichium sphaerospermum*, *Empusa radicans*, *Entomophthora radicans*, *Entomophthora phytonomi*)

On mosquitos (Thaxter, 1888).

On mosquitos (Brumpt, 1941; Fresenius, 1856; Howard, Dyar & Knab, 1912).

Grown on various media successfully (Sawyer, 1929).

E. variabilis

On mosquitos (Lakon, 1919; Thaxter, 1888).

LAGENIDIALES

Lagenidium giganteum

Culex sp. (normally not very pathogenic but nevertheless sometimes causes death) (Couch, 1935, 1960).

MUCORALES

Mucor stolonifera

Anopheles sp. (larvae fed spores and conidia, resulting in some deaths); *Culex* sp. (Bačinskij, 1926).

SAPROLEGNIALES

Saprolegnia declina

Aedes berlandi (caused death during growth) (Rioux & Achard, 1956).

S. monica

Culex pipiens fatigans (larvae were killed) (Hamlyn-Harris, 1932).

Saprolegnia sp.

Aedes (*Stegomyia*) sp. (Martini, 1920).

Aedes spp.; *Anopheles* sp. (Jettmar, 1947).

Aedes geniculatus; *A. rusticus*; *Culiseta annulata*; *C. morsitans* (Marshall, 1938).

Anopheles maculipennis (fungus recovered from *Simulium costatum* caused death of *A. maculipennis* larvae) (Chorine & Baranoff, 1929).

Saprolegnia ? (or *Coelomomyces*)

Anopheles maculipennis (zoospores from sporangia caused death of larvae under experimental conditions) (Chorine & Baranoff, 1929).

(2) ASCOMYCETES

" Yeast "

Aedes aegypti (in adult haemocoele) (Christophers, 1952; Marchoux, Salimbeni & Simond, 1903).

Anopheles maculipennis (in adult haemocoele) (Laveran, 1902).

(3) FUNGI IMPERFECTI

MONILIALES

Aspergillus flavus

Culex pipiens (no infection) (Roubaud & Toumanoff, 1930).

A. glaucus

Anopheles sp. and culicine larvae (Speer, 1927).

Anopheles sp. (infected larvae; caused heavy mortality in experimental infections); *Culex* sp. (infected larvae) (Galli-Valerio & Rochaz de Jongh, 1905).

A. niger

Anopheles sp. (caused heavy mortality by experimental infection); *Culex* sp. (caused heavy mortality by experimental infection) (Galli-Valerio & Rochaz de Jongh, 1905).

Culex sp. and anopheline larvae (Speer, 1927).

Aspergillus sp.

Anopheles sp. (Christophers, 1952).

Culex tritaeniorhynchus summorosus (in larval gut; a cause of larval mortalities in laboratory colonies) (Laird, 1959b).

Culex sp. (in larval gut) (Speer, 1927).

Beauveria bassiana (= *Botrytis bassiana*)

Beauveria bassiana penetrates the insect and multiplies in the form of short filaments or hyphal bodies in the blood. There is some liquefaction of tissues, but Dresner (1949) showed that a steam-acetone extraction of mycelium produces a substance that, when greatly diluted, is highly toxic to mosquito larvae. This fungus is abundant and affects many kinds of insects, especially silkworms and the corn borer.

Anopheles maculipennis (larvae killed) (Roubaud & Toumanoff, 1930).

Anopheles quadrimaculatus (attacked) (Charles, 1939).

Culex pipiens (adults and larvae) (Christophers, 1952).

C. pipiens (adults and larvae destroyed) (is probably *Entomophthora culicis*) (Dyé, 1905).

C. pipiens (some larvae killed, but not practicable in field) (Roubaud & Toumanoff, 1930).

C. pipiens fatigans (extract of fungus caused 92% larval death in 2-3 days) (Dresner, 1949).

B. cinerea form *theobaldiae*

Pathogenic for mosquitos (Morquer, 1933).

B. globulifera

Anopheles maculipennis (larvae killed) (Roubaud & Toumanoff, 1930).

Cladosporium ?

Culex pipiens fatigans (unidentified fungus resembling this genus caused death of an adult female; the body had outgrowths of fungal cells on mesonotum and in alar muscles) (Laird, 1959b).

Fusarium sp. ?

Aedes aegypti (brownish masses in thorax and abdomen; may be *Coelomomyces*) (Macfie, 1917b).

Nocardia sp. ?

Aedes aegypti (larvae covered with external white " hyphae ", " which had a harmful effect, impeding movement and interfering with molting "; may have been *Sphaerotilus* bacteria, or Ciliophora) (Macfie, 1917b).

Oidium lactis

Anopheles sp. (larvae fed spores and conidia, some deaths resulting); *Culex* sp. (Bačinskij, 1926).

Penicillium glaucum

Anopheles sp. (larvae fed spores and conidia, some deaths resulting); *Culex* sp. (Bačinskij, 1926).

Polyscytalum sp.

Psorophora howardii (destroyed eggs) (Martini, 1920; Speer, 1927).

Psorophora lutzii (Martini, 1920).

Psorophora sp. (fungus covers and kills eggs) (Howard, Dyar & Knab, 1912).

Spicaria sp.

Anopheles quadrimaculatus (individuals attacked) (Brown, 1949).

Trichoderma viride

Mosquitos (Steinhaus, 1949b).

Trichophyton sp. ?

Anopheles coustani (pathogenic) (Dyé, 1905).

Adult mosquitos (Christophers, 1952).

On surface of larvae (Liston, 1901).

Fungus

Anopheles maculipennis (tumours with mycelia develop after *Culicoides* bites) (Léon, 1924).

(4) TRICHOMYCETES

Orphella culici

Culex hortensis (occurs in rectum of larvae) (Tuzet & Manier, 1947).

PROTOZOA

(1) MASTIGOPHORA

EUGLENOIDINA

Euglenoid protozoons may occur as epibionts on mosquito larvae. They do little harm and cause no known mortality.

Colacium vesiculosum

Culex annulus; *C. fuscocephalus* (Laird, 1959b).

Phacus curvicauda

Aedes albopictus; *Culex pipiens fatigans* (Laird, 1959b).

Trachelomonas hispida

Anopheles hyrcanus; *A. kochi*; *Culex tritaeniorhynchus summorosus* (Laird, 1959b).

PROTOMONADINA

The entomogenous trypanosomes multiply in the digestive tract of their mosquito hosts and may cover the entire lining of the hind gut, rectal pouch, and rectal papillae. The lumen of the gut is packed with clusters of the flagellates. There is little or no demonstrable damage.

Non-parasitic protomonadinids of the genera *Codonoeca*, *Phalansterium* and *Pleuromonas* have also been recorded from mosquitos, as larval epibionts.

Blastocrithidia culicis (=*Herpetomonas culicis*, *Leptomonas culicis*)

Aedes aegypti; *A. vexans* (Christophers, 1952; Patton, 1912a; Wallace & Johnson, 1961).

Aedes triseriatus and *A. vexans* (adults) (Thomson & Robertson, 1925).

Anopheles minimus; *A. sinensis* (Feng, 1933).

Culex pipiens (in gut) (Wallace, 1943).

C. pipiens fatigans (intestine of adult and larvae); *C. richiardii* (Novy, MacNeal & Torrey, 1907).

C. pipiens fatigans (in adult, larva and pupa) (Thomson & Robertson, 1925).

Codonoeca associans ?

Culex pullus (ectocommensal flagellate) (Laird, 1956b).

Crithidia fasciculata (=*Herpetomonas culicidarum*, *H. culicis*)

Aedes aegypti (adult) (Wallace, 1943).

A. aegypti queenslandensis (adult) (Garnham, 1959).

Aedes triseriatus and *A. vexans* (adult) (Thomson & Robertson, 1925).

Anopheles aztecus; *A. gambiae* (Garnham, 1959).

Anopheles farauti (Laird, 1956b).

Anopheles jeyporiensis (3.3% infected) (Feng, 1933; Wallace, 1943).

Anopheles maculipennis (2.3% infected) (Missiroli, 1930).

A. maculipennis (5.7% infected) (Šahov, 1928).

A. maculipennis (adult) (Thomson & Robertson, 1925).

Anopheles quadrimaculatus (adult) (Garnham, 1959; Noguchi, 1926; Wallace, 1943).

Anopheles sinensis (Wallace, 1943).

Anopheles stephensi (adult); *A. sundaicus* (adult) (Garnham, 1959).

Anopheles superpictus (Wenyon, 1926).

Anopheles sp. (Léger, 1902a).

Armigeres obturbans (Laird, 1959b).

Culex pipiens (adult) (Nöller, 1917; Noguchi, 1926; Thomson & Robertson, 1925).

C. pipiens (95% of larvae and pupae from a well were parasitized, according to Patton) (Wallace, 1943).

C. pipiens fatigans (=*C. pungens*) (Léger, 1902a; Wenyon, 1926).

Culex tritaeniorhynchus summorosus (Laird, 1959b).

Culiseta annulata (Léger, 1902a).

Mansonia africanus (adult); *M. uniformis* (Garnham, 1959).

Mansonia perturbans (adult) (Thomson & Robertson, 1925).

Mansonia richiardii (Léger, 1902a).

Leptomonas algeriensis

Aedes aegypti (adult) (Thomson & Robertson, 1925).

A. aegypti (larvae) (Christophers, 1952; Sergent, 1925).

Culex pipiens (Sergent, 1925).

C. pipiens (adult) (Thomson & Robertson, 1925).

C. pipiens (larval intestine) (Sergent & Sergent, 1906).

L. anophelini

Anopheles eiseni (Fonseca & Fonseca, 1941).

L. jaculum

Anopheles maculipennis (intestine) (Léger, 1902a).

L. pessoai

Anopheles oswaldoi (7.35% infected); *A. triannulatus davisi* (3.4% infected, pathogenic action on ovaries and gut) (Ayrosa Galvão & Coutinho, 1941).

Anopheles oswaldoi; *A. triannulatus davisi* (Wallace, 1943).

Phalansterium digitatum

Anopheles kochi and *Culex annulus* (epibiont, no pathogenicity) (Laird, 1959b).

Pleuromonas jaculans

Anopheles kochi, *Culex fuscocephalus*, and *C. tritaeniorhynchus summorosus* (epibiont, no pathogenicity) (Laird, 1959b).

(2) SPOROZOA

(*a*) GREGARINIDA

Baccellia anophelis (=*B. anopheliae*)

Anopheles maculipennis (entire life cycle in gut) (Franchini, 1913).

Caulleryella

Occurs in larvae, where the sporozoites attach themselves to the gut epithelium. When pupation occurs the infection dies out leaving the adult mosquitos uninfected.

C. annulatae

Aedes rusticus (Hesse, 1926).

Culiseta annulata (larval gut) (Bresslau & Buschkiel, 1919; Hesse, 1926).

C. anophelis

Anopheles claviger (=*A. bifurcatus*) (larval gut, 15% parasitized) (Hesse, 1918, 1926; Steinhaus, 1946).

Anopheles maculipennis (Hesse, 1926).

Caulleryella maligna

Anopheles albitarsis (=*A. argyritarsis*, *Cellia allopha*) (in larva, pupa and adult; causes death) (Hesse, 1926).

A. albitarsis (=*Cellia allopha*) (larval gut) (Godoy & Pinto, 1922).

Anopheles sp. (adult gut) (Christophers, 1952).

Caulleryella pipiens

Culex pipiens (Hesse, 1926).

Caulleryella pipientis

Culex pipiens (larval gut) (Bresslau & Buschkiel, 1919; Buschkiel, 1921).

Diplocystis johnsoni

Anopheles maculipennis (parasite of outer wall of midgut; parasite level up to 80%) (Johnson, 1902; van Thiel, 1954).

D. metselaari

Anopheles farauti (van Thiel, 1954).

Diplocystis sp.

Aedes aegypti (Howard, Dyar & Knab, 1912).

Culex sp. (body cavity of larva, around outer wall of midgut) (Léger & Duboscq, 1903).

Culex sp. (Christophers, 1952).

Tripteroides dofleini (acephaline gregarine in larval body cavity) (Guenther, 1914).

From the haemocoele of mosquito larvae (Wenyon, 1926).

Lankesteria culicis (=*Gregarina culicis*)

This parasite is found in the gut and Malpighian tubules of adult mosquitos. Larvae ingest the spores, which germinate into sporozoites and invade intestinal epithelial cells. After growth and development there, the vegetative forms become motile in the gut contents, and at pupation, as sporadins, they enter the Malpighian tubules and associate in pairs. Gametogony now takes place, large numbers of spores ultimately developing within each gametocyst. At about the time the mosquito emerges from the pupa, the gametocysts rupture and the spores are ejected with the faeces into the water. The parasite is common and widespread in aedines of the subgenus *Stegomyia*. It causes little mortality, and is said to be pathogenic only when present in such large numbers as to interfere with vital functions.

Aedes aegypti (larval gut) (Bacot, 1916; Christophers, 1952; Ross, 1898, 1906).

A. aegypti (no ill effects) (Macfie, 1917a; Marchoux, Salimbeni & Simond, 1903; Wenyon, 1911, 1926).

A. aegypti (81% with Malpighian tubules infected) (Mathis & Baffet, 1934).

A. aegypti (larvae reared in captivity highly parasitized) (Bacot, 1916).

A. aegypti (Laird, 1959b; Sellards & Siler, 1928).

Aedes albopictus (adult and larva) (Feng, 1933; Ray, 1933).

A. albopictus (larval gut; 100% of larvae infected in two habitats) (Laird, 1959b).

Aedes geniculatus (Ganapati & Tate, 1949).

Aedes koreicus (adult) (Feng, 1930, 1933).

Anopheles jeyporiensis (adult mid and hind gut); *A. sinensis* (adult and larva); *Armigeres obturbans* (adult); *Culex tritaeniorhynchus* (adult and larva) (Feng, 1933).

(*b*) HAEMOSPORIDIIDA

The extensive literature on the occurrence of the malaria parasites and their relatives in mosquito hosts is not dealt with here.

(*c*) ACNIDOSPORIDIIDA

HAPLOSPORIDIA

Myiobium myzomiae

Anopheles subpictus indefinitus (from gut of female) (Swellengrebel, 1920).

(*d*) MICROSPORIDIA

Microsporidian infections may cause mosquito larvae to become sluggish or inactive. The larvae often become stunted and deformed, and frequently exhibit whitish swellings. The nuclei of the fat cells enlarge and the cytoplasm becomes swollen, and muscular degeneration may be evident. Infected larvae commonly die or fail to pupate.

Mosquito control potentialities (Kellen, 1962).

COUGOURDELLIDAE

Octosporea corethrae (=*Nosema corethrae* Lutz & Splendore, 1908).

Corethra sp. (larvae) (Lutz & Splendore, 1908; Weiser, 1961).

Toxoglugea missiroli (=*Sarcocystis anophelis*)

Anopheles maculipennis (adults) (Missiroli, 1928; Weiser, 1961).

NOSEMATIDAE

Each pansporoblast gives rise to a single spore. *Nosema* invades epithelial cells of the ovaries, gastric pouch, midgut, and fat body of larvae and adults, and heavy infections may cause death.

Glugea

Ovoid or pyriform-shaped spores are developed from pansporoblasts, which grow and produce more nuclei. Each pansporoblast grows, resulting in two sporoblasts developing to two spores. They invade individual cells instead of cell complexes. *Glugea* as now understood probably does not parasitize mosquitos. The following records refer to older identifications of *Glugea* in a broad sense.

Glugea stegomyae

Aedes aegypti (larvae and adults, body cavity and tissues) (Marchoux, Salimbeni & Simond, 1903).

Glugea sp.

Anopheles sp. (adult) (Grassi, 1900; Speer, 1927).

Culex sp. (body cavity of larvae) (Pfeiffer, 1895; Speer, 1927).

Nosema aedis

Aedes aegypti (larval fat body) (Kudo, 1930).

N. anophelis [1]

Anopheles maculipennis (Missiroli, 1928-29).

Anopheles quadrimaculatus (in larval gut, and adult female gut and fat body) (Kudo, 1925a,b).

N. culicis

Culex pipiens (larva) (life cycle not studied, so generic status uncertain) (Bresslau & Buschkiel, 1919; Steinhaus, 1951).

N. lutzi [2]

Aedes aegypti (adult gut) (Kudo, 1929; Lutz & Splendore, 1908).

N. stegomyiae (=*Plistophora stegomyiae* Chatton, 1911 ?) [3]

Aedes aegypti (Lutz & Splendore, 1908; Marchoux, Salimbeni & Simond, 1903).

Anopheles gambiae (adults); *A. melas* (invades gut, muscles, air sacs, ovaries, fat body, Malpighian tubules; infection in adults causes destruction of midgut epithelium and curtails egg production) (Fox & Weiser, 1959).

Nosema sp.

Aedes aegypti (larvae) (Martini, 1920).

Aedes cantans (larval fat body); *A. communis* (=*A. nemorosus*) (larval fat body) (Nöller, 1920).

Anopheles gambiae (affects oocysts of *Plasmodium schwetzi*) (Bray, 1958).

Plistophora

Plistophora parasitizes the Malpighian tubules, ovary, ova, alimentary tract, and eventually every other organ. The parasite inhibits reproduction but rarely kills the adults. The mosquitos are probably infected through the eggs and also from ingestion. Spontaneous disappearance of infection may occur. Each pansporoblast gives rise to many spores (more than 16).

Plistophora chaobori

Chaoborus crystallinus (Rapsch, 1950; Weiser, 1961).

P. collessi

Culex gelidus; *C. tritaeniorhynchus summorosus* (causes degeneration of oocyte, nurse cells and follicular epithelium; destroys high proportion of eggs and may inhibit reproduction; incidence of 1% observed in nature) (Laird, 1959a).

P. culicis (=*P. kudoi*)

Anopheles atroparvus (light infections) (Garnham, 1959).

Anopheles gambiae (occurs in larvae and adults, affecting *Plasmodium* oocysts in the latter; 50%-100% of adults infected) (Canning, 1957a, b).

Anopheles gambiae (Garnham, 1956).

A. gambiae (unable to pass through eggs) (Gunders, 1957).

Anopheles maculipennis (light infections) (Garnham, 1959).

Anopheles stephensi (in larvae and adults) (Canning, 1957a,b; Garnham, 1956; Laird, 1959a).

A. stephensi (found in Malpighian tubules, fat body, and on wall of midgut in larvae and adults; about 1% infection in nature but up to 100% in laboratory colonies) (Lainson & Garnham, 1957).

Anopheles sp. (affects oocysts of *Plasmodium cynomolgi* (Bano, 1958).

Culex pipiens (larvae) (Weiser, 1946, 1947).

P. mochlonicis

Mochlonyx culiciformis (Rapsch, 1956).

P. ovalis

Mochlonyx culiciformis (Rapsch, 1956).

(*P. stegomyiae*)=*Nosema stegomyiae* Marchoux et al., 1903.

Aedes aegypti (parasite of larvae and adults; 13% of adults found infected) (Marchoux, Salimbeni & Simond, 1903).

A. aegypti (Chatton, 1911; Parker, Beyer & Pothier, 1903; Simond, 1903; Speer, 1927).

Aedes sp. (affects ovaries and various other organs, but causes little damage (Parker, Beyer & Pothier, 1903).

[1] *N. anophelis* Kudo is considered to be a synonym of *N. stegomyiae* Marchoux et al. by Fox & Weiser (1959).

[2] *N. stegomyiae* Lutz & Splendore, 1908, is considered to be a synonym of *N. lutzi* by Kudo (1960).

[3] *N. stegomyiae* Lutz & Splendore, 1908, described as a new species, is a synonym of *N. stegomyiae* of Marchoux, Salimbeni & Simond (1903), according to Fox & Weiser (1959).

Stempellia

Stempellia parasitizes the fat body of the larvae, which acquires an opaque whitish coloration. A decrease in size and activity is rapidly followed by death. Spores germinate in the midgut. Sporont formation is followed by the production of one, two, four, or eight spores (usually four).

Stempellia magna (=*Thelohania magna*)

Culex pipiens (12% of larvae infected) (Kudo, 1921, 1924, 1925b).

Culex territans (15% of larvae infected) (Kudo, 1925b).

Thelohania

Thelohania has sporonts which typically give rise to 8 spores (sometimes 4-16). Infections may be highly lethal and the primary site of pathological damage is in the fat body. Whitish swollen masses deform the larvae, and death usually occurs at pupation time.

Thelohania anomola

Anopheles ramsayi (in fat body) (Sen, 1941).

T. benigna

Culex apicalis (in haemocoele of larvae; causes minute localized areas of infection and does not adversely affect larvae; 1%-3% natural infection) (Kellen & Wills, 1962a).

T. bolinasae

Aedes squamiger (in haemocoele of larvae; causes mottled appearance and death) (Kellen & Wills, 1962a).

T. californica

Culex tarsalis (in fat body; 5%-25% larvae infected naturally in field; causes 98% mortality of infected larvae) (Kellen & Lipa, 1960).

C. tarsalis (transovarian transmission) (Kellen & Wills, 1962b).

T. campbelli

Culiseta incidens (in haemocoele of larvae; causes swollen greyish-white appearance and death; usually less than 1%, but up to 30%-80% natural infection observed) (Kellen & Wills, 1962a).

T. gigantea

Culex erythrothorax (haemocoele of larvae, which appear opaque white in consequence; causes death) (Kellen & Wills, 1962a).

T. grassi

Anopheles maculipennis (eggs, fat body and ovaries of adult female) (Christophers, 1901; Grassi, 1901; Missiroli, 1929a; Nicholson, 1921).

Culex pipiens fatigans (Ross, 1906).

T. indica

Anopheles nigerrimus (=*A. hyrcanus nigerrimus*) (larval fat body) (Kudo, 1929; Sen, 1941).

Anopheles ramsayi (larval fat body) (Sen, 1941).

T. inimica

Culiseta inornata (haemocoele of larvae; causes swollen greyish-white appearance and death; usually less than 1% natural infection) (Kellen & Wills, 1962a).

T. legeri (=*T. illinoisensis* Kudo, 1921)

Aedes cantans (larva); *A. communis* (larva) (Nöller, 1920).

Anopheles annularis (=*A. fulignosus*) (larvae are not adversely affected) (Hesse, 1904a,b; Sen, 1941).

Anopheles barbirostris (larval fat body) (Sen, 1941).

Anopheles claviger (=*A. bifurcatus*) (larval fat body) Hesse, 1904a,b).

Anopheles crucians (larval fat body) (Hesse, 1904a,b; Kudo, 1924a).

Anopheles funestus (larval fat body) (Kudo, 1960).

Anopheles gambiae (larva); *A. hyrcanus* (larval fat body) Kudo, 1924a).

Anopheles maculipennis (larval fat cells) (Hesse, 1904a,b).

A. maculipennis (fat body) (Missiroli, 1929a).

Anopheles nigerrimus (Sen, 1941).

Anopheles punctipennis (larva) (Sen, 1941).

A. punctipennis (larval fat body) (Kudo, 1924a, 1929).

Anopheles quadrimaculatus (larval fat body) (Hesse, 1904a,b; Kudo, 1924a).

A. quadrimaculatus (adult) (Kudo, 1925a; Sen, 1941).

Anopheles ramsayi (larva) (Sen, 1941).

Anopheles subpictus (larva) (Sen, 1941).

Anopheles vagus (larva) (Sen, 1941).

Anopheles varuna (larval fat body) (Sen, 1941).

Anopheles spp. (4.5% infected) (Kudo, 1925a).

Anopheles spp. (0.5%-10% infected) (Weiser, 1958, 1959).

T. minuta

Culex erraticus (=*C. leprincei*) (larval and pupal fat body, nerve and muscle; causes death of larvae and adults) (Kudo, 1925b).

Culex sp. (larva, pupal fat body) (Kudo, 1925b).

T. mulleri

Anopheles maculipennis (Pfeiffer, 1895; Stempell, 1902).

T. noxia

Culex thriambus (in haemocoele of larvae, which become dull grey ventrally; causes death) (Kellen & Wills, 1962a).

T. obesa

Anopheles quadrimaculatus (larval fat body) (Kudo, 1924b, 1925).

Thelohania obscura

Anopheles funestus (causes white translucent masses in larva) (Kudo, 1929).

Anopheles varuna (larva) (Sen, 1941).

T. opacita

Aedes communis (=*A. nemorosus*) (larval fat body; 50% infected in field) (Nöller, 1920; Wenyon, 1926).

Aedes spp. (1%-7% infected) (Weiser, 1958, 1959).

Culex annulirostris (larva) (Laird, 1956b).

Culex apicalis (=*C. testaceus*) (larval fat body; fatal) (Kudo, 1921, 1924b).

Culex restuans (larva) (Kudo, 1924b).

Culex territans (larval fat body; fatal); *Culex* sp. (larval fat body; fatal) (Kudo, 1921, 1925a).

T. periculosa

Anopheles pseudopunctipennis franciscanus (in haemocoele of larvae, causes white ventral coloration of infected areas and eventual death; 1%-5% natural infection) (Kellen & Wills, 1962a).

T. pyriformis

Anopheles crucians or *A. quadrimaculatus* (opaque coloration, in larval fat body) (Kudo, 1924c, 1925c).

Anopheles sp. (larval fat body) (Kudo, 1925c).

T. rotunda

Culex erraticus (=*C. leprincei*) (larval fat body) (Kudo, 1924c).

T. unica

Aedes melanimon (in haemocoele of larvae, which become greyish-white ventrally; low infection rate in nature) (Kellen & Wills, 1962a).

Thelohania sp.

Aedes communis (=*A. nemorosus*) (larval fat body) (Nöller, 1920).

A. communis (3%-11% killed) (Welch, 1960a,b).

A. communis; *A. punctor* (Jenkins, 1950).

Anopheles annularis (=*A. fuliginosus*); *A. barbirostris*; *A. hyrcanus*; *A. ramsayi* (=*A. pseudojamesi*); *A. subpictus*; *A. varuna* (larvae die) (Iyengar, 1930).

Anopheles walkeri (Laird, 1961).

Culex pipiens (larva) (Iturbe & González, 1921).

Culex tarsalis (larva) (Steinhaus, 1951).

Culiseta annulata (larva) (Bresslau & Buschkiel, 1919).

INCERTAE SEDIS

Myxosporidium stegomyiae

Aedes aegypti (adult body cavity and tissues) (Parker, Beyer & Pothier, 1903; Speer, 1927).

Serumsporidium sp.

Aedes aegypti; *A. serratus* (Lutz & Splendore, 1908; Speer, 1927).

(3) CILIOPHORA/CILIATA

(A) HOLOTRICHA

(*a*) GYMNOSTOMATIDA

Prorodon microstoma

On *Vorticella microstoma* on *Culex pervigilans* (Graham, 1939; Stout, 1954).

(*b*) SUCTORIDA

Podophrya collini

Culex fuscanus and *C. gelidus* (larval epibiont) (Laird, 1959b).

(*c*) HYMENOSTOMATIDA

Tetrahymena pyriformis (=*Glaucoma pyriformis Turchiniella culicis*)

Found in the anal papillae and body cavity of larvae, infected examples (much paler than normal) often dying before pupation; the ciliates may escape by rupture of the integument or by detachment of the anal papillae (Lwoff, 1947).

Aedes albopictus (=*Aedes scutellaris*) (Keilin, 1921a,b; Laird, 1959).

Aedes sierrensis (Kellen, Wills & Lindegren, 1961).

Anopheles quadrimaculatus (adverse effect on colony) [1] (Schoof, personal communication, 1956).

Culex fuscocephalus; *C. gelidus* (Laird, 1959b).

Culex pipiens ? (in haemocoele of adult female; infection not fatal) [1] (Grasse & Boissezon, 1929).

C. pipiens (ciliates escape from dying adults in water to infect larvae?) [1] (Boissezon, 1930).

Culex tritaeniorhynchus summorosus (larvae) (Laird, 1959b).

Culiseta annulata (in body cavity, especially head of larva; infection fatal) [1] (MacArthur, 1922; Wenyon, 1926).

Wyeomyia smithii (in body cavity of larvae; infection fatal) (Corliss, 1954a).

T. stegomyiae (=*Lambornella stegomyiae*)

Occurs throughout the larval haemocoele; frequently causes death of larvae, but occasionally persists to adult stage.

Aedes aegypti (in larval body cavity and anal papillae; infection fatal) (Corliss, 1960; Muspratt, 1945).

Aedes albopictus (=*A. scutellaris*) (in larval body cavity and anal gills) (Keilin, 1921a,b; Lamborn, 1921).

Aedes calceatus (Muspratt, 1945).

Aedes fulgens (Muspratt, 1945, 1947).

[1] Identification of parasite uncertain.

Tetrahymena stegomyiae (continued)

Aedes haworthi; *A. marshallii*; *A. metallicus* (Muspratt, 1945).

A. metallicus (in body cavity and on cuticle of larvae; infection fatal) (Corliss, 1960).

Culex decens; *C. nebulosus* (Muspratt, 1945).

Tetrahymena sp.

Armigeres dentatus; *A. digitatus*; *A. dolichocephalus* (Corliss, 1961).

(*d*) PERITRICHIDA

These occur frequently, sometimes in great numbers, as epibionts on mosquito larvae. They are often particularly abundant on the anal papillae. These ciliates are not primarily harmful, but their presence frequently interferes with larval feeding and movement and may be a contributory cause of death.

(i) EPISTYLIDIDAE

Epistylis caldwelli

Anopheles hyrcanus; *A. kochi*; *Culex fuscanus* (Laird, 1960).

E. lacustris

Aedes albopictus; *Anopheles hyrcanus*; *A. kochi*; *Culex annulus*; *C. bitaeniorhynchus*; *C. fuscans*; *C. fuscocephalus*; *C. pseudovishnui*; *C. tritaeniorhynchus summorosus*; *Ficalbia metallica* (Laird, 1959b).

Aedes excrucians; *A. pionips* (Welch, 1960a).

Aedes lineatus; *A. nocturnus* (=*A. vexans nocturnus*); *A. vigilax*; *Anopheles annulipes*; *A. b. bancrofti*; *A. farauti*; *Bironella hollandi*; *Culex annulirostris*; C. *fraudatrix*; *C. pipiens fatigans*; *C. pullus*; *Uranotaenia civinskii*; *U. solomonis* (Laird, 1956b).

E. nympharum

Culex sp. (Roux, 1901; Stiller, 1942).

E. umbilicata (=*E. anophelis*)

Anopheles sp. (Nenninger, 1948).

Culex pipiens (larva) (Shillito, 1948).

C. pipiens (Claparède & Lachmann, 1858-61).

Mosquito larvae (Kahl, 1930-35).

Epistylis n. sp.

Epistylis sp. ?

Aedes geniculatus (Shillito, 1948).

Opercularia corethrae

Corethra sp. (Keiser, 1921).

Opercularia sp.

Aedes cantans (Brown, 1949).

Pyxidiella invaginatum (=*Pyxidium invaginatum*)

Anopheles labranchiae atroparvus (=*A. maculipennis atroparvus*) (Laird, 1958).

Culex tritaeniorhynchus summorosus (Laird, 1959b).

P. ventriosa

Corethra sp. (Keiser, 1921).

Rhabdostyla ovum var. *culicidarum*

Culicine larvae (Nenninger, 1948).

Rhabdostyla sp.

Aedes cantans; *A. punctor*; *A. rusticus*; *Culiseta annulata* (Brown, 1949).

(ii) SCYPHIDIIDAE

Scyphidia sp.

Aedes geniculatus (Beattie & Howland, 1929; Shillito, 1948).

Anopheles plumbeus (Shillito, 1948).

Anopheles Kochi; *Culex tritaeniorhynchus summorosus* (Laird, 1959b).

Orthopodomyia pulchripalpis (Shillito, 1948).

(iii) VORTICELLIDAE

Carchesium erlangensis

Aedes cinereus (Nenninger, 1948).

Eretmapodites inornatus (infested larvae almost always die at pupation or just after pupation) (Haddow, 1946).

Instrastylum invaginatum

Aedes excrucians; *A. punctor* (Jenkins, 1948).

Vorticella alba ?

Aedes cinereus; *A. communis*; *A. decticus* (=*A. impiger*); *A. punctor* (Frohne, 1953).

V. campanula

Culex annulirostris; *C. halifaxii*; *C. pipiens fatigans*; *C. pullus* (Laird, 1956b).

V. convallaria

Aedes excrucians [1] (Jenkins, 1950).

Anopheles hyrcanus; *A. kochi*; *Culex bitaeniorhynchus*; *C. fuscanus*; *C. pseudovishnui*; *C. tritaeniorhynchus summorosus*; *Ficalbia metallica* (Laird, 1959b).

[1] Identification of parasite uncertain.

Vorticella microstoma

Aedes albopictus; *A. longirostris*; *Anopheles hyrcanus*; *A. kochi*; *Culex annulus*; *C. bitaeniorhynchus*; *C. fuscanus*; *C. fuscocephalus*; *C. gelidus*; *C. mimulus*; *C. nigropunctatus*; *C. pseudovishnui*; *C. tritaeniorhynchus summorosus*; *Ficalbia metallica*; *Uranotaenia atra* (Laird, 1959b).

Aedes excrucians; *A. pionips* (Welch, 1960a).

Aedes lineatus; *A. nocturnus* (=*A. vexans nocturnus*); *A. vigilax*; *Anopheles annulipes*; *A. farauti*; *A. punctulatus*; *Bironella hollandi*; *Culex annulirostris*; *C. fraudatrix*; *C. halifaxii*; *C. mimulus*; *C. pipiens fatigans*; *C. pullus*; *C. starckeae* (=*C. basicinctus*); *Uranotaenia civinskii*; *U. solomonis* (Laird, 1956b).

Anopheles labranchiae atroparvus (=*A. maculipennis atroparvus*) (Laird, 1958).

Anopheles quadrimaculatus (Micks, 1950).

Culex pervigilans (Graham, 1939; Stout, 1954).

Culex pipiens (Ehrenberg, 1832).

V. striata

Aedes excrucians; *A. pionips* (Welch, 1960a).

Vorticella sp.

Aedes aegypti (may arrest larval development) (Macfie, 1915).

Aedes canadensis; *A. cinereus*; *A. communis*; *A. decticus* (=*A. impiger*); *A. diantaeus*; *A. excrucians*; *A. fitchii*; *A. pionips*; *A. pullatus*; *A. punctor* (Jenkins & Knight, 1952).

Aedes fitchii; *A. stimulans*; *A. trichurus* (Twinn, 1931).

Aedes scutellaris (Shillito, 1948).

Aedes simpsoni (reduced numbers of larvae) (Haddow, 1948).

Anopheles annulipes (Hamlyn-Harris, 1930a).

Anopheles brevipalpis (caused 100% mortality) (Strickland, 1915).

Anopheles crucians (large masses) (Snow, personal communication, 1957).

Anopheles farauti (Laird, 1956b).

Anopheles labranchiae atroparvus (Micks, 1955).

Anopheles stephensi (are harmful) (Sinton, 1917a).

Anopheles subpictus (=*A. rossi*) (Giles, 1902).

Anopheles sp. (Liston, 1901; Waterston, 1918).

Culex pipiens fatigans (Jetmar, 1947; Micks, 1950).

Eretmapodites inornatus (heavy growth on larvae resulted in death of pupae) (Haddow, 1946).

Various plant-axil larvae, heavily infested specimens frequently failing to pupate successfully (Haddow, 1948).

Mosquito larvae became badly overgrown (Waterston, 1918).

Zoothamnium sp.

Culex annulirostris (Laird, 1956b).

Anopheles sundaicus; *Culex sitiens* (Laird, 1959b).

(B) SPIROTRICHA

HETEROTRICHIDA

Stentor polymorphus

Anopheles crucians (Hinman, 1934a).

Stentor sp.

Aedes sp. (Matheson & Hinman, 1930).

ROTATORIA

Brachionus rubens

Anopheles kochi; *Culex annulus*; *C. tritaeniorhynchus summorosus* (larval epibiont) (Laird, 1959b).

Philodina parasitica

Culex spp. (in intestine of larvae) (Marchoux, 1898).

NEMATODA

(1) MERMITHOIDEA

MERMITHIDAE

Found quite commonly in mosquitos throughout the world, occurring as coiled eelworms in larvae and sometime in adults too. Immature worms emerging before pupation always kill the host larvae. The taxonomy is based on adult forms of the nematodes and the generic name *Agamomermis* is a " catch-all " to include unidentified larvae, those species identified with certainty being referable to the genera *Hydromermis* and *Limnomermis*. (Infected stage of mosquito: L = larvae; P = pupae; A = adult).

Agamomermis culicis

Aedes sollicitans (A; North America; up to 50% natural parasitization) (Smith, 1903; Stiles, 1903).

Agamomermis sp.

Aedes aegypti (L; Africa); *A. calceatus* (L; Africa, 70%-80% infected); *A. fulgens* (L; Africa; 70%-80% infected); *A. howarthi* (L; Africa; 70-80% infected); *A. marshallii* (L; Africa); *A. metallicus* (L; Africa; 70%-80% infected); *Aedes zethus* (L; Africa; 70%-80% infected); *Anopheles rufipes* (L; Africa; 70%-80% infected); *Culex nebulosus* (L; Africa; 70%-80% infected) (Muspratt, 1945).

Aedes canadensis (L; North America); *A. cinereus* (L; North America); *A. punctor* (L; North America) (Price, 1957).

Agamomermis sp. (continued)

Aedes cantans (A; Russia; 83% infected); *A. dorsalis* (A; Russia; 83% infected); *Aedes* sp. (Russia) (Šahov, 1927).

Aedes cinereus (L; North America); *A. decticus* (= *A. impiger* (L; North America); *A. punctor* (L; North America) (Frohne, 1953).

Aedes communis (L; North America) (Frohne, 1953; Smith, 1961).

A. communis (L, P, A; Europe) (Stiles, 1903).

Aedes excrucians (L; North America) (Frohne, 1954, 1955).

Aedes flavescens (A; North America) (Hearle, 1929).

Aedes heischi (L; Africa); *A. michaelikati* (L; Africa); *A. soleatus* (L; Africa) (Lumsden, 1955).

Aedes sollicitans (French Guiana) (Gendre, 1909).

Aedes vexans (L; North America; 50% infected); *Culex pipiens* (L; North America; 60% infected); (Stabler, 1952).

Anopheles annulipes (L; Australia; 70% infected) (Laird, 1956b).

Culex pipiens fatigans (L, in gut; India) (Ross, 1898).

Culex salinarius (L; North America; 8% infected) (Stabler, 1945).

Hydromermis churchillensis

Aedes communis (L; North America; up to 100% infected); *A. impiger* (= *A. nearcticus*) (L; North America); *A. nigripes* (L; North America); *A. pionips* (L; North America) (Jenkins & West, 1954).

Aedes communis (L; North America) (Welch, 1960b, c).

Aedes impiger (=*A. nearcticus*) (L; North America); *A. nigripes* (L; North America) (Welch, 1960b).

Aedes pullatus (L; North America) [1] (Smith, 1961).

Limnomermis aquatilis

Anopheles sp. (L; France) (Dujardin, 1845; Speer, 1927).

Mermis sp.

Aedes aegypti (L; Africa; 100% infected) (Gendre, 1909; Muspratt, 1945).

Anopheles annularis (=*A. fulignosus*) (L, A; India); *A. barbirostris* (L; India); *A. philippinensis* (L; India); *A. ramsayi* (=*A. pseudojamesi*) (L; India); *A. sinensis* (L; India); *A. subpictus* (A; India); *A. tesselatus* (L; India); *A. varuna* (L; India) (Iyengar, 1930a).

Anopheles gambiae (L; Africa; 70%-80% infected) (Muspratt, 1945).

Anopheles leucosphyrus (L; Sumatra) (Walandouw, 1934).

Paramermis canadensis

Aedes sticticus (=*A. aldrichi*) (A; North America) (Herle, 1929).

Aedes vexans (A; North America; up to 80% infected) (Steiner, 1924).

[1] Identification of parasite uncertain.

Mermithids [2]

Anopheles sp. (Johnson, 1903).

(2) FILARIOIDEA

Acanthocheilonema perstans

Aedes aegypti (thoracic muscles); *Anopheles gambiae* (=*A. costalis*); *A. maculipennis*; *Culex pipiens*; *Mansonia fuscopennata*; *M. uniformis* (Manson, 1892).

Conspiculum guindiens

Culex pipiens fatigans (kills many heavily infected adults in 1-2 days) (Pandit, Pandit & Seetharama Iyer, 1929).

Dirofilaria immitis

Aedes aegypti; *A. caspius* (=*A. punctatus*); *A. caspius* (=*A. penicillaris*) (Malpighian tubules); *A. vagans*; *A. vexans*; *Anopheles algeriensis*; *A. claviger* (= *A. bifurcatus*); *A. hyrcanus* (=*A. pseudopictus*); *A. maculipennis*; *A. superpictus* (= *A. palestinus*); *Culex pipiens* (in Malpighian tubules); *C. pipiens fatigans* (= *C. skusii*) (Leidy, 1856).

Aedes guamensis (died in 36 hours if heavily infected); *A. pandani* (Travis, 1947a).

Various mosquitos (mortality heavy first five days) (Galliard, 1957).

Various mosquitos (chitinization in Malpighian tubules) (Noè, 1901).

D. repens

Aedes aegypti (chitinized in Malpighian tubules) (Fülleborn, 1929).

Filaria sp.

Anopheles maculipennis (adult) (Reinhard, 1924).

Foleyella brachyoptera

Aedes aegypti; *Culex pipiens*; *C. pipiens fatigans* (microfilaria frequently cause death, and infected blood ingested by females fails to stimulate egg production) (Causey, 1939a).

F. dolichoptera

Aedes aegypti (in abdomen and muscles); *A. atropalpus*; *Culex pipiens*; *C. pipiens fatigans* (Causey, 1939a).

F. ranae

Aedes aegypti (in head, abdomen and thoracic muscles); *Culex pipiens*; *C. pipiens fatigans* (Causey, 1939b).

Loa diurna

Anopheles maculipennis (Manson, 1892).

Microfilaria demarquayi

Aedes aegypti (Manson, 1897).

[2] Probably *Agamomermis culicis* according to Welch (1960c).

Microfilaria tucumana

Aedes aegypti (Biglieri & Araoz, 1917).

Microfilaria sp.

Aedes aegypti (if infected with malaria, lives up to 154 days; if infected with microfilariae, lives to a maximum of 17 days) (Mayne, 1920).

Wuchereria bancrofti [1]

Aedes scutellaris (= *A. variegatus*) (chitinized in capsules in adults) (Manson-Bahr, 1912).

Many species of mosquitos; heavy infestation causes high mortality) (Brumpt, 1945; Galliard, 1957).

W. malayi

Brumpt (1945).

(3) RHABDITOIDEA

STEINERNEMATIDAE

Neoaplectana sp. (Dutkey's nematode DD 136)

Aedes aegypti (larvae infected experimentally die in 24-36 hours) (Welch, 1960c).

(4) NEMATOMORPHA

Paragordius varius

Culex sp. (encysted in killed larvae) (Leidy, 1851).

" Larval nematodes "

Anopheles gigas var. *simlensis*; *A. lindesayi* (Sinton, 1932).

Nematodes

Anopheles maculipennis (adults and larvae) (Šahov, 1928).

TREMATODA

Agamodistomum martiranoi

Anopheles claviger (Stiles, 1903).

Anopheles maculipennis (Howard, Dyar & Knab, 1912).

A. sintoni

Anopheles annularis (=*A. fuliginosa*) (Stephens & Christophers, 1902).

Anopheles claviger; *A. maculipennis* (Speer, 1927).

Anopheles culicifacies (=*A. funestus listoni*); *A. maculatus willmori*; *A. subpictus*; *Culex pipiens fatigans* (van Thiel, 1922).

Anopheles stephensi; *Culex pipiens fatigans* (Sinton, 1917b).[2]

A. neurogangliorum

Anopheles maculipennis (Conradetti, 1937).

Cercaria anophelini

Anopheles aconitus (cercarial stage, 68% of larvae infected); *A. annularis* (12% infected); *A. culicifacies* (40% infected) (Jones, 1950).

C. armata

Culiseta annulata (=*Theobaldia annulata*) (cercariae enter and cause death of larvae); *Culex pipiens* (cercariae enter and cause death of larvae) (Fülleborn, 1922).

Culex hortensis (in larvae, pupae and adults) (Joyeux, 1918).

Distomum globiporum

Anopheles maculipennis (Alessandrini, 1909).

Distomum sp.

Anopheles maculipennis (cercariae in larvae) (Eckstein, 1922).

Encysted larval trematodes

Anopheles culicifacies; *A. maculatus willmori* (adult female) (Sinton, 1917b, 1932).

Anopheles maculipennis (Reinhard, 1924).

Lecithodendrium ascidia

Anopheles maculipennis (encysted metacercariae); *Anopheles* sp. (encysted metacercariae) (Alessandrini, 1909).

Opisthioglyphe armata

Culex hortensis (Speer, 1927).

Pneumonoeces similis

Development of the metacercariae may take place in *Anopheles* (van Thiel, 1954).

Pneumonoeces variegatus (=*Agamodistomum anophelis*)

Anopheles maculipennis (cercarial stage in the mosquito; development into adult lung flukes takes place in the frog *Rana esculenta*) (van Thiel, 1921, 1922, 1925, 1930, 1954).

Xiphidiocercaria polyxena

Cercariae encysted on larval surface cause paralysis and death (Brumpt, 1945).

Unidentified trematodes

Anopheles maculipennis; *A. claviger* (=*A. bifurcatus*); *Culex hortensis*; *C. pipiens* (Eckstein, 1922).

Attempted artificial infection (Soparkar, 1918).

[1] There are of course many relevant references in the extensive literature on filariasis transmission, which is not covered in this compilation.

[2] Identification of parasite uncertain.

ACARINA

Acarina of several types attach themselves to the thorax or abdomen of mosquitos. They are often parasitic and in some cases cause pathological changes. Heavy infestations result in death, but light ones appear to have little effect. Acarina are found abundantly throughout most of the world.

(1) TROMBIDIFORMES

CHEYLETIDAE

Cheyletus eruditus

Anopheles sp; *Culex* sp. (Laveran, 1902).

(2) HYDRACHNELLAE

ARRENURIDAE

Arrenurus fimbriatus

Anopheles maculipennis (Münchberg, 1938, 1954).

A. madaraszi

Anopheles sinensis (pass from pupae to abdomen of adults; heavily parasitized females died before egg laying or laid fewer eggs) (Uchida & Miyazaki, 1935; Miyazaki, 1951).

Anopheles yatsushiroensis (Miyazaki, 1951).

Culex sp. (attached to neck and thorax; mosquitos parasitized by more than four mites do not bite man (Uchida & Miyazaki, 1935).

Arrenurus sp.

14 host species include *Anopheles claviger* and *A. maculipennis* (mites attach to larvae, suck body juices, and increase to 16 times original size; they are found on pupae and adults too) (Münchberg, 1938, 1954).

Culex sp (on larvae) (Laveran, 1902).

Mansonia perturbans (Snow, personal communication, 1957).

EYLAIDAE

Eylais sp.

Various mosquitos (Howard, Dyar & Knab, 1912).

HYDRACHNIDAE

Hydrachna sp.

Anopheles maculipennis (Giles, 1902).

A. maculipennis (Reinhard, 1924).

Culex sp. (Sergent & Sergent, 1904).

HYDRYPHANTIDAE

Hydryphantes ruber

Larvae and nymphs on adult *Culex* sp. (Crowell, 1961).

Diplodontus despiciens

Aedes cantans and *A. rusticus* (attack abdomen and thorax of adult (Marshall, 1938).

LEBERTIIDAE

Lebertia tau-insignata

Aedes annulipes, *A. cinereus*, and *Anopheles claviger* (attacks abdomen of adult) (Marshall & Staley, 1929).

Anopheles maculipennis and *Culiseta morsitans* (attacks abdomen of adult) (Marshall, 1938).

LIMNESIIDAE

Limnesia jamurensis

Mansonia unicolor ? (Speer, 1927).

UNIONICOLIDAE

Atax sp.

Anopheles pharoensis; *A. squamosus* (Giaquinto Mira, 1940).

(3) SARCOPTIFORMES

ACARIDAE

Tyroglyphus siro

Culex and *Anopheles* (Laveran, 1902).

" Water mites "

Nesoea fuscata?

Anopheles claviger (=*A. bifurcatus*); *A. maculipennis* (Blanchard, 1905 (see Speer, 1927)).

Thyas stolli

Aedes vexans (Crowell, 1961).

Thyas sp.

Mosquitos (Davies, 1959).

Aedes caspius (=*Taeniorhynchus africanus*) (Gillett, 1957a).

Unidentified mites [1]

Aedes caspius (=*Taeniorhynchus africanus*); *Anopheles coustani* (=*A. mauritianus*); *A. pharoensis*; *Culex pipiens fatigans* (Dye, 1924).

[1] Usually larval water mites.

Unidentified mites (continued)

Aedes triseriatus (infected once); *Anopheles crucians*; *A. quadrimaculatus*; *A. punctipennis*; *Culex abominator* (larvae and adult); *C. territans* (rarely infected); *Mansonia perturbans*; *Toxorhynchites septentrionalis* (rarely infected). The earliest emerging *Anopheles* and *Mansonia* showed over 95% parasitization: " It is certainly very probable that this mite destroys quite a good many mosquitoes " (Thibault, 1910).

Aedes trivittatus (15 mites per female; caused reduction in fecundity) (Abdel-Malek, 1949).

Aedes spp. (adults bearing 20 or more mites were found dead on water surface (Hocking, Richards & Twinn, 1950).

Anopheles gambiae; *Culex annulioris*; *Mansonia africana* (Brown, 1936).

Anopheles maculipalpis; *A. stephensi*; *A. willmori* (Sinton, 1917a).

Cause pathological changes (Feng & Hoeppli, 1933).

Dark serpentine tubes in integument of infected adults (Marshall & Staley, 1929).

2. PREDATORS OF MOSQUITO EGGS

MOLLUSCA

Bullinus pectorosus

Feeds on eggs and egg rafts (Hamlyn-Harris, 1929b).

ACARINA

Eutrombicula alfreddugesi

Aedes aegypti (adults and nymphs ate eggs in the laboratory; may eat eggs of other species in the field) (Jenkins, 1947).

E. batatas

Aedes aegypti (same comments as for *E. alfreddugesi*) (Jenkins, 1947).

E. goldii

Aedes aegypti (same comments as for *E. alfreddugesi*) (Jenkins, 1947).

E. splendens

Aedes aegypti (same comments as for *E. alfreddugesi*) (Jenkins, 1947).

Limnesia jamurensis

Anopheles farauti; *Culex pullus* (ate eggs in laboratory experiments) (Laird, 1947).

Trombicula alleei

Aedes aegypti (adults and nymphs ate eggs in the laboratory; may eat eggs of other species in the field) (Jenkins, 1947).

INSECTA

CORRODENTIA

Psocidae

Aedes aegypti (ate stored eggs [1]) (Bacot, 1916; Christophers, 1959).

ORTHOPTERA

Cockroaches

Ate stored eggs (Christophers, 1959).

HYMENOPTERA

Ants

Aedes scutellaris (=*A. variegatus*) (Buxton & Hopkins, 1927).

COLEOPTERA

CARABIDAE

Agonum pusillum

Aedes (Stage, Gjullin & Yates, 1952; Stage & Yates, 1939).

Bembidion sp.

Aedes (Stage, Gjullin & Yates, 1952; Stage & Yates, 1939).

Pterostichus algidus

Aedes (Stage, Gjullin & Yates, 1952; Stage & Yates, 1939).

Trechus chalybaeus

Aedes (ate 1-2 eggs per day) (Stage, Gjullin & Yates, 1952; Stage & Yates, 1939).

[1] This may not be true, since psocids are known to eat fungus, and they may merely be eating the fungus that occurs frequently on stored eggs (Jenkins, 1962).

3. PREDATORS OF LARVAL MOSQUITOS

COELENTERATA

Hydra americana (=*H. vulgaris*)

Culex (1st- to 3rd-instar larvae; paralyses many more larvae than required for food) (Twinn, 1931).

Eats mature larvae and pupae (Matheson & Hinman, 1931).

H. fusca

Hargreaves (1923).

Anopheles maculipennis; *Culex pipiens* (Jablokov, 1926).

H. vulgaris

Eats large numbers of larvae in rice fields (Hamlyn-Harris, 1929b, 1930).

Hydra sp.

Anopheles maculipennis (Bragina, 1929).

ROTATORIA

Brachionus dimidiatus

Anopheles farauti (temporary epibionts, browsing amongst ectocommensal ciliates, etc.) (Laird, 1956b).

B. quadridentatus

Anopheles farauti (same comments as for *B. dimidiatus*) (Laird, 1956b).

Habrotrocha tridens

Tripteroides purpurata (browsing among frass trapped in larval setae) (Laird, 1956b).

Habrotrocha sp.

Anopheles farauti (same comments as for *B. dimidiatus*) (Laird, 1956b).

Monostyla sp.

Anopheles farauti (same comments as for *B. dimidiatus*) (Laird, 1956b).

Unidentified rotifers

Mosquito larvae destroyed (Hinman, 1934a).

PLATYHELMINTHES

Planaria maculata

Aedes sticticus (ate 1-2 per day); *A. vexans* (ate 1-2 per day) (Stage & Yates, 1939).

Planaria sp.

Culex sp. and *Aedes aegypti* (ate 33 per day) (Lischetti, 1919).

ANNELIDA

Clespine sp.

Aedes excrucians; *A. pullatus* (Jenkins & Knight, 1950).[1]

Anopheles maculipennis (larvae eaten in aquarium; important in natural control) (Jablokov, 1926).

MOLLUSCA

Antimelania costula (=*Acrostoma variabilis*)

Mosquito larvae killed by a toxic substance given off by the snails (Pruthi, 1928).

Limnaea ovata

Anopheles maculipennis (eggs and larvae destroyed) (Gasanov, 1938).

Pila globosa

Mosquito larvae killed by a toxic substance given off by the snails (Pruthi, 1928).

Planorbula armigera

Aedes stimulans or *A. trichurus* (Baldwin, James & Welch, 1955).

Stagnicola palustris (=*Limnaea palustris*)

In both laboratory and field conditions *S. palustris* devoured larvae and pupae (Bishop & Hart, 1931).

Aedes stimulans or *A. trichurus* (Baldwin, James & Welch, 1955; James, 1961).

Vivipara bengalensis

Mosquito larvae killed by a toxic substance given off by the snails (Pruthi, 1928).

CRUSTACEA

Small crustacea

May compete with mosquito larvae for available food (Weed, 1924).

BRANCHIOPODA

Ceriodaphnia sp.

Competes for food and destroys larvae (Weed, 1924).

Daphnia pulex

Nips and pulls away hairs and finally eats larvae (Wilson, 1915).

[1] Identification of predator uncertain.

Streptocephalus seali

Competes for food with mosquito larvae (Bishop & Hart, 1931).

Triops granarius

Anopheles gambiae larvae absent from wells containing *Triops*; present in neighbouring ones lacking the crustacean) (Maffi, 1962a,b).

Triops longicaudatus (=*Apus lucasanus*)

Ate 60-100 mosquito larvae per day (Mail, 1934).

COPEPODA

Cyclops (*Megacyclops*) *viridis*

Preys on mosquito eggs and larvae (Lindberg, 1949).

C. (*Microcyclops*) *varicans*

Preys on mosquito eggs and larvae (Hurlbut, 1938).

Cyclops sp.

Preys on 1st- and 2nd-instar anopheline and culicine larvae (Hintz, 1951).

Mesocyclops obsoletus

Aedes sp; *Culex pipiens fatigans*; *Toxorhynchites brevipalpis* (eggs and larvae) (Bonnett & Mukaida, 1957).

MALACOSTRACA

AMPHIPODA

Crangonyx sp.

Aedes stimulans or *A. trichurus* (James, 1961).

Eucrangonyx sp.

Aedes stimulans or *A. trichurus* (Baldwin, James & Welch, 1955).

Gammarus pulex

Important larval predator (Apfelbeck, 1925).

Gammarus ?

Aedes aegypti (Hinman, 1934a).

Rivulogammarus roeselii (=*Carinogammarus roeselli*)

Important larval predator (Apfelbeck, 1925).

DECAPODA

Caridina nilotica brachydactyla

Culex annulirostris (ate 4 per day; larval predator under laboratory conditions) (Laird, 1956b).

C. typus

Uranotaenia argyrotarsis (ate dead larvae) (Laird, 1947).

Crabs

Eat larvae in ground pools (Hopkins, 1936).

Macrobrachium lamarrei (=*Palaemon lamarrei*)

Ate 11 larvae per day (Pruthi, 1928).

Culex pipiens fatigans (ate 3 per day) (McCay & Senior-White, 1941).

Paratelphusa spinigera

Eats many larvae (Pruthi, 1928).

Prawns

Eat larvae in ground pools (Hopkins, 1936).

Salt-water shrimps

Eat larvae in ground pools (Howard, Dyar & Knab, 1912).

Varuna litterata

Ate 42 per day (Pruthi, 1928).

ARACHNIDA

Dolomedes sp.

Aedes stimulans or *A. trichurus* (James, 1961).

Pardosa sternalis

Aedes vexans (larvae and pupae) (Bishop & Hart, 1931).

ACARINA

Limnesia jamurensis

Anopheles farauti and *Culex pullus* (eats eggs and 1st-instar larvae) (Laird, 1947).

Dark-red mite

Kills large numbers of larvae (Hearle, 1926).

Red mite

Mosquito larvae important food (Hearle, 1926).

INSECTA

(1) EPHEMEROPTERA

Cloeon spp.

Anopheles farauti; *Culex annulirostris* (nymphs stalk and seize mosquito larvae) (Laird, 1956b).

Ephemerid larvae

Aedes stimulans or *A. trichurus* (Baldwin, James & Welch, 1955).

Efficient predators (Howard, Dyar & Knab, 1912).

Eat mosquito larvae (Eysell, 1905; Foley & Yvernault, 1908; Ingram & Macfie, 1917; Lamborn, 1922; Waterston, 1918).

(2) NEUROPTERA

Aquatic larvae

Predacious on anopheline larvae; when confined in basins, the larvae ate one another instead of available mosquito larvae (Lamborn, 1921a).

(3) ODONATA

ANISOPTERA [1]

Aeschna septentrionalis nymphs

Aedes spp. (James, 1951).

Aeschna sp. nymphs

Aedes spp. (James, 1951).

Anopheles (Federici, 1920).

Anax guttatus nymphs

Eat mosquito larvae (Pruthi, 1928).

A. junius nymphs

Anopheles quadrimaculatus (Brooke & Proske, 1946).

Anax sp. nymphs

Anopheles (Federici, 1920).

Bradinopyga geminata nymphs

Eat mosquito larvae (Pruthi, 1928).

Crocothemis servilia nymphs

Eat mosquito larvae (Pruthi, 1928).

Dragonfly nymphs

Culex sp. (ate 6 per day) (Twinn, 1931).

Culex sp. (ate 192 in 19 hours) (Hearle, 1926).

Eat mosquito larvae (Geiger & Purdy, 1919; Ingram & Macfie, 1917; MacGregor, 1924).

Gomphus sp. nymphs

Anopheles (eat some larvae) (Federici, 1920).

Gymnocantha sp. nymphs

Eat mosquito larvae (Pruthi, 1928).

Ictinus rapax nymphs

Eat mosquito larvae (Pruthi, 1928).

Libellula pectoralis nymphs

Eat mosquito larvae (Eysell, 1905; Nezlobinski, 1915).

Orthetrum villosovittatum nymphs

Anopheles farauti; *Culex pullus* (Laird, 1947).

Pantala flavescens nymphs

Aedes aegypti (ate up to 550 per day) (Young, 1921).

Aedes sollicitans (Bromley, 1948).

Culex pipiens fatigans (Young, 1921).

ZYGOPTERA

Agrionidae nymphs

Culex sp. (eat larvae at surface) (Howard, Dyar & Knab, 1912).

Austroagrion sp. nymphs

Anopheles farauti; *Culex pullus* (Laird, 1947).

Calopteryx sp. nymphs

Anopheles (Federici, 1920).

Ceriagrion coromandelianum nymphs

Eat mosquito larvae (Pruthi, 1928).

Coenagrion sp. nymphs

Aedes spp. (James, 1951).

Enallagma sp. nymphs

Culex sp. (ate 4 per day (Twinn, 1931).

Ischnura senegalensis nymphs

Eat mosquito larvae (Pruthi, 1928).

Lestes sp. nymphs

Eat mosquito larvae (Federici, 1920).

Pseudagrion microcephalum nymphs

Eat mosquito larvae (Pruthi, 1928).

(4) HEMIPTERA

BELOSTOMATIDAE

Belostoma fluminea

Aedes stimulans or *A. trichurus* (predation determined by radioisotope) (Baldwin, James & Welch, 1955).

Belostoma spp. (= *Zaitha* spp.)

Aedes aegypti; *Culex pipiens fatigans* (Young, 1921).

Anopheles sp. (Lamborn, 1921a, 1922).

Effective predators (Williamson, 1926).

Lethocerus indicus (= *Belostoma indicum*)

Ate 4 larvae per day (Pruthi, 1928).

Sphaerodema annulatum

Ate 28 larvae per day (Pruthi, 1928).

Culicine and anopheline larvae; ate 23 per day (Toumanoff, 1941b).

[1] Anisopteran nymphs are primarily bottom feeders. Thus, while they consume more larvae than do the frailer Zygoptera under experimental conditions, they are probably of less significance in nature, since zygopteran nymphs usually range freely through the water mass and thereby contact both anopheline and culicine larvae relatively frequently (Laird, 1947).

Sphaerodema sp.
Hoffmann (1927).

CORIXIDAE

Arctocorixa convexa
Aedes spp. (ate 2 per day) (James, 1951).

A. hieroglyphica
Anopheles (Kirkpatrick, 1925).

Callicorixa audeni
Aedes communis (ate 2 per day) (Sailer & Lienk, 1954).
Aedes stimulans or *A. trichurus* (predation determined in field by radioisotope) (Baldwin, James & Welch, 1955),

C. alaskaensis
Aedes spp. (Sailer & Lienk, 1954).

Corixa striata
Anopheles (Federici, 1920).

Corixa sp.
Ate 2 per day (Vladimirov & Smirnov, 1932).
Important in natural control (Williamson, 1926).
Eysell (1905); MacGregor (1924).
Anopheles (Federici, 1920).

Corixids
Ate 4 larvae in 19 hours (Hearle, 1926).

Hesperocorixa interrupta (=*Arctocorixa interrupta*)
Important predator (Clarke, 1938).

Macrocorixa geoffroyi
Culex and *Anopheles* (ate 3 per day) (Vladimirov & Smirnov, 1932).
Culicines (Apfelbeck, 1925; Williamson, 1926).

Micronecta scutellaris (=*Micronecta dione*)
Ate 23 larvae per day (Hamlyn-Harris, 1929b).

Trichocorixa louisianae
Culex sp. (ate 2 larvae per day; eats anophelines and culicines (Hinman, 1934a).

GERRIDAE

Anopheles (larvae eaten at surface) (Smith, 1904).

Gerris comatus
Aedes stimulans or *A. trichurus* (James, 1961).

Gerris sp.
Aedes stimulans or *A. trichurus* (predation in field determined by radioisotope) (James, 1961).

Limnogonus fossarum
Anopheles larvae; *Culex fraudatrix* (ate teneral emerging adults) (Laird, 1947).

HYDROMETRIDAE

Very important predators of *Anopheles* larvae (Apfelbeck, 1925).

Hydrometra sp.
Ate 15 larvae per day (Pruthi, 1928).

NAUCORIDAE

Naucoris cimicoides
Anopheles (Federici, 1920).
Eats both larvae and pupae (Eysell, 1905).
Hamlyn-Harris (1929a).
Ate 8 larvae per day (Vladimirov & Smirnov, 1932).

NEPIDAE

Cercometus sp.
Feeds almost exclusively on mosquito larvae, eating 20 per day; one adult can keep an area of 5-6 yards radius around itself almost clear of larvae (Williamson, 1925, 1949).

Laccotrephes griseus
Ate 26 larvae per day (Pruthi, 1928).

L. kohlii
Eats both larvae and pupae; under experimental conditions appeared to have some biological control potential (Hoffmann, 1927, 1933).

L. tristis
Hamlyn-Harris (1929b).

Laccotrephes sp.
Controlled larvae (Hoffmann, 1927).

Nepa cinerea
Eysell (1905); Waterston (1918).

Ranatra chinensis
Reported to be an active larval predator (Hoffmann, 1930).

R. fusca (adult)
Anopheles quadrimaculatus (Brooke & Proske, 1946).

R. fusca (nymphs)
Anopheles and *Culex* (ate 33 per hour) (Howard, Dyar & Knab, 1912; Smith, 1904).

Ranatra linearis
Eysell (1905).

R. longipes
Ate 34 larvae per day (Pruthi, 1928).

Ranatra sp.
Ate 3 larvae per day (Twinn, 1931).
Ate stream-inhabiting larvae (Barber et al., 1915).
Williamson (1925).

NOTONECTIDAE

Anisops assimilis
Graham (1939).

A. cleopatra
Artificial introduction failed to control mosquitos (Davis, 1949).

A. producta
Destroys large numbers of larvae ((Poisson, 1925).

Enithares bergrothi
Anopheles farauti; *Culex pullus* (Laird, 1947).

Enithares sp.
Aedes scutellaris (Christophers, 1960).

Notonecta glauca
Anopheline and culicine larvae (Ingram & Macfie, 1917; Wilson, 1915).

N. undulata
Most voracious of all Hemiptera known to him (Hinman, 1934a).
Ate 200 larvae per day (Clarke, 1938).
Appeared in numbers and controlled larvae (Lutz & Chambers, 1902).

Notonecta sp.
Introduced into 17 water tanks and killed all larvae (Dempwolff, 1904; Howard, Dyar & Knab, 1912).
Ate about 25 larvae per day (Balfour, 1915; Bare, 1926; Boyce, 1909; Eysell, 1905; Vladimirov & Smirnov, 1932).
Apfelbeck (1925); Federici (1920); Hamlyn-Harris (1929b); MacGregor (1924a); Poisson (1925); Waterston (1918).
Ate 94 larvae in 8 hours ((Hearle, 1926).
Culex sp. (ate 9 per day) (Twinn, 1931).

Plea sp.
Ate 27 larvae per day (Pruthi, 1928).

SALDIDAE

Saldula interstitialis
Fed on stranded pupae (Darrow, 1949).

VELIIDAE

Anopheles (Apfelbeck, 1925).

Microvelia capitata
Anopheles albimanus (adults sucked body fluids of 1st- to 4th-instar larvae); *A. pseudopunctipennis* (ate larvae) (Frick, 1949).

M. schneideri
Attacked adults as they emerged (Bragina, 1931).

Microvelia sp.
Culex femineus (ate egg rafts) (Laird, 1956b).

Velia currens
Anopheles claviger (=*A. bifurcatus*) (attacked larvae in wells (Apfelbeck, 1925).

(5) TRICHOPTERA

LIMNEPHILIDAE

Limnephilus indivisus
Aedes stimulans or *A. trichurus*; *A. trichurus* (Baldwin, James & Welch, 1955; James, 1961).

Limnephilus sp.
Aedes stimulans or *A. trichurus* (predation in field determined by radioisotope) (Baldwin, James & Welch, 1955; James, 1961).

PSYCHOMYIIDAE

Larval psychomyid trapped *Aedes* sp. in net (Twinn, 1931).

(6) COLEOPTERA

CARABIDAE

Bembidion americanum
Fed on stranded larvae (Darrow, 1949).

CHRYSOMELIDAE

Haltica ignea

Has poisonous property that kills plants and mosquito larvae (Hamlyn-Harris, 1930b).

CINCINDELIDAE

Cincindela octoguttata

Aedes aegypti; *Anopheles gambiae* (=*A. costalis*) (larvae and pupae); *Culex pipiens fatigans*; *C. thalassius* (Macfie, 1923).

DYTISCIDAE

Acilius semisulcatus

Aedes stimulans or *A. trichurus* (James, 1961).

A. sulcatus

Culex (ate 40 larvae per day) (Eysell, 1905).

Ate 24 larvae per day (Vladimirov & Smirnov, 1932).

Acilius sp.

Attacks culicines and anophelines (Waterston, 1922).

Agabus erichsoni

Aedes stimulans or *A. trichurus* (James, 1961).

A. phaeopterus

Aedes stimulans or *A. trichurus* (James, 1961).

A. sharpi

Aedes stimulans or *A. trichurus* (James, 1961).

A. solieri

Aedes pullatus (fed on pupae) (Galli-Valerio, 1926).

A. sturmi

Mostly *Culex* (ate 14 per day) (Vladimirov & Smirnov, 1932).

A. undulatus

Ate 8 larvae per day (Vladimirov & Smirnov, 1932).

Agabus sp.

Aedes sp. (ate 4 larvae per day) (Sailer & Lienk, 1954).

Carrhydrus crassipes

Ate 1 larva per day (James, 1951).

Coelambus impressopunctatus

Ate 5 larvae per day (Vladimirov & Smirnov, 1932).

Colymbetes fuscus

Ate 20 larvae per day (Hargreaves, 1923).

C. sculptilis

Aedes stimulans or *A. trichurus* (James, 1961).

Copelatus caelatipennis

Aedes taeniorhynchus (Nielsen & Nielsen, 1953).

C. chevrolati

Aedes taeniorhynchus (Nielsen & Nielsen, 1953).

Copelatus sp.

Anopheles farauti (Laird, 1947).

Culex pullus (feeds at surface and destroys both culicine and anopheline larvae) (Laird, 1947, 1956b).

Cybister desjardinsi

Ate 8 larvae per day (Howard, Dyar & Knab, 1912).

C. limbatus

Ate 17 larvae per day (Pruthi, 1928).

Cybister sp. (larvae)

Anopheles quadrimaculatus (Brooke & Proske, 1946).

Dytiscus hybridus

Ate 1000 larvae per day (Clarke, 1938).

D. marginalis

Ate a great number of larvae (Howard, Dyar & Knab, 1912).

Vladimirov & Smirnov (1932).

Dytiscus sp.

Aedes vexans (larvae ate 250 mosquito larvae per day) (Hearle, 1926).

Important enemy; ate 217 mosquito larvae per day (Chidester, 1917).

Unidentified Dytiscidae

Aedes stimulans or *A. trichurus* (predation by larvae and adults in field determined by radioisotope) (Baldwin, James & Welch, 1955).

Larvae important in mosquito control in Australia (Jones, 1918).

Larvae ate 3 mosquito larvae per day (Twinn, 1931).

Larvae ate 300 mosquito larvae per day (Hearle, 1926).

Larvae very important in control of *Aedes flavescens* (Hearle, 1929).

Eretes sticticus

Important in control of *Anopheles* (Kerandel, 1925).

Ate 35 larvae per day (Pruthi, 1928).

Ate 100 larvae per day (Sher Khan, 1942).

Hydaticus bimarginatus

Culex pipiens fatigans (ate 25 larvae per day) (Hinman, 1934a).

Hydaticus consanguineus
Eats culicine larvae (Laird, 1956b).

H. litigiosus
Anopheles farauti; *Culex pullus* (destroyed about 30 times as many *Culex* as *Anopheles* larvae) (Laird, 1947).

Hydaticus sp.
Kills mosquito larvae (Ingram & Macfie, 1917).

Hydroporus aper
Anopheline and culicine larvae (Fletcher, 1928).

H. tenebrosus
Aedes stimulans or *A. trichurus* (James, 1961).

Hygrotus turbidus
Aedes stimulans or *A. trichurus* (James, 1961).

Hyphydrus ferrugineus
Ate 14 larvae per day (Vladimirov & Smirnov, 1932).

Ilybius ater
Ate 16 larvae per day (Vladimirov & Smirnov, 1932).

I. fenestratus
Ate 7 larvae per day (Vladimirov & Smirnov, 1932).

Laccophilus clarki
Voracious (Laird, 1956b).

Macrodytes marginalis
Ate 26 larvae per day (Vladimirov & Smirnov, 1932).

Platynectes insularis
Laird (1956b).

Rhantus notatus
Aedes stimulans or *A. trichurus* (James, 1961).

R. zimmermani
James (1951).

Thermonectus basillaris
Aedes taeniorhynchus (Nielsen & Nielsen, 1953).

GYRINIDAE

Dineutus indus
Ate 25 larvae in 3 hours (Howard, Dyar & Knab, 1912).
Anopheles (ate 8 larvae per day) (Derivaux, 1916).

D. assimilis
Anopheles (ate 38 larvae per day) (Clarke, 1938).

Gyrinus lecontei
Aedes stimulans or *A. trichurus* (predation in field determined by radioisotope) (Baldwin, James & Welch, 1955).

G. sericeolimbatus
Anopheles punctulatus (readily devoured larvae in transient pools) (Laird, 1947).

Orectochilus gangeticus
Ate 11 larvae per day (Pruthi, 1928).

HYDROPHILIDAE

Berosus infuscatus
Aedes taeniorhynchus (Nielsen & Nielsen, 1953).

Hydrochara obtusatus (=*Hydrophilus obtusatus*)
Aedes stimulans or *A. trichurus* (Baldwin, James & Welch, 1955; James, 1961).
Important enemy of mosquito larvae (Howard, Dyar & Knab, 1912).

Hydrophilus olivaceus
Larvae ate 25 mosquito larvae per day (Pruthi, 1928).

H. triangularis
3 larvae each ate about 1000 mosquito larvae (Clarke, 1938).

Tropisternus lateralis nimbatus
Exterminated larvae of *Aedes taeniorhynchus* in study pools (Nielsen & Nielsen, 1953).

Tropisternus spp.
Anopheles crucians; *A. quadrimaculatus* (decreased population by 81% from 1st to 4th instar) (Hixson, 1943).

(7) DIPTERA

CALLIPHORIDAE

Lucilia caesar
Fed on *Culex pipiens* larvae in drained breeding place (Hornig, 1923).

CERATOPOGONIDAE

Forcipomyia indecora (=*Forcipomyia ingrami*)
Aedes aegypti (preys on larvae in tree holes) (Carter, 1919).

CHAOBORIDAE

Chaoborus borealis
Aedes spp. (James & Smith, 1958).

Chaoborus crystallina

Aedes communis (Jenkins, 1950a).
Aedes vexans (Twinn, 1931).

C. flavicans

Aedes spp. (James, 1950, 1951).
Aedes spp. (ate 9 larvae per day) (Sailer & Lienk, 1954).

C. nyblaei

Aedes excrucians; *A. pullatus*; very effective predator (Jenkins & Knight, 1950).
Aedes spp. (James & Smith, 1958).

C. punctipennis

Culex pipiens (Howard, Dyar & Knab, 1912).
Mosquito larvae (Twinn, 1931).

C. trivittatus

Mosquito larvae (Hearle, 1926).

Corethra cinctipes

Aedes vexans (ate 11 larvae per day) (Twinn, 1931).
Culiseta melaneura (Smith, 1904).

C. culiciformis

Culiseta morsitans (Twinn, 1931).

Corethra sp.

Aedes (Howard, Dyar & Knab, 1912).

Corethrella jenningsi

Feeds readily on young mosquito larvae (Lane & Aitken, 1956).

C. tarsata

Wyomyia (ate 4th-instar larvae in bromeliad) (Lane & Aitken, 1956).

Corethrella sp.

Leaf-axil breeders (Laird, 1956b).

Eucorethra underwoodi

Aedes aboriginis (Dyar, 1924a)
Aedes communis; *A. hexadontus* (Jenkins, 1950a).
Aedes excrucians; *A. pullatus*; *A. punctor* (Jenkins & Knight, 1950).
Culiseta impatiens (Twinn, 1931).
Culiseta melanura (Lake, 1960).
Predacious (Hearle, 1926; Underwood, 1903).
Ate 4 larvae in 10 hours (Howard, Dyar & Knab, 1912).

Mochlonyx velutinus (= *Mochlonyx culiciformis*)

Aedes communis (Jenkins, 1957).
Aedes stimulans (not effective owing to comparatively small size); *Aedes trichurus* (James, 1957).
Aedes spp. (excellent control) (Curtis, 1953; Jenkins & Knight, 1952).
Aedes spp. (excellent control; where present, mosquito larvae were almost completely absent) (Curtis, 1953; Twinn, 1926, 1931).
Aedes spp. (not significant predator, as evaluated by radioisotope technique) (Baldwin, James & Welch, 1955).

M. cinctipes

Aedes stimulans (not important for field control of this species) (O'Connor, 1959).
Aedes spp. (Twinn, 1931).

CHIRONOMIDAE

Chironomid larvae

Anopheles punctipennis (Hegh, 1921).

Pentaneura dyari (= *Tanypus dyari*)

Destroyed mosquito larvae (Howard, Dyar & Knab, 1912).

CULICIDAE

Aedes (*Mucidus*) *alternans*

Aedes vigilax; *Anopheles annulipes* (Hamlyn-Harris, 1927).

Aedes (*Mucidus*) *scatophagoides*

Predacious on larvae (Howard, Dyar & Knab, 1912; Innes, 1925).

Aedes (*Finlaya*) *notoscriptus*

Cannibalistic (Hamlyn-Harris, 1929a).

Anopheles barberi ?

Predacious (Howard, Dyar & Knab, 1912).

Anopheles costalis

Cannibalistic (Balfour, 1921).

Anopheles maculatus

Senior-White (1926).

Anopheles punctipennis

Aedes taeniorhynchus (Nielsen & Nielsen, 1953).
Cannibalistic (Hinman, 1934a).

Armigeres obturbans (= *Desvoidya obturbans*)

Anopheles subpictus; *Culex gelidus*; cannibalistic (Iyengar, 1920).

Culex (*Lutzia*) *allostigma*

Anopheles apicimacula; *A. argyritarsis*; *A. eiseni*; *A. evansae* (=*A. strodei*); *A. kompi*; *A. punctimacula*; *Chagasia bathana*; *Culex conspirator*; *C. corniger*; *C. coronator*; *C. declarator*; *C. mollis*; *Haemogogus argyromeris*; *H. lucifer*; *Uranotaenia coatzacoalcos* (Arnett, 1950).

Culex (*Lutzia*) *bigoti*

Aedes aegypti (effective predator) (Howard, Dyar & Knab, 1912).

Culex (*Lutzia*) *fuscanus* (=*C. concolor*)

Anopheles stephensi (Iyengar, 1920).

Cannibalistic (Bentley, 1910; Borel, 1926).

Culex (*Lutzia*) *halifaxii*

Anopheles farauti; *Culex pullus*; eats larvae and is also cannibalistic (Laird, 1947).

Predacious on various species of mosquito larvae (Bertram, 1927).

Culex (*Lutzia*) *tigripes*

Aedes aegypti (ate 88 larvae) (Jackson, 1953).

A. aegypti (Hill, 1917).

Anopheles funestus (McHardy, 1927).

Anopheles gambiae (effective in small pools) (Haddow, 1942b; McHardy, 1927).

Culex pipiens fatigans (McHardy, 1927).

Cannibalistic (MacGregor, 1927).

Culex tritaeniorhynchus (Ingram & Macfie, 1917).

Culex (*Lutzia*) *vorax*

Aedes japonicus; *A. togoi*; *Anopheles hyrcanus*; *Culex tritaeniorhynchus*; *C. vagans* (Pavlovskij, 1948).

Culex pipiens fatigans (Edwards, 1921).

Cannibalistic (Severn, 1926).

Culex (*Culex*) *mimeticus*

Predacious on other larvae (Buddle, 1928).

Culiseta longiareolata

Predacious and cannibalistic (Foley, 1923; Hargreaves, 1923; Kirkpatrick, 1925).

Eretmapodites chrysogaster

Aedes simpsoni (larvae readily eaten in the field; in the laboratory large *Eretmapodites* larvae each ate 6 *Aedes* larvae in 24 hours and 2nd instar each ate 5 larvae in 24 hours); *Culex nebulosus*; *Harpagomyia taeniorostris*; *Uranotaenia ornata musarum*. The four prey species are attacked and destroyed in plant axils, and cannibalism is not pronounced (Haddow, 1946).

Eretmapodites ferox (=*E. dracaena* of Gibbins, not Edwards)

Aedes simpsoni (each large *Eretmapodites* larva ate 9 *Aedes* larvae in 24 hours, and the prey was killed very rapidly) (Haddow, 1946).

Aedes simpsoni (Gibbins, 1942).

Eretmapodites inornatus

Aedes simpsoni (each large *Eretmapodites* larva ate 2 *Aedes* larvae in 24 hours) (Haddow, 1946).

Eretmapodites leucopus productus

Aedes simpsoni (each large *Eretmapodites* larva ate 2 *Aedes* larvae in 24 hours) (Haddow, 1946).

Eretmapodites penicillatus

Aedes simpsoni (each large *Eretmapodites* larva ate 5 *Aedes* larvae in 24 hours) (Haddow, 1946).

Eretmapodites semisimplicipes

Aedes simpsoni (each large *Eretmapodites* larva ate 8 *Aedes* larvae in 24 hours) (Haddow, 1946).

Eretmapodites silvestris conchobius

Cannibalistic (Hoogstraal & Knight, 1951).

Opifex fuscus

Predacious and cannibalistic (Miller, 1922).

Psorophora ciliata

Aedes taeniorhynchus (Nielsen & Nielsen, 1953).

Aedes vexans (ate 3-4 larvae per day); *Psorophora confinnis* (ate 3-4 larvae per day) (Breeland, Snow & Pickard, 1961).

Culex pipiens (Allen, 1922; Smith, 1904).

Psorophora confinnis (Dyar, 1922).

Cannibalistic (Allen, 1922; Breland, 1948).

3 large larvae ate 27 smaller larvae of their own species and *P. confinnis* in one night (Hinman, 1934a).

Is wholly predacious (Dyar, 1922).

Psorophora howardii

Aedes vexans and other mosquito larvae (Breeland, Snow & Pickard, 1961).

Cannibalistic (Breland, 1948).

Psorophora lineata

Trichoprosopon digitatum (Arnett, 1950).

Sabethes bipartipes

Predacious (Bonne-Wepster & Bonne, 1925).

Sabethes cyaneus

Aedes terrens; *Culex declarator* (Dyar, 1926).

Sabethes undosus

Cannibalistic (Boyce, 1909).

Toxorhynchites [1] *brevipalpus* (= *T. marshalli*)

Aedes aegypti (ate 195 larvae in 12 days; 20 per night) (Garnham, Harper & Highton, 1946).

Aedes aegypti (ate 100-200 larvae; 30 per day; kills many larvae without eating them); *A. demeilloni*; *A. simpsoni*; *A. strelitziae* (Muspratt, 1952).

Aedes albopictus (Bonnett & Hu, 1951).

Aedes polynesiensis (introduced into Samoa and Tahiti) (Bonnet & Chapman, 1956; Peterson, 1956).

Aedes scutellaris (=*A. variegatus*) (introduced into South Pacific) (Wigglesworth, 1929).

Aedes (*Stegomyia*) spp. (Iyengar, 1920).

Culex sp. and syrphids (Lamborn, 1920).

Introduced into Hawaii in 1950 (Bonnett & Hu, 1915; Muspratt, 1952).

Toxorhynchites guadeloupensis (=*Megarhinus horei*)

Culex pipiens fatigans; *Uranotaenia calosomata* (Gordon, 1922).

Toxorhynchites haemorrhoidalis superbus (=*T. superbus*; *Megarhinus superbus*)

Anopheles cruzii (Dyar, 1928a).

Cannibalistic (Boyce, 1909).

Wyeomyia quasiluteoventralis; *W. scotinomus* (Arnett, 1950).

Toxorhynchites inornatus

Aedes albolineatus; *A. scutellaris*; *Armigeres lacuum*; cannibalistic (Laird, 1947).

Disappointing initial results from control standpoint, but dispersed for several miles radius (Swezey, 1931).

Introduced into Hawaii in 1929 (no longer found one year later); introduced into Fiji in 1931 and established (Paine, 1934).

Toxorhynchites rutilus rutilus

Aedes triseriatus (ate large number); *Orthopodomyia signifera* (ate 20 larvae per day); cannibalistic (Jenkins & Carpenter, 1946).

Orthopodomyia signifera, *Aedes triseriatus*, and *Culex pipiens fatigans* (ate 128 larvae in nature) (Basham, Mulrennan & Obermuller, 1947).

Toxorhynchites rutilus septentrionalis

Aedes triseriatus (ate 10 larvae per day); *Anopheles barberi*; *Orthopodomyia alba*; *O. signifera* (ate 8 larvae per day); cannibalistic (Jenkins & Carpenter, 1946).

Aedes vexans (1st- to 4th-instar larvae ate 200 *Aedes* larvae (Breeland, Snow & Pickard, 1961).

Ate an average of 9 larvae in 1st instar, 13 in 2nd instar, and 82 in 3rd and 4th instars. Feeds on other tree-hole mosquito larvae, including *Aedes triseriatus*, *Orthopodomyia signifera*, *O. alba*, and *Culex restuans*. In the laboratory feeds on *Aedes*, *Culex*, and *Culiseta* larvae when these are supplied (Lake, 1954).

Toxorhynchites ruwenzori

Aedes simpsoni (prepupal larvae killed 10-20 *Aedes* larvae per hour without eating them) (van Someren, 1948).

Toxorhynchites splendens (=*T. regius*)

Aedes aegypti (Paiva, 1910).

Aedes albopictus (introduced into Fiji and has gained a foothold; individual larvae have eaten 100-150 other larvae) (Paine, 1934, 1943).

Aedes polynesiensis (introduced into Samoa) (Peterson, 1956).

Aedes pseudoscutellaris (Lever, 1941).

Frequently cannibalistic (Newkirk, 1947; Paine, 1934).

Predacious on other mosquito larvae and cannibalistic (Severn, 1926).

Toxorhynchites theobaldi (=*Megarhinus hypoptes*; *M. moengoensis*; *M. moctezuma*; *T. trinidadensis*)

Aedes aegypti (Boyce, 1909; Urich, 1913).

Culex conservator; *Haemagogus argyromeris*; *H. lucifer*; *Wyeomyia arthrostigma*; *W. personata* (Arnett, 1950).

Culex pipiens fatigans (Urich, 1913).

Wyeomyia occulta (Bonne-Wepster & Bonne, 1923).

Toxorhynchites sp.

Aedes aegypti (a single example ate 21 *Aedes* larvae in one night) (Garnham, Harper & Highton, 1946).

Tripteroides mathesoni

Uranotaenia quadrimaculata (predacious on larvae, and also cannibalistic) (Laird, 1956b).

Trichoprosopon digitatum (=*T. wilsoni*)

Cannibalistic (Arnett, 1950; Ludlow, 1918).

Trichoprosopon compressum

Wyeomyia personata (Arnett, 1950).

Trisoprosopon longipes (=*Goeldia trichopus*)

Aedes aegypti; *Sabethes cyaneus*; *S. undosus*; *Wyeomyia complosa*; *W. pseudopecten* (Arnett, 1950).

Wyeomyia occulta (Bonne, 1923).

[1] (=*Megarhinus*).

Trichoprosopon (*Isostomyia*) sp.

Howard, Dyar & Knab (1912).

Trichoprosopon (*Runchomyia*) sp. (=*Listicocampa* sp.)

Bonne-Wepster & Bonne (1925).

Trichoprosopon perturbans

Wyeomyia pertinans (Dyar, 1924b).

Trichoprosopon sp. (=*Goeldia* sp.)

Howard, Dyar & Knab (1912).

Uranotaenia colocasiae

Capture and consume weaker larvae (Paine, 1943).

Uranotaenia unguiculatus

Cannibalistic (Kirkpatrick, 1925).

DOLICHOPODIDAE

Atkinson (1909); Christophers (1960); Howard, Dyat & Knab (1912).

Dolichopus appendiculatus

Bishop & Hart (1931).

D. nigricauda

Bishop & Hart (1931).

D. renidescens

Bishop & Hart (1931).

D. walkeri

Ate 7 larvae per day (Bishop & Hart, 1931).

Pelastoneurus collarti

Moves about on water surface and preys on larvae (Collart, 1927).

P. schoutedeni

Moves about on water surface and preys on larvae (Collart, 1927).

P. vagans

Fed on stranded larvae (Darrow, 1949).

Paraclius germanus

Fed on *Culex annulirostris* and *C. pipiens fatigans* (Travis, 1947b).

Thinophilus sp.

Fed on stranded larvae (Darrow, 1949).

EPHYDRIDAE

Ochthera brevitibialis

Fed on *Anopheles* (Travis, 1947b).

O. canescens

Fed on *Culex annulirostris* and *C. pipiens fatigans* (Travis, 1947b).

MUSCIDAE

Lispe armipes

Macfie & Ingram (1922).

L. sinensis

Attacks larvae, pupae, and emerging adults (Atkinson, 1909; Macfie & Ingram, 1922).

L. tentaculata var. *sakhaliensis*

Attacks larvae, pupae, and emerging adults of *Topomyia tipuliformis* (Yamada, 1927).

L. tuberculata

Eats larvae, pupae and emerging adults (Dufour, 1864).

L. uliginosa

Anopheles maculipennis (adults feed on larvae at surface of water) (Nikolsky, 1924).

Lispe sp.

Culex sp. (feeds on emerging adults) (Lamborn, 1920).

Phaonia mirabilis

Aedes geniculatus (larvae feed on tree-hole mosquito larvae; one example destroyed 80 mosquito larvae in 2 weeks) (Tate, 1935).

Stomoxys calcitrans

Surcouf (1923).

SIMULIIDAE

Simulium sp.

Attacked newly emerged mosquitos (Combes, 1896).

TIPULIDAE

Sigmatomera shannoniana

Aedes aegypti (in course of rearing, 20 tipulid larvae consumed about 2500 larvae of this mosquito) (Alexander, 1930).

A. aegypti (in tree holes) (Shannon, 1929).

VERTEBRATA

(1) FISH

There is a very extensive literature on the destruction of mosquitos by fish. Over 400 references have been consulted in summarizing this information. Of the several tabulations that have been made, the most ambitious is that of Gerberich (1946), who listed about 165 species of fish reported to be predacious on 35 species of mosquito in 41 countries. In the present review 189 species of fish are reported, together with a large number of synonyms. These are referable to 33 different families of the Class Teleostomi. They are found in nearly all countries of the world, in both temperate and tropical regions. They occur in fresh and brackish water in a wide variety of habitats, from wells and temporary pools to rivers, lakes, and extensive swamps and salt marshes. Some have been employed for the direct destruction of larvae, and others for modifying the habitat to render it unsuitable for mosquitos.

Various indigenous species of fish are reported to be highly effective in controlling mosquito larvae in their native habitats. Limited experiments have been carried out with these, to show their potential for more wide-scale application. Several species of fish have been found to be effective when transported beyond their natural range for mosquito control. Perhaps the most widely used fish are the top-minnows *Gambusia affinis* and *G. a. holbrooki*, native to the southern parts of N. America. These have been introduced into many parts of the world with varying results. Where larger predatory fish have been culled, and where *Gambusia* have been used with careful ecological insight, the latter have been quite successful in controlling culicine and in some cases anopheline mosquitos. The " millions fish ", *Girardinus poeciloides*, has been established in many places with success, as has *Lebistes reticulatus* (*Girardinus guppyi*). Various other fish have been transported and tested for mosquito control, including *Haplochilus panchax*, *Fundus heteroclitus*, *Pseudomugil signifer*, goldfish, and carp. The results of all such tests indicate that it is essential to exercise proper understanding of both the mosquito larvae to be controlled and their fish enemies, if the latter are to be of significance as biological control agents.

An interesting example of the indirect usefulness of fish against mosquitos is described by Schuster (1952), who states that in Indonesia (*Puntius*) = *Barbus javanicus* helps to keep milkfish ponds free from vegetation, thereby decreasing their suitability as anopheline larval habitats. The soft faecal masses of *B. javanicus* often contain incompletely digested vegetable matter, and both serve as food for milkfish (*Chanos chanos*, itself reported to feed on mosquito larvae) and stimulate the growth of Myxophyceae. It has been commented (Laird, personal communication) that the latter often contraindicate suitability of water bodies as mosquito larval habitats (see also Gerhardt, 1954, 1956).

Much of the literature is of a rather general nature, and many authors fail to name the species of mosquitos eaten or controlled. Specific references to relevant papers appearing in the bibliography are not given in the following list. For a detailed consideration of the subject, reference should be made to Gerbevitch (1946).

AMBASSIDAE

Ambassis baculis (glassfish), India; *A. commersoni* (glassfish), India, East Africa; *A. nama* (glassfish), India; *A. ranga* (glassfish), India; *Priopis olivaceus*, Australia.

ANGUILLIDAE

Anguilla sp. (eel), France.

ANABANTIDAE

Anabas testudineus (=*A. scadens*) (kazari, climbing perch), India to Philippines; *Betta pugnax* (Siamese fighting fish), Thailand; *Colisa fasciata* (=*Trichogaster fasciata*) (giant gourami), India; *C. lalia*, India; *Macropodus cupanus* (=*Polyacanthus cupanus*), India; *M. opercularis* (=*Polyacanthus opercularis*) (paradise fish), China; *M. paradisi* (paradise fish).

ASTROBLEPIDAE

Astroblepus (*Arges*) sp. (cave catfish), South America.

ATHERINIDAE

Craterocephalus fluviatilis (hardhead), Australia; *Labidesthes sicculus* (brook silversides), USA; *Melanotaenia nigrans* (rainbow fish), Australia; *Pseudomugil signifer* (rainbow fish), Australia.

CALLICHTHYIDAE

Hoplosternum littorale (catfish), South America.

CENTRARCHIDAE

Centrarchus macropterus (round sunfish, flier), USA; *Chaenobryttus gulosus* (warmouth), USA; *Elassoma evergladei* (pygmy sunfish), USA; *E. zonatum* (banded pygmy sunfish), USA; *Enneacanthus obesus* (spotted sunfish), USA; *E. gloriosus* (blue spotted sunfish), USA; *Lepomis cyanellus* (=*Apomotis cyanellus*) (green sunfish), USA; *L. gibbosus* (=*Eupomotis gibbosus*) (pumpkinseed, sunfish), USA; *Mesogonistius chaetodon* (black banded sunfish), USA.

CENTROPOMIDAE

Centropomus undecimalis (snook), USA.

CHANTIDAE

Chanos chanos (milkfish), Indonesia.

CHARACIDAE

Alestes sp., Africa; *Astyanax aeneus* (=*Tetragonopterus aeneus*) (characin), Mexico, South America; *A. bimaculatus*, Brazil; *A. rutilus*, Brazil; *Charax gibbosus* (silverbait), South America; *Hemigrammus rodwayi* (silverbait),

South America; *H. unilineatus* (silverbait, featherfin), South America; *Lebiasina bimaculata* (two-spotted lebiasina), western South America; *Piabucina festae* (includes records as *P. panamensis*), South America; *P. panamensis*, South America; *Tetragonopterus chalceus* (silverbait), South America.

CICHLIDAE

Cichlasoma bimaculatum (patwa, parch), South America; *C. octofasciatum* (patwa, perch), northern South America; *Etroplus maculatus*, India; *E. suratensis*, India; *Geophagus steindachneri*, South America; *Haplochromis nubelis*, Uganda; *Hemichromis microcephalus*, Gambia; *Tilapia heudeloti*, Africa; *T. mossambica*, South and East Africa; *T. natalensis*, East Africa; *T. nilotica*, East Africa, Upper Volta; *T. ovata*, East Africa; *T. zillii*, Palestine.

CLARIIDAE

Clarius lazera, Upper Volta.

COBITIDAE

Cobitus barbatula (=*Nemachilus barbatulus* (marbled loach), Europe, USSR; *Misgurnus angillicaudatus* (Japanese weatherfish), Japan, China; *Nemachilus malapterurus*, USSR.

CYPRINIDAE

Alburnus lucidus (bleak), Italy; *Alburnoides bipunctatus eichwaldi*, USSR; *Barbus figuiensis* (barb), Algeria; *B. phutunio* (dwarf barb), India; *B. sophore* (barb), India; *B. stigma* (barb), India; *B. terio* (barb), India; *B. ticto* (barb), India; *Brachydanio rerio* (=*Barilius rerio*, *Danio rerio*) (zebra fish); *Carassius auratus* (goldfish), worldwide; *Catla buchanani* (=*Catla catla*) (carp), India; *Chela argentea* (chilwai, white carp), India; *C. punctis*, India; *Cirrhina latia* (carp), India; *C. mrigala* (carp), India; *Cyclocheilichthys apogon*, Malaya; *Cyprinus carpio* (tench, carp), worldwide; *C. prasenus*, worldwide; *Dangila cuvieri*, Malaya; *Danio cyprinides*, India; *Esomus danricus* (=*Nuria danrici*) (flying barb), India, Burma; *Gila atraria* (chub), USA; *Iotichythys phlegethontis* (least chub), USA; *Labe orohita* (carp), India; *Leucaspius delineatus*, USSR; *Leuciscus erythrophthalmus*, Italy; *L. multicellus* (=*Telestes multicellus*), Asia; *L. rutilus* Switzerland; *Notemigonus chrysoleucas* (=*Abramis chrysoleucas*) (golden shiner), USA; *Paraphoxinus epiroticus*, Yugoslavia; *P. minutus*, Yugoslavia; *Perilampus atpar* (=*Laubuca atpar*), India; *P. laubuca* (=*Laubuca laubuca*), India; *Phoxinus laevis*; *Phoxinellus chaignoni*, Algeria; *Pseudogobio rivularis* (=*Pseudogobio sinensis*), China, USSR; *Pseudorasbora parva*, China, USSR; *Puntius javanicus* (barb), Indonesia; *Rasborichthys helfrichi*, Viet-Nam; *Rasbora daniconius* (rasboro), India; *Rhinichythys atratulus* (=*Rhinichthys atronasus*) (black-nosed dace), USA; *Rhodeus amarus* (bitterling), Yugoslavia; *Schizothorax progastus*, India, China; *Varichorhinus heratensis*, USSR.

CYPRINODONTIDAE

Aphanius iberus (=*Cyprinodon iberus*), Spain, Algeria, Morocco; *Aphysemion gardneri* (=*Fundulus gardneri*) (Togo fundulus), Togo, Africa; *Aplocheilus blochi* (=*Panchax parvus*) (haplochilus), India, Ceylon; *A. panchax* (=*Panchax panchax*, *Haplochilus panchax*) (techoko, kepala timah), India, Malayan region; *A. lineatus* (=*Panchax lineatus*, *Haplochilus lineolatus*, *H. rubrostigma*) (piku), India; *Cyprinodon calaritanus* (nonni, killifish), Italy, Palestine; *C. fasciatus* (killifish), Algeria; *C. hispanicus* (killifish), Spain; *C. macularius* (desert pupfish), western USA; *C. variegatus* (sheepshead minnow, sheepshead killifish), USA; *Fundulus bermudae*, Bermuda; *F. chrysotus* (golden top-minnow), USA; *F. confluentus* (marsh killifish), USA; *F. diaphanus* (fresh-water killy, banded killifish), USA; *F. grandis* (gulf killifish), USA; *F. heteroclitus* (mummichog, salt-water minnow, killifish), USA; *F. majalis* (striped killifish, star-headed minnow), USA; *F. notti* (=*F. dispar*) (star-headed top-minnow), USA; *F. notatus* (black stripe top-minnow), USA; *F. similis* (long-nosed killifish), USA; *Haplochilus melanostigma* (=*Aplocheilus*), India; *Horaichthys setnai*, India; *Lucania parva* (rainwater killifish), USA; *L. p. venusta* (rainwater killifish), USA; *Nothobranchius guentheri*, East Africa; *Oryzias javanicus* (=*Haplocheilus javanicus*), Indonesia, Malay Peninsula; *O. latipes* (=*Aplocheilus latipes*) (medaka, ricefish), Japan, China; *Pachypanchax playfairi* (=*Panchax playfairi*), Zanzibar, East Africa; *Rivulus marmoratus* (rivulus), USA; *R. santensis* (rivulus), Brazil; *Rivulus* sp., South America; *Tellia apoda*, Algeria.

ELEOTRIDAE

Carassiops compressus, Australia; *C.* (*Austrogobio*) galli, Australia; *Dormitator latifrons*, South America; *D. maculatus* (mapo, striped sleeper, fat sleeper), USA, South America; *Eleotris fusca* (sleeper), East Africa, Fiji; *E. swinhonis* (sleeper), China; *Lairdina hopletupus*, Fiji.

ELOPIDAE

Elops saurus (lady fish), USA; *Megalops atlantica* (tarpon), USA.

GALAXIDAE

Galaxias sp., Africa; *Percottus glehni*, USSR.

GASTEROSTEIDAE

Eucalia inconstans (brook stickleback), USA, Canada; *Gasterosteus aculeatus* (stickleback), Spain, USA; *G. cataphractus* (stickleback), western USA; *G. enneaculeatus* (stickleback), Italy; *Pungitius pungitius* (nine-spined stickleback), USA, Canada.

GOBIIDAE

Ctenogobius nebulosus (goby), Fiji; *Evorthodus lyricus* (lyre goby), USA; *Gobius criniger* (goby), Africa; *G.* (*Glossogobius*) *guiris* (goby), East Africa, India; *G. microps* (goby), Hayling Island (England).

MUGILIDAE

Mugil cephalus (striped mullet), USA; *M. macrolepis* (mullet), East Africa.

NANDIDAE

Badis badis, India.

NOTOPTERIDAE

Notopterus kapirat (=*Notopterus notopterus*) (wingback knifefish), India.

OPHIOCEPHALIDAE

Ophiocephalus punctatus; *O. striatus* (channa, striped snakehead), India to Malaya.

PIMELODELIDAE

Pimelodella chagresi, South America; *P. chargrensis* (catfish), South America; *Rhamdia sebae* (catfish), South America.

POMACENTRIDAE

Chromis bimaculatus (damselfish), Gambia.

POECILIIDAE

Gambusia affinis affinis (top-minnow, mosquito fish), midwestern USA, Mexico; *G. a. holbrooki* (=*Gambusia holbrooki*) (top-minnow, mosquito fish), eastern USA (1 fish ate 165 larvae in 12 hours); *G. dominicensis*, Haiti; *G. gracilior*, Jamaica; *G. nicaraguensis* (mosquito fish), Mexico to Panama; *Gambusia patruelis* (=*Heterandria patruelis*), Haiti, USA; *Girardinus poeciloides* (millions fish), Jamaica; *Heterandria formosa* (dwarf top-minnow, mosquito fish, least killifish), USA; *Jenynsia lineata* (=*Lebias lineata*, *Fitzroya lineata*) (one-sided live bearer), South America; *Lebistes reticulatus* (=*Acanthocephalus*, *Girardinus guppyi*, *Poecilia reticulatus*) (guppy, rainbow fish, millions fish), Trinidad, Venezuela, British Guiana; *Limia dominicensis*, Jamaica; *Mollienesia caucana* (South American molly), South America; *M. latipinna* (top-minnow, molly, sail fin), USA to Mexico; *M. sphenops* (=*Poecilia sphenops*) (molly), Mexico to South America; *Phalloptychus januarius* (=*Glaridodon januarius*, *Girardinus januarius*) (barred millions fish), Brazil; *Phalloceros caudomaculatus* (=*Girardinus caudomaculatus*) (caudo), South America; *Poecilia vivipara* (one-spot live bearer), South America, West Indies.

PYGIDIDAE

Pygidium piurae (catfish), South America; *P. striatum* (catfish), South America.

RETROPINNIDAE

Retropinna retropinna (smelt), New Zealand.

SCHILBEIDAE

Schilbe mystus, Upper Volta.

SILURIDAE

Wallago attu (catfish), India.

THERAPONIDAE

Therapon jarbua (salt-water zebrafish), India, Pacific.

UMBRIDAE

Umbra pygmaea (mud minnow), USA.

(2) AMPHIBIA

CAUDATA

Ambystoma macrodactylum

Culex pipiens (Sergent, 1940).

Culiseta longiareolata (Hearle, 1926).

A. opacum

Eats larvae readily (Howard, Dyar & Knab, 1912).

A. tigrinum

Eats larvae readily (Bishop & Hart, 1931).

Diemyctylus viridescens

Aedes sp. (ate up to 45 per day; 25 pupae in 40 minutes) (Matheson & Hinman, 1929b).

Eurycea bislineata

Culex sp. (ate 7 larvae per day) (Twinn, 1931).

Salamandra salamandra (=*S. maculosa*)

Eats larvae readily (Howard, Dyar & Knab, 1912).

Taricha (*Triturus*) *torosa* (=*Notophthalmus torosus*, *Triturus torosus*)

Highly efficient predator; ate 208 larvae per day (Chandler, 1918).

Efficient predator (Hearle, 1926).

Eats many larvae; used successfully for control (Howard, Dyar & Knab, 1912).

Triturus (*Triton*) *alpestris*

Important larval predator (Galli-Valerio & Rochaz de Jongh, 1906).

T. (*T.*) *cristatus*

Important larval predator (Galli-Valerio & Rochaz de Jongh, 1906).

Used successfully in control (Howard, Dyar & Knab, 1912).

Newt ate 21 *Anopheles* and 25 *Culex* larvae per day (Sergent & Foot, 1922).

Anopheles larvae (Garofolini, 1924).

Triturus (Triton) multicellus

Valuable larval predator (Galli-Valerio & Rochaz de Jongh, 1906).

SALIENTA

Discoglossus pictus

Eats larvae captured under water (Galli-Valerio & Rochaz de Jongh, 1906).

Pleurodeles (Euproctus) poireti

Anopheles labranchiae (ate 16 per day); *Culex pipiens* (ate 64 per day); *Culiseta longiareolata* (ate 70 per day) (Sergent, 1940).

Pseudacris sp.

Bishop & Hart (1931).

Rana pipiens

Bishop & Hart (1931).

R. tigrina tadpoles

Ate up to 21 larvae per day (Pruthi, 1928).

Rana sp. tadpoles

Anopheles farauti; *Culex pullus* (Laird, 1947).

Scaphiophus hammondii

Aedes dorsalis (ate 7 per day); tadpoles prey on anophelines and culicines (Barber & King, 1927).

Xenopus clivii

Ate 115 larvae and pupae per day (Brumpt, 1945).

X. laevis

Aedes sp. (ate 45 per hour); *Anopheles maculipennis* (Brumpt, 1945).

(3) REPTILES

Leiolopisma zelandica

An example of this New Zealand skink was found to have 63 2-mm larvae of *Opifex fuscus* in its gastrointestinal contents (Barwick, 1959).

Pelomedusa galeata

Aedes aegypti (complete control in jars) (Lewis, 1942).

Pseudemys elegans

In captivity ate 300-400 *Aedes* in 4 hours (Hinman, 1934a).

Sternotherus odoratus

Eats numerous larvae (Shaw, 1925).

(4) BIRDS

Domestic ducks

Very effective in clearing out larvae and pupae; several experiments showed that ducks eliminated larvae and pupae in ponds (Myers & Atkinson, 1924).

Mallard

Many larvae in gizzard (McAtee, 1911).

Various species of duck

Very effective for larval control (McAtee, 1911).

Northern phalarope

53% of food consisted of mosquito larvae (McAtee, 1911).

6% of food consisted of mosquito larvae (Wetmore, 1925).

Wilson phalarope

McAtee (1911).

5% of food consisted of mosquito larvae (Wetmore, 1925).

Killdeer (plover)

McAtee (1911).

Semipalmated plover

McAtee (1911); Smith (1904).

Baird sandpiper

McAtee (1911).

Least sandpiper

McAtee (1911); Smith (1904).

Pectoral sandpiper

McAtee (1911).

Semipalmated sandpiper

McAtee (1911); Smith (1904).

Stilt sandpiper

McAtee (1911).

Charadrius minor

Waterston (1918).

Tringa hypoleucus

Waterston (1918).

T. (Totanus) ochropus

Waterston (1918).

4. PREDATORS OF ADULT MOSQUITOS

ARACHNIDA

Plexippus paykulli

Aedes aegypti (effective predator in cages) (Mathis & Berland, 1933).

ARGIOPIDAE

Araneus nordmanni

Spiders were radioactive from feeding on field-released radioactive *Aedes communis* and other *Aedes* species (Jenkins, 1950).

Meta patagiata

Same comment as for *A. nordmanni* (Jenkins, 1950).

Meta sp.

Many mosquitos in webs (Laird, 1945).

Tetragnatha extensa

Same comment as for *A. nordmanni* (Jenkins, 1950).

LINYPHIIDAE

Pityohyphantes subarcticus

Same comment as for *A. nordmanni* (Jenkins, 1950).

LYCOSIDAE

Pardosa mackenziana

Same comment as for *A. nordmanni* (Jenkins, 1950).

P. sternalis

Preys on emerging mosquitos (Bishop & Hart, 1931).

SALTICIDAE

Akela sp.

Aedes aegypti and *Culex pipiens fatigans* (eats adults in habitations) (Gordon, 1922).

Salticus sp.

Same comment as for *Akela* sp. (Marchoux, Salimbeni & Simond, 1903; Howard, Dyar & Knab, 1912).

THERIDIIDAE

Theridion zelotypum

Same comment as for *A. nordmanni* (Jenkins, 1950).

THOMISIDAE

Xyticus triangulosus

Same comment as for *A. nordmanni* (Jenkins, 1950).

OTHER SPIDERS

Nephila madagascariensis

Anopheles and other mosquitos (suggested that destruction of spiders may have caused increase in vector populations and hence of malaria) (Fontoynont, 1922).

Uloborus feniculatus

Aedes aegypti (Bacot, 1916).

SCORPIONIDA

Isometrus maculatus

Aedes aegypti (Bacot, 1916).

Meta sp.

Aedes aegypti (Bacot, 1916).

INSECTA

(1) ODONATA

ANISOPTERA

Aeschna constricta

Aedes vexans; *Culex pipiens* (Bromley, 1948).

A. umbrosa

Aedes vexans; *Culex pipiens* (Bromley, 1948).

A. verticalis

Culex pipiens (Bromley, 1948).

Aeschna sp.

Important predator (Howard, Dyar & Knab, 1912).

Anax junius

Aedes sollicitans (Bromley, 1948).

Boyeria vinosa

Culex pipiens (Bromley, 1948).

Didymops transversa

Aedes canadensis (Bromley, 1948).

Dorocordulia libera

Aedes canadensis; *A. excrucians* (Bromley, 1948).

Epiaeschna heros

Aedes sollicitans (Bromley, 1948).

Erythemis simplicicollis

Aedes canadensis; *A. sollicitans*; *A. vexans* (Bromley, 1948).

Erythemis simplicicollis (continued)

Anopheles quadrimaculatus (McAtee, cited in Howard, Dyar & Knab, 1912).

Gomphus exilis

Aedes canadensis? (Bromley, 1948).

G. lividus

Aedes sp. (Bromley, 1948).

G. spicatus

Aedes canadensis (Bromley, 1948).

Libellula cyanea

Aedes vexans (Bromley, 1948).

L. julia

Aedes canadensis (Bromley, 1948).

L. pectoralis

Destroyed all mosquitos in vicinity (Nezlobinski, 1915).

Destroyed many mosquitos (Hegh, 1921).

L. pulchella

Aedes sollicitans (Bromley, 1948).

L. quadrimaculata

Aedes canadensis; *Anopheles* sp. (Šarleman, 1915).

Pantala flavescens

Aedes sollicitans (Bromley, 1948).

P. hymenea

Aedes bimaculatus; *A. scapularis*; *A. vexans*; *Psorophora ciliata* (Bromley, 1948).

Plathemis lydia

Aedes sollicitans (Bromley, 1948).

Tetragoneuria cynosura

Aedes excrucians; *A. sollicitans*; *A. vexans*; *Mansonia perturbans* (Bromley, 1948).

Williamsonia lintneri

Aedes canadensis (Bromley, 1948).

Unidentified dragonflies

Aedes aegypti (pursue and eat) (Young, 1921).

ZYGOPTERA

Argia moesta (=*Argia putrida*)

Aedes vexans (Bromley, 1948).

Austrolestes annulosus

Important in natural mosquito control (Taylor, 1917).

Enallagma civile

Aedes vexans; *Culex pipiens* (Bromley, 1948).

Ischnura verticalis

Aedes canadensis; *A. vexans* (Bromley, 1948).

Lestes eurinus

Aedes vexans (Bromley, 1948)

Xanthagrion erythroneurum

Important in natural mosquito control (Taylor, 1917).

(2) ORTHOPTERA

" Locusts "

Howard, Dyar & Knab (1912).

Young mantids

Bacot (1916).

(3) HEMIPTERA

GERRIDAE

Eat mosquitos on water surface (Comstock, 1936).

HYDROMETRIDAE

Hydrometra sp.

Catches and eats emerging and ovipositing mosquitos (Eysell, 1905).

Limnobates sp.

Same comment as for *Hydrometra* sp. (Eysell, 1905).

REDUVIIDAE

Bagauda gilletti

Destroys adults as they leave breeding places (Gillett, 1957b).

Ploiarola domestica

Anopheles quadrimaculatus (are eaten in houses) (Balard, 1921).

Eats adult mosquitos (Roubaud & Weiss, 1927).

P. errabunda (=*Emesa longipes*)

Anopheles quadrimaculatus (Howard, Dyar & Knab, 1912).

Sycanus falleni

Anopheles spp. (1 ate 1200 mosquitos in 164 days) (Toumanoff, 1941a).

VELIIDAE

Microvelia schneideri

Attacks emerging adults (Bragina, 1931).

(4) MECOPTERA

Panorpa sp.

Eysell (1905).

(5) COLEOPTERA

STAPHYLINIDAE

Stenus biguttatus

Anopheles maculipennis (eats hibernating mosquitos) (Šingareva, 1926).

(6) DIPTERA

ANTHOMYIIDAE

Cordilura haemorrhoidalis

Howard, Dyar & Knab (1912).

ASILIDAE

Asilus notatus

Aedes canadensis (Bromley, 1948).

A. sadyates

Aedes vexans; *Culex pipiens* (Bromley, 1948).

Asilids

Nearly all species active in pursuit of mosquitos (Beyer, 1923).

Atomosia culicivora

Many mosquitos caught and killed (Hamlyn-Harris, 1929b).

Cyrtopogon falto

Aedes canadensis (Bromley, 1948).

Erax aestuans

Aedes sollicitans; *A. vexans*; *Culex pipiens*; *Mansonia perturbans* (Bromley, 1948).

E. barbatus

Aedes vexans; *A. scapularis*; *Psorophora confinnis* (Bromley, 1948).

E. rufibarbis

Aedes vexans; *Culex pipiens* (Bromley, 1948).

Leptogaster flavipes

Aedes vexans (Bromley, 1948).

Psilonyx annulatus (=*Leptogaster annulatus*)

Various mosquitos (Bromley, 1948).

DOLICHOPODIDAE

Beyer (1923).

EMPIDIDAE

Dance flies commonly skim along the water surface and seize adults emerging from the pupae.

Hilara sp.

Culex (ate emerging adults) (Séguy, 1923).

Hormopeza obliterata

Howard, Dyar & Knab (1912).

Rhamphomyia (*Megacyttarus*) *argenteus*?

Aedes sp. and *Culiseta* sp. (ate emerging adults) (Hubert, 1953).

Rhamphomyia sp.

Aedes cataphylla and *A. communis* (attack male swarms); *A. pionips*, *A. pullatus* and *A. punctor* (ate emerging adults) (Frohne, 1959).

Aedes punctor (attack male swarms) (Frohne, 1952b).

Tachydromia macula

Howard, Dyar & Knab (1912).

MUSCIDAE

Lispe armipes

Macfie & Ingram (1922).

L. sinensis

Macfie & Ingram (1922).

L. tentaculata sakhaliensis

Culex vagans (= *C. tipuliformis*) (attacks newly emerging adults) (Yamada, 1927).

Lispe sp.

Culex (attacks pupae and emerging adult mosquitos) (Lamborn, 1920).

PSYCHODIDAE

Attack engorged mosquitos.

Culicoides anophelis (India to Taiwan)

Anopheles annularis (=*A. fulignosus*) (Sinton & Little, 1925).

Anopheles karwari; *A. minimus*; *A. subpictus* (= *A. rossi*); *A. umbrosus*; *A. vagus*; *Culex tritaeniorhynchus*; *C. vishnui* (Wirth & Hubert, 1959).

Anopheles maculatus (Edwards, 1922).

Anopheles nigerrimus; *A. sinensis* (Galliard & Gaschen, 1937).

Armigeres lacuum (Laird, 1946b).

Culex pipiens fatigans; *Mansonia annulifera* (Sen & Das Gupta, 1958).

Culicoides baisasi

Aedes poecilus; *Anopheles vagus limosus* (Wirth & Hubert, 1959).

Culicoides culiciphagus

Anopheles lungae (Wirth & Hubert, 1959).

Culicoides sp.

Anopheles maculipennis (Léon, 1924).

Anopheles sp.; *Culex pipiens fatigans* (Knab, 1914).

Ceratopogon sp.[1]

Anopheles annularis (=*A. fulignosus*); *A. karwari*; *A. sinensis* (Knab, 1914).

A. annularis (= *A. fulignosus*) (6% parasitized); *Anopheles* (3 spp., 2 parasites each); *Culex pipiens fatigans* (Peyerimhoff, 1917).

Attack engorged mosquitos (Celli, 1913; Sinton & Little, 1925).

SIMULIIDAE

Simulium sp.

Newly emerged mosquitos were attacked (Howard, Dyar & Knab, 1912).

(7) HYMENOPTERA

FORMICIDAE

Monomorium pharaonis

Aedes aegypti (Bacot, 1916).

Pheidole sp.

Aedes aegypti (attacks newly emerged adults) (Drake-Brockman, 1913).

Red ant

Aedes scutellaris (=*A. variegatus*) (ants walk over surface film and attack emerging adults) (O'Connor, 1923).

Solenopsis geminata

Aedes aegypti (Bacot, 1916).

NYSSONINAE

Seriocophorus relucens

Catches mosquitos on wing for nest provisioning (Hamlyn-Harris, 1924a).

VESPIDAE

Crossocerus quadrimaculata (=*Crabro quadrimaculatus*)

Howard, Dyar & Knab (1912).

Stictia signata (=*Monedula signata*)

20 *Aedes aegypti* adults taken in 5 minutes (Howard, Dyar & Knab, 1912).

[1] Probably used in the old broad sense but referring to *Culicoides*.

Vespula maculifrons

Culex pipiens (Bromley, 1948).

VERTEBRATA

AMPHIBIA

Ambystoma tigrinum

Bishop & Hart (1931).

Frogs

Eat egg-laying and emerging adults (Wilson, 1913).

Pseudacris sp.

Bishop & Hart (1931).

Rana pipiens

Bishop & Hart (1931).

Tree frogs

Devour many mosquitos (Eysell, 1905).

Toads

Devour many mosquitos (Bacot, 1916).

REPTILES

Anolis carolinensis

Hinman (1934b).

House gecko

Destroys mosquitos on walls of rooms (Giles, 1902; Gordon, 1922).

Bacot (1916); Kirkpatrick (1925).

Lizards (4 species)

Destroyed significant numbers of adult mosquitos (O'Connor, 1923).

Pseudemys elegans

Ate dead adults; thought probable that emerging or ovipositing adults are captured (Hinman, 1934b).

BIRDS

Many references available: insect-eating birds in general; fly catchers, swallows, goatsuckers, and certain warblers in particular.

Chimney swift

Over 600 insects, mostly mosquitos, counted in one stomach examination (Howard, Dyar & Knab, 1912).

Flycatchers

Of some importance (Forbush, 1907).

Goat-suckers

Harvey (1880).

House martins

Anopheles (Theobald, 1901).

Nighthawks (Cuban)

Stomachs distended with *Culex* (Jennings, 1909).

Swallows

Christophers (1960).

Said to keep Venice relatively free of mosquitos until migration (Kirkpatrick, 1925).

Warblers

Stomachs distended with *Culex* (Jennings, 1909).

BATS

Many references available, e.g., Campbell (1925); Covell (1934); Herms & Gray (1944).

Claims bats destroyed a very large mosquito population in Texas (Campbell, 1913).

Pipistrellus abramus

Mosquitos were found in 12 of 45 bat stomachs; one bat caught 1527 in three hours; the stomachs of three bats were more than half full of mosquitos (Miyamoto, 1930).

Taderida mexicana

Not successful in reducing mosquitos (Nelson, 1926).

5. PLANTS IN RELATION TO MOSQUITOS

Certain carnivorous plants actively trap and digest the developmental stages of mosquitos. Other plants are beneficial to these insects by providing them with larval harbourage or actually acting as larval habitats. In between these extremes aquatic vegetation of various kinds inhibits mosquito development by drastically modifying the environment (e.g., by completely covering the water surface, producing toxic effects, etc.).

ALGAE

CHLOROPHYTA

Characium anophelesi

Anopheles barbirostris; *A. hyrcanus*; *A. ramsayi* (=*A. pseudojamesi*); *A. subpictus*; *A. vagus*; *A. varuna* (covered all of larval body, but caused no harm except slight impeding of movement) (Iyengar & Iyengar, 1932).

C. saccatum

Anopheles farauti; *Culex annulirostris* (larval movement somewhat hampered; anal papillae were occasionally shrivelled or distorted as a result of heavy infestations, but pupation was not impeded) (Laird, 1956b).

Characium sp.

Aedes diantaeus; *A. excrucians*; *A. fitchii*; *A. pionips*; *A. punctor* (most abundant on the anal papillae of larvae; movement was slightly impaired, but no mortality was observed) (Jenkins, 1948).

Cladophora holsatica

Culex pipiens fatigans (larvae fail to reach maturity in the presence of these algae, although oviposition was not inhibited by their presence in laboratory containers) (Hamlyn-Harris, 1928).

Spirogyra spp.

Culex squamosus and *Aedomyia catastica* (were abundant in thick masses of *Spirogyra*); *Culex starckeae* (= *C. basicinctus*) (usual larval harbourage) (Laird, 1956b).

The algae entangle larvae, and act as a poison (Smith, 1904).

CHARACEAE

The stoneworts have attracted much attention, and a controversial literature exists on the effect of these plants on mosquito production. Whilst some species definitely control larvae under certain conditions, others have little adverse effect and may even be beneficial.

Chara connivens

Larvicidal; virulence of toxicants decreases after removal of plants (Alluaud, 1922).

C. contraria

Causes death of mosquito larvae under field conditions (Caballero, 1922a).

Causes death of mosquito larvae under laboratory conditions (Caballero, 1922a, b).

Has a markedly unfavourable effect on development of mosquito larvae, by producing excessive amounts of oxygen in tiny bubbles. Death ensues whether these bubbles are swallowed by larvae or become entangled in their mouth brushes, body hairs, etc. Larvae kept with *Chara* in the dark developed to adults, but in sunlight all died (Matheson & Hinman, 1931).

C. delicatula

Same effect as *C. contraria* (Matheson & Hinman, 1931).

Chara foetida

Aedes, *Culex*, and *Anopheles* (larvae are killed by an oil film that develops on the surface of water; tanks in the laboratory with 1/8 of water volume filled by *Chara* produced no larvae) (Caballero, 1919).

Destroys mosquito larvae under field conditions (Caballero, 1922a).

Has some toxic effect on larvae; an active toxic principle similar to derris was isolated (Howard, 1924).

A poisonous excretion in the water causes death of larvae, none of which were ever found in water with this plant present; removal of the surface oil film no impediment to death of larvae (Caballero, 1922b).

No toxic effects in laboratory tests, but in water with living *Chara*, *Culex pipiens* developed poorly; scum had to be broken repeatedly to enable larvae to get air (MacGregor, 1924b).

C. foliorosa

A lake covered with floating mats of this species provided extensive and troublesome larval habitats for *Anopheles albimanus* (Fisher, 1923).

C. fragilis

Water in which *Chara* had grown was toxic to *Aedes* larvae (Caballero, 1922c).

Culex pipiens, *C. territans*, *Aedes vexans*, and *Anopheles punctipennis* larvae were introduced into aquaria with *C. fragilis*; 100% mortality resulted; solutions of dried plants were toxic, and it was also felt that the high pH was a contributory factor (Matheson & Hinman, 1928).

Larvae of several species grew normally in an aquarium with growing *C. fragilis* and in an extract of *Chara*; larvae were also observed growing in pools with *Chara* (Levi Castillo, 1944).

Culex and *Anopheles walkeri* (larvae developed normally in a small lake where this plant grew in abundance) (Twinn, 1931).

Aedes aegypti, *Aedes notoscriptus*, and *Culex pipiens fatigans* (larvae develop normally in presence of this plant) (Hamlyn-Harris, 1932).

Same effects as for *C. contraria* (Matheson & Hinman, 1931).

C. hispida

Inimical to mosquito larvae under field conditions (Caballero, 1922a).

Has stronger larvicidal action than *C. foetida* (Pardo, 1923).

No toxic effects in laboratory tests, but *Culex pipiens* developed poorly (MacGregor, 1924b).

C. intermedia

Killed all larvae within 48 hours of introduction (Caballero, 1922c).

C. robbinsi

Anopheline larvae developed so well in heavy mats of this plant that it was regularly used in laboratory cultures (Barber, 1924).

Chara sp.

Anopheles maculipennis grew well in water with *Chara* (Apfelbeck, 1925).

Anopheles barbirostris, *A. sinensis*, *A. fulignosus* bred in an abundance of *Chara* in a lake (Williamson, 1926).

Chara is toxic to larvae in the field and in the laboratory, more so to *Aedes* than to *Culex* or *Anopheles*. The action s not constant; the toxic effect seems due to a substance produced by the functional activity of the plant (Federici, 1927).

Provided excellent protection from *Gambusia* and did not avert high larval production (Bradley, 1932).

A pool with *Chara* with no mosquito larvae contained abundant larval food; the excessive oxygen bubbles from *Chara* may account for larval mortality, the pH having little effect (Matheson & Hinman, 1930).

Nitella gracilis

No toxic effect on larvae (Barber, 1924).

N. phauloteles

Aedes aegypti (is toxic and repellent); *Culex pipiens fatigans* (is toxic and repellent); *Anopheles* (*Nyssorhynchus*) sp. (is toxic to larvae, and serves to repel ovipositing adults) (Buhôt, 1927).

CYANOPHYTA

Anabaena unispora and *Aulosira implexa*

No larvae in pools with these algae in California rice fields (Gerhardt, 1954, 1956a).

Blue-green algae

Density of anopheline larvae was greatly reduced if only blue-green algae were present, but abundant if in association with *Chlorophyceae* (Bradley, 1932).

A negative correlation existed between anopheline larvae and unicellular *Cyanophyceae* (Boyd & Foote, 1928).

Oscillatoria brevis

Aedes albopictus (ball-like masses form on abdomen of larvae) (Laird, 1959b).

Oscillatoria sp. and other blue-green algae

Anopheles maculatus (when blue-green algae replace Chlorophyta in waters that become fouled, mosquito breeding is inhibited (Williamson, 1935).

Oscillatoria and *Anabaena*

Anopheles farauti (larvae were absent from two pools with only these algae present; however, larvae occurred in other pools with Chlorophyta present (Laird, 1956b).

CARNIVOROUS PLANTS CAPTURING LARVAE

Aldrovanda vesiculosa

Submerged sundew, traps mosquito larvae (Eysell, 1924; França, 1922).

Genlisia ornata

Traps mosquito larvae (Howard, Dyar & Knab, 1912).

Utricularia clandestina

Traps mosquito larvae (Howard, Dyar & Knab, 1912).

U. gibba

Larval production high, bladders may be too small to capture mosquito larvae (Hess & Hall, 1945).

U. intermedia

Captures larvae and pupae (Twinn, 1931).

U. macrorhiza

Captures larvae and pupae (Twinn, 1931).

No larvae found in bladders (Hildebrand, 1925).

U. minor

Captures small larvae (Twinn, 1931).

U. vulgaris

Anopheles bifurcatus (captures many larvae) (França, 1922).

Anopheles maculipennis (captures many larvae) (Brumpt, 1925).

Culiseta longiareolata (captures many larvae) (França, 1922).

Culex apicalis (captures many larvae) (Brumpt, 1925).

Culex territans (nearly all of 495 larvae captured in 5 days) (Matheson, 1930).

Larvae feed on glandular secretion at opening of bladder; the valve opens and current draws them into bladder (Brocher, 1927).

One plant destroyed 1800 small larvae; when several plants were put in a garden pool, large numbers of mosquito larvae were destroyed (Clarke, 1938).

PLANTS THAT COVER WATER SURFACE AND CONTROL LARVAE

Azolla caroliniana

Prevents larval development (França, 1922).

A. filiculoides

Prevents larval development (França, 1922).

Azolla sp.

If surface cover complete, larvae are not found (França, 1922).

A species of *Azolla* was tested in Africa to control mosquito breeding; as the plant would not grow in shaded pools the attempt failed (Howard, Dyar & Knab, 1912).

Brasenia schreberi

Watershield " is inimical to the production of *Anopheles quadrimaculatus* ". The plant may almost completely cover the surface, but anopheline larvae are absent even in sparse stands of *Brasenia* (Bellamy, 1940; Hess & Hall, 1945).

Lemna minor

A dense surface cover resulted in an absence of larvae (Vasil'ev, 1925).

Dense cover precludes anopheline breeding; sparse cover provides excellent harbourage (Hess & Hall, 1945).

Lemna sp.

Complete covering of water surface controlled larval production (Bradley, 1932).

Lemna-covered tanks in India harboured no mosquito larvae (Adie, 1904).

Myriophyllum brasiliense

Anopheles larvae are not associated with this plant (Bachmann, 1921; Hess & Hall, 1945).

Naias major

River beds with heavy coverage free from mosquito larvae (Vasil'ev, 1925).

Nymphaea odorata

White water-lily is rarely associated with anopheline larval production (Bellamy, 1940; Hess & Hall, 1945).

When white water-lily is associated with submerged aquatics, anopheline development takes place (Bradley, 1932).

Spirodela oligorrhiza

Anopheles farauti (if water surface completely covered, larvae are absent; water bugs are also probably important predators in these habitats) (Laird, 1956b).

S. polyrhiza

A dense surface cover precluded larval development (Vasil'ev, 1925).

This was the only plant that completely prevented mosquito breeding, by completely covering the water surface (Hildebrand, 1925).

Wolffia sp.

If surface covered, no mosquito larvae occur, but if continuity of the blanket is broken by emergent vegetation the reverse is true (Bentley, 1910).