Kavanaugh, D. H. 1991. Amphizoidae (Adephaga). Pp. 312-314. In: Stehr, F. W. (editor), Immature insects. Volume 2. Kendall / Hunt Publishing Company, Dubuque, Iowa, xvi + 975 pp.

AMPHIZOIDAE (ADEPHAGA)

David H. Kavanaugh,
California Academy of Sciences

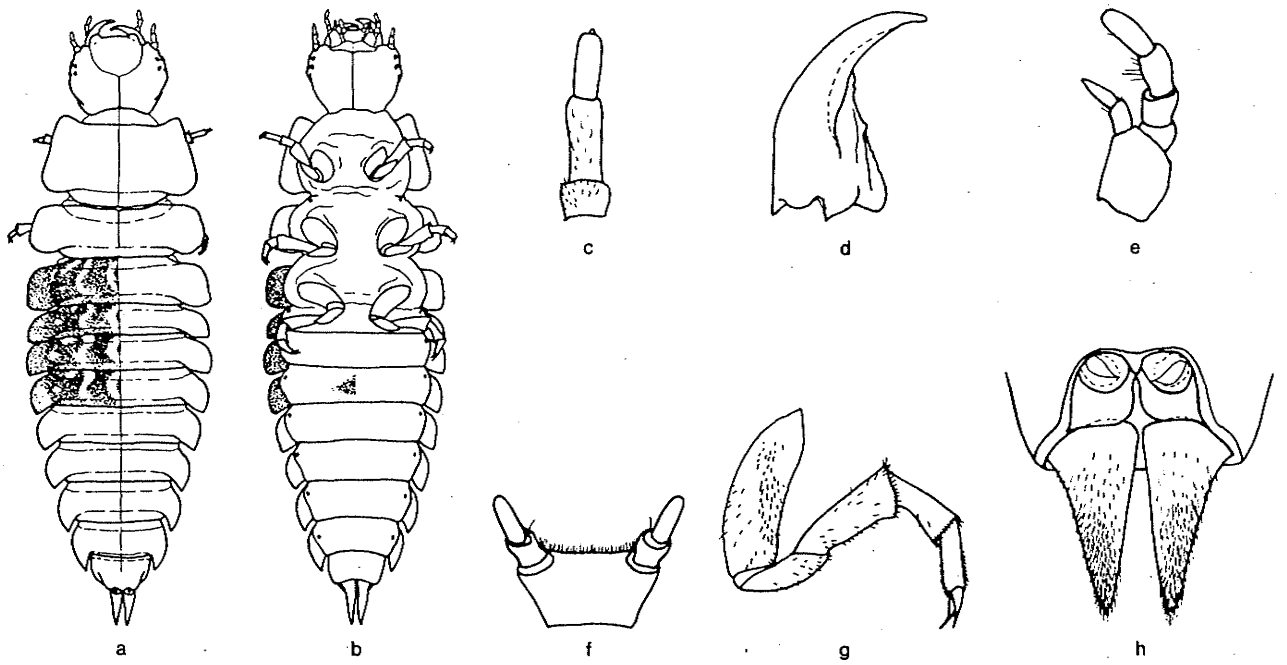
Trout-Stream Beetles

Figures 34.107a-h

Relationships and Diagnosis: Members of the genus *Amphizoa* LeConte represent a family distinct from but clearly related to the other Caraboidea. They share many characteristics with Carabidae on one hand and Dytiscidae on the other (Edwards, 1951; Horn, 1883; Hubbard, 1892a, 1892b; Leech and Chandler, 1956; Roughley, 1981). Based on a cladistic analysis of both extinct and extant "families" of Adephaga, Kavanaugh (1986) concluded that amphizoids represent the earliest divergent lineage from the common ancestor of all Hydradephaga, excluding Haliplidae, and that this divergence probably occurred in the Triassic.

Larval amphizoids are most similar in size and form to carabid larvae of the tribe Cychrini or to silphid larvae (e.g. genus *Silpha* or *Nicrophorus*); however, their aquatic habits readily distinguish them from members of these other groups. Further, amphizoid larvae are distinguished from larvae of all other North American beetles in having their mandibles sulcate medially, without an internal duct, thoracic legs ambulatory, each 6-segmented, including pretarsus with two movable, terminal claws, the abdomen 8-segmented, without hooks at apex, urogomphi present, short, 1-segmented, and with the spiracles of the eighth abdominal segment located paramedially on the dorsum (basal to urogomphi).

Biology and Ecology: Amphizoids are primarily aquatic, although both adults and larvae are sometimes found out of water; eggs deposited in moist places on land will develop and hatch, and mature larvae leave the water to pupate on land. They inhabit cool or cold fresh water streams (from small rills to large rivers) and (less frequently) lakes, where they are confined to the shallow shorelines. Neither adults nor larvae swim. They crawl over submerged rocks, logs, and vegetation in search of food and shelter, and are often found clinging to floating debris, especially in eddies and backwashes. If dislodged from their substrate, they make feeble walking movements and drift with the current. They are much more agile out of water. Adults have fully formed wings and are no doubt capable of dispersal by flight (Darlington, 1930). Both adults and larvae must come to the surface for air. Larvae assume a posture such that the apex of the abdomen breaks the water surface and the spiracles of the eighth segment are in contact with air.



Figures 34.107a-h. Amphizoidae. *Amphizoa insolens* LeConte. **a.** dorsal (pigmentation pattern for left half of metathoracic and abdominal terga 1-3); **b.** ventral (pigmentation pattern for right half of metathorax and abdominal segments 1-3); **c.** left antenna, dorsal; **d.** left mandible, dorsal; **e.** left maxilla, ventral; **f.** labium, ventral; **g.** left metathoracic leg, anterior; **h.** apex of abdomen, posterodorsal oblique aspect, showing spiracles of abdominal segment 8 and urogomphi.

Although previously assumed to feed as scavengers on sluggish or dead and drifting insects. Edwards (1954) found that all stages of larvae and adults studied fed exclusively on living stonefly (Plecoptera) larvae. However, if kept out of water, amphizoids will accept a variety of freshly macerated insects presented as food.

Eggs, which are very large (over 2 mm in length), may be deposited in protected spots under water, such as in cracks on the undersurfaces of floating logs (Edwards, 1954; Leech and Chandler, 1956), or in moist places on land adjacent to water bodies. Oviposition is usually in late August or early September. First instar larvae, also exceptionally large, are found in September through November and again in early spring. This is probably the normal overwintering stage. Mature larvae appear in May through August and leave the water to pupate under stones on adjacent shores in July and August. Adults may be found throughout the year, but teneral (newly-emerged) adults are common only in August.

Description: Mature (i.e. third instar) larvae with total length 12.0 to 17.0 mm, maximum width 3.5 to 4.7 mm. Body form (figs. 34.107a, b), elongate, spindle-shaped, depressed, broadest at mid-length and tapered toward both ends, moderately convex and markedly sclerotized dorsally, flat and only faintly sclerotized ventrally; combined lengths of head and thorax almost equal to length of abdomen; thoracic and abdominal terga broadly explanate laterally as thin, laterally projected lobes; dorsal midline, from vertex of head to apex of abdomen, with a deeply incised longitudinal furrow (actually the ecdysial line of weakness). Dorsum brown (teneral individuals may be testaceous) to piceous, with maculation pattern as in fig. 34.107a but less evident in darkest individuals; venter pale, yellowish white, except undersurface of head and eighth abdominal sternum brown; darkest individuals also with darkened areas along midline on 1 or more abdominal sterna. Surface of dorsal sclerites finely punctulate and/or transversely rugulose, sparsely covered with short, fine, apically hooked, prostrate setae; ventral sclerites smooth and glabrous, except ventrolateral surfaces of head with fine punctures and setae as on dorsum.

Head: Large, protruded, circular in silhouette, narrowed posteriorly, flattened dorsally, moderately convex ventrally, with lateral margins (of genae) carinate. Antennae (fig. 34.107c) short, apparently 3-segmented, but with reduced 4th segment at apex. Three pairs of lateral stemmata present on each side, 1 pair each above, on, and below the lateral margin. Labrum trapezoidal, vertical, glabrous dorsally (anteriorly), except for a fringe of short setae at clypeolabral suture. Mandibles (fig. 34.107d) sickle-shaped, each with a deep, longitudinal groove medially (but without an internal duct), retinaculum minutely dentiform, ventral cutting edge minutely denticulate, without prostheca or penicillus, molar region simple, narrow, unmodified, without denticles. Maxillae (fig. 34.107e) stout, with cardo and stipes fused, lacinia and galea fused as a 2-segmented mala, palpifer present, palp 3-segmented. Labium (fig. 34.107f) broad, transverse, with a fringe of short setae across apical margin, without distinct ligula, palps 2-segmented. Gula absent, gular suture simple, linear in midline.

Thorax and Abdomen: Broad, with prothorax relatively long and narrow; lateral lobes of prothoracic tergum short, subrectangular, narrowed anteriorly, those of pterothoracic terga longer, more broadly rounded in outline. Legs (fig. 34.107g) moderate in length, 6-segmented, the pretarsus bearing 2 movable claws.

Abdomen eight-segmented, explanate lateral lobes of terga 1–7 thin, successively more acutely pointed, slightly overlapped; eighth segment trapezoidal in outline, tergum with lateral explanations present only as lateral carinae. Urogomphi (fig. 34.107h) present, 1-segmented, short but prominent, conical and apically pointed, articulated (not fused) with eighth tergum posterolaterally.

Spiracles: Thoracic spiracles restricted to a single mesothoracic pair located anterolateral to bases of mesocoxae, annular, apparently non-functional. Paired abdominal spiracles of segments 1–7 (fig. 34.107b) located ventrally, anterolaterally near base of each explanate lateral lobe, apparently non-functional; spiracular pair of eighth segment (fig. 34.107h) valvular, functional, located dorsomedially between bases of urogomphi and posteromedial margin of eighth tergum on short, sclerotized turrets.

Comments: The family is very small, with only three species known from North America (Kavanaugh, 1986) and one species from western China. In North America, the family is restricted to the western half of the continent, from the Rocky Mountains west to the Pacific Coast, and from southern Alaska and Yukon Territory to southern California and northern Arizona and New Mexico. The larvae of *Amphizoa insolens* LeConte and *A. lecontei* Matthews have been described and illustrated (Böving and Craighead, 1931; Hubbard, 1892a, 1892b; Peterson, 1951) and their habits discussed (Darlington, 1930; Edwards, 1951, 1953, 1954; Leech and Chandler, 1956). Neither immatures nor adults of this family have apparent economic importance.

Selected Bibliography

Böving and Craighead 1931.
Darlington 1930.
Edwards 1951, 1953, 1954.
Horn 1883.
Hubbard 1892a, 1892b.
Kavanaugh 1986.
Leech and Chandler 1956.
Peterson 1951.
Roughley 1981.

NOTERIDAE (ADEPHAGA)

Paul J. Spangler, *Smithsonian Institution*

The Noterids

Figures 34.108a–e, 34.109

Relationships and Diagnosis: The noterids were formerly considered a subfamily of the Dytiscidae. However, morphological and biological differences readily distinguish them from the dytiscids.

Noterid larvae may be distinguished from dytiscid larvae by the following combination of characters: compact fusiform body shape; short legs; very short urogomphi; mandibles with retinaculum, but not sulcate nor tubular as they are in dytiscid larvae. Also, all noterid pupae presently known were found pupating underwater in watertight cocoons made by the larvae; these cocoons were attached to aerenchymatous cells of aquatic plant stems, leaves, or roots. Mature noterid larvae range in length from 2.0 to 4.5 mm.

Biology and Ecology: Adults and larvae of *Hydrocanthus, Suphis,* and *Suphisellus* are commonly found among roots of floating aquatic plants, especially *Eichhornia* and *Pistia;* they also occur, but in lesser numbers, among emergent plants where floating plants are absent. The habitat of the larvae of *Pronoterus* is not definitely known but presumably they occur in floating mats of aquatic plants where their adults have been found. Larvae of *Notomicrus* also are unknown but the adults have been collected from freshwater in weedy margins of shallow ponds, in *Sphagnum* swamps, in woodlands where there were small temporary puddles containing culicid larvae, in water-filled tire ruts, and brackish water in crabholes excavated by land crabs; presumably, their tiny larvae will be found in the same habitats where the adults live.

The life cycles of most noterids are unknown. However, F. Balfour-Browne and J. Balfour-Browne (1940) described the interesting larval and pupal stage of the European species *Noterus capricornis* Herbst and showed that pupation took place underwater in cocoons attached to aerenchymatous cells of roots of aquatic plants. Spangler (1981, 1982) reported the same pupal habits for the genera *Hydrocanthus, Suphis,* and *Suphisellus.*

Because noterid larvae are present in the United States in the months of June through August, it is presumed that noterids oviposit in late spring or early summer. Because the ovipositor is long and soft, it is assumed that the eggs are laid on aquatic plants or in the mud near the plants. The complete life cycle has not been established for any noterid but the available evidence suggests that it is similar to that of dytiscid beetles except noterid pupation occurs underwater instead of on land.

The food habits of the noterids are poorly known. Wesenberg-Lund (1912) assumed from the shape of the mandibles of a European larva of *Noterus* that it was entirely vegetarian. However, F. Balfour-Browne and J. Balfour-Browne (1940) observed that larvae of *Noterus* feed readily on dead *Chironomus* larvae and dead individuals of their own kind; they also saw the larvae work their mandibles on the surface of roots but seemed not to get anything off. They suggested that the larval mandibles may be a modification of the phytophagous type of mandible and stated, "possibly, therefore, the larva flourishes on a mixed diet." Young (1967) reported that noterid larvae and adults are vegetation-detritus feeders.

Description: Body cylindrical, spindle shaped, or teardrop shaped (*Suphis*); usually tapering strongly posteriorly; subcylindrical in cross section. Cuticle relatively smooth. Integument and sclerotized parts white when freshly hatched but yellow to reddish-brown upon aging. Larvae of some species of *Hydrocanthus* may have dark bands in early instars.