CHAPTER XI.

The Aquatic Insects of Freshwater

AQUATIC INSECTS

Insects and their larvæ are one of the most unfailing sources of food supply for freshwater fishes. There are many, however, which in some or all the stages of existence are injurious to the spawn and young, and these belong to many orders, families, genera and species, among them being some genera of the Heteroptera or Water-bugs; the Neuroptera or Dragon-flies and kindred insects; the Diptera or true Flies; the Coleoptera or Beetles; the Lepidoptera or Moths; the Hymenoptera or Ichneumons; the Arachnidæ or Spiders; and other families of the insect world, or forms closely related thereto.

Some are not entirely rapacious nor depend solely on the blood of animals for food, but also suck the juices from insects and plants, yet become active enemies in the confines of the rearing basins for fishes, in the absence of larger fishes which would devour them and their larvæ; thus permitting them to prey upon the smaller fishes and to so increase in numbers as to become very destructive. These will be briefly described, their habits noted, and illustrations given for their identification. Others which serve as food for young and mature fishes will also be mentioned.

Freshwater plants grow in more or less shallow water, as they are dependent for nutrition upon the decomposition of carbonic acid gas by sunlight, and as plant-feeding animals establish themselves among them, they are also frequented by predatory animals, to whom these serve as food. Insects are of both these classes but the predatory more particularly claim our attention. It should be stated that insects deriving oxygen from the air are generally lighter than water, so that, should they exhaust the air carried with them under the water or become disabled, they rise to the surface by gravity in such position that the air-breathing parts first come to the surface. The insects deriving oxygen from the air held in suspension in the water are heavier than water and no effort is necessary for them to keep below the surface. Changes in water temperature are also provided against and most of the aquatic insects pass the winter in the larval stage, to undergo the further transformations in the following spring or early summer,

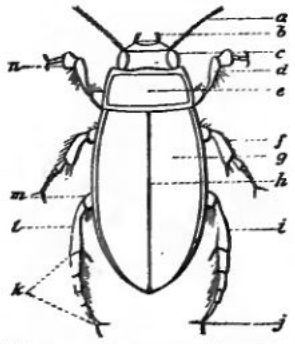

FIG. 195. Outline of a Water Beetle.

a. Antennæ.
b. Maxillary palpi.
c. Eye.
d. Fore-leg.
e. Thorax.
f. Middle-leg.
g. Elytron.
h. Suture.
i. Hind-leg.
j. Claw.
k. Tarsus or foot.
l. Tibia or shank.
m. Femur or thigh.
n. First three joints of foot.

though there is often more than one summer brood, and many remain more than a year in the larval state. A further provision of nature is the enormous number of eggs produced.

No insect is so completely aquatic as to pass its entire existence in the water, yet the final perfect stage and the acquisition of wings is usually a brief one; its purpose being principally the mating of the sexes and the distribution of the eggs over a wider area, where the chances of survival are improved. Fig. 195 shows the external anatomy of a beetle.

Insect Enemies. The following are the principal insect enemies of the freshwater fishes.

Order Hemiptera. This order includes three sub-orders, the Heteroptera, Parasitica and Homoptera; the aquatic and semi-aquatic bugs belonging to the first named. They have four membranous wings, the first pair partly overlapping the others. The mouth parts are developed for piercing and sucking. Many families are comprised in this sub-order including the Water-boatmen or Corisidæ; the Backswimmers or Notonectidæ; the Water-scorpions or Nepidæ; the Giant Water-bugs or Belostomidæ; and the Creeping Water-bugs or Naucoridæ. Those which live near the water and are semi-aquatic are the Toad-bugs or Galgulidæ; the Broad-shouldered Water-striders or Valiidæ; the Water-striders or Hydrobatidæ; and the Marsh-treaders or Limnobatidæ: all of which will be described in this order.

Water-Boatmen belong to the family of Corisidæ and about forty North American species to the genus Corisa. They are of oval form, flattened on the back and below, of mottled grey and black color, about ⅜ inch long, eyes small and inconspicuous, and the body covered with fine hairs, which, in the water, cause an almost complete envelopment in air like a glittering armor, and enables the bug to descend below the surface for considerable periods, where it attaches itself by its anterior legs. The posterior legs are more largely developed and oar-like, covered with swimming bristles. The four membranous wings lie on the back, the first pair of thicker structure, the hind wings very delicate, white and lace-like. It swims with the back upwards and in cold weather buries itself in the mud and lies dormant until spring. The eggs are attached to the stems of plants under the water and the larval stage is brief. All the genera are predatory, the food consisting of insects and other aquatic animals, and the strong and sharp beak inflicting severe bites. They are destructive to

FIG. 196. Water-boatman, *Corisa interupta*. Enlarged.*

*The line at the right of the figures indicate the natural size.

young fishes, weak flyers and clumsy of movement out of the water. In Mexico the eggs of two species, *C. mercenaria* and *C. femorata*, are collected in enormous quantities to be eaten by the Indians and are exported in a dried state as food for birds, poultry and fishes. They are distributed over the entire United States, the most general species being *C. undulata*, *C. interupta*, Fig. 196, *C. calva*, *C. alternata* and *C. vulnerata*.

BACK-SWIMMERS belong to the family of Notonectidæ, of which about twelve species of the genera Notonecta, Anisops and Plea are known in the United States. Though greatly resembling the water-boatmen in appearance and habit they are more convex on the back, which is keeled like a boat and on which they swim with the ventral side upwards and the hind end of the body projecting to admit air beneath the wings where the breathing apparatus is located. The anterior and middle legs are shorter than the oarlike posterior legs, which are strongly developed for swimming. The eggs are laid in incisions, pierced by the ovipositor of the female in the stems of water plants. After hatching they rapidly pass through the larval stage and assume the appearance of the adult. They are predaceous and feed upon other water insects and small fishes, the powerful beak inflicting severe wounds to the fingers in careless handling. They attack young fishes which are entirely devoured. The most generally distributed species are *N. undulata*, Fig. 197, *N. insulata*, *N. irrorata*, *A. platycnemis* and *P. striola*.

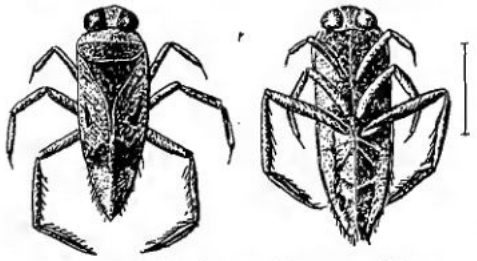

FIG. 197. Back-swimmer, *Notonecta undulata*. Ventral and dorsal views. Enlarged.

WATER-SCORPIONS belong to the family of Nepidæ and are so named from the appearance of the anterior legs, of which the coxa are long and the femor furnished with a groove into which the tibia and tarsus fits, greatly resembling the hooklike cheliceres of the scorpion, and admirably fitted for seizing prey. The middle and posterior legs are adapted for walking. At the posterior end of the body two long half-tubes are developed, which when united form a tube for inhaling air when under water. The species of Nepa are flat oval in form, about one inch long, and the Ranatra long, slender and twiglike, with all the legs thin and very long, the body often attaining a length of 2½ to 3 inches. The eggs are deposited in the stems of water plants and have long protruding filiments with probably pul-

FIG. 198. Water-scorpion, *Nepa apiculata*.

monary functions. The insect rests on the stalks of plants or slowly moves over the bottom and is difficult to observe on account of its form and the mud on the body. It is a weak flyer and only migrates when the pool is dry and in the mating season. Food largely consists of the eggs of fishes, frogs, snails and insects, but it will prey upon other water inhabitants and on young tadpoles and fishes. The most generally distributed species are *N. apiculata*, Fig. 198, *R. fusca*, Fig. 199, and *R. quadridentata.*

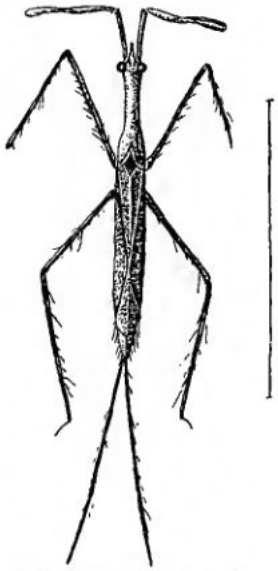

FIG. 199. Water-scorpion, *Ranatra fusca.* Enlarged.

GIANT WATER-BUGS belong to the family of Belostomatidæ, are all strictly aquatic and are most dangerous to spawn and young fishes, as they are predatory, live on the bottom and feed on aquatic animals. In the Eastern section of the United States the common forms of these bugs belong to the genera Belostoma, Benucus and Zaitha; of which the first named are the largest and are of elongated oval outline, very flat with almost transparent wings of greyish or brownish color. Benucus is almost as large and may be distinguished by the absence of the double groove on the under side of the fore thighs, which is characteristic of the first named. But one species of Benucus, *B. haldermanum*, is found in the United States. The form in Zaitha is like the foregoing but the species are smaller. Belostoma are abundant in the tropical and temperate zones of America, a tropical species, *B. grande*, reaching a length of four inches and *B. griseum*, Fig. 200, the largest of the United States attains a length of three inches. Their general color is greyish, yellowish or greenish-brown but they are usually covered with mud and when wet are darker in color than in the specimen cabinet. The anterior legs are strongly developed to seize their prey and the oarshaped posterior legs for swimming. When fully developed they have strong wings capable of long sustained flight, which takes place at night, and enables them to seek other ponds and water courses when theirs dry out. They are often found in cities, their defective sight leading them to mistake large reflecting surfaces, like skylights and green-

FIG. 200. Giant Water-bug, *Belostoma griseum.*

houses for sheets of water. Lamps and electric lights also attract them in numbers. They deposit the eggs in masses under logs and stones on the borders of ponds and ditches. The young are predaceous and feed upon small snails and other living creatures and differ but little in appearance from the adults, except in the absence of wings. They reach maturity during the first year. Living prey only is acceptable to both the larva and bug and in attacking smaller fishes they seize them with the fore legs, pierce them with the proboscis, which forms a sucking tube, and extract the blood but do not eat the animal. Some of the species of Zaitha attack the spawn of fishes. Of this genus the most common in the Eastern section of the United States is *Z. fluminea*, which reaches a length of 1 to 1½ inches. Figs. 201 and 202. The females of all three genera deposit the eggs on their backs which are often entirely covered by nicely arranged transverse rows of from 60 to 200 elongate-ovate dark grey eggs deposited by means of a protrusile ovipositor which can be extended over the back. The Giant Water-bugs and their larvæ are among the most destructive enemies of the young of the goldfish and other freshwater fishes, which are often introduced into the hatching troughs as eggs or in the larval stage. Some adults reach the tanks in their nuptual flights.

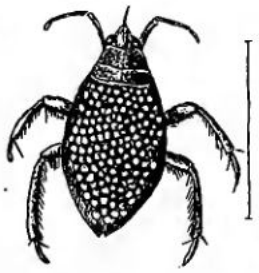

FIG. 201. Giant Water-bug, *Zaitha fluminea*. Female with eggs on her back. ½

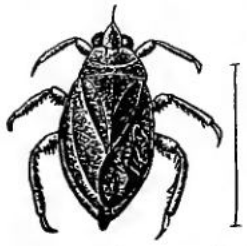

FIG. 202. Giant Water-bug, *Zaitha fluminea*. Male.

Creeping Water-Bugs belong to the Naucoridæ, a small family of flat-bodied oval-shaped bugs, having the anterior legs developed to seize their prey and the middle and posterior legs for creeping over the bottom of ponds and water ways. All the species are predaceous but confine their attacks more generally to insects and their larvæ. *Pilocoris femarata* and *Ambrysus signoretti*, Fig. 203, are the principally distributed Atlantic Coast and Western species. They are both of small size, rarely over ⅜ inch in length and of a reddish-brown color.

FIG. 203. Creeping Water-bug, *Ambrysus signoretti*. Enlarged.

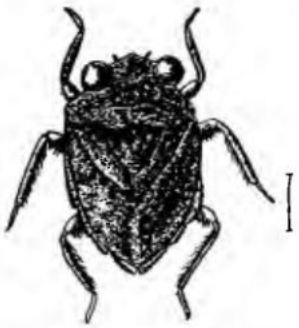

FIG. 204. Toad-bug, *Pelogonus americanus*. Enlarged.

Toad-Bugs belong to the family of Galgulidæ, and inhabit the muddy margins of ponds,

streams and marshes. The toad-like appearance, the short and broad body, mottled color and protruding eyes led to the popular designation. They are ¼ to ⅜ inch long, are all predaceous and live principally on spawn, insect larvæ and small snails. The most generally distributed species of the United States are *Galgulus oculatus*, *Pelogonus americanus*, Fig. 204, and *Mononyx stygicus*.

SHORE-BUGS belong to the family of Saldidæ, of which twelve species inhabit the United States, four on the Atlantic Coast. They may often be seen in considerable numbers on the margins of water ways and take flight when disturbed but soon alight. Their color is dark grey with white and yellow markings, and their size $\frac{5}{16}$ to ⅜ inch in length. The most generally distributed Eastern United States species are *Salda signoretii*, Fig. 205, *S. pellita*, *S. splacelata* and *S. anthracina*.

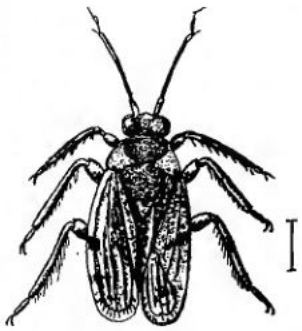

FIG. 205. Shore-bug, *Salda signoretti*. Enlarged.

BROAD-SHOULDERED WATER-STRIDERS belong to the family of Veliidæ and are distinct and different from the true Water-striders. They are smaller, much broader across the thorax and thicker of limb, all of them aquatic in habit and almost constantly on the water, congregating in school of hundreds. The most generally distributed species of the Atlantic Coast States are *Hebrus americanus*, Fig. 206, and *Rhagovelia collaris*, Fig. 207, both of small size. All are predaceous and feed on the juices of insects which fall into the water, mosquito larvæ and the tiny alevins of fishes, when they come to the surface of the water to take air.

FIG. 206. Broad-shouldered Water-strider, *Hebrus americanus*. Enlarged.

FIG. 207. Broad-shouldered Water-strider, *Rhagovelia collaris*. Enlarged.

WATER-STRIDERS belong to the family of Hydrometridæ, slender long-legged insects which dart about on the surface of ponds and pools of both fresh and salt water. Some species are winged and others wingless, varying in length from ½ to ⅝ inch. The elongated body has very closely folded wings and long hairlike legs, both covered with minute hairs, which prevent the insect from becoming wet and sustain it upon the surface of the water, the legs being almost continuously lifted to prevent their becoming wet, in which case the insect would sink into the

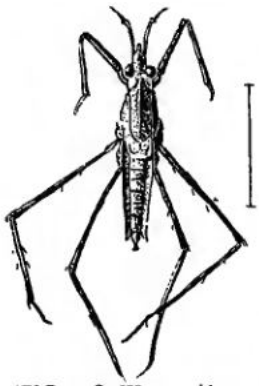

FIG. 208. Water-strider or Skater, *Hydrometra lineata*. Enlarged.

water. The eggs are remarkably large for the size of the insect. They are predaceous, feeding upon living prey from which they suck the juices. The most general species of the Eastern United States are *Hydrometra lineata*, Fig. 208, and *Hygrotrechus remigis*.

MARSH-TREADERS belong to the family of Limnobatidæ and are very slender, almost thread-like insects rarely over ½ inch long, with long heads, elongated thorax and abdomen, hairlike legs and of inconspicuous dark color. They crawl over the mud and the water surface or adhere to water plants partly above the surface, feeding upon the eggs and small larvæ of insects and snails. The most generally distributed species are *Limnobates lineata*, Fig. 209, and the allied *Limnopus rufoscutellatus*.

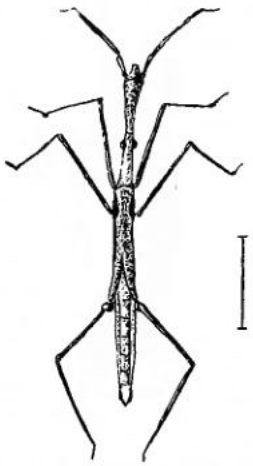

FIG. 209. Marsh-treader, *Limnobates lineata*. Enlarged.

AQUATIC PLANT-LICE belong to the family of Aphididæ, commonly known as Aphides, small soft-bodied winged or wingless insects, with oval-lobed bodies, small heads, distinct eyes, filiform antennæ and six legs; which when winged have two pairs of lace-like membranous wings. At the tip of the abdomen there are usually a pair of cauda or upward protruding air breathing tubes. They are usually viviparous and feed upon juices by means of a three-jointed piercing and sucking beak inserted into the tender portion of growing plants. The most general species of Aphides which the aquariist is likely to encounter is *Rhopalosiphus nymphææ*, Fig. 210, which infests the emersed and floating leaves of Sagittaria, Potamogeton, Duckweed, Cattails, Water-plantains, Water-poppies and Lilies; while the last two mentioned plants also have *Siphonophora lilii*, and two greenhouse species, *Aphis lilicola* and *Rhopalosiphus dianthi*. They produce a disfigurement of the leaves and cause decay by sapping the juices.

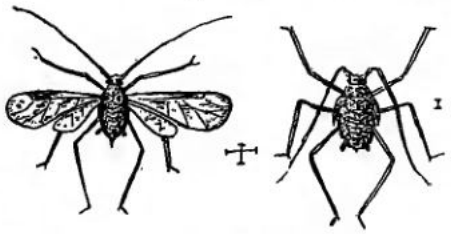

FIG. 210. Aquatic plant-louse, *Rhopalosiphus nymphææ*, winged and wingless stages. Enlarged.

ORDER NEUROPTERA. Of this order a considerable number of families are aquatic. All have the body elongated, thin and broad, net-veined membranous wings, large head with the mouth parts well developed,

prominent eyes, filiform antennæ, long and full thorax and segmental abdomen. This order is now restricted to a few families in the United States, including the Dobsons or Sialidæ, the May- or Shad-flies or Ephemeridæ; the Stone-flies or Plecoptera; the Dragon-flies or Odonata; and the Caddice-flies or Trichoptera.

Dobsons belong to the family of Sialiadæ, and include the Fish-flies, Hellgramites, Alder-flies and others of diverse popular names. They have four thin, broad, net-veined wings which are folded when at rest. All are weak flyers with legs scarcely able to support the body. The mouth parts are developed for biting, the abdomen long and slender, the antennæ long, the head broad with protruding eyes, and the mandables well developed. Of the Fish-flies or Sialis there are but two species, *S. infumata* and *S. americana*, both small insects which frequent vegetation on the banks of streams. The eggs are laid in white cottony masses on plants overhanging the water, on bridges, piers, etc., into which the larvæ drop when hatched.

The largest species of Dobson is the Horned Corydalis, *C. corinita*, which has a spread of wings of over five inches and is quite generally distributed.

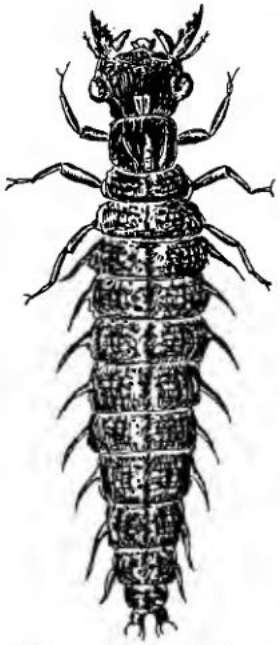

FIG. 211. Hellgramite, larva of the Dobson.

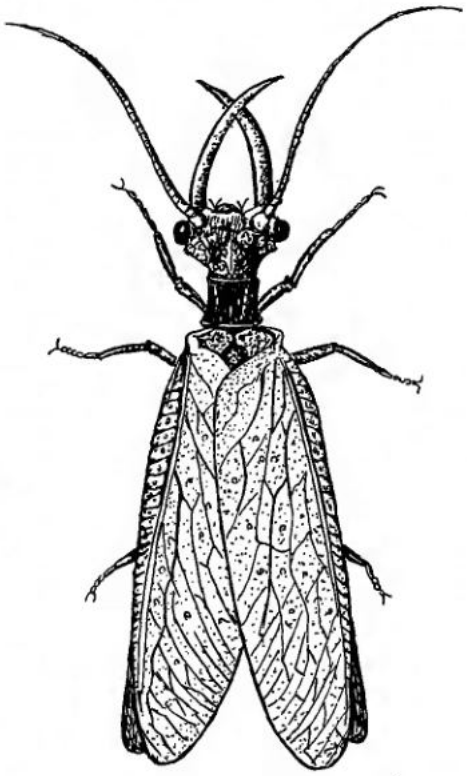

FIG. 212. Horned Dobson, *Corydalis corinita*.

The larvæ are known as Dobsons, Hellgramites, Bugies, etc., and are extensively used as bait for game fishes. They live under rocks and

stones in the streams and feed on the larvæ and nymphæ of May-flies, Stone-flies and other aquatic insects. The larval stage lasts three months and longer, but the pupal stage is quickly passed, and in less than a month after the larva leaves the water to make a cell for itself nearby, in which to undergo the metamorphosis, the adult insect or imago appears.

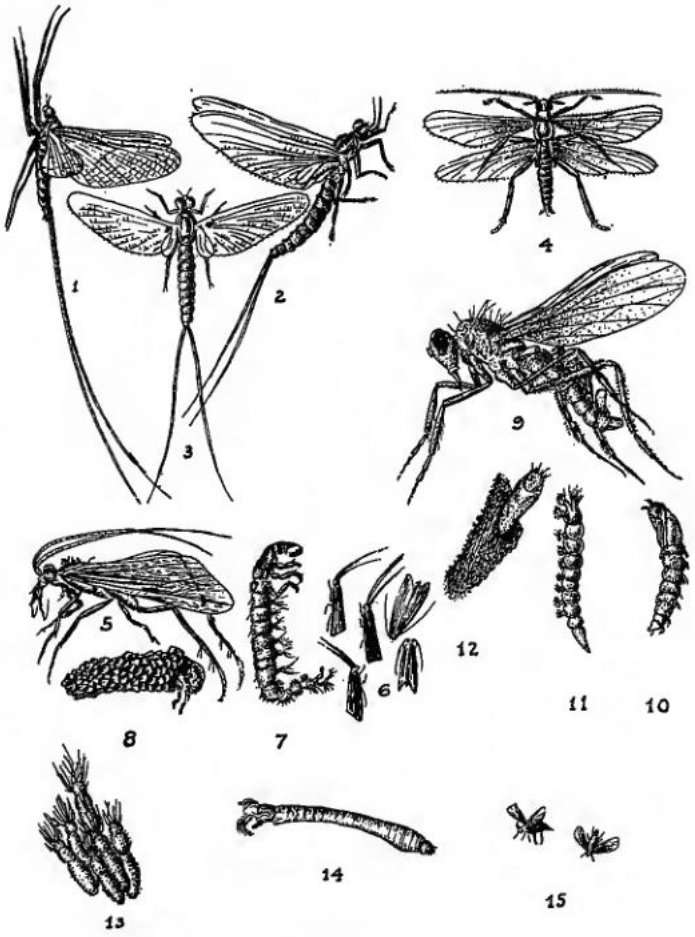

FIG. 213.

1. May-fly, *Heptagenia pulchella*, of the family Ephemeridæ.
2 and 3. " *Bætis pygmæa*, lateral and dorsal views.
4. Stone-fly, *Leuctra tenella*, of the family Plecoptera.
5. Caddice-fly, *Phryganea interrupta*, of the family Hydropsychidæ. Enlarged x 6.
6. " *Phryganea interrupta*, Imagos at rest. Natural size.
7. " larva. Enlarged x 5.
8. " pupal case. Enlarged x 4.
9. Black-fly, *Roederiodes juncta*, of the family Empididæ. Enlarged x 10.
10. " larva. Enlarged x 5.
11. " pupa. " x 5.
12. " " in case. Enlarged x 5.
13. Buffalo-fly, *Simulium venustus*, of the family Simuliidæ. Enlarged x 5. Group of pupæ.
14. " larva. Enlarged x 6.
15. " Natural size.

Some of the common species of Sialiadæ, of smaller size, the Alder-flies, or Chauliodes, are *C. pecticornis*, having greyish wings and featherlike antennæ, and *C. serricornis* of a brownish - black color with white-spotted wings. Four other species are not quite so generally distributed. All the Dobson larvæ are carnivorous and destructive to small fishes and snails.

MAY-FLIES OR SHAD-FLIES belong to family of Ephemeridæ, signifying lasting but a day. They have delicate membranous wings, with a fine network of veins, the fore wings larger than the second pair, which latter

pair are wanting in some species. All are aquatic, the larvæ active, swimming among the water plants, crawling over the bottom, or burrowing into the banks. The nymph has small wing pads and in its transformation floats on the surface of the water until the skin opens and the winged insect emerges, when a molt takes place, followed by a second before the adult stage is reached. In the final metamorphosis the mouth parts and the alimentary canal are atrophied so that the insect cannot eat, its life being very brief, often but a day; but when the atmosphere is moist, it may survive several days. Flight principally takes place in the early morning and evening hours. The eggs are deposited in the water either by dropping on the surface or by the female creeping into the water incased in a film of air. The larval life is from two to three years, during which as many as twenty molts take place. Both the larvæ and nymphæ of nearly all species feed on vegetal matter, diatoms, algæ and confervæ and are harmless to young fishes. Though enormously numerous in individuals there are comparatively few species, not more than eight or ten in the Eastern section of the United States; of which the more common are *Ephemera varia*, *Bætis pygmæa*, *Heptagenia pulchella*, Fig. 213, and *Siphlutus alternatus*, some of which are extensively grown by fish breeders as a food for young fishes, especially the trout.

Stone-Flies belong to the order of Plecoptera, signifying plaited wing and referring to the folding of the hind wings. The body is long and flat, and of the four membranous wings the hind pair are slightly the larger and are folded on the abdomen when in repose. The antennæ are long and threadlike and the mouth parts developed for biting. All the species are aquatic and propagate in enormous numbers in almost every rapid rocky stream, the female depositing 5000 to 6000 eggs on the water. The larvæ require aerated water and will not survive in any numbers in stagnant or stillwater ponds and ditches. They are active and carnivorous, feeding upon the young May-flies, soft-bodied Dipterous larvæ and upon vegetal matter. They have large flat heads, compound eyes and a flat body, which enables them to crawl under stones in the water. Usually they have long antennæ and breathe by tracheal gills. The full-grown nymph is active and varies with different species from ½ to 1½ inches in length, their cast skins being common objects along the banks of streams. The most generally distributed species are *Leuctra tenella*, Fig. 213, *Pteronarays proteus*, *Acroneuria abnormis*, *Isogenus frontalis* and *Perla ephyre*. There are no records of their being injurious to young fishes, and larvæ form one of the principal natural foods of the young trout, dace and other cold-water fishes.

DRAGON-FLIES belong to the order of Odonata, signifying a tooth. More than 2000 species have been established, of which about 300 inhabit the United States. They are very slender insects having four elongated membranous wings, finely netted with veins, each with a jointed structure or nodus near the middle of the front margin. The head is large and may be rotated on the slender neck, and the large eyes are placed at the sides of the head. The antennæ are short and slender, the mouth parts developed for biting and the legs placed near the front of the thorax and fitted more for grasping their prey and adhering to leaves and twigs than for walking. They are day flyers, the prey being captured by the legs and mandables in their darting flights. It consists of flies, mosquitoes, midges, gnats and other small insects. All the species are aquatic. The eggs are laid in the water, on the stems or in the tissue of aquatic plants. As soon as the young are hatched they begin their predatory life under water, feeding upon eggs, larvæ, small insects and entomostraca, which is continued during their entire larval and nymphal existence, attacks being directed to larger insects and animals as they increase in size. The larvæ and nymphæ, Figs. 214 and 215, have a formidable structure known as a mask, consisting of a long, hinged apparatus with sharp hook teeth which may be folded under the head or darted forward to seize insects and fishes to draw them to the mouth. Most of them breathe by rectal gills, this apparatus also affording the means of locomotion by the violent expulsion of the water. Some have both lateral and caudal abdominal gills. There is a marked difference in appearance between the larva and nymph of most species, the latter assuming a broad, flat form different from the slender larva and the adult insect. Both larva and nymph have short wing pads. When the final metamorphosis takes place the nymph crawls out of the water, the skin splits over the back, and the adult dragon-fly emerges. From nine to twelve months are required to develop

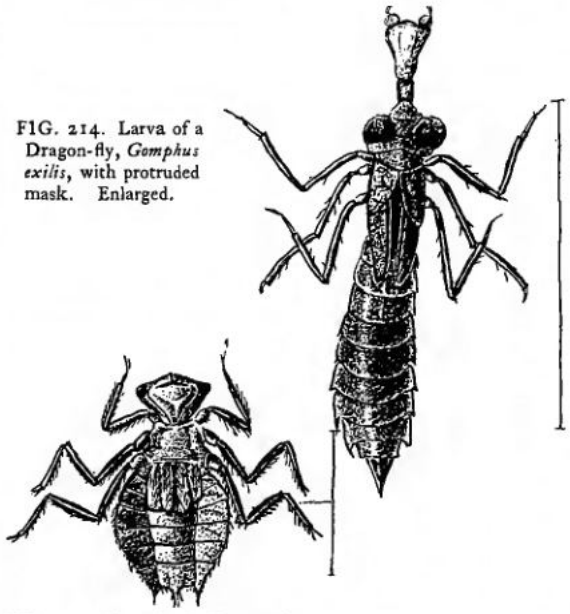

FIG. 214. Larva of a Dragon-fly, *Gomphus exilis*, with protruded mask. Enlarged.

FIG. 215. Nymph of a Dragon-fly, *Anax junius*, with mask folded, not visible from above. Enlarged.

the adult, and the winged existence lasts but a few weeks; oviposition being conducted by the same individual for a number of days. The larvæ of the same brood also develop unequally, some growing so rapidly that they devour their more tardy brethren. When captured, the nymphæ not only prey upon each other but upon any living thing kept with them, and the larvæ and nymphæ are the most rapacious and destructive enemies of young fishes which the aquariist encounters, a single one often destroying an entire hatching of several hundred young fishes in a few days. Nor are their attacks confined to young fishes, whatever contains life is fair game to them. The principal families of the Atlantic Coast and Gulf States are the Æschinidæ, Libellulidæ, Cordullidæ, Cordulegasteridæ, Agrionidæ, Gomphidæ; and the Calepterygidæ or Damsel-flies, Fig. 216. The "Hammer-headed dragon-flies" comprise the genera Agrion, Lestes and Calopteryx, which frequent grassy margins of ponds, pools and swamps. The larger are the "High-flying-dragon flies," Æschna and Corduligaster, which frequent tall shrubbery and trees and are seldom seen over ponds

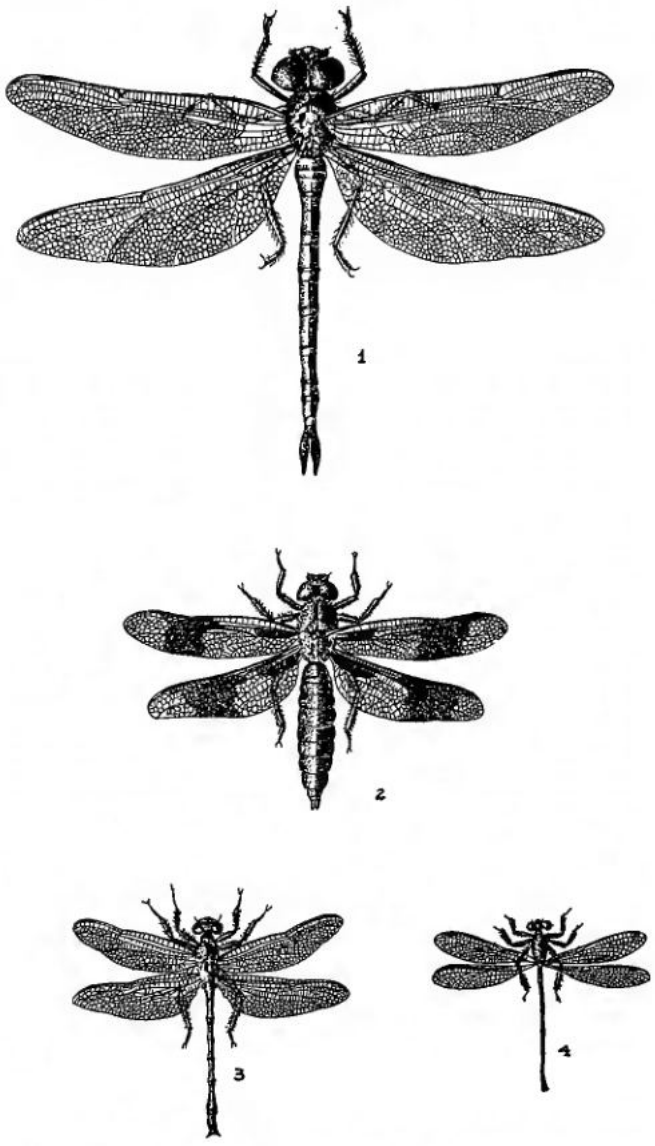

FIG. 216. Dragon-flies.
1. *Æschna heros.*
2. *Libellula pulchella.*
3. *Gomphus exilis.*
4. *Argia violacea*, a Damsel-fly.
Reduced one-fourth.

and waterways. These attack all winged insects, none seem too large to escape their onslaughts; but their principal prey is the evening flying Diptera and juicy, winged insects. The "Swift-flying dragon-flies" comprise the genera Æschnina, Gomphus, Anax, Cordulia, Tramea, Libellula, Celithemis and Diplax; some of them nearly as swift of wing as Æschna but not capable of as lofty and long-sustained flight. Dragon-flies are local in their habits, rarely flying far from their accustomed haunts, except in occasional cases of migration. Belostoma, Notonecta, Ranatra and other predaceous insects prey on the younger Dragon-fly larvæ, and frogs will take the perfect insect, as will also some of the birds, notably the Fly-catchers. It may be noted that Dragon-flies are most inveterate enemies of the mosquito in all the stages of its development, attempts having been made to introduce them extensively to aid in exterminating this pest. The most common species of Dragon-flies in the Eastern and Middle States are *Gomphus exilis*, *Cordulegaster maculatus*, *Æschna heros*, *A. clepsydra*, *Anax junius*, *Tramea carolina*, *Libellula pulchella*, *Celithemis elisa*, *Diplax ribicunda*, *Calopteryx maculata*, *Lestes unguiculata*, *Epicordulia princeps* and *Argia violacea*. Fig. 216. Agrion is not found in the Eastern section of the United States.

Caddice-Flies or Caddice-Worms belong to the order of Trichoptera, signifying hair-winged. They are mothlike insects usually having four membranous wings with numerous longitudinal veins, few cross veins and more or less clothed with hairs, which, at rest, are folded against the abdomen, the hind wings being usually the broader. They are common near ponds, streams and lakes and frequent shady places, resting on leaves and twigs, rarely flying during the day. The eggs are laid in gelatinous masses attached to water plants. The larvæ, known as Rock-worms, are aquatic, elongate and cylindrical in form with a tough horny head and thorax and a soft thin-skinned abdomen; which construct protective cases, open at the ends, of any available materials, leaves, twigs, sand, shells and small stones, all spun together by means of silk threads, to protect the Caddice-worm from predatory insects and other natural enemies. They breathe by tracheal gills at the side of the abdomen, and live several months in the larval condition, passing the pupal stage in the cases, both ends of which are then sealed with a silk netting. The final metamorphosis takes place above the water on plants or on the banks, the fly emerging from the pupa fully developed and immediately takes to flight. The food of the larvæ is principally vegetal, but one family is carnivorous and feeds upon small insect larvæ. There are more than 150 North American species, the more generally distributed of the Eastern and Middle States being *Phryganea interrupta*, Fig. 213, *Limnephilus rhombicus*,

Sericostoma americana, *Rhyacophila torva*, *Leptocerus transversus* and *Macronema zebratus*, each also representative of a distinct genus of the order Trichoptera.

ORDER THYSANURA. This order includes the so-called Bristle-tails, Spring-tails, Fish-moths and others; wingless insects which undergo no metamorphoses and retain the larval form in the adult. The mouth parts are developed for biting and chewing soft substances and they are sometimes provided with rudimentary legs only. The sub-orders comprise the Bristle-tails or Cinura; the Spring-tails or Collembola, and the Water Spring-tails or Poduridæ, with only the last of which we are concerned.

WATER SPRING-TAILS belong to the family of Poduridæ, of which *P. aquatica*, Fig. 217, is often found on the surface of quiet ponds and still water. It is a black insect with six legs, distinctly segmental abdomen without a constriction to divide it and the thorax, plumed antennæ, reddish legs provided with hairs and sharp claws, devoid of wings, and of which the larvæ may be distinguished from the adult only by their still smaller size. *Achorutes nivicola* is another species sometimes found under the surface of the water, and *Lepidocyrtus americanus* in greenhouses, under logs and in similar situations. They are small entirely harmless insects, mentioned only because they often attract the attention of the fish culturist and Natural History collector.

FIG. 217. Water-springtail, *Podurus aquatica*. Enlarged.

ORDER DIPTERA. This order includes insects which may be properly called Flies; those having but two wings borne by the mesothorax and include the Mosquitoes, Midges and Gnats. The wings are thin and membranous, the mouth parts formed for sucking, the thorax and abdomen slender, and the eyes distinct and placed at the sides of the head. The order includes the Mosquitoes or Culicidæ; Net-winged Midges or Blepharoceridæ and Chironomidæ; Moth-like Flies or Psychodidæ, Crane-flies and False Crane-flies, Black and Buffalo-flies, Horse-flies, Soldier-flies, the Long-legged flies, Snipe-flies and many others.

MOSQUITOES belong to the family of Culicidæ, small flies with narrow wings and long and slender abdomen, of which the males have plumelike antennæ. They frequent moist localities and pass all the stages of development to the perfect insect in the water, a new brood appearing every three or four weeks. In depositing the eggs the female rests upon some floating object with the anterior legs, the middle legs rest on the water and the posterior legs are crossed to hold the eggs as they are laid, with their longer diameter vertical, and glued together to form a raft of often 200

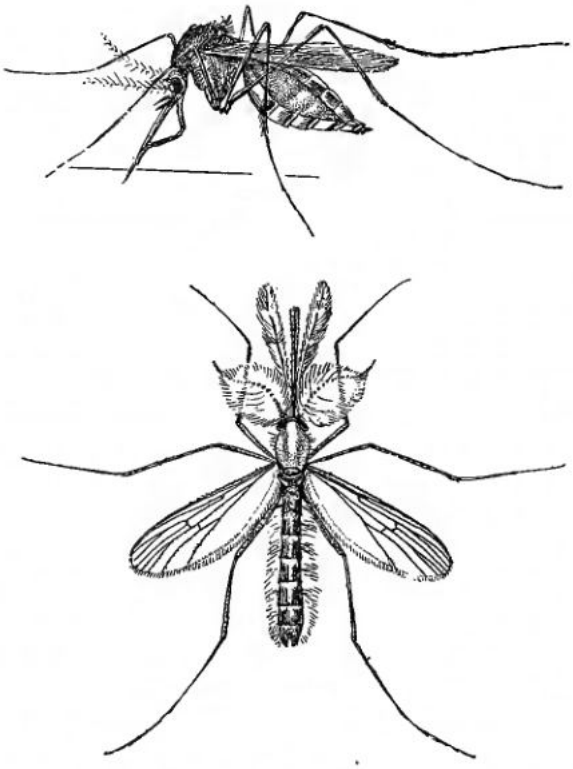

FIG. 216. Long-beaked Mosquitoes, *Culex pungens*. Adult female and male. Greatly enlarged.

together, which float about five or six days till the embrios emerge from the under side and at once take to the water. The larvæ keep near the sides of the pools or just below the water level, as they are not deepwater feeders and must frequently come to the surface to breathe, the oriface of the air tube being thrust out of the water. After a number of molts the pupa is developed, which has the head, thorax, wings and legs folded in one mass and the abdomen free for navigation. The pupa and nymph stages are passed in a few days and when the period of emergence is reached, the nymph case opens over the back and the perfect insect appears; which, after drying itself, takes wing and disappears. The food of the larvæ is vegetal substances and the minute water infusoria. It is only the female insect which has the proboscis developed for drawing blood, and both it and the male feed principally by sucking the juices of plants at night, the irritation of the bite being due to a venomous salivary secretion which probably serves to make the blood more liquid. The perfect insect also attacks other insects, cold-blooded vertebrates, small fishes, birds and other warm-blooded animals. The enemies of the larvæ and pupæ are all the carnivorous insects and their larvæ, tadpoles, frogs, salamanders, newts, minnows, sunfishes, perch, sticklebacks, etc.; and those of the adult Dragon-flies are frogs and toads, night-flying birds and bats. It was a theory that the female Mosquito required animal blood to perfect the eggs, but this is scarcely possible considering the enormous numbers of which only an infinitesimal proportion ever taste the blood of animals. Mosquitoes are classified as long and short beaked. The long-beaked genera of North America are Anopheles, Mergarhinus, Psorophora, Toxorhynchites, Stegomyia, Conchyliastes, Culex, Uranotænia and Aëdes, of which there are several hundred species.

Of these *Anopheles* bear the *Plasmodium malariæ* which produces malarial fever, *Culex pipiens* those of Roman fever, *Stegomyia fasciata* those of yellow

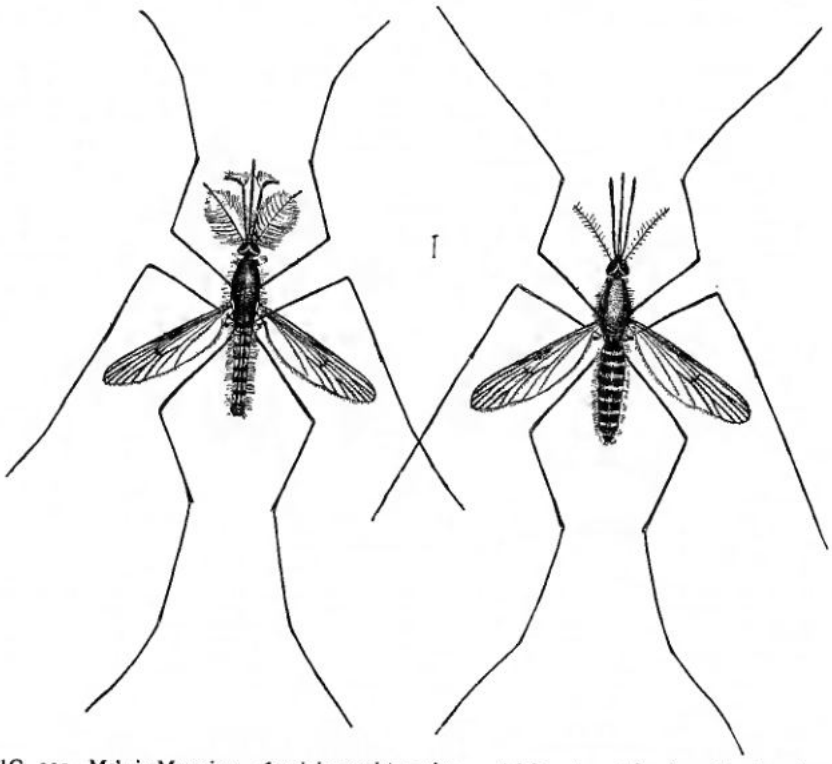

FIG. 219. Malaria Mosquitos, *Anopheles quadrimaculatus*. Adult male and female. Greatly enlarged.

fever, and *Culex ciliaris* the parasitic *Filarias* which produce elephantiasis. Figs. 218 to 221 incl. Fishes of the carp family are very useful in ponds to destroy mosquito larvæ, but the surface-feeding Top-minnow is the best to destroy *Anopheles* the malaria mosquito larva, which develops and

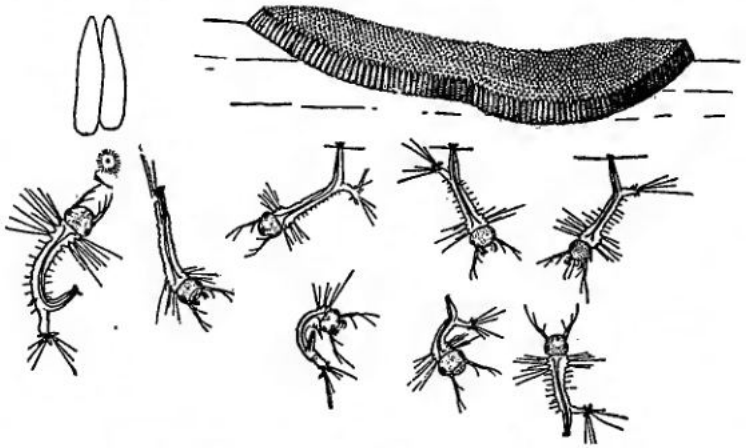

FIG. 220. Mosquito-boat or Egg-mass, with enlarged eggs and young larvæ.

hatches on the surface of the water, and stocking with these is an approved preventive measure.

The larvæ and pupæ of mosquitoes are one of the best natural foods for goldfishes, in many respects preferable to the entomostraca. They are usually more easily obtained, larger in size, more tenacious of life and are eagerly eaten by the young fishes, who acquire a most remarkably rapid growth on this diet. It is not advisible to feed them to very small fishes, as these are not able to swallow them and may, in turn, be attacked by the larvæ, but for fishes which have reached a growth of half an inch, they should form one of the principal foods. A few barrels filled with rain water at any convenient place only are required; in which they may be bred either by the visits of female mosquitoes, or more quickly stocked by catches in ponds and ditches. They breed very rapidly and are a cleaner diet than the usual live pond food. The use of mosquito larvæ is almost universal among goldfish breeders and is to be in every way recommended.

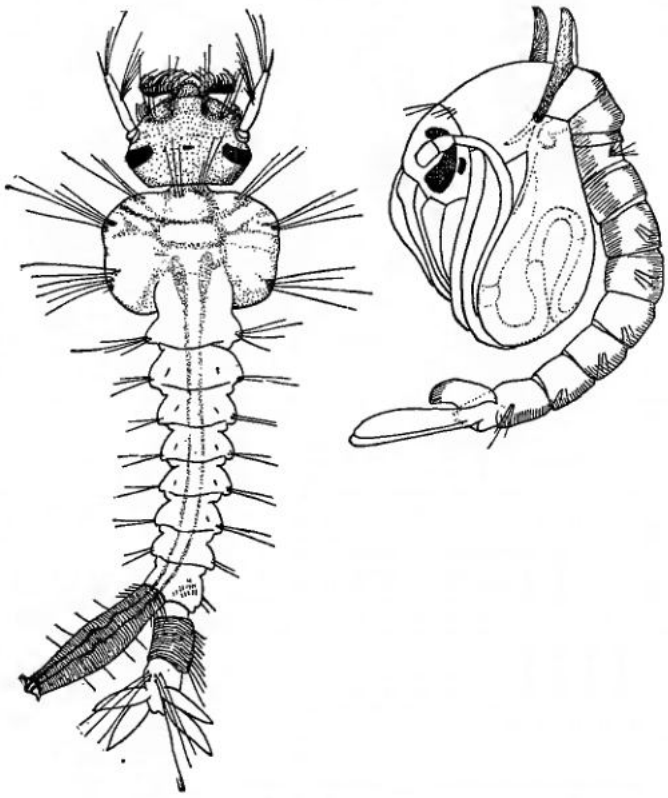

FIG. 221. Full-grown larva and pupa of *Culex pungens*. Greatly enlarged.

NET-WINGED MIDGES belong to the families of Blepharoceridæ and Chironomidæ, of which the tiny larvæ appears more like crustaceans than insects. Some of the species, *Blepharocera capitata*, *Chironomus minutus* and *C. plomosus*, live in the water during the larval and pupal stages, are of black color and consist of segments bearing leg-like appendages, each having sucker breathing gills. They usually occur in clusters which form black patches on submerged rocks. When the final metamorphosis takes place the pupa detaches itself from its mooring, floats to the surface, and the Midge rends the case and takes to flight. They form the natural

food for many of the larger insects, young fishes, etc. Net-winged Midges are a very numerous family of hundreds of genera and species.

AQUATIC FLIES. Some of the flies frequent water courses, ponds and pools in which they deposit eggs and where they pass the larval and pupal stages. Among these are the Moth-like flies of the family *Psychodidæ*; the Crane-flies of the families *Tipulidæ*, *Syrphidæ* and *Muscidæ;* the False Crane-flies, *Rhyphidæ;* the Black-flies, *Empididæ*; and the Buffalo-flies, *Simulidæ*; Fig. 213; the Horse-flies, *Tabanidæ*; the Soldier-flies, *Stratiomyiidæ*; the Snipe-flies, *Leptidæ*; the Long-legged Flies, *Dolichopodidæ;* and many others, far too many and too complex in classification for further description in a volume of this character. The aquatic genera are all harmless to young fishes and constitute a part of their natural food.

ORDER COLEOPTERA. Of this order a number of families are aquatic. They have a pair of veinless horny wing covers or elytra, occupying the position of the fore wings, folded and meeting in a straight line down the back, under which is a single pair of membranous wings, though some species have the rudiments of fore wings under the elytra. More than 80 families of Coleoptera occur in America north of Mexico and over 11,000 species have been described. The most generally distributed genera and species of the Eastern section of the United States, which for either a part of, or their entire existence, inhabit the water, are the Predaceous Diving-beetles or Dytiscidæ; the Water-scavenger beetles and Great Water-beetles or Hydrophilidæ, the Whirligig-beetles or Gyrinidæ; the Pond-beetles or Haliplidæ; and many other smaller beetles belonging to these genera.

PREDACEOUS DIVING-BEETLES OR WATER-DIVERS belong to the family of Dytiscidæ and are brownish-black shining beetles of oval form with threadlike antennæ. The anterior and middle legs are adapted for crawling, the posterior legs are longer, fringed with hairs and adapted for swimming. They abound in ponds and still water, sometimes in streams. The breathing apparatus is located at the hind end of the body, the beetle at rest floating on the water in an inclined position, head downward, and by slightly raising the wing covers admits air under them for breathing under the water. They are voraceous and attack all water animals, even large fishes, frogs and snakes. The larvæ are known as Water-tigers, Fig. 222, most ferocious enemies to all living water animals, some of them growing to a length of 2½ inches. They have an elongated spindle form with a large head, and strong, curved and hollow mandables for holding and sucking the juices of their prey. The segmental body has six legs and terminates in a pair of breathing tubes. The eggs are deposit-

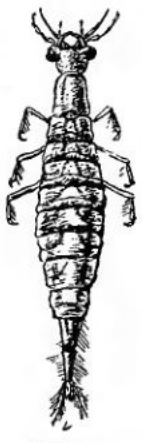

FIG. 222. Water-tiger. Larva of a Predaceous Diving-beetle.

ed in the water and the larvæ leave the water, burrow into the ground to there undergo the final metamorphosis. The flight of the Diving-beetles is nocturnal and their migrations are from pond to pond, being also attracted by bright surfaces and lights. The common genus is Acilius which is about ¾ inch long, of a polished brownish-black color, marked with dull yellow; the elytra covered with fine punctures, the female having four furrows on each wing cover. The more common species are *A. fraternus*, Fig. 223, and *A. mediatus*. The largest belong to the Dytiscus, Cybister and allied genera; the former having the cups on the under side of the tarsal discs varying in size, and the latter similar and of uniform size. The more common of these are *D. fasciventris*, Fig. 224, *D. hybridus*, and *C. fimbriolatus*. The genus Colymbetes has the elytra marked with numerous fine transverse striations. The most common species is *C. sculptilis*. All are fairly good flyers and widely distributed in almost the entire United States.

FIG. 223. Predaceous Diving-beetle, *Acilius fraternus*. Female and male. Enlarged.

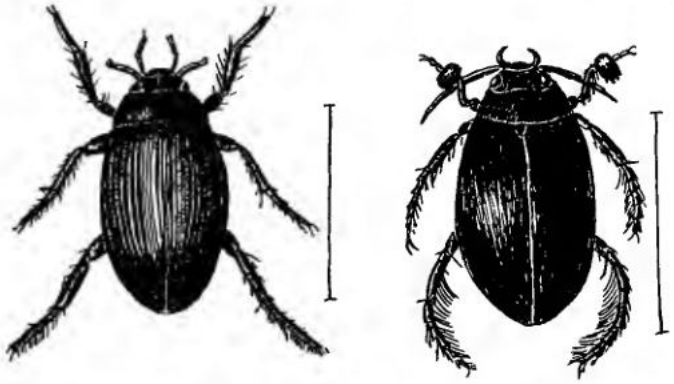

FIG. 224. Predaceous Diving-beetle, *Dydiscus fasciventris*. Female and male. Enlarged.

WATER-SCAVENGER BEETLES (GREAT WATER-BEETLES) belong to the family of Hydrophilidæ and closely resemble the Predaceous Diving-beetles in general appearance, but are more convex and have short club-shaped antennæ concealed beneath the head and very long palpi, the parts next to the mandables. They are dusky-black beetles of elong-elliptical form, strong, active and of savage disposition. Both the middle and the posterior legs are fringed with hairs and adapted for swimming; while the

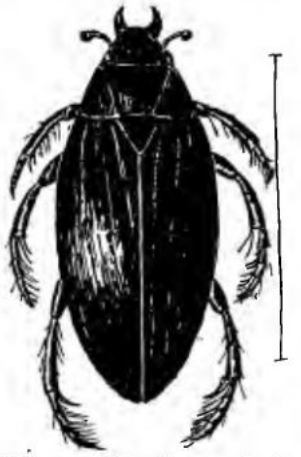

FIG. 225. Water Scavenger-beetle or Great Water-beetle, *Hydrophilus glaber*. Male.

anterior legs are prehensile and adapted to aid in holding their prey. The many hundred eggs are deposited in a cocoon spun by the female and attached to the lower side of the floating leaves of aquatic plants or drifting leaves and branches, Fig. 226, to which the female clings with her posterior legs, and guards until the larvæ are hatched. These also somewhat resemble those of the Dytiscidæ but are thicker and have shorter mandables, those of the larger genera growing to 2½ or 3 inches in length and ½ inch thick. They are popularly known as Spear-mouths, and are ravenous feeders, destroying water insects, flies, small snails, tadpoles, fishes, and their younger and weaker brethren; all of which they attack and crush with their powerful madables to extract the juices. They are very destructive to young fishes and will destroy hundreds in a few days in the hatching and rearing tanks. The largest beetles of this family belong to the genus Hydrophilus of which the most common species are *H. triangularis* and *H. glaber*, Fig. 225, the next larger to Hydrocharis, of which *H. obtusatus* is the more common, and the smaller to Hydrochus, of which about twelve species inhabit the Eastern and Middle States, the more common forms being *H. scabratus* and *H. variolatus*. There are a number of other genera, and some of the smaller species are not aquatic but live in moist earth and manure, feeding upon Dipterous larvæ. The Water-scavenger beetles are nocturnal in their flights, strong of wing and are attracted by lights and bright surfaces; are frequently seen near electric lights and will penetrate into houses, instances being recorded of their having found their way into household aquaria through open windows. All of this order have short antennæ, clavate or clubbed at the tips and may easily be distinguished from the Diving-beetles.

FIG. 226. Water Scavenger-beetle or Great Water-beetle, *Hydrophilus glaber*. Female attached to Egg-pouch and predaceous larva, or Spear-mouth.

WHIRLIGIG-BEETLES, also popularly known as Scuttle Bugs and Spinners, belong to the family of Gyrinidæ and occur in great numbers on almost all still and slow-flowing waters. They are brilliant bluish-black beetles

with peculiar jointed antennæ, strong mandables and eyes divided by the margins of the head, so that they appear to have eyes for looking into the air and a second pair for seeing into the water. The body is of slightly flattened oval or elliptical form, the anterior legs very long and the middle and posterior legs short, broad and flattened. The breathing apparatus is located at the sides and back of the abdomen. Small cylindrical eggs are laid in parallel rows upon aquatic plants, and the larvæ are narrow, flat and long, somewhat resembling centipedes. Each abdominal segment is furnished with gills and the caudal end has a pair of breathing tubes. Fig. 229. When fully developed the larva leaves the water to spin a cocoon on some near by object, in which it passes the pupal stage and emerges in about one month as the fully developed beetle. The food of the larva consists of the smaller water animals; that of the beetle of flies and other insects, small tadpoles and young fishes. The mouth parts of the beetle are developed for biting and can inflict stinging and bleeding wounds. They are very agile swimmers, their peculiar gyrations on the water having earned for them both their scientific and popular names. There are three generally distributed genera, Gyretes, of which the most common species is *G. simatus*; Gyrinus, of which *G. rockinghamensis* and *G. affinis*, Fig. 227, are most generally distributed; and Dineutus, of which *D. vittatus*, Fig. 228, and *D. assimelis* are the more generally distributed forms in the Eastern and Middle States.

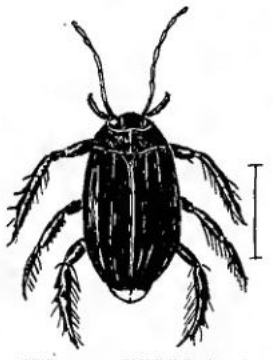

FIG. 227. Whirligig-beetle, *Gyrinus affinis*. Enlarged.

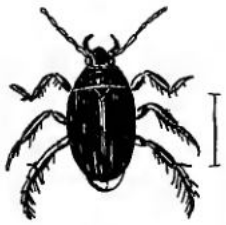

FIG. 228. Whirligig-beetle, *Dineutus vittatus*. Enlarged.

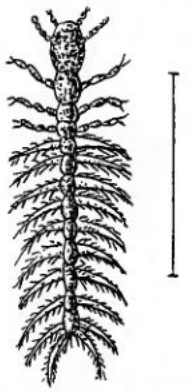

FIG. 229. False Water-milliped, larva of a Whirligig-beetle. Enlarged.

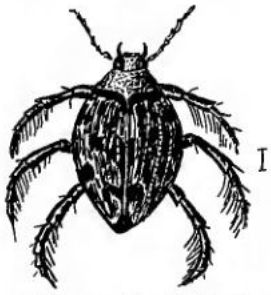

FIG. 230. Pond-beetle or Haliplid, *Haliplus ruficollis*. Greatly enlarged.

POND-BEETLES OR HALIPLIDS are small beetles belonging to the large family of Haliplidæ, having oval bodies more or less pointed at each end; the three most generally distributed aquatic genera being Brychius of the Pacific Coast States, and Haliplus and Cnemidotus, common to almost all ponds and streams on the Atlantic slope. The larvæ are aquatic and have a slender segmental body furnished with spiny tips, the last segment bearing a long single or forked caudal appendage. The most

generally distributed species of Haliplus are *H. fasciatus* and *H. ruficollis*, Fig. 230, and of Cnemidotus, *C. punctatus*. They are harmless to young fishes but have been observed to feed upon spawn.

SMALLER WATER-BEETLES. A small water-beetle of the family Parnidæ, *Psephemus lecontii*, Fig. 231, has a dark five-jointed body clothed with fine silken hair to retain a film of air when it crawls below the water surface, adhering to plants and stones, as the legs are not so well developed for swimming. The larva is very flat, broadly oval or almost circular, $\frac{5}{16}$ inch in length, and consists of 10 to 12 closely fitted segments. It lives principally upon vegetal substances but attacks the spawn of snails and fishes.

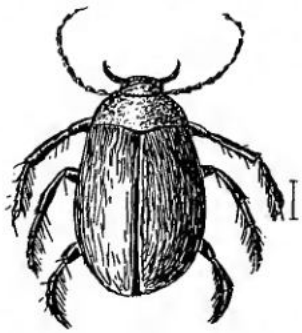

FIG. 231. A Smaller Water-beetle, *Psephemus lecontii*. Greatly enlarged.

Another small aquatic beetle belonging to the family of Heterocerus, *H. pusillus*, has an oblong or nearly oval form of dark-brown color with bands and spots of yellow. It is almost covered with hairs for the retention of air and burrows galleries into the mud at the margins of ponds and streams. The mouth parts are developed for biting. The larvæ and nymphæ of another member of this family, *H. rosæatus*, are of a bright-red color.

There are many other small Water-beetles not so frequently met with and mention of all of which would too greatly amplify this volume. They are usually harmless to fishes, and are scavengers rather than active enemies.

ORDER LEPIDOPTERA. Of this order a number of families abound in the neighborhood of marshes and ponds and several species feed upon the leaves of aquatic plants. Of these the larvæ have in various degrees adopted an aquatic existence. They are the China-Moths or Hydrocampa, the China-Marks or Cataclysta, and several other smaller genera.

CHINA-MOTHS belong to the genus Hydrocampa, the species varying in length of body from $\frac{3}{8}$ to $\frac{5}{8}$ inch and in spread of wings from $\frac{3}{4}$ to $1\frac{1}{4}$ inch, while the larvæ or caterpillars are $\frac{1}{2}$ to 1 inch long, of a white color tinged with yellow, with the body thickest at the middle and narrowed at both the ends, having 16 feet, the last pair very short. The popular name of the moth is due to the markings on the wings which are white, mottled with vary-

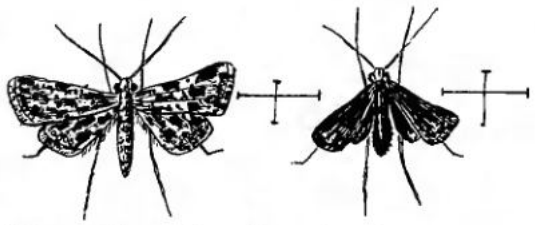

FIG. 232. Water-moths. China-moth, *Hydrocampa obliteralis* and China-mark, *Cataclysta fulicalis*. Enlarged with extended wings.

ing patterns and shades in brown. It may be seen on the wing in early summer, deposits its eggs, encased in a gelatinous capsule, on the under side of floating leaves near the edges. The larvæ burrow into the leaf until too large to find a refuge, when they bite off oval pieces and fasten them to other parts of the leaf with a gelatinous secretion or silk; and in this secure retreat the molts take place. The more general species are *H. obliteralis*, Fig. 232, which lives on water plants in greenhouses, rarely out-of-doors, *H. albalis*, *H. allionealis*, *A. ekthlipsis*, *H. icciusalis*, *H. obscuralis*, *H. stenialis*, and six other species on the Atlantic slope of the United States.

China-Marks or Cataclysta are small moths, rarely over 5/8 inch spread of wings, of which those of the male are white, with black markings and of the female brownish with darker markings. The larva is brownish and is most often found among the duckweed, of which it spins together the leaves to form a casing. The more general species are *C. fulicalis*, Fig. 232, and *C. bifascialis*, with three other species not so generally distributed in the United States.

There are several other genera of Lepidoptera which are semi-aquatic but which are not generally distributed and need not be mentioned here.

Order Arichnidæ. This order, consisting of the spiders, scorpions mites and harvest-men, possesses certain characteristics in common with the Crustaceans with which it is allied. All the families have a combined head and thorax, a globular, ovate, cylindrical or triangular abdomen connected by a slender waist; eight legs attached to the thorax, and simple eyes, varying from 2 to 12 in number, placed in two transverse rows. The mouth parts are armed with powerful forceps to seize, hold and poison their prey, below which is a pair of maxillæ, somewhat resembling a pair of legs. The spinning organs are situated at the tip of the abdomen and the breathing apparatus is at the forward portion of the abdomen. It serves the purpose of lungs, the colorless blood circulates around and through it and is aerated by the absorption of air. There is no metamorphosis, as the young, just issued from the egg, exactly resembles the adult. Molting continues after the spiders have reached the adult stage. All the aquatic genera belong to the Senoculina, or six-eyed group. One species, *Argyroneta aquatica*, Fig. 233, about 3/8 inch long, spins a baglike web of silk half the size of an acorn among the water plants with the opening below the surface, and lives in it under the water, taking a bubble of air into it each time it comes to the surface; effected by erecting

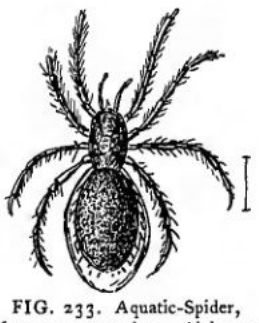

FIG. 233. Aquatic-Spider, *Argyroneta aquatica*. Abdomen surrounded with air. Enlarged.

the end of the abdomen out of the water, jerking it under and quickly crossing the hind legs over it, then descending to the nest and by opening the legs the air bubble escapes into the nest. The hairs on the body keep the surface from becoming wet, and in the nest the spider is as dry as on land. The 40 to 100 cocoons, containing the round saffron-colored eggs, are laid in the nest during June, and in July the young are large enough to spin a nest of their own. Another family of the eight-eyed group, the Lycosidæ, have semi-aquatic genera which almost exclusively live on the banks of ponds and streams and prey upon aquatic insects, chasing them on the surface of the water. Some species grow to nearly one inch in length. Other smaller species are of similar habit. These often dive below the surface when pursued by enemies from above the water or when in pursuit of their prey.

ACARINA. This family consists of the lowest order of the Arachnidæ, which live in the earth and in both fresh and salt water. They comprise the Mites and Ticks which differ from other Arachnids in their oval or rounded forms, which are not articulated. The mouth parts are developed for biting and sucking and they breathe by tracheal gills. Of this family the Water-mites are known as Hydrachnidæ, which have soft, oval unsegmented bodies, and limbs adapted for swimming, terminating with adhesive vesicles. They are parasitic on fishes and mussels, while some of the smaller species live on the Hemiptera, Coleoptera and other insects. The most generally distributed genera are Hydrachna, Atex, Limnochares and the marine Pontarachna. Atex has an oval solid body of bright red color with curved, clawlike mandables, acute, pointed maxillaries, and short, weak legs. The species inhabit some of the mussels, *A. ypsilophorus* in Anadonta and *A. humorosa* in Unios. The eggs are laid in the spring on the stems of water plants and when hatched seek hosts in which to pass their subsequent existence. A bright red species, *Bdella maritima*, occurs under stones between tidemarks. Three species of Trombidium are represented in the United States, all of red color.

HYDRACHNA OR WATER-MITES, are common in ponds. They are tenacious of life and steadily move about by the rapid movements of their fringed legs. The larvæ have six and the adult eight legs, which increase in length, with the posterior pair the longest. The body is slightly convex, the mandables needle-shaped, the third joint of the maxillæ the longest, and all the species have two distinct eyes. They are parasitic on both fishes and mussels, and are frequent external freshwater parasites, easily detected by their size. The largest and most widely distributed form is *H. geographica*, Fig. 234, while *H. globosa* and *H. triangularis* are also frequently occurring species.

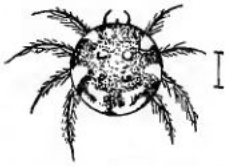

FIG. 234. Water-mite, *Hydrachna geographica*. Enlarged.