

SOME MODIFICATIONS OF LEG STRUCTURE IN THE HYDROPHILIDAE

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This paper has for its main purpose to show some modifications of leg structures in the Hydrophilidae. Thirty-five species were picked from the various sub-families for study. The legs on the left side of the body were removed and mounted on slides. The various specializations were noted and found, in general, to fall in three classes. First, the modifications for aquatic life; second, for terrestrial life, and, third, for a fossorial habitat. Within the family all three types are well shown with intermediate forms. Also within a given genus various sequences of characters may be shown. Only certain modifications will be elaborated upon in this account, particularly the gradation of structural characters from the more or less terrestrial or land-inhabiting type to the aquatic. The Hydrophilidae, as the names of the various sub-groups would imply, are known to be associated with an aquatic habitat, living in or near the water. The family is unique, however, in showing the sequences of modifications for the two widely different modes of life.

CHARACTERS AND HABITS OF THE HYDROPHILIDAE

The Hydrophilidae, or Water-scavenger Beetles, are oval or elliptical, usually blackish beetles, with a distinctly convex dorsal surface. They vary in length from 1.2 mm. to 37 mm. These insects are usually found in or near bodies of fresh water, but are less active swimmers than some of the other diving beetles. When they swim the hind legs are moved alternately, while the Dytiscidae strike with them both together, like a frog. The convexity of the body, the striations, tubercles and irregularities, along with the modifications of the legs, may give an indication of the reason for their inferiority in the swimming method of locomotion. There are some genera having terrestrial habits. These forms live in damp places, in decaying vegetation or in the excrement of herbivorous mammals. The forms, not fitted for aquatic life, have the first joint of the middle and hind tarsi elongated.

In general, the structural characteristics defining the family are as follows: Tarsi with five joints, the first one in many cases so small as to be scarcely evident; the middle and hind legs sometimes having the tibial and tarsal segments compressed and fringed for swimming; the antennae short, of less than eleven joints, not filiform, but consisting of three parts—a basal part of one or two elongate joints, an intermediate part of two or more small joints, and an apical part of larger joints, which are pubescent, the others are bare; the maxillary palpi are often very long; the hind coxae extending the width of the body, nearly or quite immobile.

CLASSIFICATION OF THE FORMS STUDIED

Hydrophilidae

1. Hydraeninae
 - (1) *Ochthebius rectus* Lec.
 - (2) *Ochthebius holmbergi* Mann.
 - (3) *Hydraena pennsylvanica* Kies.
2. Helophorinae
 - (1) *Helophorus inquinatus* Mann.
 - (2) *Helophorus obscurus* Lec.
 - (3) *Helophorus nitidulus* Lec.
 - (4) *Helophorus lineatus* Say.
 - (5) *Helophorus auricollis* Esch.
3. Hydrochinae
 - (1) *Hydrochus squamifer* Lec.
4. Hydrophilinae
 - a. Berosini
 - (1) *Berosus punctatissimus* Lec.
 - (2) *Berosus miles* Lec.
 - (3) *Berosus aculeatus* Lec.
 - (4) *Berosus subsignatus* Lec.
 - (5) *Berosus exilis* Lec.
 - (6) *Berosus exiguus* (Say).
 - (7) *Berosus infuscatus* Lec.
 - (8) *Berosus striatus* (Say).
 - b. Hydrophilini
 - (1) *Hydrous triangularis* (Say).
 - (2) *Hydrophilus obtusatus* Say.
 - (3) *Tropisternus striolatus* (Lec.).
 - (4) *Tropisternus lateralis* (Fabr.).
 - c. Hydrobiini
 - (1) *Hydrobius fuscipes* L.
 - (2) *Hydrobius scabrosus* Horn.
 - (3) *Enochrus nebulosus* (Say).
 - (4) *Enochrus perplexus* (Lec.).
 - (5) *Enochrus cinctus* (Say).
 - (6) *Laccobius agilis* Rand.
 - (7) *Laccobius ellipticus* Lec.
 - d. Chaetarthriini
 - (1) *Chaetarthria pallida* (Lec.).
5. Sphaeridiinae
 - (1) *Daetylosternum cacti* (Lec.).
 - (2) *Sphaeridium scarabaeoides* (L.).
 - (3) *Cereyon fembratus* Mann.
 - (4) *Cereyon praetextatus* (Say).
 - (5) *Pelosoma capillatum* Lec.
 - (6) *Cryptopleurum minutum*.

DESCRIPTION OF THE LEG STRUCTURES

Ochthebius. The legs are moderately elongate and appear rather strong. The coxal joints are average size, showing very little modifica-

tion even in the hind legs. The tibiae are more lengthened, becoming flattened and widened distally. The outer margin and surfaces, particularly the ventral, have spines, which become larger and more formidable along the edge. The tarsal claws are only moderately developed.

The tibial spurs are moderately long in *O. rectus*. The tibial spines are quite numerous, appearing in longitudinal rows on the middle and hind legs. The first four tarsal segments are of about equal length in each of the three pairs of legs, possibly enlarging slightly from the first to the fourth. The fifth tarsal joint is longer than the first four together and a very little wider. There are two or three short hairs arising from between the tarsal joints of each leg. These hairs are about as long as three of the smaller segments.

The tibial spines in *O. holmbergi* are less numerous and scattered, and also shorter than in *O. rectus*. The tarsal fringe, if it can be called fringe, is much shorter in *O. holmbergi*.

Hydraena. This genus, represented by *H. pennsylvanica*, shows even more uniformity in the coxal joints of the three legs than the preceding. The hind coxae are slightly larger and all three are distinctly pubescent, which is also true of the trochanters and femora. The femur of the hind leg has short, blunt spines scattered over the ventral side. The tibiae of the middle and hind legs are long and slender, being straight and somewhat flattened. These segments also have scattered spines and a considerable covering of hair on the middle tibia. The pro-tibial joint has numerous blunt spines located near the distal end. The first four tarsal segments are small, the proximal one exceedingly so. The hairs in the fringe are a little more numerous in this genus than in *Ochthebius*, and the tarsal claws are slightly longer and more recurved.

Helophorus. In this genus there appears a lengthening of the segments in the three pairs of legs. The front and middle coxae are more or less oval and the hind coxae distinctly elongated, appearing very strong. The femora are quite straight and not enlarged or flattened. The tibiae are slender and straight, with two or sometimes three rows of sharp spines. The anterior tibia is slightly flattened and widened distally. The tarsi are somewhat compressed laterally. The first tarsal segment is small, the second longer, the third and fourth about the length of the second, and the fifth a little shorter than the first four together. The front tarsi have a few scattered short hairs. The middle and hind tarsal joints give rise to a fringe varying in the different species. The modifications of each species will be taken up separately.

Helophorus lineatus

Front tibia—ridged; four rows sharp spines; spurs moderately long.

Front tarsus—first four segments equal in length, fifth longer; two or three hairs.

Mid tibia—three rows of spines, those along outer side longest.

Mid tarsus—first joint short, second longer, third and fourth equal, shorter than second, fifth as long as second, third and fourth; claws moderate; three or four delicate short hairs.

Hind tibia—long, slender segment; four rows of very fine delicate spines—longer distally; spurs moderate.

Hind tarsus—one or two short hairs; two short spines on ventral, distal part of each tarsal segment.

Helophorus inquilatus

Front tibia—flattened; four rows of delicate spines, longer at distal end; spurs short.

Front tarsus—first three equal in length, fifth long; four or five delicate hairs; claws moderately recurved.

Mid-tibia—longitudinal ridges; three rows of delicate spines; spurs longer.

Mid-tarsus—as in *lineatus*; five or six delicate, short hairs.

Hind tibia—long, slender; four rows of delicate spines; spurs like mid-tibia.

Hind tarsus—proportion of segments as in mid-tarsus; fringe delicate, ten or eleven hairs, long as three segments; claws moderate.

Helophorus nitidulus

Front tibia—flattened, widened distally; four rows of small spines; short spurs.

Front tarsus—segments one, two and three gradually larger distally; sparse hairs, twelve or fifteen; spurs short.

Mid-tibia—four irregular rows of very delicate spines, almost hair-like; spurs moderate.

Mid-tarsus—ventral spines long and fine, almost hairlike; fifth segment with very fine, short fringe.

Hind tibia—flattened, elongate; four irregular rows of delicate spines; spurs moderate, delicate.

Hind tarsus—long, delicate spines; a few delicate hairs.

Helophorus obscurus

Front tibia—spines elongated, fine, almost hairlike on the distal end; spurs short, curved; sparse fine hairs near end.

Front tarsus—four, sometimes five long hairs; numerous short fine hairs; claws longer.

Mid-tibia—four long spines; seven or eight long fine hairs; row of spines along the distal edge.

Mid-tarsus—fine short fringe, a little longer than in *nitidulus*.

Hind tibia—slender, long, flattened; short spines along the margins; long spurs.

Hind tarsus—fringe of fifteen to twenty hairs, over half the length of the tarsal segments.

Helophorus auricollis

Front tibia—spines delicate along the inner edge, outer margin with blunt spines distally located; five or six hairs; spurs short, recurved.

Front tarsus—two or three hairs; claws moderate; a few very short ventral spines.

Mid-tibia—four rows of fine spines; spurs short, slender.

Mid-tarsus—fringe sparse, five or six hairs, longer than *obscurus*.

Hind tibia—elongated, spines short, few.

Hind tarsus—fringe long, sparse.

Hydrochus. *H. squamifer*, in general, has leg structures much like the preceding genera. The femora are more elongate and distally enlarged, making the joints appear club-like. The tibiae are slender, with short, blunt spines on the ventral side. The first four tarsal segments gradually lengthen, and the fifth is about the length of the first four. The tarsi, as well as the tibiae, are compressed laterally and between the segments short hairs project dorsally. The tibial spurs are comparatively short and the tarsal claws are long and sharp. There are only very minor differences in the leg modifications in this species and those of some of the forms in the genera, *Ochthebius* and *Helophorus*.

Berosus. In this genus there is a lengthening of segments. All the joints have become more slender and graceful. There is little change in the coxa of the foreleg, but those of the middle and hind legs are elongated and widened. They are often pubescent and tuberculate. In most cases there is a distinct protuberance opposite the place of attachment with the trochanter. The femora have a sparse covering of fine short spines or tubercles. The tibiae are of about the same shape in the different species, being slender, straight and slightly compressed. The tibial spurs are of unequal length, the longest being almost the length of the first two tarsal segments. The first joint of the tarsus is small, the second considerably longer, the third and fourth about the length of the second, and the fifth much elongated, usually longer than the preceding four. The tarsal claws are long, slender and sharp, but not as recurved and formidable as the *Hydraeninae*. In the species of *Berosus* the bifurcate onychium is very prominent. The spines, fringes found on the tibial and tarsal segments vary in the different species; these will be described separately.

Berosus striatus

Front tibia—three rows of delicate spines, close together; short spurs; ridged slightly.

Front tarsus—six or seven short hairs; modified hairs on the ventral side of the second and third segments in the male sex.

Mid-tibia—four or sometimes five rows of slender sharp spines; no fringes; one tibial spur long and sharp.

Mid-tarsus—short hairlike spines on the ventral side; fringes thick and as long as the tarsus; claws are long, slender, curved moderately.

Hind tibia—fringe half the length of the tibia; outer margin long slender spines; long spurs.

Hind tarsus—fringe as long as tarsal segments; two short spines on ventral side of each segment.

Berosus exiguus

Front tibia—three rows of short spines; very short spurs.

Front tarsus—three or four short hairs; short ventral spines; claws are long, slender; not recurved.

Mid-tibia—two rows of elongate, delicate spines; a fine fringe of hairs, half as long as the tibia.

Mid-tarsus—segments elongated; fringe about half the length of the tarsus; long, slender spines on segments.

Hind tibia—shortened; three or sometimes four rows of spines, thin; short fringe; slender spurs.

Hind tarsus—fringe sparse, almost half the length of the tarsus.

Berosus miles

Front tibia—three rows of delicate spines, sharp, gradually larger distally; spurs quite long.

Front tarsus—two or three hairs; modified hairs on the second and third segment in the male, adhesive sexual hairs; claws long, curved; bifurcate onychium.

Mid-tibia—four rows of fine spines; anterior row heavier, posterior row almost hairlike; long spurs; very fine fringe.

Mid-tarsus—long, dense fringe; longer than tarsus; long ventral spines; long claws.

Hind tibia—three rows of fairly long spines; fringe over one-half length of tibia; thin, slender spurs.

Hind tarsus—fringe almost as long as tarsus; two longitudinal rows of small spines; long claws.

Berosus exilis

Front tibia—two rows of very fine spines; spurs short.

Front tarsus—one or two hairs; short spines on ventral side; claws delicate.

Mid-tibia—delicate, slender spines; a few hairs; long spurs.

Mid-tarsus—longer fringe than tarsus; claws slender.

Hind tibia—a very few slender spines; sparse fringe; large spurs.

Hind tarsus—sparse fringe; hairs about half length of tarsus.

Berosus punctatissimus

Front tibia—elongate; three irregular rows of compact spines; blunt spurs.

Front tarsus—three hairs, sexual hairs on second and third segments; long, slender, recurved claws.

Mid-tibia—long, slender spines, two rows; a delicate fringe; long spurs.

Mid-tarsus—fringe heavy, almost as long as tarsal segments; row of short spines on ventral side; slender, long claws.

Hind tibia—fringe along entire segment; gradually longer distally; one-third length of tibia; three rows of long spines; long spurs.

Hind tarsus—long fringe, length of entire tarsus; slender, delicate claws; moderately long spines on ventral side.

Berosus aculeatus

Front tibia—three rows of spines; very short spurs scattered over the segment.

Front tarsus—three or four hairs; male sex hairs on the second and third segments; long recurved claws.

Mid-tibia—three rows of spines; a few hairs; long spurs.

Mid-tarsus—fringe one-half the length of tarsus; long, slightly curved claws.

Hind tibia—three rows of spines; sparse fringe.

Hind tarsus—short, sparse fringe.

Berosus subsignatus

Front tibia—three rows of short spines, inner row elongated, almost hairlike; blunt spurs.

Front tarsus—few scattered hairs; spines on ventral side fairly long; recurved, slender claws.

Mid-tibia—few, long, sharp spines in four longitudinal rows; long spurs; no fringe.

Mid-tarsus—long fringe; sharp ventral spines.

Hind tibia—long; four rows of long spines; fringe one-third the length of the tibia; long spurs.

Hind tarsus—fairly long, thick fringe.

Berosus infuscatus

Front tibia—three rows of very short spines; blunt spurs, recurved.

Front tarsus—two hairs; six hairs on ventral side of segment one and two; slender, recurved spines.

Mid-tibia—fairly sharp, delicate spines in four rows; long spurs.

Mid-tarsus—very long fringe, thick, longer than tarsus.

Hind tibia—sharp, irregular spines in four incomplete rows; delicate fringe.

Hind tarsus—long, heavy fringe.

Hydrous. *H. triangularis* has rather sturdy segments, with strong hinge attachments between the coxa and trochanter. The foreleg is comparatively short, being about one-half the length of the middle leg and a little over one-third the length of the hind one. There is a fine pubescence covering the front leg. The middle and hind legs are greatly compressed. The coxal joint is triangular in the former and much elongated and widened in the latter. The femur on the middle leg is shorter and has more spines than the hind leg. The tibiae are about equal in length in the two pairs of legs, but considerably wider and more compressed in the posterior leg. In comparison with other forms previously mentioned, the tibiae have become greatly shortened. These segments, as mentioned before, are covered with short spines irregularly arranged. The longest of the tibial spurs is about one-third the length of the tarsal joints. The tarsi are very much compressed and taper in width from the proximal joint, which is as wide as the distal portion of the tibia to the small, weak tarsal claws. The first small tarsal segment fits diagonally onto the second, which is the longest joint, three times the length of the first. The third, fourth and fifth segments gradually get smaller. There are tarsal fringes on the middle and hind pair of legs; these short fringes are along the entire tarsi.

Hydrophilus. *H. obtusatus* resembles *Hydrous triangularis* very much. The foreleg is proportionately longer, the middle femur elongate, and both tibiae lengthened and with longitudinal rows of spines. The tarsal joints, as well as the tibiae, are compressed laterally and fitted together diagonally as in *Hydrous*. The fringes are almost one-half the length of the tarsal segments.

Tropisternus. Another genus having leg modifications much like the two preceding forms. Here again the anterior leg is considerably short-

ened and the last tarsal segment is large with comparatively large recurved claws. The middle coxae of *T. striolatus* and *T. lateralis* are elongate and flattened, being almost as large as the hind coxae. The tibiae have irregular rows of spines, which are short and slender. The outer tibial spur is over one-half the length of the tarsal joint and margined with small spines. The tarsal fringes are not thick, but are over two-thirds as long as the entire tarsus.

Hydrobius. In this genus the hind coxae are extremely long and narrow. The tibiae of the foreleg are compressed and gradually expanded distally. The tibiae are covered with spines, which are short and rather sharp. The tibial spurs of the front leg are gradually recurved outwardly. The tarsal joints are slender and weak, the fifth being the largest. In *H. fuscipes* the tarsal fringes are irregular in length and sparse. *H. scabrosus* has only a few hairs arising from the tarsi. The claws are of moderate length, but comparatively weak.

Enochrus. This group resembles Hydrobius, except the fact that the segments have become slender and more elongate. The tibial and tarsal joints are considerably longer in all three pairs of legs.

In *E. perplexus* the distal part of the middle tibia is widened and compressed. The tibiae have spines and short fringes along the inner margin. The tarsi have scattered short hairs. The first tarsal joint is short, the second a little longer, the third and fourth together the length of the second, and the fifth about the length of the second.

E. nebulosus has the tarsal joints of the foreleg much shorter than other species observed. *E. cinctus* has considerably weakened tarsi, but the fringes are heavy. The tibiae as well as the tarsi are pilose.

Laccobius. This genus has sturdy segments with large, strong coxae in all three pair of legs. The trochanters and femora are short and strong, with a few spines and short hairs. The tibia of the foreleg is almost triangular, heavily spined and recurved spurs. The middle tibia is shorter and densely spined. The hind tibia is elongate and spined. The mid and hind tarsi have a scanty fringe of hairs about half the length of the entire tarsal segments. The claws are well developed. In *L. agilis* the tarsi are almost equal in length, having a heavier fringe than *L. ellipticus*.

Chaetarthria. *C. pallida* has heavy coxal segments and rather large trochanters. The pro-femur is longer than either the mid or hind femora. The mid femur is short and almost oval, the hind a little longer than wide. The front tibia is clubshaped, with the distal portion enlarged and rounded, with short, irregularly arranged spines. The middle and hind tibiae are compressed and spinous. The pro-tarsal segments are very small with a few short hairs. The middle and hind tarsi have five segments with a few short hairs. The claws are small and weak.

Dactylosternum. In the species *D. cacti* the hind coxa is longer than the femur. The three femora are almost alike in size and shape, the anterior being just a little smaller. The tibial segments are compressed and become wider distally. The tibiae are spined in all three pairs of

legs, but more distinctly so in the anterior pair. The entire tarsal segments are about one-half the length of the tibia; they are weak and scantily fringed in the middle and hind pairs. The claws are long, but very weak.

Sphaeridium. The species *S. scarabaeoides* has short, stubby segments. The coxa of the foreleg is rounded and heavily spined. On the middle and hind leg the coxal joints are elongate and strong. There is a short but very wide femur in the foreleg. The femora of the middle and hind pair of legs are a little larger. The tibiae are very much expanded, being almost triangular in the middle and foreleg. The hind tibia is more elongate and compressed. Very large, irregularly arranged spines cover the tibiae, increasing in size distally. The tibial spurs are about one-half the length of the entire tarsal joints. The first tarsal segment is long, about one-half the length of the tarsus; the second, third and fourth are shortened, with a little longer fifth segment.

Cercyon. In this genus the coxal joints are lengthened. The femora are all about the same size and length. The tibiae are spined, the protibia having a groove or pocket in the outer side, margined with spines. The tarsal segments bend forward and fit into the groove when the leg is being used for digging. The middle tibia is shorter than the hind; both are compressed and widened distally. The tarsal segments are weak, especially those of the foreleg. There are only a few short tarsal hairs on the middle and hind legs. *C. fembratus* has heavier tarsal segments than *C. praetextatus*, the latter having more hairs on the middle and hind tarsi.

Pelcsona. *P. capillatum* has the same general leg structure as *Cercyon*. There is, however, an elongation of the femora and tibiae. The mid and hind tibiae are slender, with delicate spines arranged in longitudinal rows. The spines are a little heavier in the middle pair of legs. The tibial spurs and tarsal claws are medium in size. The tarsus of the foreleg have very small segments, which fit into a groove in the tibia. There are few hairs on the mid and hind tarsi.

Cryptopleurum. In *C. minutum* there are leg modifications like the two preceding genera. The femora and tibiae are a little heavier proportionately. The tibiae of the middle and hind legs are expanded and spined. The tarsal segments are small and delicate. There are three or four short hairs on the middle and hind tarsal joints. The claws are very weak.

DISCUSSION

The Hydrophilidae are, primarily, terrestrial beetles which have invaded the waters. There are many instances of this occurring in insect life as well as in other animals, a changing from a land to water habitat.

This family shows, in a morphological way, various gradations of structural modifications correlating the insect to the environment. There is not a regular sequence of changes in all the forms. Quite often there

are gaps in the development of some particular modification; then again the character may show varying degrees of formation within a given genus.

Since the mode of progression would be one of the most important changes necessary, and associated closely with this are the legs, one would naturally expect these structures to be the ones which would undergo the most noticeable adaptations. Undoubtedly the shape of the body, the roughness or smoothness of the outer parts, would also enter into the modifications for swimming and possibly would be found to account for various irregularities which we find in the sequences of leg structures. For instance, in a group of known good swimmers, we may find the leg modifications quite unlike the type we would expect in so proficient a swimmer—the body convexity or smoothness may compensate for the lack of leg development.

But the leg structures, as will be noted in the description of the various species, show the sequence of specialization from the land to aquatic type.

In general, the modifications are concerned with the middle and hind pairs of legs, particularly the tibial and tarsal segments of these two pairs. The anterior legs are always least modified for aquatic life, the principal change being a reduction of size, so they will not be in the way of the other two pairs of legs.

The Hydrophilidae may be roughly grouped into three categories, according to the modification of the leg structures.

The land-inhabiting forms. *Dactylosternum* and *Sphaeridium* are of this type. *Dactylosternum* has long coxae on the hind legs and compressed tibiae, especially in the foreleg. These modifications aid in land locomotion. These forms live in the soft, semi-fluid debris of decaying cacti; the strong femur and sharpened spines on the legs aid in pushing the insect through the mass. Only a few hairs are present on the tarsal segments.

Sphaeridium has large, heavy segments to contain the strong muscular development. These insects live in dung of herbivorous animals and in carrion; they are distinctly scavengers. The strong muscles and the extremely heavy spines covering the tibiae are used to work the animal through the thickened food material. The tarsi are comparatively small, but the claws are large, also an aid in progression.

Another type of land-inhabiting forms are those modified for a fossorial life, exhibited by *Cercyon*, *Cryptopleurum* and *Pelosoma*. The leg structures in these three genera are very much alike, the greatest change being the tibia of the foreleg. This segment is widened with a distinct pocket or groove on the outer side margined with spines. The small tarsi can be bent forward in the groove. This is done when the insects are digging their way through moist debris.

Those feebly developed for swimming will be found in the sub-families *Hydraeninae*, *Helophorinae* and *Hydrochinae*. There appears a gradual lengthening of segments to a greater or less degree, to allow a wider sweep in movement. The flattening of the tibia and the few spines in *Ochthebius* suggests a crawling habit in the sediment on the bottom of pools or near the shore. The spines on the tarsi and tibiae

are gradually replaced by sparse hairs. A gradation of spines to hairs can be seen especially on the tibial segments of the middle and hind pair of legs. The few hairs are indicative of an aquatic type of locomotion. The fringes are found, first, on the tarsi of the middle and hind legs. Next, the tibiae of the hind legs will bear fringe and, lastly, the mid tibia. These forms cling to aquatic plants, swim poorly, and are unable to dive rapidly. *Hydraena*, *Hydrochus* and *Helophorus* show a loose sequence in the modification of these structures. *Helophorus*, particularly, shows a gradation in the production and length of hairs. The group includes intermediate forms, having many modifications for the terrestrial life and the beginning of specialization for an aquatic habitat.

The third group comprises those strongly developed for an aquatic habitat and are found in the sub-family *Hydrophilinae*.

Chaetarthria has heavy, enlarged segments to allow space for the strong muscles used in propelling the insect through the water. The tibiae are flattened and spined, particularly in the foreleg, which would indicate the legs were used to work the body through aquatic vegetation. The tarsal segments are slender and elongated, with only a few hairs. This genus has not developed all the swimming modifications. *Hydrobius* and *Enochrus* show a lengthening of the joints, which is an aid in swimming. There is also a gradual increase of the hairs on the tibial and tarsal segments. *Laccobius* is a good swimmer and accordingly there is a denser, longer fringe on the tarsal segments.

Berosus, *Hydrophilus* and *Hydrous* are the best swimmers in this sub-family and in the *Hydrophilidae*. The forelegs become very much shorter, since they are of very little use in swimming and must cause as little friction as possible. The middle legs lengthen somewhat and the hind leg is very much longer. The hind coxae are long and immobile, giving strength and rigidity. All the segments are compressed, forming a more or less oarlike structure. The tibiae are shortened, because the direction of the movements of the legs in the water does not necessitate as long tibiae as the terrestrial movements do. The tibial spines are reduced and fringes appear, which adds to the effectiveness of the oars. The tibial spurs are long and toothed, probably protective rather than an aid in locomotion. The tarsi on the middle and hind legs become longer than the tibiae, which give a wider, stronger stroke in swimming. The segments are flattened and compressed with sutures diagonal. The flattening adds to the effectiveness of the stroke, and the overlapping of segments gives rigidity to the paddlelike structures formed. There is a gradual twisting of the tarsal segments so the ventral side becomes anterior, offering little resistance as the leg is pulled forward for a stroke. The claws are weakened, also, for the same reason. The fringes are not as long in these insects as in *Enochrus* and allied genera, since very long fringes would be a hindrance rather than an aid in rapid swimming and diving. The *Hydrophilidae* have developed within the group very effective leg structures for an aquatic habitat.

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