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ON THE NEW WORLD BEETLES OF THE FAMILY HYDROSCAPHIDAE

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ABSTRACT

A comparative account is given of the chief characters of the adults of the New World Hydroscaphidae, and the structure of the immature stages of Hydroscapha *and* Scaphydra *is compared. A new genus,* Yara, *is erected for a new species from Brazil,* vanini. *Another new species from Panama,* Yara dybasi, *is provisionally included in the new genus. Additional locality records are given for some species, and* Hydroscapha natans *Leconte is recorded from Idaho, Texas, and a number of localities in Mexico. The little that is known about the biology of the species is also summarised.*

INTRODUCTION

The first extensive account of the morphology of the family Hydroscaphidae was given 100 years ago (Matthews, 1876). In recent years much has been discovered about the South American species (Reichardt, 1973a, 1973b, 1974), and sufficient material has now been accumulated by us to make it desirable to extend these studies to the whole of the New World.

Hydroscapha natans Leconte, the genotype, is here recorded from Idaho, Texas and various localities in Mexico. It is the unidentified species previously recorded from Mexico (Hinton, 1969). A new genus, *Yara,* is erected for a new species from Brazil, and a second new species, of which only females from Panama are available, is provisionally placed in this new genus. The immature stages of *Hydroscapha* and *Scaphydra* are compared. The immature stages of the new genus *Yara* have not yet been discovered. Our studies of the New World species suggest that the generic status of some of the Old World species should be re-examined. As now redefined, *Hydroscapha* may not include all species described in it. From d'Orchymont's study (1945), however, it is clear that at least the

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Palaearctic *Hydroscapha granulum* (Motschulsky) is congeneric with *Hydroscapha natans*.

We have said nothing about the relations between the Hydroscaphidae and the other families of Myxophaga. It now seems evident that the Hydroscaphidae are only distantly related to the Torridincolidae. Of the other two families of Myxophaga, the Sphaeriidae and Lepiceridae, nothing is known of the immature stages of the latter, and speculation about the phylogeny of the myxophagan families is best deferred until the immature stages of the Lepiceridae are discovered.

Material

Over 1,300 specimens of the 6 studied species were examined, most belonging to the H. E. Hinton collection (HEHC) and to the Museu de Zoologia, Universidade de São Paulo (MZSP). Other specimens were received from the Field Museum of Natural History (FMNH). Paratypes of *Yara vanini* will be deposited, as indicated under that species, in the British Museum (Natural History), London (BMNH), the National Museum of Natural History, Washington, D. C. (USNM), and the Museum of Comparative Zoology, Harvard University, Cambridge, Mass. (MCZC).

Key to new world hydroscaphidae

1. Antennae 5-segmented. Sutural angle of elytra with a denticle with short seta(e). Posterior margin of some abdominal segments finely dentate. Last abdominal tergite with a small, median tooth at apex and serrate on either side of tooth. Southeastern Brazil; *Scaphydra* Reichardt, 1973 2

   Antennae 8-segmented. Sutural angle of elytra rounded. Posterior margin of abdominal tergites and sternites straight. Last abdominal tergite without median tooth at apex 4

2. Larger species (total length over 1.45 mm; length from apex of head to apex of elytra, 1.05 mm) .... *hintoni* (Reichardt, 1971)

   Smaller species (total length less than 1.3 mm; length from apex of head to apex of elytra less than 0.9 mm) 3

3. Posterior margin of abdominal tergite 4 dentate. Hind wings atrophied .....*angra* (Reichardt, 1971)

   Posterior margin of tergite 4 not dentate. Hind wings normally developed ..... *pygmaea* (Reichardt, 1971)

4. Hind coxa with femoral plate as long as coxa. Hind trochanter glabrous. Tarsi of middle and hind legs distinctly shorter than corresponding tibiae, with claws short but well-developed. Last abdominal segment at base about as long as wide. Last abdominal sternite of male arcuately emarginate at apex. United States and Mexico. .... *Hydroscapha natans* Leconte, 1874

Hind coxa with femoral plate short and confined to the area of articulation with the trochanter. Hind trochanter with a row of long setae on free margin. Tarsi of middle and hind legs at least as long as corresponding tibiae, with long and slender claws. Last abdominal segment with width at base almost twice its length. Last abdominal sternite of (known) males with a small incision on left side and with 4 to 5 curved setae on outer margin of incision. Panama and Southeastern Brazil; *Yara,* gen. n. 5

5. Larger species (total length, 1.8 mm; length from apex of head to apex of elytra, 0.95 mm). Color dark brown, almost black. Hind wings normally developed and folded. Female with last abdominal sternite evenly rounded at apex. Southeastern Brazil ..... *vanini,* sp. n.

Smaller species (total length, 1.1-1.2 mm; length from front of head to apex of elytra, 0.5-0.6 mm). Color brown with the two abdominal segments before the last yellowish. Hind wings atrophied. Abdomen of female with apices of both tergite and sternite of last segment deeply and narrowly emarginate. Panama ..... *dybasi,* sp. n.

Hydroscapha Leconte, 1874

Hydroscapha Leconte, 1874: 45 (Type-species, by monotypy and original designation, *Hydroscapha natans* Leconte, 1874).

Antenna 8-segmented; segments 3-7 about as long as wide and their combined length less than that of club; 2 longer than any segment before club but shorter than scape. Lacinia with 3 to 4 apical setae. Front legs with first two tarsal segments wider than long and third segment about as long as first two together. Middle and hind legs with second segment longer than first but shorter than third. Claws short but well-developed. Hind coxa with femoral plate as long as coxa. Abdomen with posterior margins of segments straight; last segment at base about as wide as long. Male with last external abdominal tergite rounded at apex, but last sternite arcuately emarginate at apex; last invaginated sternite with a lateral group of long setae on each side of apex; last invaginated tergite of male with a lateral spine on each side of apex. Male genitalia (fig. 40) with median lobe short, not coiled; apophysis (tegmen?) articulated to basal bulb. Female genitalia (fig. 45) with a bifid setose structure on each side, the ventral part of each with a tuft of long setae; median lobe narrowly rounded at apex, without setae.

Hydroscapha natans Leconte, 1874

(Figs. 1, 4-7, 12-15, 25, 30, 34-36, 40, 45, 57-81, 83-86)

Hydroscapha natans Leconte, 1874: 46 (Ten syntypes, Los Angeles in the river; MCZC, not studied); Matthews, 1876: 16-17 (Los Angeles); 1877: 167; Fall, 1901: 81 (near Pomona, California, 'close to the bank in a mountain stream, and also in a muddy

spot in a cow pasture'); Csiki, 1911: 4 (Catalog; California); Schwarz, 1914: 165 (Hot Springs, Yavapai Co., Arizona, 1,970 ft.); Böving, 1914: 169 (description of larva and pupa); Leng, 1920: 83 (Catalog; southern California and Arizona); d'Orchymont, 1945: 16, fig. 8 (Arrowhead Hotspring and Riverside, California); La Rivers, 1950: 68 (Amargosa River, Nye Co., Beatty, Nevada, 3,390 ft.); Leech & Chandler, 1956: 347 (Los Angeles, San Bernardino, San Luis Obispo and Lake Counties, California); Arnett, 1961: 214 (California).

Material examined. UNITED STATES. *Idaho*: Hot Creek Falls, Owhyee Co., 14.VIII.1974, 21.V.1975 (A.D. Allen; 4♂, 7♀, larvae). *Nevada*: Amargosa Hot Springs, Nye Co., 16.IV.1966 (F. Andrews; 1♂, 2♀, 1 larva. *California*: Camp Pendleton, Oceanside, 26.X.1945 (H.P. Chandler; 1♂, 1♀). *Arizona*: Pima Co., Peppersauce Canyon, E slope Mt. Sta. Catalina, 4,500 ft., 25.VIII.1948 (F.G. Werner; 6♂, 5♀); Pima Co., Arivaca, 18.II.1972, 29.III.1972 (R. Lenczy; 8♂, 3♀). *Texas*: Glenn Springs, Big Bend National Park, 23.III.1972 (H.P. Brown; 2♂, 2♀).

MEXICO. *Mexico*: District of Temascaltepec, Tejupilco, 1,200 m, VIII.1934 (H.E. Hinton; 3 adults). *Morelos*: Jojutla, 890 m, 19.XI. 1941 (A. Dampf, 'swept from air from bus 6.43-6.45 p.m. (sunset) at 25 km/hr open country'; about 270 adults); Cuernavaca, 1,400 m, X.1969 (H.E. Hinton; 10 adults in swimming pool); Alpyuyeca, 1,075 m, X.1969 (H.E. Hinton; 1 adult); Acatilpa, near Temisco, 1,250 m, X.1969 (H.E. & J. Hinton; about 200 adults, 100 larvae and 7 pupae). *Guerrero*: Rio Naranjo de Tierra Colorada, 5.IV.1969 (H.P. Brown; 1 adult); Rio Papagayo, X.1969 (H.E. & J. Hinton; 3 adults).

Distribution. *Hydroscapha natans* was previously recorded from a few localities in Nevada, Arizona, and southern California. It is the species recorded by Hinton (1969) from Tejupilco as an 'apparently undescribed species'. It is now recorded from Idaho and Texas as well as from several localities in the Mexican states of Mexico, Guerrero and Morelos. All Mexican areas in which it has been found are part of the water-shed of the Balsas River with the exception of those found in the Papagayo River (or its tributary, the Rio Naranjo), which enters the Pacific near Acapulco. No speciments have so far been found on the Mexican plateau.

Discussion. Since the discovery of the pupa in Mexico at Acatilpa, one of us (HEH) has supposed that the specimens from Morelos and Guerrero might well belong to a new species. In the pupae found in Mexico (figs. 60, 61), the first three abdominal segments are laterally expanded, which they are not in the pupa illustrated by Böving (1914). However, careful comparison of the adult structures and the genitalia of specimens from Mexico and from the United States leaves little room for doubt that the Mexican species is *Hydroscapha natans*. For this reason, it seems now evident that the illustration given by Böving (1914) of the pupa is incorrect so far as concerns the shape of the first three abdominal segments. It should be noted here that there is much intraspecific variation in

the development of hind wings. All of the Idaho specimens examined have atrophied, unfolded wings. However, as noted in a later page, we consider this no more than an intraspecific variation.

Yara, gen. n.

Antenna 8-segmented; segments 3-7 about as long as wide and their combined length about as great as that of club; 2 about as long as scape. Lacinia (fig. 22) with a row of stout setae along inner margin. Sutural angle of elytra rounded. Front legs with first two tarsal segments longer than wide and third longer than first two together. Middle and hind legs with second tarsal segment nearly or quite twice as long as first but distinctly shorter than third. Claws long and slender. Hind coxa with femoral plate short and confined to area of articulation with the trochanter. Hind trochanter (fig. 39) with a row of long setae on free margin. Abdomen with posterior margins of segments straight; last segment with width at base almost twice its length. Male with last abdominal sternite (fig. 53) with a small incision on left side and with 4 to 5 curved setae on outer margin of incision; last invaginated tergite and sternite plate-like (figs. 43, 44), with long marginal setae, and usually partly exposed. Female with a median, semi-circular incision on last tergite. Last sternite of female entire in *vanini*, incised in *dybasi*. Male genitalia (fig. 42) with median lobe not coiled, long and thin; apophysis (tegmen?) long, forked, and articulated to basal bulb. Female genitalia (fig. 48) formed of two paired blades; dorsal blade shorter than ventral and with a few setae on external margin; ventral blade long, with several setae along external margin, and with two long, pre-apical setae.

Type-species, *Yara vanini*, sp. n.

Yara vanini, sp. n.

(Figs. 20-23, 26, 27, 37-39, 42-44, 48, 53-56)

Length, 1.8 mm; length from front of head to apex of elytra, 0.95 mm; maximum width of elytra, 0.60 mm. Color dark brown, almost black. Surface clothed with long hairs that are denser on abdomen. Hind wings normally developed and folded. Female with sternite (fig. 55) of last abdominal segment evenly rounded at apex, but tergite (fig. 56) narrowly and deeply emarginate.

Holotype: 1♂ from BRAZIL. *Minas Gerais*: Jaboticatubas, Serra do Cipó (Km 121, 7.X.1975, S.A. Vanin & C.G. Froehlich; on slide, MZSP).

Paratypes. 123♂, 111♀, same data as holotype. 1♂, same locality (Km 115, 7.VII.1974, C.G. Froehlich, 'in pool of temporary stream'). 1♂, same locality (Km 131, 11.VII.1972, C.G. Froehlich, 'in mud of temporary pool'). 8♂, 10♀, same locality (Rio Brauninha, Km 117, 6.X.1975, S.A. Vanin & C.G. Froehlich). 1♂, same locality (Km 117, 1,320 m, 8.X.1975, S.A. Vanin & C.G. Froehlich; 'temporary stream').

Comparative notes. This species is easily distinguished from *Yara dybasi* because it is larger (length 1.8:1.2 mm), has normally

developed hind wings, and the apex of the last abdominal sternite of the female is evenly rounded instead of narrowly emarginate.

Yara dybasi, sp. n.
(Figs. 28, 47, 49, 50)

Length, 1.1-1.2 mm; length from front of head to apex of elytra, 0.52-0.62 mm; maximum width of elytra, 0.27-0.42 mm. Color brown with the two abdominal segments before the last yellowish; last abdominal tergite pale at base and darker towards apex; last abdominal sternite yellowish but with a dark band near apex (fig. 49). Hind wings atrophied. Abdomen with apices of both tergite (fig. 50) and sternite (fig. 49) of last segment deeply and narrowly emarginate.

Holotype: 1♀ from PANAMA. *Panama*: Madden Lake, 15.XI. 1959 (H. Dybas, 'pocket of damp leaves in day stream bed'; on slide, FMNH).

Paratypes: 4♀, same data as holotype (on slides; FMNH, HEHC, MZSP).

Comparative notes. We have provisionally included this species in *Yara* because of the structure of the female genitalia (fig. 47) and because of the elongate last exposed segment of the abdomen. It may prove necessary to erect a new genus for this species when the male is discovered.

Scaphydra Reichardt, 1973

Scaphydra Reichardt, 1973: 150 (Type-species, by original designation, *Hydroscapha hintoni* Reichardt, 1971).

Antenna 5-segmented; segments 2-4 longer than wide and their combined length slightly more than that of club; scape about as long as club. Lacinia (fig. 18) with 4 to 5 apical setae. Elytra with sutural angle toothed (fig. 82). Legs with third segment of tarsi much longer than combined length of two basal segments; claws well-developed but relatively short; hind coxa with femoral plate as long as coxa. Abdomen with posterior margin of the 5 basal sternites and the 3 or 4 tergites before the last finely serrate; last segment about as long as width at base; last tergite of both sexes and last sternite of female with a small, median tooth on apex and serrate on either side of tooth (fig. 52); last sternite of male (fig. 51) with apex deeply emarginate; last exposed tergite and sternite of female not emarginate at apex; last invaginated tergite and sternite of male (fig. 41) each with a lateral apical spine and without setae. Male genitalia (fig. 41) with median lobe coiled; apophysis (tegmen ?) forked, and articulated to basal bulb. Female genitalia (fig. 46) with both lateral bifid structures and median lobe without setae; apex of median lobe and ventral lobe of bifid structures also serrate.

Scaphydra hintoni (Reichardt, 1971)
(Fig. 82)

Hydroscapha hintoni Reichardt, 1971; 290-291, figs. 1-6 (Holotype ♀, from Brazil, Rio de Janeiro, Andrade Pinto; MZSP).
Scaphydra hintoni; Reichardt, 1973a: 152, figs. 38, 62, 64-67, 105-116.

Material examined. BRAZIL. *Minas Gerais*: Jaboticatubas, Serra do Cipó (Km 117, Rio Brauninha, 6.X.1975, S.A. Vanin & C.G. Froehlich; 3♂, 6♀).

Notes. This species was only known from the original specimens, all from the state of Rio de Janeiro. The hind wings of the type-series are normally developed; of the present series, 4♀ have normally developed wings while the remaining 3♂ and 2♀ have atrophied wings.

Scaphydra pygmaea (Reichardt, 1971)
(Figs. 31-33, 45, 46, 51, 52)

Hydroscapha pygmaea Reichardt, 1971: 291 (Holotype ♀, from Brazil, Espírito Santo, Rio Jucu; MZSP).
Scaphydra pygmaea; Reichardt, 1973a: 153, figs. 63, 69.

Material examined. BRAZIL. *Espírito Santo*: Rio Jucu, Domingos Marins, 0 m (BR 262, Km 27.5, 6.II.1975, H. & B. Reichardt; 14♂, 14♀); Santa Isabel, Domingos Martins, 300 m (BR 262, Km 34, 6.II.1975, H. & B. Reichardt; 19♂, 19♀); 18 Km E Itatiba, 900 m (BR 262, Km 138, 7.II.1975, H. & B. Reichardt; 1♂, 1♀). *Minas Gerais*: BR 262, Km 200 (near state limits of Espírito Santo/Minas Gerais), 600 m (7.II.1975; H. & B. Reichardt; 22♂, 37♀); Realeza, 650 m (BR 262, Km 242, 7.II.1975, H. & B. Reichardt; 18♂, 39♀).

Notes. All specimens have normal wings except one male from the type-locality, in which the hind wings are atrophied. Larvae were collected in the type-locality and at Santa Isabel. We have not been able to distinguish them from the larvae of *Scaphydra angra*. The latter were previously described by Reichardt (1974).

Scaphydra angra (Reichardt, 1971)
(Figs. 2, 3, 8-11, 16-19, 24, 29, 41, 46)

Hydroscapha angra Reichardt, 1971: 291 (Holotype ♀, from Brazil, Rio de Janeiro, Angra dos Reis; MZSP).
Scaphydra angra; Reichardt, 1973a: 153, figs. 68, 70; 1973b: 109-110 (Description of male genitalia and mouthparts); 1974: 118, figs. 1-4, 6 (Description of larva and pupa).

Material examined. BRAZIL. *Rio de Janeiro*: Angra dos Reis, Alto da Serra, 645 m (23.XII.1974, H. & B. Reichardt; 1♂); same locality (8.II.1975, H. & B. Reichardt; 12♂, 24♀); Mangaratiba (7-8.II.1973, H. & B. Reichardt; 44♂, 69♀); same locality (25.II.1974,

H. & B. Reichardt; 19♂, 14♀) *São Paulo*: Ubatuba, Praia da Sununga, 'Gruta que Chora' (3.III.1976, S.A. Vanin & A.M. Pires; 42♂, 43♀, larvae and pupae)

Notes. The hind wings of this species are normally greatly reduced, but one male and two females with normally developed hind wings were collected in the type-locality. One male with normal wings was collected at Mangaratiba.

Comparative morphology of the genera

1. Larvae

Only larvae of *Hydroscapha natans* (Böving, 1914) and *Scaphydra angra* (Reichardt, 1974) have been described. In *Hydroscapha natans* only the first pair of thoracic spiracles and those of the first and eighth abdominal segments are functional. All three pairs are balloon-like, those of the 8th abdominal segment being nearly four times as long as wide (figures in Hilton, 1967, 1968). The spiracular atrium extends through the peritreme of each spiracle to open at its distal end. The peritreme is only about 0.1 μm thick. The total water-air interface across the opening of the six spiracles is about 0.9×10^4 μm^2 per milligram of wet body weight (Hinton, 1968). Thus, the water-air interface available for plastron respiration is about an order of magnitude more per miligram wet body weight than that established across the spiracles of terrestrial insects (Hinton, 1966). It may be noted here that the spiracles are very similar to those of the Sphaeriidae (Hinton, 1967, 1968). However, in this family of the Myxophaga the balloon-like spiracles are not as large as in *Hydroscapha*. In *Sphaerius ovensensis* (Oke) of Australia functional spiracles are absent on the thorax but are present on the first eight abdominal segments. The total water-air interface of the eight pairs of spiracles of *Sphaerius* is 1.2×10^4 μm^2 per milligram wet body weight. As noted by Hinton (1968), it has not yet been possible to determine the permeability of the outer walls of the spiracles: it is just possible that they may function as a plastron, but at a resolution of 30nm no holes could be found in them.

In *Scaphydra*, like *Hydroscapha*, only the first pair of thoracic spiracles and those of the first and eighth abdominal segments are functional. The eighth abdominal segment is like that of *Hydroscapha*, but its latero-posterior projections are longer, being slightly more than twice as long as the segment itself. *Scaphydra* lacks the closely packed setae of the posterior margins of the thoracic tergites. The thorax of *Scaphydra* is relatively narrower so that parts of the legs are visible from above, whereas in *Hydroscapha* the thorax is relatively wider and completely conceals the legs from above. The mouthparts of the larvae of the two genera have been compared by Reichardt (1974). Further examination of *Hydroscapha* shows that the small projection on the base of the last segment of the maxillary palp (fig. 6) is present and not absent, as previously stated.

2. Pupae

Böving (1914) described the pupa of *Hydroscapha natans* from what he said was a single poorly preserved specimen found in Arizona. Seven pupae of *Hydroscapha natans* were found by one of us (HEH) in Mexico near Cuernavaca (Temisco). From a study of these pupae it seems very probable that the pupa identified by Böving as that of *Hydroscapha* belongs to some other family, possibly one of the Hydraenidae. It lacks any trace of the lateral expansions of the first three abdominal segments that are such a conspicous feature in *Hydroscapha natans* (see figs. 60, 61). Moreover, Böving has drawn two prominent setae near the middle posterior margin of the metanotum, whereas there are no such setae in *Hydroscapha natans*.

The pupae of the Hydroscaphidae are obtect, as are the pupae of the Torridincolidae (Reichardt, 1973a) and some of the smaller Polyphaga, e.g. Ptiliidae and Corylophidae. In *Hydroscapha* and *Scaphydra* the pupa remains within the last larval cuticle and only the posterior part of the thorax and the basal part of the abdomen are exposed when the larval cuticle is split along the median ecdysial line. The exposed parts of the pupal cuticle are more heavily sclerotised than those that are concealed by the larval cuticle.

Functional spiracles are present on the first three ablominal segments in *Hydroscapha* (fig. 62). In *Scaphydra* (Reichardt, 1974) long spiracular gills are present on the first three abdominal segments (fig. 2). These spiracular gills probably support a plastron, as do the spiracular gills present on the first two abdominal segments of Torridincolidae (Hinton, 1968), but their fine structure has not yet been examined.

3. Adults

Antennae. In all described species of *Hydroscapha* and *Yara* the antennae are 8-segmented. The description of *Hydroscapha jumaloni* Satô (1972) metions 9-segmented antennae; examination of one paratype, however, showed that they are actually 8-segmented. *Scaphydra* has 5-segmented antennae.

Mouthparts. The mouthparts of *Scaphydra angra* have been described and illustrated in some detail (Reichardt, 1973b). Trey are similar to those of *Hydroscapha* and *Yara.* In all three genera the left mandible has a subapical, movable tooth as in other Myxophaga (figs. 12, 16, 20). An elongate prostheca is present between the movable tooth and the bifid apical tooth. The maxilla of *Hydroscapha* (fig. 14) is like that of *Scaphydra* (fig. 18), and in both genera the palpiger is expanded beyond the point of insertion of the palp. Reichardt (1973b) suggested that this expanded part of the palpiger might be the galea. However, in the Myxophaga the only maxillary lobe present is the lacinia. In *Hydroscapha* the lacinia has 3 and in *Scaphydra* 4-5 apical setae, whereas in *Yara* (fig. 22) there is a row of setae on the mesal margin of the lacinia. The labium of the three genera is rather similar in structure. The sensory organs of *Hydroscapha natans* are shown in figs. 67, 68.

Hind wings. The Hydroscaphidae are the only Myxophaga that lack the oblong cell. The venation of all three genera is similar.

There is much intraspecific variation in the extent to wich the wings are reduced. In *Scaphydra angra* only two males and two females of 80 males and 127 females had normally developed wings, the remainder being apterous. Of 73 males and 110 females of *Scaphydra pygmaea* only a single male was apterous. Of the 3 males and 6 females of *Scaphydra hintoni* examined herein, the 3 males and 2 females also have atrophied wings. In all of the many specimens of *Yara vanini* examined the hind wings were normally developed, but the few known specimens of *Yara dybasi* are apterous. As already noted, *Hydroscapha natans* usually has normally developed wings, but in the series from Idaho the wings are atrophied, unfolded, and extend only slightly beyond the apices of the elytra.

Legs. Tarsi always 3-segmented. The relative lengths of the tarsal segments of the three genera are shown in figs. 31-39. In *Yara* (figs. 37-39) the tarsal claws are longer and more slender than in *Hydroscapha* and *Scaphydra* The hind coxae of all three genera have femoral plates (figs. 33, 36, 39). These plates are long in *Hydroscapha* and *Scaphydra* and short in *Yara.* The femoral plate of *Yara* has a row of long setae. In *Yara* there is a row of long setae on the mesal margin of hind trochanter, whereas *Hydroscapha* and *Scaphydra* lack such setae.

Abdomen. In the male the apex of the last exposed tergite is evenly rounded except in *Scaphydra* where it is truncate and has a small median tooth (fig. 52). The apex of the last exposed sternite of the male has a shallow or deep emargination in *Hydroscapha* and *Scaphydra* (fig. 51), whereas in *Yara vanini* (fig. 53) there is a narrow and deep incision on the left side. The male of *Yara dybasi* is still unknown. In the female of *Hydroscapha* the apex of the last exposed tergite and sternite is evenly rounded, whereas in *Scaphydra* both have a small median tooth, like the tergite of the male. In *Yara vanini* the apex of the last exposed tergite has a median emargination (fig. 56), and in *Yara dybasi* the apex of both the tergite and the sternite has a deep, median emargination (figs. 49, 50).

Male genitalia. Parameres are absent, and the median lobe is short (*Hydroscapha,* fig. 40), or long and coiled (*Scaphydra,* fig. 41), or long and not coiled (*Yara,* fig. 42). The basal bulb is well-developed in *Hydroscapha* and *Scaphydra* but not in *Yara.* In all three genera a forked structure is articulated to the basal bulb. This structure is probably the homolog of the tegmen of other Coleoptera.

Female genitalia. In both *Hydroscapha* and *Scaphydra* the genitalia consist of two paired structures, one dorsal and one ventral. In addition, there is a median, unpaired structure. These five blades (figs. 45, 46) are usually partly exposed but are retractable. In *Yara* the genitalia are similar but consist of only four blades, and the median unpaired structure is absent (figs. 47, 48). We have not attempted to homologize any of these structures with the parts of the genitalia of other beetles. We may note in passing that Paulian (1959) mistook the female genitalia for those of the male. In the Philippine species of *Hydroscapha* illustrated by Satô (1972) a median blade seems to be absent as in the New World species of *Yara.*

Paulian (1959) described a sclerotised spermatheca in *Hydroscapha saboureaui,* but the spermatheca is not sclerotised in any of the New World species of the family that we have examined.

HABITS AND ECOLOGY

Brief summaries of the biology and ecology of the Hydroscaphidae have previously been given (Hinton, 1969; Reichardt, 1973a). The larvae and adults are most commonly found on algae over which a thin film of water is flowing, usually into a stream or river. Sometimes they are very abundant in such hygropetric habitats and hundreds may be collected in a relatively short time. The larvae pupate among algae at the edge of the water film or even among algae over which a thin film of water is flowing. The pupa of *Scaphydra* with its three pair of long (plastron-bearing) spiracular gills is clearly better adapted for aquatic respiration than the pupa of *Hydroscapha* that has the functional spiracles near the apices of the lateral expansions of the first three abdominal segments. Adults of *Hydroscapha natans* have been found in wet algae at the edges of a swimming pool in Cuernavaca, Mexico, and they have also been netted in the open water of the swimming pool. Adults of both *Hydroscapha natans* and *Hydroscapha granulum* have been netted in Mexico and Bulgaria respectively by turning over stones as much as two to three feet below the surface of fast-flowing streams (Hinton, 1969). It is possible that Hydroscaphidae are not more often taken in streams simply because most collecting is done with nets with a mesh not fine enough to retain Hydroscaphidae.

Yara vanini was at first collected in the moist mud of temporary strams. The larger series was taken in the Rio Brauninha and in temporary streams in rocky (quartzite) area, at altitudes between 1,250 and 1,320 m. In the Rio Brauninha they were collected in rapids, on tufts of mosses and algae, covered by few millimeters of water. In the temporary streams they were taken from clusters of *Leiothrix* sp. (Eriocaulaceae, Monocotyledoneae) found especially in small falls in the rapids, where the plants projected 5-10 cm above the surface of the water. The rocks were covered by about 10 cm of water; only few specimens were seen directly on the rocks; most were hidden in the plants.

The adults do not breathe by means of an air bubble carried over the general body surface. It seems likely that they may carry an air bubble under the elytra. Such an air bubble would, by analogy with many other aquatic beetles, function as a compressible gill. However, in some of the places where Hydroscaphidae have been found, e.g. on stones well below the surface of fast flowing streams, they would seem to have no ready means of replenishing air bubbles, at least during the night when bubbles of oxygen are not formed by algae and other plants. It is possible that under some conditions the adults may rely entirely upon cutaneous respiration: because of their very small size they have a very favorable surface area/volume ratio even though the bodywall cuticle is heavily sclerotised and looks relatively impermeable.

It is of interest briefly to compare what we have said about the habits and ecology of the Hydroscaphidae with what is known

about the other families of Myxophaga. The hygropetric habitat is also that of the Torridincolidae (Reichardt, 1973a), but one of the South American genera, *Hintonia,* is normally found in waterfalls.

The Sphaeriidae, unlike Hydroscaphidae and Torridincolidae, are found in wet sand or gravel, or under stones in wet sand, on the banks of streams and rivers, e.g. the Australian *Sphaerius ovensensis* (Oke) (Britton, 1966) and an unidentified species of *Sphaerius* (*Sphaerius tropicus* Matthews, 1888?) found by one of us (HEH) in wet sand and under stones in wet sand on the banks of the river at Palo Bolero (Morelos, Mexico). Sphaeriidae have apparently never been taken with Hydroscaphidae, and in the best known localities in which Sphaeriidae are found, algae were not as conspicuous as in the hygropetric habitat.

The Lepiceridae are the least known family of tne Myxophaga. Larvae and pupae have not yet been found. Adults of the only two known species of the family, *Lepicerus inaequalis* Motschulsky (= *Lepicerus horni* Sharp; Reichardt, 1976) and *Lepicerus bufo* (Hinton) have been found together in damp debris on the banks of a stream in Mexico (Hinton, 1934).

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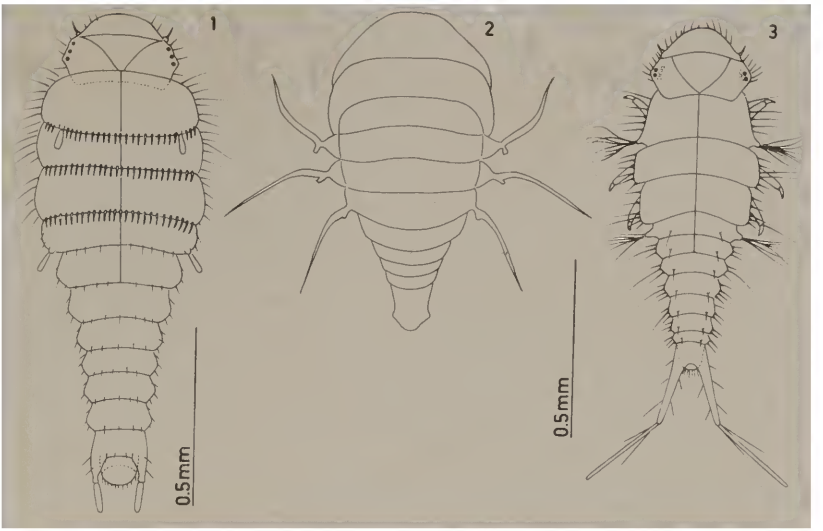
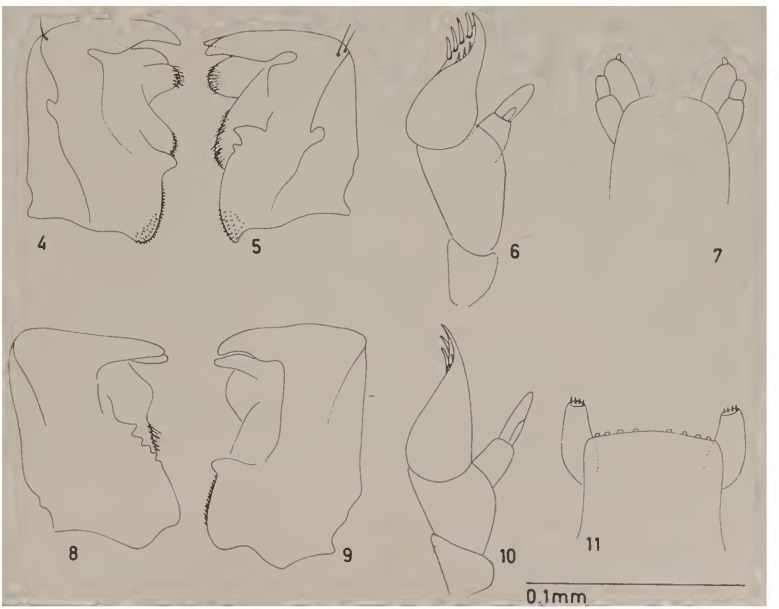
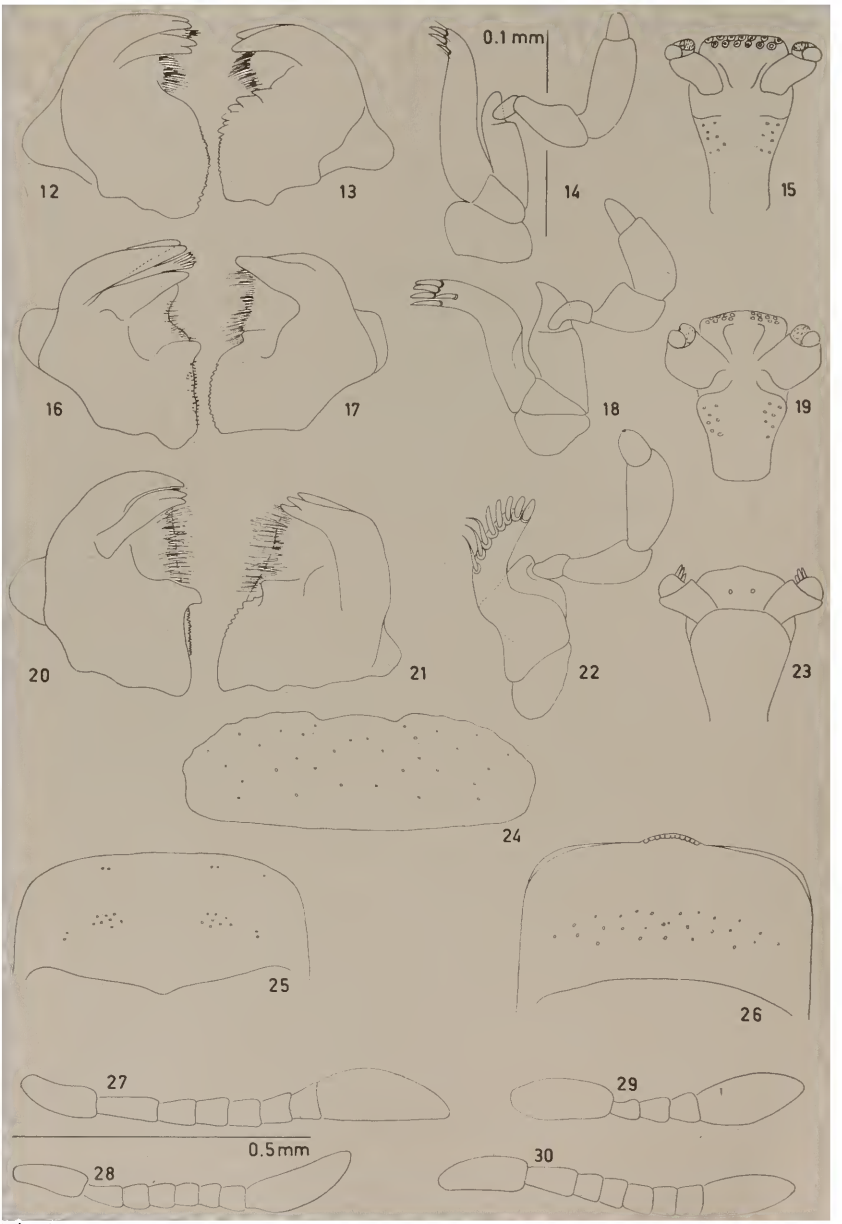
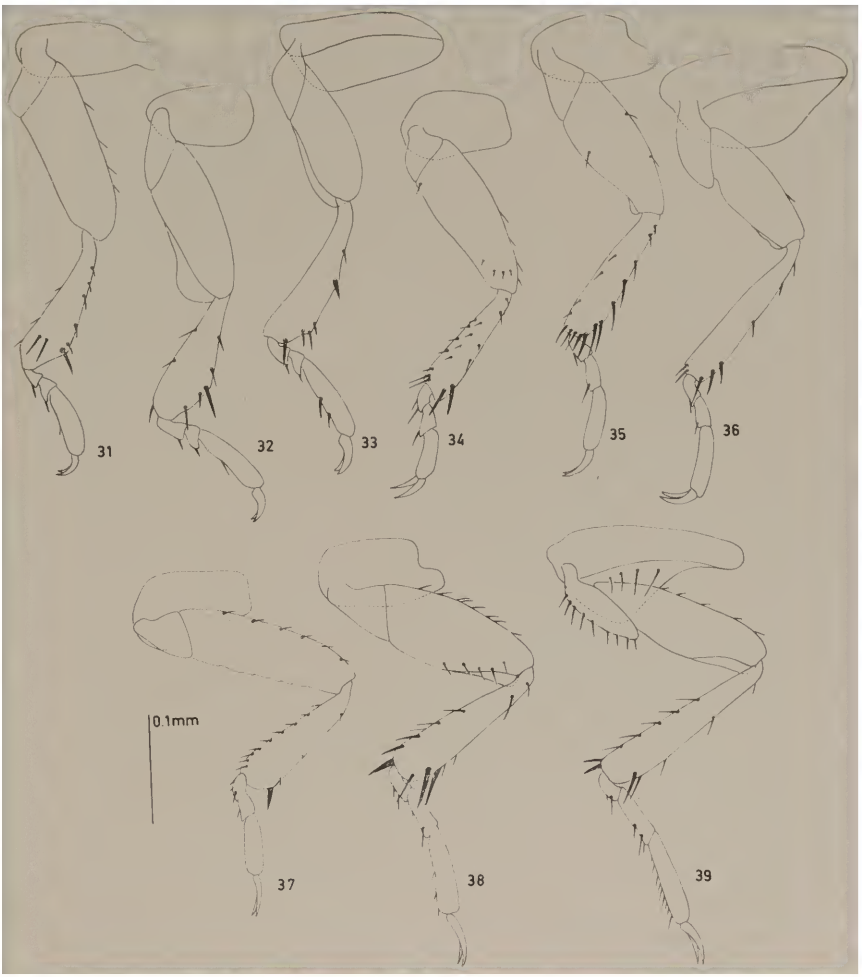




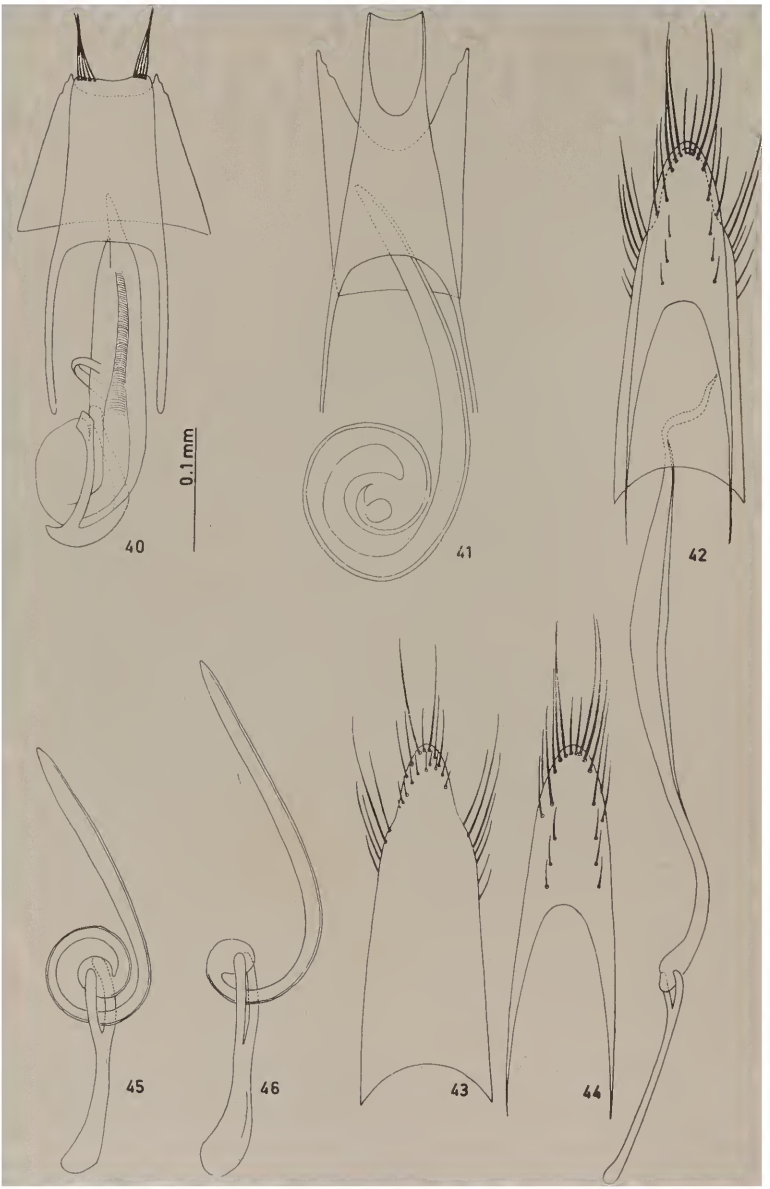
Hydroscapha natans, larva from Mexico, Acatilpa. 1, dorsal view; 4, 5, mandibles; 6, maxilla; 7, labium. *Scaphydra angra,* from Brazil, Mangaratiba. 2, pupa; 3, larva; 8-11, mouthparts of larva: 8, 9, mandibles; 10, maxilla; 11, labium.



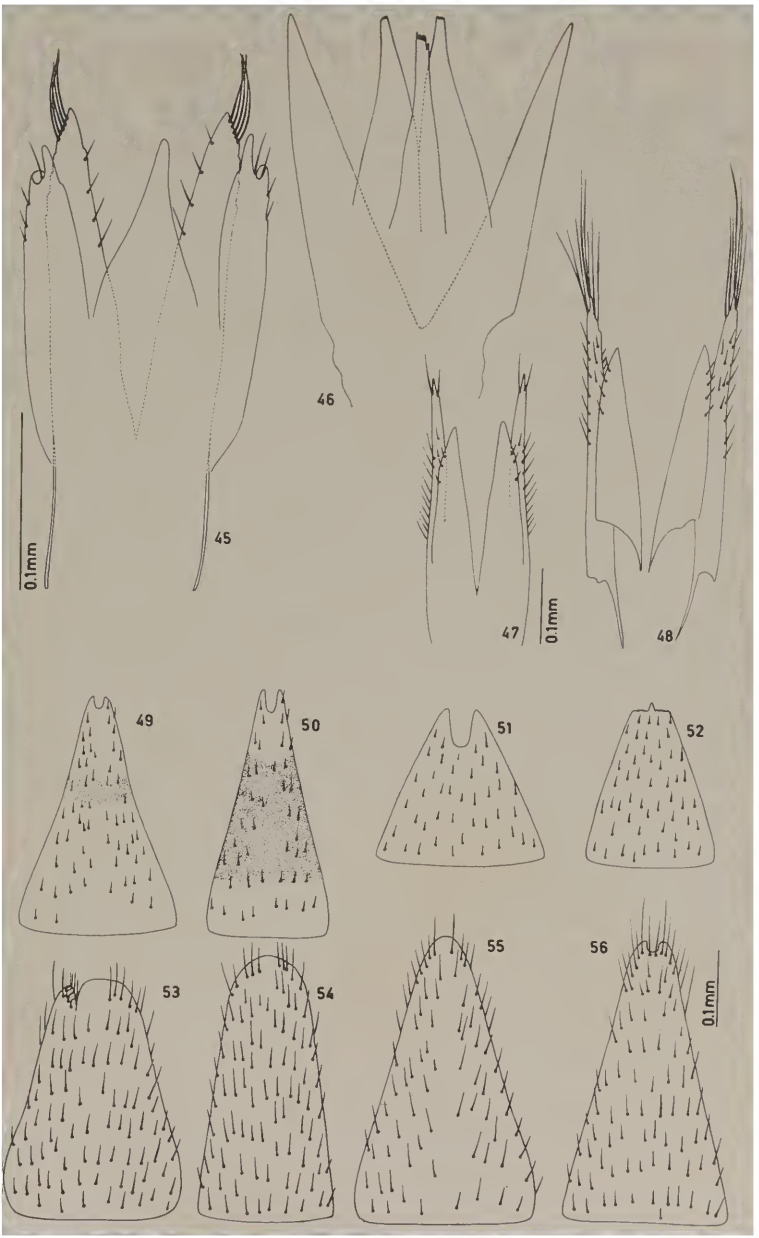
Mouthparts and antennae of adults. *Hydroscapha natans,* Mexico, Acatilpa: 12, 13, mandibles; 14, maxilla; 15, labium; 25, labrum; 30, antenna. *Scaphydra angra,* Brazil, Mangaratiba: 16, 17, mandibles; 18, maxilla; 19, labium; 24, labrum; 29, antenna. *Yara vanini,* Brazil, Serra do Cipó: 20, 21, mandibles; 22, maxilla; 23, labium; 26, labrum; 27, antenna. *Yara dybasi,* paratype: 28, antenna.



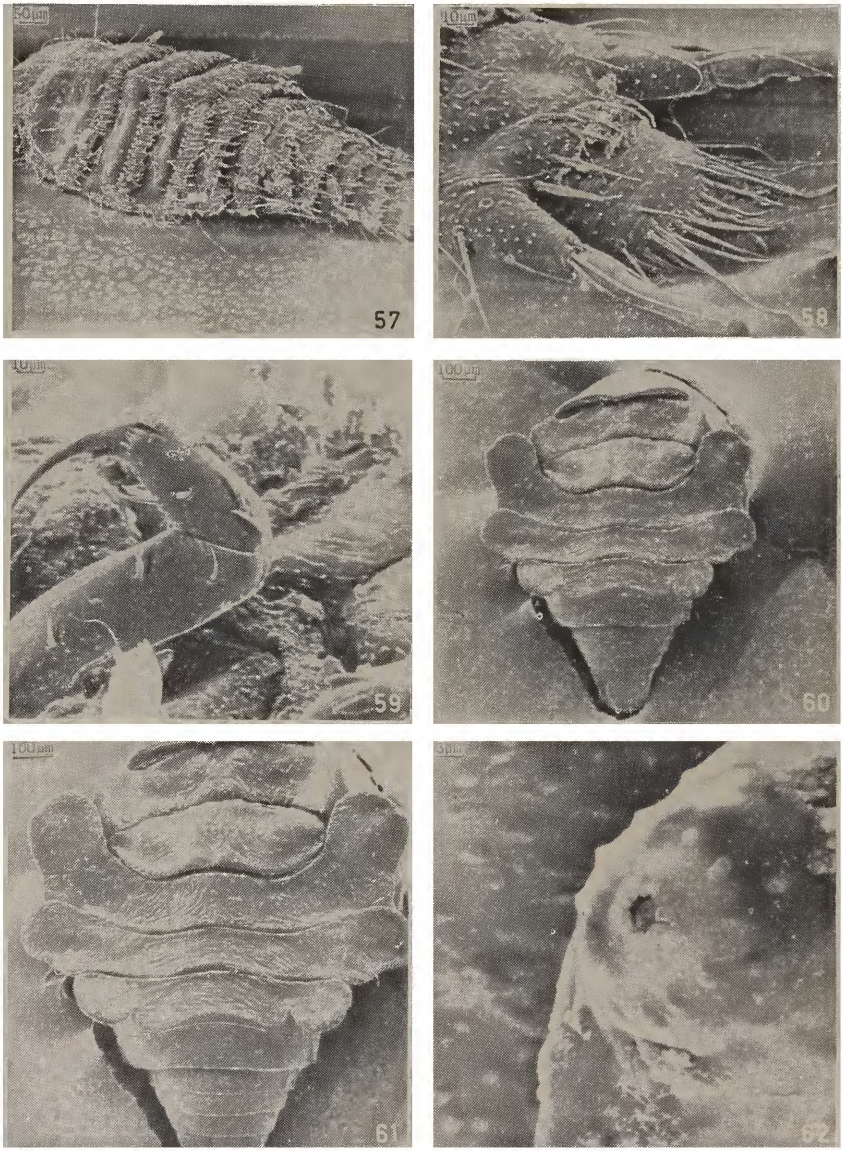
Front, middle and hind legs of *Scaphydra pygmaea* (31, 32, 33, from Brazil, Santa Isabel); *Hydroscapha natans* (34, 35, 36, from Mexico, Jojutla); *Yara vanini* (37, 38, 39, from Brazil, Serra do Cipó).



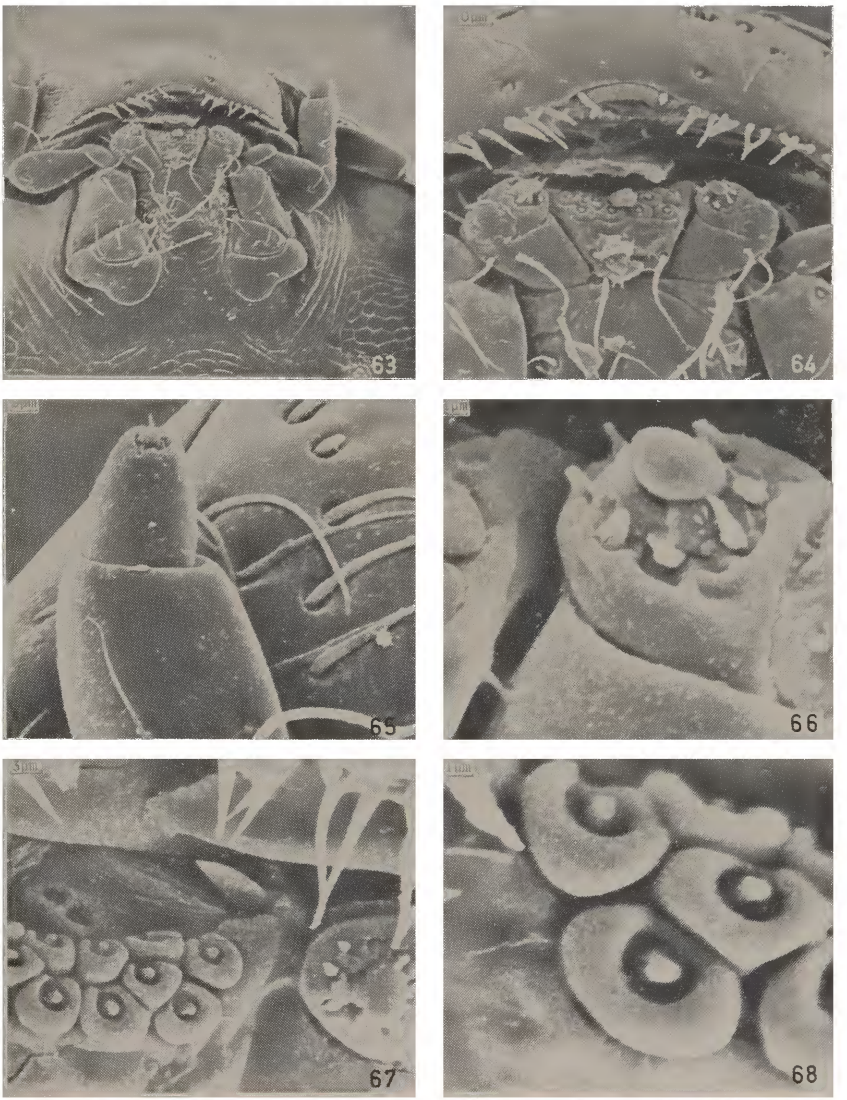
Male genitalia, ventral view, with invaginated sternite and tergite. 40, *Hydroscapha natans,* Mexico, Acatilpa; 41, *Scaphydra angra,* Brazil, Mangaratiba; 45, 46, *Scaphydra pygmaea,* in fig. 46, aedeagus partially uncoiled; Brazil, Rio Jucu; 42, *Yara vanini,* Brazil, Serra do Cipó; 43, invaginated tergite of same species; 44, invaginated sternite of same species.



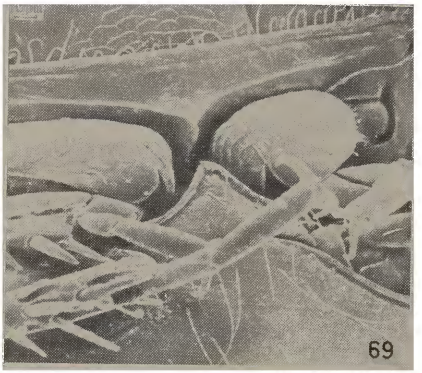
Female genitalia, dorsal view. 45, *Hydroscapha natans,* Mexico, Acatilpa; 46, *Scaphydra angra,* Brazil, Mangaratiba; 47, *Yara dybasi,* Panama, Madden Lake; 48, *Yara vanini,* Brazil, Serra do Cipó. Last visible sternite and tergite, respectively: 49, 50, *Yara dybasi,* female; 51, 52, *Scaphydra pygmaea,* male; 53, 54, *Yara vanini,* male; 55, 56, same species, female.

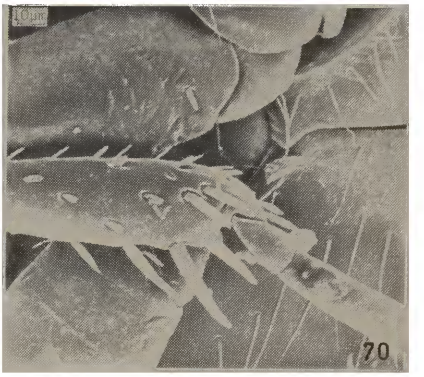


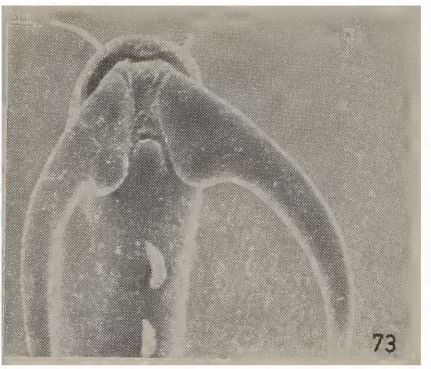
Hydroscapha natans, Mexico, Acatilpa. 57, 58, larva; 59, leg of larva. 60, 61, pupa; 62, spiracle of pupa.



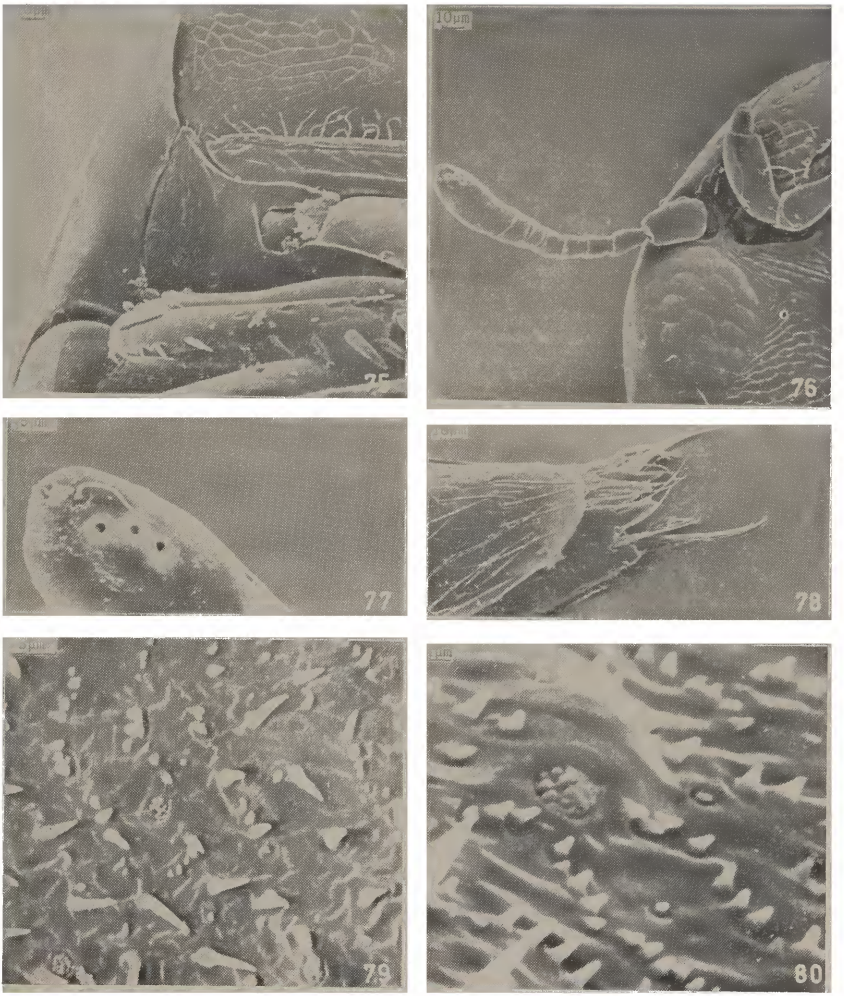
Hydroscapha natans, adult from Mexico, Acatilpa. Mouthparts and details. 63, total view; 64, detail of labium; 65, apex of maxillary palp; 66, apex of labial palp; 67, 68, sensory organs of labium.



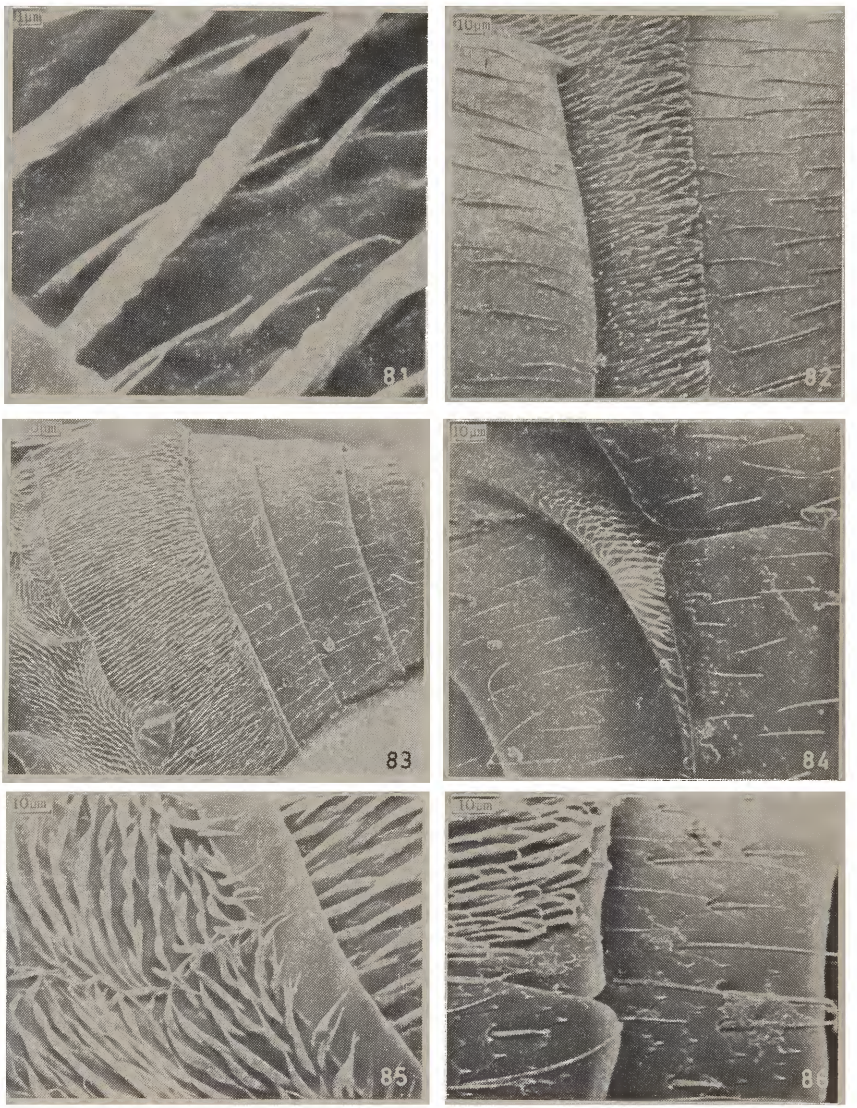




Hydroscapha natans, adult from Mexico, Acatilpa. 69, front coxae; 70, front leg; 71, metasternum and middle leg; 72, middle leg; 73, tarsal claws; 74, abdominal sternites and hind leg.



Hydroscapha natans, adult from Mexico, Acatilpa. 75, ventral view of prothorax; 76, maxillary palp, antenna and eye; 77, detail of apex of antennal club; 78, apex of abdomen of female; 79, 80, internal surface of elytron.



Hydroscapha natans, adult from Mexico, Acatilpa. 81, setae of margin of hind wing; 83, abdominal tergites III to VII; 84, apex of elytra and abdominal tergites IV and V; 85, details of setae of tergites III and IV; 86, lateral view of tergites IV and V. *Scaphydra hintoni,* paratype: 82, apex of elytron and tergites IV and V.