United States
Environmental Protection
Agency

Environmental Monitoring and
Support Laboratory
Cincinnati OH 45268

600382025
April 1982

Research and Development

EPA

Leeches (Annelida: Hirudinea) of North America

XX-3

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EPA-600/3-82-025
April 1982

LEECHES (ANNELIDA: HIRUDINEA) OF NORTH AMERICA

by

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FOREWORD

Environmental measurements are required to determine the quality of ambient water, the character of effluents, and the effects of pollutants on aquatic life. The Environmental Monitoring and Support Laboratory - Cincinnati conducts an Agency-wide quality assurance program to assure standardization and quality control of systems for monitoring water and wastewater and carries out research to develop, evaluate, standardize, and promulgate methods to:

* Measure the presence and concentration of physical, chemical, and radiological pollutants in water, wastewater, bottom sediments, and solid waste.

* Concentrate, recover, and identify enteric viruses, bacteria, and other microorganisms in water.

* Measure the effects of pollution on freshwater, estuarine, and marine organisms, including the phytoplankton, zooplankton, periphyton, macrophyton, macroinvertebrates, and fish.

* Automate the measurement of physical, chemical, and biological quality of water.

The effectiveness of measures taken to maintain and restore the biological integrity of the Nation's surface waters is dependent upon our knowledge of the changes in the taxonomic composition of the aquatic life caused by discharges of toxic substances and other pollutants and upon the level of our understanding of the complex relationships that prevail in aquatic ecosystems. Leeches compose a significant portion of the fauna in a variety of freshwater and marine habitats. On a world-wide basis some species are important economically as parasites of mammals, fishes, and birds. Occasionally, in North America some species are blood sucking pests to humans in aquatic recreational areas. Other species are important as parasites and predators of an assortment of animals. Also, leeches act as hosts of parasites or as vectors for parasites of vertebrates. Several of the more common species are associated with polluted waters, while others are associated with water of high quality. This manual was developed to assist biologists in identifying specimens of leeches to the species level and in evaluating data collected during studies of the effects of toxic substances and other pollutants on indigenous communities of aquatic organisms.

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PREFACE

The previous manual, "Freshwater Leeches (Annelida: Hirudinea) of North America," Identification Manual No. 8, Biota of Freshwater Ecosystems, published in 1972, was prepared under contract with the Oceanography and Limnology Program, Smithsonian Institution, with funds provided by the United States Environmental Protection Agency.

In the ten years that have elapsed since publication of the above manual, additional work has been done in North America on the ecology and systematics of the leeches. This publication serves to correct several errors found in the above manual, to make several desirable taxonomic changes, to add new sections and various relevant information to the text with the intent of making the manual more useful, and to add new and improved quality illustrations. The new materials include expanded methods for collecting, narcotizing, fixing, and preserving leeches, notes on systematics, distribution maps, a glossary, synonymies, and an expanded bibliography. This is not a monographic revision, but offers some new insights into the systematics of the North American freshwater leeches. Hopefully, this publication will make identification easier and will stimulate much needed research on the ecology of leeches, especially on the water quality requirements and pollution tolerances of individual species.

If errors are found in the manual, they should be transmitted to the author. Also, constructive criticism regarding the manual will be gratefully appreciated.

ABSTRACT

Leeches are represented in North America by four orders, five families, 22 genera, and 63 species. The primitive family Acanthobdellidae is represented by one genus and species. The families Glossiphoniidae are represented by 10 genera and 29 species, the Piscicolidae by four genera and 10 species, the Hirudinidae by three genera and 13 species, and the Erpobdellidae by four genera, nine species and two subspecies. The systematics are still incompletely worked out for some of the groups, which makes a definitive listing of species somewhat arbitrary at this time. Taxonomic problems are discussed, and the present key in most instances reflects a conservative approach to the lower taxa and represents all the known species. External characters are used mostly in the key to separate the taxa, but some dissection of internal anatomy may be required for the identification of a few species in the families Hirudinidae and Erpobdellidae.

The main features of this publication are an introduction, methods of collection, narcotization, fixation and preservation, important notes on systematics and identification, an illustrated key for species level identification, a glossary, species distribution, a partial synonymy, and a selected bibliography which includes the references cited in the text and other publications which provide additional information on taxonomy and ecology of the Hirudinea.

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ACKNOWLEDGMENTS

I wish to extend my thanks to Roy T. Sawyer, Bruce Daniels, and Thomas P. Poe for their reviews of the technical contents of the manuscript. I also thank Cornelius I. Weber for reading the manuscript and making valuable suggestions. I especially thank Marvin C. Meyer and Roy T. Sawyer for sharing their thoughts and opinions on Hirudinea ecology and taxonomy. I am grateful to the following persons and institutions: Marian H. Pettibone and Meredith L. Jones, Division of Worms, Department of Invertebrate Zoology, U.S. National Museum of Natural History, Smithsonian Institution, Washington, D. C.; John D. Unzicher, Illinois Natural History Survey, Urbana, Illinois; Richard Franz, Florida State Museum, The University of Florida, Gainesville, Floirda; H. W. Levi, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; Donald G. Huggins, State Biological Survey of Kansas, The Unversity of Kansas, Lawrence, Kansas; James Reddell, Texas Memorial Museum, The University of Texas, Austin, Texas; Peter Frank, Invertebrate Zoology, National Museums of Canada, Ottawa, Canada; Philip Lambert, British Columbia Provincial Museum, Department of the Provincial Secretary, Victoria, British Columbia, Canada, and The Academy of National Sciences of Philadelphia, Department of Invertebrate Zoology, Philadelphia, Pennsylvania for making the leech collections of these museums available for my examination.

I am particularly indebted to George Ford and Frances O. Paulson of the Worm Division, U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. for their kind assistance with the leech collections and library references.

The following persons have helped to supply specimens for either identification or verification and for distribution records and should receive special thanks: Omar Amin, Michael T. Barbour, L. Todd Beck, C. Dale Becker, David C. Beckett, Michael D. Bilger, R. Bland, Edward Bolton, Eugene M. Burreson, Stephen W. Carney, William H. Clark, Mary G. Curry, Bruce A. Daniels, Charles R. Demas, Scott R. Derrickson, William G. Deutsch, Graig W. Dye, John M. Epler, Tom M. Freitag, Dean Furbish, Joseph W. Gorsuch, Mike Gross, George L. Harp, Charles O. Hatcher, A. K. Hauck, Ethel Helsel, Jarl K. Hiltunen, Glenn L. Hoffman, Peter Hovingh, John R. Howland, Richard Howmiller, James L. Hulbert, Guy M. Johnson, Michael W. Jones, Jerry Kaiser, Martin L. Kopenski, Robert E. Kuntz, David R. Lenat, Philip A. Lewis, Gerry Mackie, Anthony F. Maciorowski, Jacqueline Madill, Willis E. McConnaha, Mike McIntosh, Charles N. Merckel, Lewis Giles Miller, Robert L. Newell, Preston Newman, Jr., Gene K. Okamoto, Jeff Osborn, John A. Osborne, Peter M. Nolan, Lee O. Pendergraft, Wendell L. Pennington, Thomas P. Poe, Janet L. Polk, Bayliss Prater, Buford C. Pruitt, Jr., Fred W. Robe, Henry W. Robison, Brenda J. Rogers, Harvey D. Rudolph, Robert P.

ACKNOWLEDGMENTS - continued

Rutter, Gerard M. Sala, Harry M. Savage, Steward C. Schell, Gerald Schnytema, Donald Schultz, Douglas G. Smith, Gerry Smrchek, August A. Staats, Charles S. Steiner, Kurt S. Stimpson, Daniel Stoneburner, Donald Tarter, George Te, William M. Turner, Bruno Vincent, Robert E. Watson, Mark J. Wetzel, Steve White, Wilbur J. Widmer, Nixon A. Wilson.

I would also like to acknowledge the use of the following illustrations: Thomas P. Poe (Fig. 12b-e); Roy T. Sawyer and Rowland M. Shelley (Fig. 52).

The secretarial assistance of Cordelia Nowell and Diane Schirmann is gratefully acknowledged.

SECTION 1

INTRODUCTION

The leeches are evolutionarily derived from an ancient protostome stock which gave rise to the segmented worms (Phylum Annelida), thus establishing the metameric line. The earliest fossil record of leeches comes from the Jurassic Period of Bavaria (Kozur, 1970). Other fossil annelid records of the middle Cambrian Period indicate that they were already differentiated into well-established groups (such as Polychaeta, Oligochaeta, and Hirudinea). The leeches are considered the most highly specialized annelids and are thought to have arisen from an oligochaete progenitor.

The Class Hirudinea is divided into four Orders: Acanthobdellida, Rhynchobdellida, Gnathobdellida, and Pharyngobdellida. On a world-wide distribution Soos (1969b,1970) indicated that the Class Hirudinea contains over 500 species, approximately 140 genera, and ten families. Currently, in North America the leech fauna is composed of five families, 22 genera, and 63 species.

Leeches are predominantly freshwater invertebrates, but there are many marine forms, as well as numerous terrestrial species which occur mainly in the tropics. Unfortunately, all leeches are often disliked by the layman and popularly considered to be "bloodsuckers" because of the bloodsucking habits of a few species. As a result, it is usually this activity that attracts the attention of anyone who encounters them. However, their food habits are far more diverse than most people realize; many are not sanguivorous. These animals are predatory or parasitic with anterior and posterior suckers that serve as organs of attachment, feeding, and locomotion. Some species are morphologically adapted for obtaining and digesting food consisting chiefly of the blood of fishes, turtles, crocodilians, frogs, salamanders, birds, and mammals; other species can also consume blood fluids, tissues, and whole live or dead invertebrates, such as annelids (including leeches), crustaceans, insect larvae, and mollusks.

Members of the Class Hirudinea compose a significant part of the North American invertebrate fauna in both lentic and lotic waters. However, we know very little about the ecology, natural history, and water quality requirements of individual species. Herrmann (1970), Klemm (1972a), and Kopenski (1969) are the only broad ecological studies for the group in North America. Sawyer (1974) has also reviewed the pertinent literatuare for the ecology of freshwater leeches especially in relationship to various kinds of pollution. The mention of other important papers with specific information on natural history and ecology can be found in the Selected Bibliography.

Leeches are important components of food webs (Fig. 1), as predators, parasites, vectors of parasites, and as food of aquatic animals. Economically, the leeches of North America are not nearly as serious a pest as tropical leeches, but they occasionally become numerous and bothersome to humans in aquatic recreational areas. More importantly, their activities may have a direct or indirect effect upon the life histories of fishes (Hoffman, 1979; Khaibulaeu, 1970; Paperna and Zwerner, 1974; Poe, 1972; Shuster, Smith, and McDermott, 1951; Thompson, 1927; and others listed in the Selected Bibliography. Leeches are also hosts (Corkum and Beckerdite, 1975; Fish and Vande Vusse, 1976; Vande Vusse, 1980) or intermediate hosts (Becker, 1965-1977; Becker and Katz, 1975; Khan, 1980; Klemm, 1975; Mann, 1962; Putz, 1972) in the life cycles of potentially disease-causing blood protozoans, trematodes, and cestodes of fishes. In addition, certain leeches infest waterfowl, but the incidence and significance of these infestations are poorly understood or documented (Meyer and Moore, 1954; Roberts, 1955; Keymer, 1969; Bartonek and Trauger, 1975; Trauger and Bartonek, 1977; McKinney and Derrickson, 1979; Davies and Wilkialis, 1981).

Leeches are sometimes ignored in macroinvertebrate analysis or misidentified by investigators not familiar with their morphology or taxonomy. Frequently authors of environmental studies have recorded the group by class, family, genus or merely as "leeches." The improper or inadequate treatment of the leeches is attributable at least in part, to the lack of a practical key to all species, unfamiliarity with the current literature, and the difficulty associated with identifying some preserved specimens. To determine the water quality requirements and pollution tolerances of aquatic organisms, the animals must be identified to the species level (Resh and Unzicker, 1975; Carricker, 1977).

This publication excludes the leeches of the West Indies, an archipelago in the Caribbean Sea between North and South America, which are discussed in Sawyer and Kinard (1980); the leeches of Central and South America which are discussed to genera in Ringuelet (1976) and the exclusively marine leeches. An identification manual to the marine fauna of North America is not currently available, but is badly needed. However, the following publications will help and should be consulted for identifying most marine taxa: Burreson (1976a,b; 1977a-d), Burreson and Allen (1978), Davies (1978), Knight-Jones (1962), Khan and Meyer (1976), Meyer and Khan (1979), Moore (1946), Moore and Meyer (1951), Sawyer, et al. (1975), Sawyer and Kinard (1980), Soos (1965), and Appy and Dadswell (1981).

Earlier taxonomic keys to the leeches include: Moore, J.P. (1918, 1959), Klemm (1972b), and Sawyer (1972) for North America; Mann (1962) for the British Isles, Central Europe, and North America; Pennak (1953, 1978) for the United States; Meyer (1946a) and Hoffman (1976) for the fish leeches of North America; Hayunga and Grey (1976) for fish leeches of the genus Cystobranchus; Soos (1962-1969b) for genera or species of the world with catalogues of the species; Davies (1971) for Canada; Klemm (1976) for leeches found in North American mollusks; Ringuelet (1976) for families and genera of MesoAmerica and South America; Mann (1964) and Elliot and

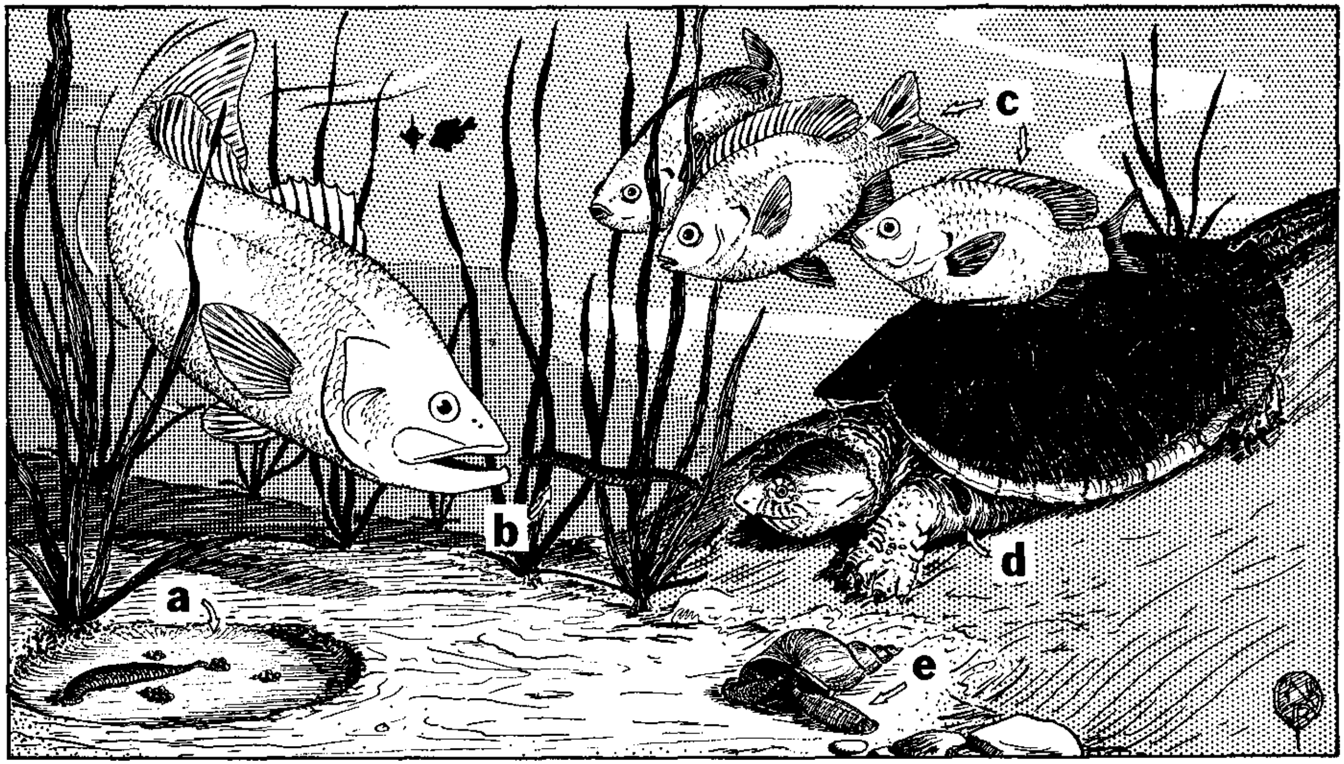

FIG. 1. Some feeding and behavioral activities of leeches that may have a direct or indirect effect upon the ecology of fishes: (a) leech feeding upon the eggs of fish (and other aquatic animals); (b) fish feeding on leech; (c) leeches feeding on the blood of fishes; (d) leech infesting an aquatic reptile (birds, etc.); (e) leeches feeding on snails (and other macroinvertebrates). (Modified from Shuster, Smith, and McDermott, 1951).

Mann (1979) for the British Isles. Keys for specific geographic regions of North America include: Moore, J.P. (1906, 1912, 1922) for the Great Lakes Region, Minnesota, and Southern Canada; Bere (1929) for Jasper Park (Alberta, Canada); Miller (1929; 1937) for Ohio and Michigan; Eddy and Hodson (1950) for the North Central United States; Keith (1960) for Minnesota; Moore, J.E. (1962; 1965) for Alberta, Canada. and Sawyer and Shelley (1976) for North and South Carolina.

All the above keys have limited use today because they are either outdated, are based only on sparce collections, or are limited in the number of species for which they are written. Furthermore, some of the authors neglected consideration of the overall morphological variation found in some species, and thus these keys have been deficient for use in the identification of specimens collected from throughout the geographic ranges of the species. Finally, they are in need of the taxonomic changes proposed by Meyer (1968), Sawyer (1972), Daniels and Freedman (1976), Klemm (1976, 1977), Sawyer, et al. (1975), and Sawyer and Shelley (1976). They lack the several new species recently described by Meyer (1975), Hayunga and Grey (1976), Johnson and Klemm (1977), Sawyer and Shelley (1976), the redescription of a species by Smith (1977), and new and important geographical distribution records for many species.

Therefore, I have attempted in the present manual to analyse critically the leech species of the families Glossiphoniidae, Piscicolidae, Hirudinidae, and Erpobdellidae in North America. This entailed the examination of over 15,000 live and preserved specimens collected or received by the author for identification or verification by the many individuals mentioned in the Acknowledgment and also the examination of leech collections from museums also mentioned in the Acknowledgment.

The manual includes a methods section, a species list, notes on systematics and identification, an illustrated key, a glossary, a species distribution section, a section on synonymy for each species in North America, and an extensive bibliography. The section on Methods contains information on collecting and processing specimens. The forms with uncertain taxonomic status are discussed in the section on Notes on Systematics. In the section on Notes on Identification, emphasis has been placed on external characters. Where internal characters are used, dissection methods are given. The dichotomous key comprises as many external characters for identification as necessary, and the drawings were made from living and preserved specimens. All the illustrations with the exception of Figures 12b-e and 52 were drawn by the author. To facilitate identification, each species and the most common variety have been illustrated. The morphological terms for the diagnostic characters used to differentiate the species are defined in the Glossary. The section on Species Distribution consists of a discussion and maps for each species found in North America. The bibliography of the primary literature on leeches of North America is presented to encourage and aid future investigations. Additional works are found in the bibliographies of Sawyer (1972), Klemm (1972a, 1977), and Windsor (1972).

This manual was prepared to provide USEPA and other biologists in Federal, state, and private water monitoring agencies with an updated and improved key of the species, to consolidate available information on distribution so that specimens of leeches can be identified to species, and to evaluate data collected during water quality studies concerning the effects of toxic substances and other pollutants.

SECTION 2

METHODS

COLLECTION

In surveying any body of water for its leech population it is important to remember that they usually avoid strong sunlight. Free-living species are found attached to the sides, in cracks, and under surfaces of a variety of substrates such as rocks, boards and logs, or almost any inanimate object littering both lentic and lotic environments. This includes submergent vegetation, leaf packs, and masses of other organic debris.

Many species of Glossiphoniidae and Piscicolidae are well adapted as ectoparasites in that they pierce and suck the blood and tissue contents of their hosts. The collection and examination of vertebrates (amphibians, aquatic reptiles, fishes, and waterfowl) and macroinvertebrates (snails, mussels, and so on) are, therefore, occasionally required when collecting certain species of these leeches. The parasitic forms remain attached to the host and cling there for a period of time, and then drop off after feeding and creep away to seek the shelter of a suitable substrate where they may remain while digesting their meal. Most parasitic forms are generally found free-living during part of their development or reproductive cycle (deposition of cocoons, or eggs, and brooding young) and require a substrate for attachment.

Most species of Hirudinidae have jaws and teeth and are either sanguiorous (blood sucking), or macrophagous (swallowing their invertebrate prey whole), but the few species lacking jaws and teeth are strictly macrophagous. Species of Erpobdellidae also lack jaws and are macrophagous. Hirudinids and erpobdellids are usually collected free-living.

Some species of Haemopis (Hirudinidae) are amphibious, while H. septagon and some populations of H. terrestris, are terrestrial. The terrestrial species are collected from moist places under rocks, boards, logs, or almost any type of inanimate object, usually near water. Sometimes, however, terrestrial populations are found a great distance from water. On occasion, these leeches can even be collected when they are foraging for food along the shores of bodies of water or on land when moist atmospheric conditions exist, especially at night. Leeches are collected either by hand, with forceps, or any other instrument which can be used to gently dislodge them. Some benthic forms may be collected with bottom samplers (grabs or dredges) while some of the actively swimming species can be collected with a dipnet. In addition, dipnets are useful in collecting debris, vegetation, and organisms which may be examined for leeches.

NARCOTIZATION, FIXATION, AND PRESERVATION

In some cases, it may be extremely difficult or impossible to identify some leech specimens to the species level because of faulty preparation and unsuitable preservation. Leeches are very sensitive, and respond to irritants and react differently to different substances and concentrations. They have a soft, highly contractile body. Therefore, if leeches are dropped alive into preservatives such as 70% alcohol (ethanol), 5-10% formalin solution (commercial formaldehyde), for instance, they contract strongly and sometimes such features as the eyes, general body shape, and the genital pores become distorted and difficult for the non-specialist and occasionally even for the expert to discern. When leeches are properly anesthetized prior to fixation, there is usually less muscular contraction. The body shape remains more uniform, and there is less variabilty of the anatomical structures. Many specimens of leeches which are preserved rapidly without anesthetization or fixation can still be identified to the species level, but this is not the ideal procedure because it can delay or prevent the identification of some specimens. Experience will help alleviate this problem. The preserved leech should be straight, moderately extended and undistorted. For best results they should be fixed and preserved in fluids strong enough to prevent maceration or softening of the tissues but not so strong that they are rendered overly hard and brittle. Leeches are ruined completely when they dry out.

Leeches should never be flattened between glass plates and the like except for special histological purposes. Flattening causes distortion of the body and internal organs, and the important external organs of the integument can become altered, thus causing difficulity in determining the diagnostic characters.

The characteristic color patterns on the dorsal surface of some leeches, especially the blue, green, red, and yellow pigments (see chromatophore), can be dissolved or altered by preserving in ethanol, and it is sometimes very desirable that the color of the living leeches be noted on the label of the specimen jar and used in the identification of some specimens. However, some of these colors seem to persist for longer periods of time if the specimens are first fixed in formalin and then preserved in alcohol. Brown and black chromotophores, usually remain after using either preservative. Some people prefer to use alcohol because formalin is odoriferous, irritating to the skin and eyes, and causes the specimens to become hard and brittle over time.

The addition of ecological data to the record can help in the identification and increases the value of the specimen. Sometimes, to ensure proper identification and to make a thorough anatomical study of a species, several specimens are needed. A single specimen, especially when poorly preserved, may be either impossible or at least difficult to identify to the species level and may, therefore, not make a good specimen for morphological studies.

If large specimens of the eropbdellids or hirudinids are placed directly in 70% alcohol (ethanol) rather than first fixed in formalin, the body cavities of the specimens should be injected with 70% alcohol to insure preservation of the internal organs, which may be necessary for identification of some specimens.

The following methods for preparing specimens for taxonomic studies and a reference colection are recommended by the author, and all will generally give good results:

Narcotizing

Specimens can be narcotized through direct placement into carbonated water, in 70% alcohol (ethanol), or in a 5-10% solution of Chloretone added slowly to the container of water containing the leeches. These should be added gradually, increasing the concentration, until all movement stops or the specimens no longer respond to probing. Depending on size and number being nacotized, the leeches should be completely relaxed in a 15 to 30 minute period.

Another method requires adding a few drops of chloroform to the water containing the leeches (The chloroform will sink to the bottom if introduced beneath the surface of the water with a pipette or eye dropper), and covering the container with a glass plate until the leeches are anesthetized.

One per cent solution of propylene phenoxetol or sodium nembutal may also be used for narcotizing leeches. Excessive relaxation of specimens in these nacotizing agents can cause the furrows between the annuli to diasppear. Therefore, the specimens must be fixed in 10% formalin as soon as possible after nacotization.

Specimens can be placed directly in a 4% ether solution (4 mL ether: 96 mL water) in a stoppered bottle. The volume of ether solution should be approximately 10 times the volume of the leeches. This procedure (Richardson, 1975) will result in the narcotization and death of the leeches in two to five hours, depending on the size of the specimens and the temperature (e.g. small specimens and at warmer temperatures). This solution is bacteriostatic and if specimens for systematics and general morphological studies, are left in it for 15 to 20 hours at high room temperature, 35 to 40°C, the leeches do not deteriorate appreciably. However, for best results, do not leave in the stock solution for long periods of time because leeches having a very weak or thin muscular body wall which will extend to such a degree that annulation is obliterated.

Narcotize specimens in 5 mL of a 1% aqueous solution of Eucaine hydrochloride. This method (Zinn and Kneeland, 1964) results in retention of body form, preservation of color, rapid action, and completeness of relaxation of the specimens. The dosage, however, will vary from 0.25 mL for a leech one half inch long, taking about ten minutes for narcotization, to 1 mL for a two inch leech, with narcotization in about 20 minutes. Larger leeches require up to 4 mL of the anesthetizing solution in a maximum of 50 mL of water.

Fixing

After narcotization, large specimens should be drawn between the fingers and washed so that the mucus is removed if secreted. Small specimens can be wiped free of mucus with a small brush or piece of paper toweling. Then, straighten the specimen out and place between damp paper toweling or filter paper in a tray, such as a dissecting tray, and gently flood with 10% formalin for 12 hours to fix and prevent softening of the tissue. Small specimens can be fixed in a shorter period of time. After the tissue is hard, the leeches are placed in the final preservative.

Preserving

Wash specimen in water to remove the formalin of fixation and preserve in 70%-80% ethyl alcohol (ethanol), or preserve specimens in 5% buffered formalin.

If whole mount slides of some specimens are prepared for anatomical details, the modified technique of Palmeieri, et al. (1973) is excellent. The most critical step in preparing a quality specimen for slides or display is anaesthetizing. Place specimens in culture dish with clean water and refrigerated at 35 to 40^{o}F (2 to 4.5^{o}C) for 40 minutes. Refrigeration slows movement and makes the leech easier to handle. After refrigeration, place the leech between two microscope slides, one of which is covered with paper toweling, and apply slight pressure. The "sandwiched" leech is then placed under running hot tap water (approximately 180^{o}F or 82^{o}C) for about one minute. This has a narcotizing effect and yields straight, flat leeches without excess mucus. Care must be taken to use only hard paper toweling, as the fibers of soft papers tend to adhere to the leech. Elastic bands or spring clips (Meyer, 1957) should be placed around the slides, and the entire leech-paper towel-slide complex placed into a 10% neutral formalin, (FAA, Bouin's, or Flemming's fixatives) fixing solution for about 24 hours. After fixation, the leeches should be removed from between the slides, cleaned and placed in a Petri dish filled with distilled water.

Leeches should be stained with Mayer's paracarmine stain (Gray, 1954) or Harris' hematoxylin. The specimens are stained for 12 to 24 hours, then destained in a 1% HCL-70% ethanol solution until the leech epidermis is free of stain. After being destained, leeches should be neutralized in 1% NH_4OH-70% ethanol solution.

With large leeches, counterstaining may not be desirable, but to show organs of the integument of small leeches, fast green or eosin may be used. Stained specimens should be dehydrated by passing them through a series of ethanol solutions, and remain at least 1-4 hours at each ethanol concentration (35% -50% -70% -80% -95% -100% -100%). Leeches should be cleared for at least 20 minutes in methyl salicylate (xylol tends to harden leeches) and mounted in a neutral pH mounting medium. When mounting large leeches, cover slips can be supported with chips of microscope slides. See Meyer and Olsen (1971) for methods for whole mounting and histological sectioning of leech material.

DEPOSITORY FOR LEECHES

The value of a Hirudinea collection is that it will provide permanent preservation for type-specimens, other voucher specimens, and records of collection data, and that it may serve biologists both here and abroad as a reference for further systematic and ecological studies.

Leech material which is no longer needed should be deposited in The United States National Museum of Natural History or some other museum that is concerned with the safety of the specimens, has a reputation for properly maintaining the collection, and will allow accessibility of the voucher specimens for scientific research.

Specimens with proper collection data can be sent to the Division of Worms, Department of Invertebrate Zoology, U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. 40560. The specimens should be correctly preserved and labelled. The following information should be included for each specimen: *(1) the locality, including state, county, and distance from nearest town, if known, *(2) date collected, (3) scientific name (if known), (4) habitat, *(5) collector, (6) name of person who identified the specimen, and (7) other ecological information if available, such as found free-living, or parasitic, and host; the scientific name of the host (if known), and so on. Specimens sent to museums without the minimum (*) accompanying data are worthless.

SECTION 3

LIST OF SPECIES

Phylum Annelida

Class Hirudinea Lamarck, 1818

Order Acanthobdellida Livanow 1905

Family Acanthobdellidae Livanow, 1905

Genus: *Acanthobdella* Grube, 1851

Acanthobdella peledina Grube, 1851

Order Rhynchobdellida Blanchard, 1887

Family Glossiphoniidae

Genus: *Actinobdella* Moore, 1901

Actinobdella annectens Moore, 1906
Actinobdella inequiannulata Moore, 1901

Genus: *Alboglossiphonia* Lukin, 1976

Alboglossiphonia heteroclita (Linnaeus, 1761)

Genus: *Batracobdella* Viquier, 1879

Batracobdella cryptobranchii Johnson & Klemm, 1977
Batracobdella michiganensis Sawyer, 1972
Batracobdella paludosa (Carena, 1824)[1]
Batracobdella phalera (Graf, 1899)
Batracobdella picta (Verrill, 1872)

Genus: *Boreobdella* Johansson, 1929

Boreobdella verrucata (F.R. Muller, 1844)

Genus: *Glossiphonia* Johnson, 1817

Glossiphonia complanata (Linnaeus, 1758)

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[1]See Notes On Distribution.

Genus: *Helobdella* R. Blanchard. 1896

Helobdella elongata (Castle, 1900)
Helobdella fusca (Castle, 1900)
Helobdella papillata (Moore, 1906)
Helobdella stagnalis (Linnaeus, 1758)
Helobdella transversa Sawyer, 1972
Helobdella triserialis (E. Blanchard, 1849)

Genus: *Marvinmeyeria* Soos, 1969

Marvinmeyeria lucida (Moore, 1954)

Genus: *Oligobdella* Moore, 1918

Oligobdella biannulata (Moore, 1900)

Genus: *Placobdella* blanchard, 1893

Placobdella hollensis (Whitman, 1892)
Placobdella montifera Moore, 1906
Placobdella multilineata Moore, 1953
Placobdella nuchalis Sawyer & Shelley, 1976
Placobdella ornata (Verrill, 1872)
Placobdella papillifera (Verrill, 1872)
Placobdella parasitica (Say, 1824)
Placobdella pediculata Hemingway, 1908
Placobdella translucens Sawyer and Shelley, 1976

Genus: *Theromyzon* Phillippi, 1867

Theromyzon biannulatum Klemm, 1977
Theromyzon rude (Baird, 1869)
Theromyzon tessulatum (O.F. Muller, 1774)

Family Piscicolidae Johnston, 1865

Genus: *Cystobranchus* Diesing, 1859

Cystobranchus mammillatus(Malm. 1863)
Cystobranchus meyeri Hayunga & Grey, 1976
Cystobranchus verrilli Meyer 1940
Cystobranchus virginicus Hoffman, 1964

Genus: *Myzobdella* Leidy, 1851

Myzobdella lugubris Leidy, 1851

Genus *Piscicola* de Blainville, 1818

Piscicola geometra (Linnaeus, 1758)
Piscicola milneri (Verrill, 1874)
Piscicola punctata (Verrill, 1871)
Piscicola salmositica Meyer, 1946

Genus: *Piscicolaria* Whitman, 1889

Piscicolaria reducta Meyer, 1940

Order Gnathobdellida Vaillant, 1890

Family Hirudinidae Whitman, 1886

Genus: *Haemopis* Savigny, 1822

Haemopis grandis (Verrill, 1874)
Haemopis kingi Mathers, 1954
Haemopis lateromaculata Mathers, 1963
Haemopis marmorata (Say, 1824)
Haemopis plumbea Moore, 1912
Haemopis septagon Sawyer & Shelley, 1976
Haemopis terrestris (Forbes, 1890)

Genus: *Hirudo* Linnaeus, 1758

Hirudo medicinalis Linnaeus, 1758 [2]

Genus: *Macrobdella* Verrill, 1872

Macrobdella decora (Say, 1824)
Macrobdella diplotertia Meyer, 1975
Macrobdella ditetra Moore, 1953
Macrobdella sestertia Whitman, 1886

Genus: *Philobdella* Verrill, 1874

Philobdella floridana (Verrill, 1874)
Philobdella gracilis Moore, 1901

Order Pharyngobdellida Johnson, 1913

Family Erpobdellidae

Genus: *Dina* R. Blanchard, 1892

Dina anoculata Moore, 1898
Dina dubia Moore & Meyer, 1951
Dina parva Moore, 1912

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[2] See Notes On Distribution.

Genus: *Erpobdella* de Blainville, 1818

Erpobdella punctata coastalis Sawyer & Shelley, 1976
Erpobdella punctata punctata (Leidy, 1870)

Genus: *Mooreobdella* Pawlowski, 1955

Mooreobdella bucera Moore, 1949
Mooreobdella fervida Verrill, 1871
Mooreobdella melanostoma Sawyer & Shelley, 1976
Mooreobdella microstoma (Moore, 1901)
Mooreobdella tetragon Sawyer & Shelley, 1976

Genus: *Nephelopsis* Verrill, 1872

Nephelopsis obscura Verrill, 1872

SECTION 4

NOTES ON SYSTEMATICS

The taxonomy of Hirudinea has suffered greatly in the past because of the brief and ambiguous descriptions of species which have been based only on a single or few specimens, and on the use of a few, mainly external characters, such as eyes and color. In fact, the lack of distinct taxonomic characters even occurs in some genera. Furthermore, authors have usually neglected consideration of the full range of variation of forms throughout geographic ranges. Consequently, the critical examination and comparison of museum specimens with additional leech material and the descriptions of these earlier species has led to an excessive number of synonyms (cf. Partial Synonym Section).

The taxonomy employed in this manual is basically that proposed by Moore (1959) and Klemm (1972b, 1976, 1977), and the variations proposed by Sawyer (1972), Sawyer et al., (1975), as well as Sawyer and Shelley (1976). In preparing this manual, however, a clarification and refinement of the nomenclature for the leeches of North America has been attempted. A discussion of specific and generic changes and major existing problems follows.

FAMILY GLOSSIPHONIIDAE

Under the genus Glossiphonia Johnson, 1817, some hirudinologists recognize anatomical differences between G. complanata (Linnaeus, 1758) and G. heteroclita (Linnaeus, 1761) at greater than species level. For example, Lukin (1976) recognized the strong difference between the two species and, therefore, erected the subgenus Alboglossiphonia to accommodate heteroclita. Sawyer (personal communication) and I believe the distinction between the two species to be at the generic level. Thus, I have elevated Alboglossiphonia to generic rank, including under it heteroclita, but retaining complanata under Glossiphonia.

Glossiphonia swampina Bosc (1802), redescribed by Sawyer (1973), is reported from the Carolinas (Sawyer and Shelley, 1976). They suggest that G. swampina represents a disjunct derivative of the northern species, A. heteroclita. However, Moore (1952) indicated that G. swampina is A. heteroclita or a very closely related species. In an earlier publication, I (Klemm, 1976) discussed the two species and suggested that G. swampina might be a color variant of A. heteroclita. The new material from Quebec and Maryland was examined and the appearance of the specimens agrees with that of G. swampina, thus extending its distribution. After examining specimens of both color forms from the Carolinas and the Great Lakes region, and comparing their anatomy, I am convinced that these two forms represent color differences within one species. I consider G. swampina a synonym under A. heteroclita.

Variations of taxonomic characters due to polymorphism are discussed in Sawyer (1972) and Klemm (1976, 1977) for Helobdella fusca (Castle, 1900), H. punctatolineata Moore (1939), and H. triserialis (E. Blanchard, 1849). After examining and comparing the anatomy of many North American specimens that resemble H. punctatolineata with specimens from the West Indies, I have concluded that there are no distinguishing characters to separate the two species, H. punctatolineata and H. triserialis. Thus, H. punctatolineata has been placed in synonymy under H. triserialis.

In addition to the typical color form of H. fusca (Fig. 23b), four other unpapillated forms were encountered during this study. Three forms (Fig. 23b-d) resembled specimens discussed by Sawyer (1972). The fourth form is new (Fig. 23e). It has a whitish dorsal surface with irregularly scattered black stellate pigment cells (chromatophores). During this study, specimens of this form were received only from Quebec. Until the degree of polymorphism of H. fusca is determined, it should remain a distinct species.

Several color variations (Figs. 25a-b, 26a-b, 27) of H. triserialis have been reported (Ringulet, 1943, 1944, 1945; Sawyer, 1972, Klemm, 1976, 1977, and this study). A new distinct form (Fig. 26c), not previously discussed, was also encountered during this study. Its dorsal surface contains the typical three rows of black (with some pale white) papillae but also had irregular shaped clusters of metameric white spots which fuse together to form three prominant longitudinal white stripes and two smaller white stripes in the anal region. The dorsal ground color is gray with some longitudinal gray striping. Specimens of this form were examined from the Detroit River, near Fighting Island, and from Quebec.

There is still considerable confusion in the systematics of the genus Theromyzon (Klemm, 1977), and the various nominal species have undergone considerable synonymy (Soos, 1969; cf. Partial Synonymy Section). In North America, the identification of T. biannulatum Klemm (1977), T. rude (Baird, 1869), and T. tessulatum (O.F. Muller, 1774) is based mainly on color and the number of annuli (two, three, or four) between the male and female gonopores. Soos (1969) recognizes T. maculosum (Rathke, 1862), T. rude, and T. tessulatum as the species with the two, three or four annuli between gonopores. Davies (1971, 1973) and I (Klemm, 1972a,b) later accepted the synonymy of Soos for both T. maculosum and T. rude. However, in my review of Theromyzon of North America (Klemm, 1977), Sawyer (personal communication) and I are still not convinced that the establishment of T. maculosum bearing the two annuli between gonopores and unique pigmentation pattern, occurs in North America. Furthermore, Sawyer (personal communication) and I (Klemm, 1977) believe that Moore's (1912) description of T. occidentalis (cf. Partial Synonymy) from Minnesota is neither T. rude nor T. maculosum. Therefore, I (Klemm, 1977) proposed the new name T. biannulatum for Moore's (1912) occidentalis, the Theromyzon form from North America with the two annuli between the gonopores. Based on Meyer and Moore's (1951) contention that the number of annuli between gonopores of T. rude varies, Sawyer (1972) and I (Klemm, 1977) postulated that the validity of separating these species on the basis of only the number of annuli between gonopores is questionable. To resolve this problem, a detailed examination of the internal anatomy of the various species of Theromyzon and a comparison of the annuli between gonopores of specimens in different geographical ranges (cf. Species Distribution Section) is needed to determine whether only one or two species exist in North America. Until these problems are critically examined, I recognize the following three American Theromyzon taxa: T. biannulatum (with two annuli separating the gonopores), T. rude (with three annuli between the gonopores), and T. tessulatum (gonopores separated by four annuli). A fourth species, T. propinquus Ringuelet (1947), known from Argentina, closely resembles T. rude by having three annuli between the gonopores and might be synonymous.

FAMILY PISCICOLIDAE

In North America, the taxonomic status of several species of Piscicolidae is uncertain. A description of the external morphology of Piscicola zebra is given by Moore (1898), but there is no information concerning the internal morphology to ascertain that its species status is sound. P. zebra was taken from the lip of the sea lamprey, Petromyzon marinus (an anadromous parasitic fish), at Arichat, Cape Breton, Nova Scotia, in 1890, but has not been reported since. Soos (1965), Davies (1971), and I (Klemm, 1972b) considered it a legitimate species based on Moore's earlier description. However, the only available syntypes (USNM 4818) are poorly preserved and difficult to assess. Sawyer et al. (1975) could not determine the validity of the species and concluded that it should be considered as species inquirendae. I have reconsidered the status of this taxon, and am now of the opinion that until new material is collected and a detailed study of the anatomy is published, this species should not be recognized as valid.

Some doubt also exists as to whether Piscicola geometra (Linnaeus, 1758) and P. milneri (Verrill, 1874) are synonymous. Current knowledge on the differences between the two species shows that P. milneri has 10-12 (ususally 10) punctiform eyespots on the caudal sucker and lacks dark pigmented rays, while P. geometra has 12-14 punctiform eyespots and the presence of dark pigmented rays. According to Mann (1962, p. 161), another difference lies in the annuli between the gonopores. There are two in P. milneri and three in P. geometra. Moore, (1959) and Mann (1962) state that in both species, sperm ducts are simply looped. Meyer (1946) and Moore and Meyer (1951) indicate that the general body forms of the two are closely similar; Soos (1964) stated that especially the size and color of P. geometra, are also highly variable. Holmquist (1975) and I (Klemm, 1977) maintain that some variability exists in the number of punctiform eyespots in the caudal sucker and in the presnece or absence of the pigmented rays as a result of the age of the specimens. A critical examination of the internal anatomy of mature specimens of both species is needed to determine species clarification. However, Holmquist (1975), as well as this author, suspect that the two species are identical.

I included Cystobranchus vividus Verrill (1872) in my earlier key to freshwater leeches (Klemm, 1972b) on the bases of the descriptions by Verrill (1872) and Moore (1898). Later, Sawyer, et al. (1975) reassigned Verrill's species vividus to the genus Calliobdella van Beneden and Hess (1863), as C. vivida (Verrill, 1872), because of the lack of no type material and because of the vague and inadequate descriptions of both Verrill and Moore which caused confusion in the specific name vividus. Since C. vivida is a marine and estuarine species, I have not included it in this manual of freshwater leeches.

In regard to another piscicolid problem, Sawyer (1972) and Sawyer and Shelley (1976) state that Cystobranchus virginicus Hoffman, 1964, known from Virginia and West Virginia, may be transferable to another genus.

FAMILY HIRUDINIDAE

The genus Haemopis Savigny (1822), in the family Hirudinidae, was recently subdivided by Richardson (1969) into three genera, Percymoorensis, Mollibdella, and Bdellarogatis. This revision was followed by Soos (1969b), Davies (1971, 1972, 1973), and me (Klemm, 1972a,b). However, Sawyer (1972), in his morphological investigation of the genus Haemopis, rejected Richardson's revision of Haemopis into the new genus Percymoorensis for the North American species H. marmorata (Say, 1824), H. terrestris (Forbes, 1890), H. lateromaculata Mathers (1963), and H. kingi Mathers (1954) and the placement of H. grandis (Verrill, 1874) and H. plumbea Moore (1912) into the monotypic genera Mollibdella and Bdellarogatis respecitvely. Later, Sawyer's view was strengthened with additional anatomical information and the description of a new species, H. septagon (Sawyer and Shelley, 1976), which does not belong in any of Richardson's narrowly defined genera. They indicated that if the revision is accepted, a new monotypic genus must be erected to accummodate H. septagon. Consequently, they placed the new species in the genus Haemopis. This manual and previously I (Klemm, 1977) follow the recommendations of Sawyer (1972) and Sawyer and Shelley (1976) for the genus Haemopis in North America.

Verrill (1874) established Philobdella as a subgenus of Macrobdella on the basis of the external genital region, which is characterized by having either copulatory glands containing pores behind the gonopores, or copulatory depressions and pits around the gonopores (Fig. 73a-e). By 1898, J.P. Moore had elevated Philobdella to full generic rank. Soos (1969b) grouped Philobdella with Macrobdella, but others have accepted Moore's treatment (Pennak, 1953, 1978; Sawyer, 1972; Klemm, 1972b, 1977), and I have retained it in this manual.

Moore (1952) and I also doubt whether there are two species of Philobdella Verrill, 1874 (P. floridana Verrill, 1874 and P. gracilis Moore, 1901). The type specimen, P. floridana, is from Lake Okeechobee, Florida, and is known only from the original description. Moore (1901), in a morphological study of specimens of Philobdella from Illinois, described a new species, P. gracilis. Most authors continue to distinguish P. floridana and P. gracilis as separate species, primarily on the basis of pigmentation and number of teeth. Nothing is known of the internal anatomy of P. floridana, except the dentition of the jaws. Moore (1959) stated that the denticles, as orginially described for P. floridana, are 20 teeth per jaw, and in P. gracilis are 40 (35-48) per jaw. He indicated the dentition as partly distichodont. Richardson (1972), in an anatomical study of P. gracilis from S. Carolina, indicated only a single row (monostichodont) of 20 acute teeth, with no indication of distichodonty. The study of Richardson (1972) also showed that the number of teeth of P. gracilis differed greatly from the number reported in Moore's (1901) orginial description, 40 (35-48), but was similar to the number of teeth in P. floridana. Therefore, the variability in the number of teeth suggests it is a poor diagnostic character for the two species. During this study, specimens which resemble P. floridana were sent to me from Jacksonville, Florida, and were found to have 24 monostichodont teeth per jaw. However, the internal anatomy of these specimens has not been studied. The variability of teeth and color of these forms indicate that there is considerable doubt that Philobdella is represented in the southern states as two species. A comparison of the internal anatomy of the two forms would resolve the question.

FAMILY ERPOBDELLIDAE

The taxonomic rank of certain erpobdellid groups, Dina R. Blanchard, 1892, Erpobdella de Blainville, 1818, and Mooreobdella Pawlowski (1955), sustained a number of changes over the years. The Dina-Erpobdella complex still remains unresolved. Sawyer (1972) and I (Klemm, 1977) have discussed the taxonomic characters that have caused the confusion. In Sawyer's opinion (personal communication) the genus Dina does not actually occur in North America. Moore (1959), Meyer (1968), Sawyer (1972), Sawyer and Shelley (1976), and I (Klemm, 1977) consider Mooreobdella a distinct genus, endemic to North America, and consists of five species: bucera Moore, 1949; fervida, Verrill, 1871; melanostoma, Sawyer and Shelley, 1976; microstoma, (Moore, 1901); and tetragon, Sawyer and Shelley, 1976.

A subspecies, Erpobdella punctata annulata, of E. punctata (Leidy, 1870) was described by Moore (1922) from British Columbia . It differs from E. p. punctata only by the conspicuously barred or completely black annuli of its dorsum. Meyer and Moore (1954) reported finding both subspecies throughout Canada, and I (Klemm, 1972a,b) have reported these forms from Michigan, Washington, and Oregon. Moore (1959) Soos (1966a), Davies (1971), I (Klemm, 1972a,b) retained this color form at the subspecies level. Sawyer (1972), however, synonymized E. p annulata under E. p. punctata. During this study, I found no evidence of anatomical difference between the two forms, other than color and size, and recognize the synonymy of Sawyer (1972).

Dina lateralis Verrill (1871), a poorly described species, was relegated to synonym under Erpobdella punctata punctata by Sawyer (1972). Soos (1966a) and Klemm (1972b) retain the species, based on Moore's interpretation (1952, 1959) of the species, as D. lateralais or E. lateralis (Verrill). However, no type materal is available, no new material has been collected, and because of the vague and inadequate description by Verrill, I concur with the synonymy of Sawyer.

Dina anoculata Moore (1898), described from San Diego County, California, is poorly known. Moore's vague description of the morphological type states that the species has no eyes, the gonopores are separated by two annuli, and the body is colored with longitudinal stripes. However, nothing is known of its internal reproductive system. Sawyer (personal communication) stated he had collected specimens from San Diego with three pairs of eyes. I have examined several syntypes (USNM 4844) from San Diego County, California, and have added to Moore's description the internal anatomy of the reproductive system. Based on information from Moore (1898); Soos(1963), Sawyer (personal communication), as well as an examination of preserved material, the following is a more complete description for D. anoculata:

> Eyes absent or if present, 3 pairs, in separate labial and buccal groups (Fig. 13b); genital pores separated by two annuli (Fig. 92d); male pore in furrow XIb6/XIIb1, female pore also in furrow XIIb2/a2. Annulation: Somites I-IV:1, V-VI:3, VII-XXIV:5, XXV:3, XXVI-XXVII:1 (2); three annuli behind anus. Atrium (Fig. 93d) is globoid with prominent horns (cornua) projecting laterad and with long preatrial loops of vas deferens extending to ganglion XI.

I have not seen fresh material, but the ground color of specimens preserved in alcohol is dull yellowish gray, immaculate below and on the margins, but largely replaced above by four longitudinal stripes (vague in some specimens) of grayish or dull black. The outer pair of stripes is submarginal, duller in color, and narrower than the more distinct inner pair, which is separated by a median stripe of ground color.

SECTION 5

NOTES ON IDENTIFICATION

The taxonomic key in this manual, which has been constructed mainly of external anatomical and biological characters, is sufficient for the identification of most North American leeches to the species level. However, the identification of a few species of Haemopis and some Erpobdellidae, especially species of the genera Mooreobdella and Dina, may require dissection. If reference is made in a couplet to an internal feature after reference to an external one, the key can be used first for the identification of some specimens without resorting to dissection, provided the external characters are clearly discernible. Also, some collections will contain specimens that can not be identified to the species level for various reasons, but they should be identified to the lowest taxonomic category (taxon) possible, based only on characters of the specimen used in the key. A glossary of diagnostic terms has been provided.

The external diagnostic features which are important for identifying the leeches are: presence or absence of chaetae in the cephalic region, size of mouth, general shape of body, form of suckers, form of cephalic region, number and arrangement of eyes, presence or absence of jaws and number of teeth (denticles), eyespots (ocelli), papillae, pulsatile vesicles, sensillae, digitate processes on rim of caudal (posterior) sucker, caudal sucker separated from body on narrow pedicle (peduncle), copulatory gland pores, the number of annuli per somite (segments) and between gonopores, and the pigmentation patterns.

Only seven internal characters are used in the key, four of which are used to determine certain species of Haemopis: the presence or absence of jaws, the number of teeth (denticles) per jaw, the velum, and the internal ridges of the pharynx. The shape of atrium and atrial horns, and the length of the ejaculatory ducts are three other internal anatomical parts used in the identification of some species of erpobdellids. Biological characters useful for the identification of specimens include hosts, methods of feeding, the manner of locomotion, and caring for eggs and young, and ecological and geographical variations.

The body of the leech consists of 34 somites (segments), designated by Roman numerals (I through XXXIV). Each somite contains a ganglion in the central nervous system. Each neuromeric somite is divided externally by superficial furrows into 2-16 annuli or rings . Somites that have the full number of annuli (termed complete or perfect somites) are found in the middle of the body, and this number is generally characteristic of the genera or species. Incomplete or abbreviated somites occur at both ends of the body. The annuli are best seen after careful narcotization or proper preservation. Reference to annulation in the key is always to complete somites, and with the aide of a dissecting stereomicroscope the outline of the annuli can be seen most easily in the lateral margins of the ventral surface. Moore (1898) and Castle (1900) independently recognized that the nerve cord ganglia are located in the middle annulus of the somite, and that the triannulate somite is the basic form. In the 3-or 5-annulate somite for example, the middle annulus is aligned with the ganglion and is known as the neural or sensory annulus. The annulation suggested by Moore (1898) (Table 1) is used throughout the key. Counting from the cephalic end, the triannulate somite consist of three primary annuli (best seen in middle of body), numbered a1, a2, and a3 (or sometimes written a1-3). Annulus a2 (the neural annulus) contains the ganglion and is marked externally by transverse rows of minute, cutaneous sensillae (segmental receptors), which are difficult to see in some specimens. Repeated bissection of the three primary annuli give rise to more complex annulation.

Table 1. Theoretical table of the annuli produced by repeated bisection of the three primary annuli (after Moore, 1898).

Primary	Secondary	Tertiary	Quaternary
*a*1	*b*1	*c*1	*d*1
			*d*2
		*c*2	*d*3
			*d*4
	*b*2	*c*3	*d*5
			*d*6
		*c*4	*d*7
			*d*8
*a*2	*b*3	*c*5	*d*9
			*d*10
		*c*6	*d*11
			*d*12
	*b*4	*c*7	*d*13
			*d*14
		*c*8	*d*15
			*d*16
*a*3	*b*5	*c*9	*d*17
			*d*18
		*c*10	*d*19
			*d*20
	*b*6	*c*11	*d*21
			*d*22
		*c*12	*d*23
			*d*24

External Features

Chaetae--

The genus Acanthobdella consists of only two species, A. peledina and A. livanowi, which are considered primitive leeches. In addition to their hirudinean characters, these species show their peculiarity by possessing some oligochaete-like evolutionary traits. Externally, the main anatomical character that separates the Acanthobdella from all other leeches is the presence of chaetae (setae) in the first five anterior somites (Fig. 3a).

The important diagnostic characters for A. peledina (Fig. 3) are the irregularly spindle-shaped body, narrower anteriorly than posteriorly (Fig. 3b,c), lacking an oral sucker and consisting of 30 somites (segments). The last four somites are united to form a small caudal sucker which has its concavity directed posteriorly. In the cephalic region, the three pairs of eyes are small and located (one pair each) on the 3rd, the 6th, and 10th annuli. The chaetae bundles, consisting of two pairs (10 pairs in all) (Fig. 3a) in approximately equal distance are located on the ventral surface (on the posterior margins) of the 1st, the 2nd, the 3rd, the 6th, and 10th annuli (counting posteriorly). The color of live A. peledina, as described in the literature, varies in specimens from gray to red in appearance or dark greenish with yellowish spots anteriorly. In some individuals the body can have 6-7 dark transverse bands, and sometimes these bands occur over the entire body. Preserved specimens often lose their color and become whitish in appearance. The main diagnostic characters which separate A. livanowi from A. peledina are the enlarged, expanded (orbicular) anterior somites of the cephalic region, and the oral sucker like depression. The chaetae bundles in the anterior somites of the ventral surface of A. livanowi are also of unequal distance in arrangement.

In addition to the sensillae, which are confined to the sensory annuli, other visible organs of the integument are the cephalic eyes (ocelli) and papillae (tubercles). Eyespots when present on the caudal sucker and lateral margins (Fig. 10), which are usually embedded in pigment, are also termed ocelli. Varying in number and shape (punctiform, crescentiform), eyespots are used in the identification of some species of piscicolids. They are absent in the Glossiphoniidae. The number and position of the eyes of the cephalic (anterior) region are important taxonomic features.

Cephalic Eyes--

The glossiphoniids have one to four pairs of eyes (Figs. 7-9), the piscicolids, none to two pairs (Fig. 10,11), the erpobdellids, three or four pairs (Fig. 13b-d), except Dina anoculata, which can have none or three pairs (Sawyer, personal communication), and the hirudinids, five pairs (Fig. 13a). As reported only by European authors, coalescence of the eyes occurs occasionally in Gossiphonia complanata, Alboglossiphonia heteroclita, Batracobdella paludosa, and Boreobdella verrucata occurs

(Fig. 9j-m). The relative distance between eyes is another important diagnostic character in identification. If the distance between them is equal to or greater then the diameter of the eyes, they are termed "well separated" (Fig. 7). If they touch, they are termed "fused" or "confluent" (Fig. 8g-n). If the distance between a pair of eyes is less then the diameter of a single eye, they are termed "close together" (Fig. 8a-f). However, some variation in eye location can occur ocasionally, as a result of rapid preservation.

The eyes are arranged in separate labial and buccal groups (Fig. 13b-d) in the erpobdellids, and the eyes are arranged in a submarginal (parabolic) arch (Fig. 13a) in the hirudinids. If the leech has been fixed and the eyes cannot be seen, the head of small specimens can be flattened between two glass slides, which will generally make the eyes visible. If the eyes are hidden by dark pigmentation, decolorize the head of the preserved specimen by immersion in 5% caustic potash or Amman's lactophenol (specimens in formalin work best) for 10 to 30 minutes, but the time will vary with the specimen. Amman's lactophenal is prepared as follows: 100g phenol, 100 mL lactic acid, 200 mL glycerine, 100 mL water.

Papillae--

The papillae of the dorsal surface vary in size, type, and arrangement. They may be limited to small, minute protrusible sense organs that are often scattered in small and great numbers over the dorsal surface, or are large (tubercle-like) smooth, conical, or rounded cone projections that include some of the dermal tissue and muscles, and which are often themselves covered with minute papillae. The segmental arrangement of the papillae is an important characteristic used in distinguishing between certain species of Helobdella and Placobdella, and also separating Glossiphonia complanata from Boreobdella verrcuata. In G. complanata, if the papillae are present, they lie on the 2nd (middle ring) of the somite only (Fig. 57a). A reliable characteristic for B. verrcuata is the large and distinct papillae on the 2nd and 3rd rings of the somite (Fig. 57b). In Helobdella triserialis, the papillae are small, smooth, and conical in three or less longitudinal rows. In H. papillata, the papillae are prominent and arranged in five to nine longitudinal rows. Numerous large and scattered papillae are present on the dorsum of Placobdella ornata, and the surface of these papillae is covered with minute papillae which results in a very rough or warty appearance. In P. multilineata the papillae are small, less numerous, on the dorsum, but with the larger ones tending to be segmentally arranged in five distinct, longitudinal rows. In P. papillifera, the dorsal papillae occasionally vary from small to inconspicuous, or large and pointed, and are arranged in five to seven distinct longitudinal rows. However, in specimens of the above species, variation occurs in these chararacters, and they must be used with other features such as shape and pigmentation, as indicated in the key.

Cephalic Region--

The form of the cephalic region (anterior somites) of leeches is a diagnostic character. In the Glossiphoniidae, the cephalic region of all the species (except *P. montifera* and *P. nuchalis*) is not, or is only slightly, differentiated (Figs. 7a-f,8,9). The mouth pore is located on the rim or within the oral sucker (Figs. 4a,b,d,). Both *P. montifera* and *P. nuchalis* have the cephalic regions in the form of a distinct "discoid" head (Fig. 7g,h). The anterior sucker of the piscicolids is always expanded and usually distinctly marked off from the body, and the mouth pore is in the middle of the sucker (Figs. 4c,10,11). In Erpobdellidae and Hirudinidae, the mouth is medium to large in size and the anterior sucker is little more than the expanded lips of the mouth opening (Fig. 4e-h).

Caudal Region--

The form of the caudal (posterior) sucker is characteristic of some leech species, and is included in the key as a diagnostic feature. Species of *Actinobdella* possess digitate processes (glands and papillae) on the rim of the caudal sucker (Figs. 33,34), and the hemispherical sucker is separated from the body on a short, narrow pedicel (peduncle). In preserved specimens, the digitate processes are usually retracted. They are finger-like when everted (Fig. 33a,b). The position of the digitate processes is indicated on the dorsal surface of the caudal sucker by faint radiating ridges (Figs. 33,34). In *Batracobdella cryptobranchii* and *Placobdella pediculata*, the digitate processes are absent, but the posterior sucker is separated from the body on a narrow pedicel (Figs. 31,32). Other minor characters not discussed here will be found appropriately in the key.

Body Regions--

In all the Piscicolidae, with the exception of some specimens of *Piscicolaria reducta* and *Myzobdella lugubris*, the body is characteristically divided into two distinct regions (Figs. 10,11); a narrow anterior trachelosome region and a larger and wider posterior urosome region. However, the separation of these two regions is less conspicuous and not always observible in preserved specimens of *Piscicola*, but they are always present in *Cystobranchus*. Some preserved specimens of *Myzobdella* and *Piscicolaria* also show a distinct separation of these two regions due to contraction (Fig. 11c-e).

Pusatile Vesicles--

In the genera *Piscicola* and *Cystobranchus* only, the neural annuli of the urosome bear 11 pairs of pulsatile vesicle (Fig. 10). In *Piscicola*, the vesicles are small or usually undifferentiated in preserved specimens (Fig. 10f,g,h,i), but in *Cystobranchus*, the pulsatile vesicles are large and clearly visible in both living and preserved individuals (Fig. 10a,c,d,e).

Pigmentation--

Pigmentation patterns and color are important diagnostic features for some species of leeches. Coloration features, such as blotches, dots, spots, stripes, bands, lines are easy to determine in living as well as freshly preserved specimens, and usually persist for sometime. They may fade away in some specimens which have been preserved in alcohol or preserved for a considerable length of time. Green and blue pigments are lost almost immediately in alcohol, although they usually persist longer in formalin. The red color of blood is lost almost as soon as the green and blue, and the other reds and yellows are lost more slowly. The browns and blacks usually remain for years. It should be noted, however, that in some species the colors of the dorsal surface change with the development, age, and environmental conditions. Also, the pigmentation pattern of the dorsal surface in several species is a poor diagnoistic character because several color forms exist.

Size--

The average size of each species is given in the key, but many variations appear in the species due to the age and development of the specimen collected and also due to contraction during processing.

Finally, it should be noted again that most specimens of leeches can be identified to the species level. The key will, however, enable the user to identify these difficult forms to the lowest taxonomic level of which diagnostic characters of the specimen are available to a particular taxa.

Internal Features

Digestive Tract--

The alimentary canal is a tube from mouth to anus and is divided into the buccal chamber, pharynx, esophagus, stomach to crop, intestine with or without diverticula, and rectum. In the Glossiphoniidae and Piscicolidae, the mouth is a small pore on the rim or in the center of the anterior sucker (Fig. 4a-d). The pharynx of the Rhynchobdellida is muscular and protrusible through the mouth as a proboscis (Fig. 4d). The proboscis has a crown-like tip, and is adapted to penetrate both invertebrate and some vertebrate tissues. In Hirudinidae and Erpobdellidae, the mouth is medium to large in size (Fig. 4e-h) and occupies the entire cavity of the anterior sucker. In the hirudinids, the buccal cavity, which may or may not contain jaws with denticles, is separated from the cavity of the sucker by a flap of skin called the velum (Fig. 85). The shape and form of the anterior sucker, the absence of teeth, the number of internal ridges (fleshy pods) of the pharynx, and the presence or absence of papillae on the velum are used as diagnostic features to separate Haemopis plumbea and Haemopis grandis. The velum is finely papillated in H. plumbea and smooth in H. grandis. In H. plumbea, the lip of the oral sucker is broad, thick, flat, and rounded, and the aperature is transverse and lower margin anteriorly convexed (Fig. 88).

The lip of the anterior sucker of H. grandis is narrow, thin and arched, and the aperature is elongated (Fig. 89). All other species of Hirudinidae have three muscular jaws, two ventrolateral and one dorsomedial (Fig. 85a-d). The free edge of each bears teeth arranged in either one (monostichodont) or in two (distichodont) rows. Moore (1952) indicated that some or all of the teeth in old or poorly preserved specimens of H. marmorata can fall off when the cuticle of the preserved leeches separates. Therefore, separating H. marmorata from H. grandis only on the basis of the presence or absence of teeth can be difficult, perhaps impossible in some specimens. To examine the velum and jaws (Fig. 85), the specimen should be positioned ventrally or pinned out in such a manner. A medial incission should be made from the lower lip of the anterior sucker back far enough for the margins to be pinned out to expose the inner surface of the buccal cavity and pharynx. Details of the denticles (Fig. 85a,b,d) can only be seen by first removing a jaw and making a whole mount, using CMCS, Hydramount or other mounting media on a microscope slide, and examining with a compound microscope to determine the number of teeth.

Reproductive System

External Reproductive Features--

The male and female gonopores are visible on the middle of the ventral surface of somites XI and XII and are generally separated by two to seven annuli. Alboglossiphonia heteroclita and Marvinmeyeria lucida are two unusual species in that the male and female ducts open into a single gonopore. The male gonopore is large, more readily visible in the mature specimen, and anterior to the female gonopore. In some specimens the female pore can be difficult to find due to its small size. It is seen most easily immediately after narcotization, and its position often being revealed by a small opening or some color difference which may be lost if the specimen is not properly preserved.

Another important characteristic used in determining species of erpobdellids is the number of annuli between the male and female gonopores (Fig. 92). If it is necessary to make evident the female opening, the following procedure has sometimes proven successful. The leeches are narcotized, fixed in 10% formalin, and preserved in formalin or alcohol. The leech is then placed in creosote-beechwood or Amman's lactophenol (clearing agents) for 15 to 30 minutes, depending on the size of the leech (the larger the leech the longer the time), until the female gonopore begins to stand out. Amman's lactophenol works best with specimens preserved in formalin. Gentle application of heat will speed up the process. The area of the gonopores should periodically be observed under a stereomicroscope, for if the specimens are left too long in the clearing agent, desiccation and wrinkling ensues. Sawyer (1972) indicated that slight variations in the location and number of annuli between gonopores exist in some specimens of Hirudinidae and Erpobdellidae. Meyer and Moore (1954), Sawyer (1972), and Klemm (1977) stated that some variation occurs in species of Theromyzon of Glossiphoniidae. Therefore, some specimens of these taxa can only be determined to the generic level. (cf. Notes on Systematics).

External copulatory glands with pores are present in a linear or transverse pattern of either 4, 6, 8, or 28 (Fig. 74a-d) on adult Macrobdella decora, M. diplotertia, M. ditetra, and M. sestertia. Immature forms may not have a set number of copulatory pores (Sawyer and Pass, 1972), but other characters in the key can be used for identification. The copulatory glands are located on the ventral surface, four to five annuli posterior to the female gonopore. In some immature specimens the copulatory glands and pores are absent and other diagonstic characters are indicated whenever possible in this key for identification. In Philobdella, the gonopores and copulatory pits are surrounded by an undifferiated glandular area (Fig. 74e).

Internal Reproductive Features--

Leeches are hermaphroditic. The female reproductive system is comprised of ovisacs, terminating in ducts which join to form a common duct or vagina. The male reproductive system consists of testisacs in metameric patterns, five to ten in the Glossiphoniidae and Piscicolidiae and nine to ten in the American Hirudinidae. But in the Erpobdellidae, they are small, numerous and arranged in grape-like clusters. The vasa deferentia connect the testisacs to the vasa deferens on each side. These ducts lead into the seminal vesicles and ejaculatory ducts, which open into the atrium. The shape of the atrium is diagonistic for some species of Erpobdellidae (Figs. 93,103). This organ is a medium chamber and consists of three parts: a thin-walled eversible bursa, a thick walled glandular chamber, and a muscular medium chamber, as well as a pair of lateral horns (atrial cornua), which receive the ejaculatory ducts. In Nephelopsis obscura, the atrial cornua is spirally arranged like a ram's horn (Fig. 103a,b). In the Mooreobdella and Dina-Erpobdella complex, the atrium is simply curved, globular, rounded, ellipsoidal, or short and curved (Figs. 93,103c,d). Some species also have ejaculatory ducts with or without long preatrial loops (Figs. 93,103).

To examine the male reproductive structures (Fig. 2a-c), which may be necessary in the identification of some species of Erpobdellidae, the following procedures should be followed: (1) specimens fixed in formalin should be used when dissection is necessary, (2) position or pin out the preserved specimen with the dorsal surface up, (3) make a transverse incision across the body 4 or 5 annuli posterior to the male gonopore, (4) cuts anteriorly up the lateral margins of the body for about 15 annuli, and (5) the posterior edge of the flap thus made can now be lifted forward or removed to expose the inner tissue which can be carefully cleared away to fully expose the atrium and ejaculatory ducts.

Another method (Fig. 2d) involves positioning or pinning the specimen ventral side up and make a rectangular cut to remove a portion of the body wall, beginning about 4 to 5 annuli in front of the male pore and including 3 annuli behind the female pore. Once this portion is removed, the connective tissue surrounding the male reproductive structures should be carefully teased away, thus exposing the genital atrium and ejaculatory ducts.

To accurately identify small forms of the family Erpobdellidae, a technique which sometimes works is the following: (1) fix the leech in formalin, (2) stain and destain, (3) run through an alcohol series, (4) clear and mount as described earlier, to determine the size and shape of the atrium, atrial horns, and length of the vasa deferentia (ejaculatory ducts).

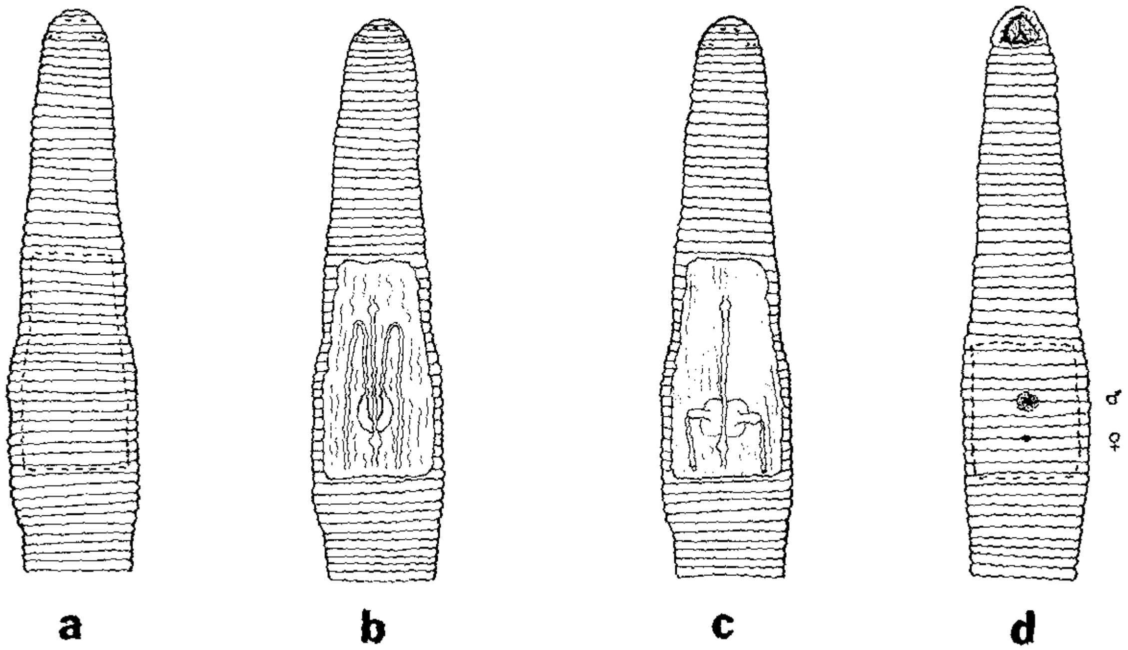


FIG. 2. Diagrams of methods to show male reproductive system of Erpobdellidae: (a) dash lines indicate cut on dorsal surface, (b,c) dorsal portion of annuli removed and connective tissure teased away displaying the reproductive structures; (d) dash lines indicate cut on ventral surface.

SECTION 6

KEY TO THE LEECHES (HIRUDINEA) OF NORTH AMERICA, NORTH OF MEXICO

1 Chaetae present in cephalic region of anterior somites (Fig. 3a); body shape, cylindrical, spindle-like (Fig. 3b,c); length 10-22 mm. Order Acanthobdellida, Family Acanthobdellidae. . . . . Acanthobdella peledina Grube, 1851

Chaetae absent from cephalic region of anterior somites; body shape various. 2

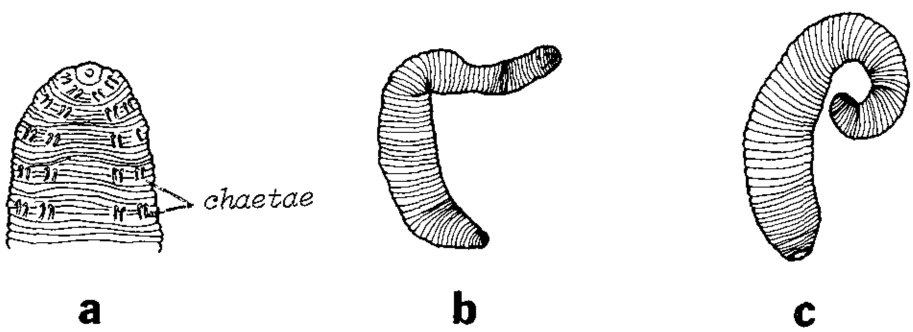


FIG. 3. Acanthobdellidae: (a) cephalic region, ventral view; (b,c) general body shape (cf. Notes on Identification).

2(1) Mouth a small pore on rim or within oral sucker cavity from which a pharyngeal proboscis can be protruded (Fig. 4a-d); jaws absent; rarely swims. Order Rhynchobdellida. 3

Mouth opening medium to large, occupying entire oral sucker cavity, forming rounded lips, not pore-like (Fig. 4e-h); lacking a protrusible proboscis; jaws and teeth either present or absent; good swimmers. 4

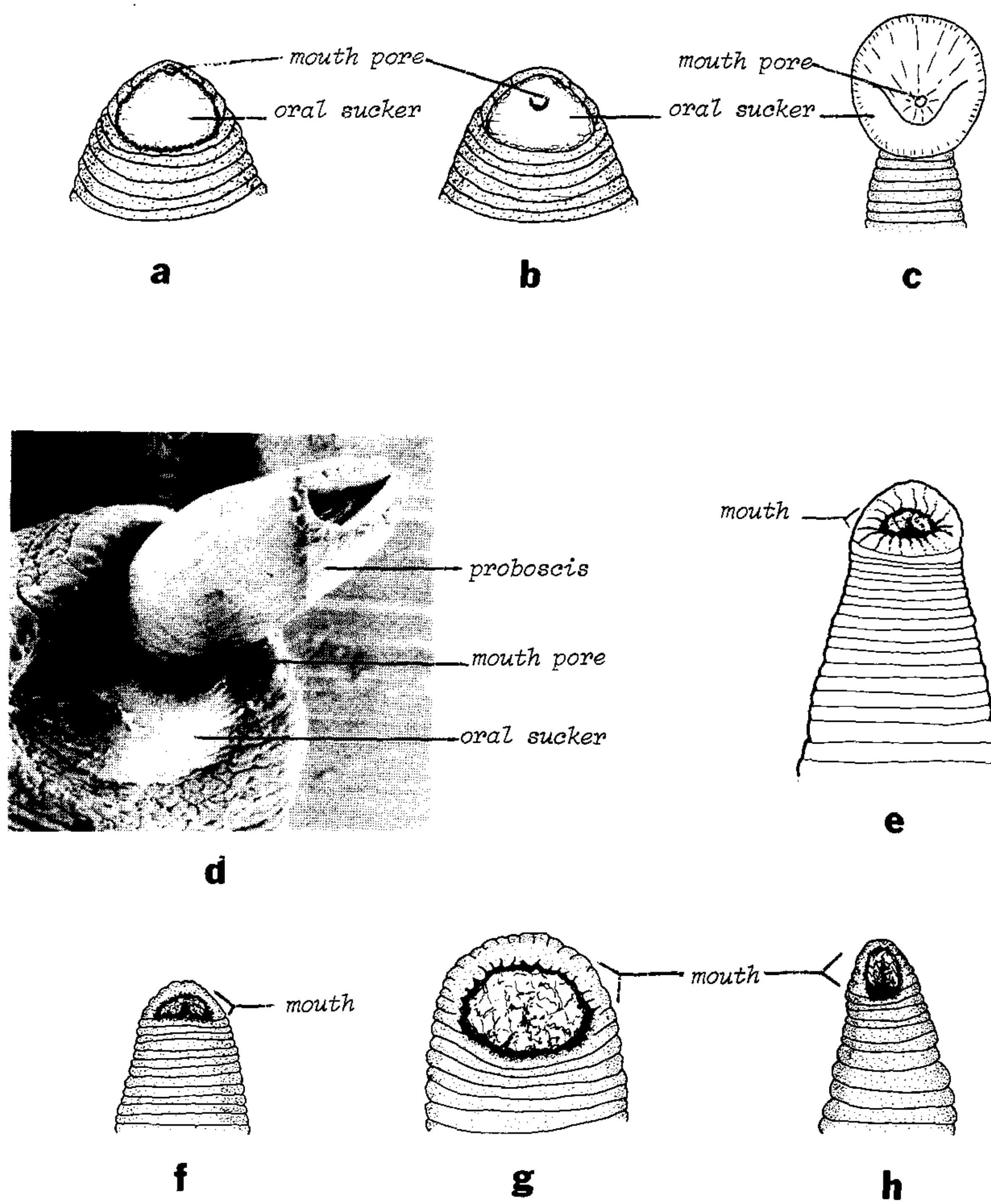


FIG. 4. Ventral views of anterior (oral) suckers to show mouth and sucker differences: (a) pore on rim of sucker; (b) pore within sucker; (c) pore near center of sucker; (d) SEM of protruding muscular proboscis cavity of Helobdella triserialis (X 250); (e-h) mouth occupying entire sucker cavity.

3(2) Body at rest flattened dorsoventrally, posterior half usually much wider than tapering cephalic end (Figs. 5,6), never cylindrical (except Helobdella elongata which is very sub-cylindrical, terete, Fig. 5c); not differentiated into two body regions; oral sucker ventral and more or less confluent with cephalic region (except Placobdella montifera, P. nuchalis, (Figs.6d,e; 7g,h); eyes 1, 2, 3, or 4 pairs (Figs. 7-9); eyespots (ocelli) never on caudal sucker or lateral margins of body; 3 annuli per complete somite (except Oligobdella biannulata which is 2-annulate); free-living or predaceous, parasitic on invertebrates (insects, oligochaetes, snails, and so forth) and vertebrates (crocodilians, turtles, fishes, or waterfowl); young always attached to ventral surface of parent; eggs in membraneous sacs either attached to ventral surface of parent or to substrates and covered by parent's body. Family Glossiphoniidae. 5

Body at rest cylindrical, narrow, (Figs. 10,11), posterior half can be slightly flattened; may be divided (especially in contraction) into a narrow neck (trachelosome) and wider body (urosome) regions (Fig. 10,11); oral sucker expanded, distinct from neck (Figs. 10,11) eyes 0, 1, or 2 pairs (Figs. 10,11); 7 or more annuli per complete somite (except Piscicolaria reducta which is 3-annulate); with or without eyespots (ocelli) on caudal sucker and lateral margins of urosome (Fig. 10); with or without lateral pulsatile vesicles (Figs. 10,11); young never attached to ventral surface of parents; cocoons attached to substrates, young never brooded; rarely found free-living, usually parasitic on fishes (Fig. 12). Family Piscicolidae. 34

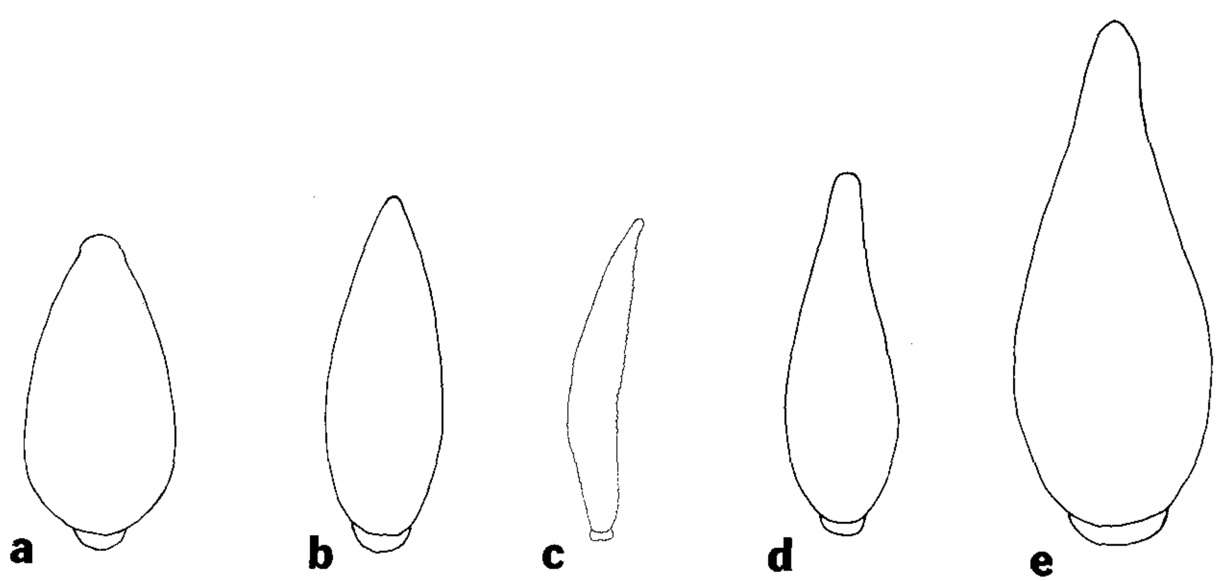


FIG. 5. General body shapes of Glossiphoniidae in dorsal view: (a) ovate-lanceolate; (b) lanceolate; (c) subcylindrical (terete); (d,e) various shapes.

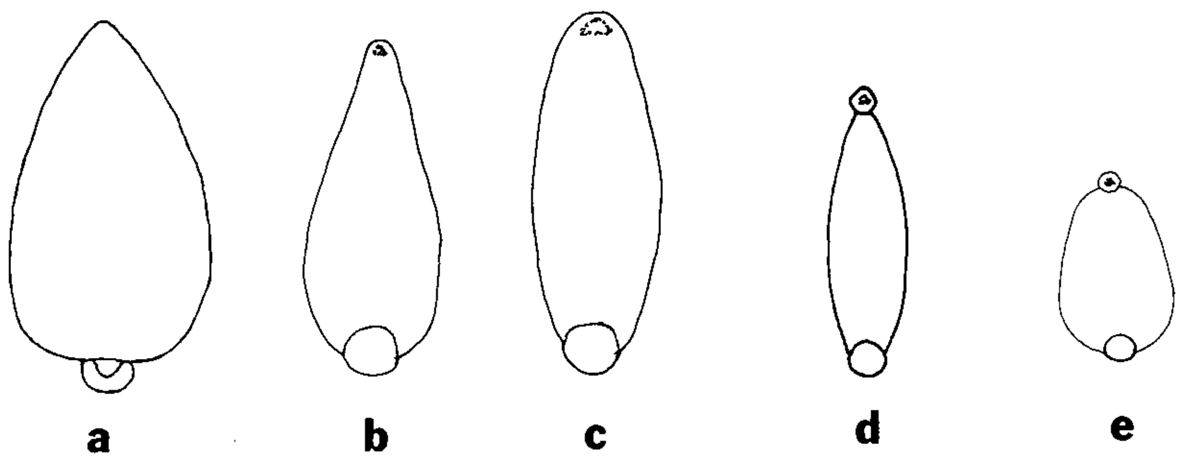


FIG. 6. Glossiphonbiidae, general body shapes: (a) dorsal view; (b-e) ventral view.

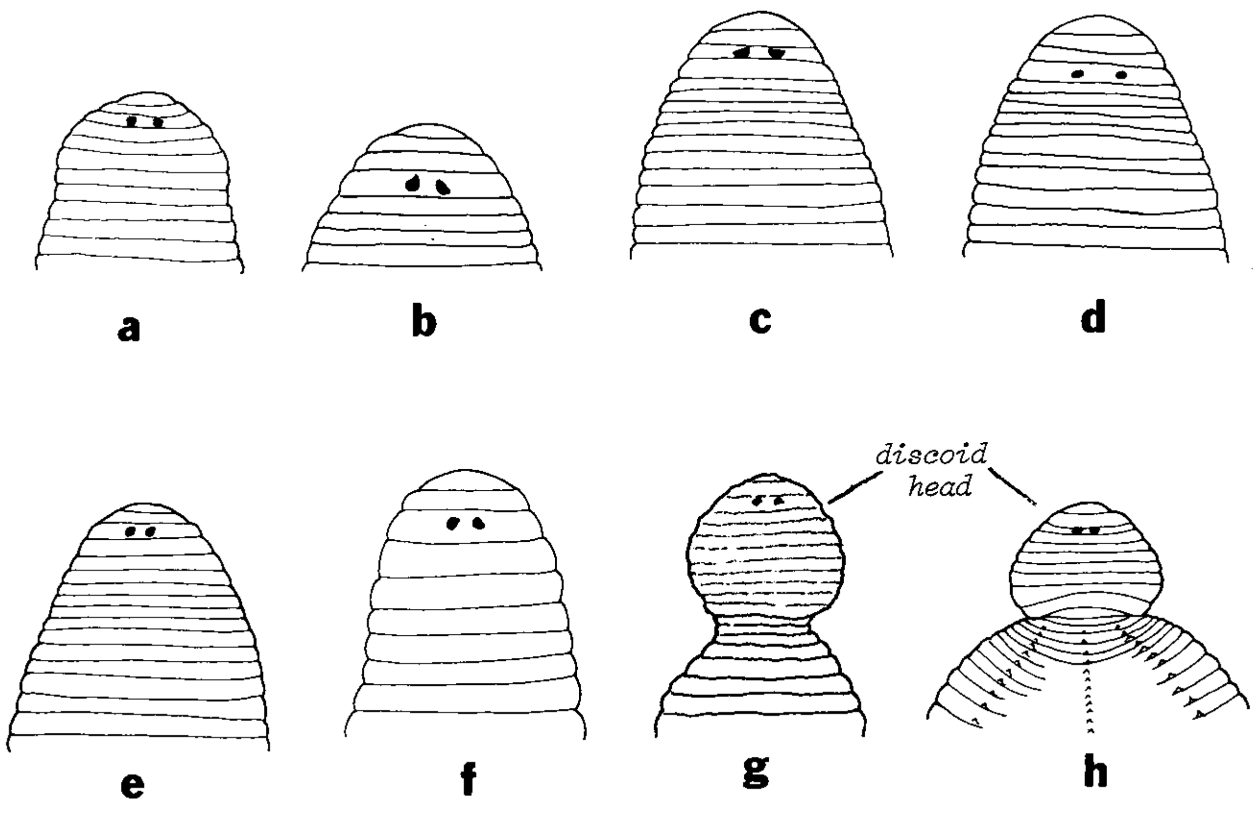


FIG. 7. Glossiphoniidae, dorsal views of eyes: (a-f) eyes well separated, cepahlic region undifferentiated; (g,h) eyes well separated, cepahlic region differentiated "discoid head."

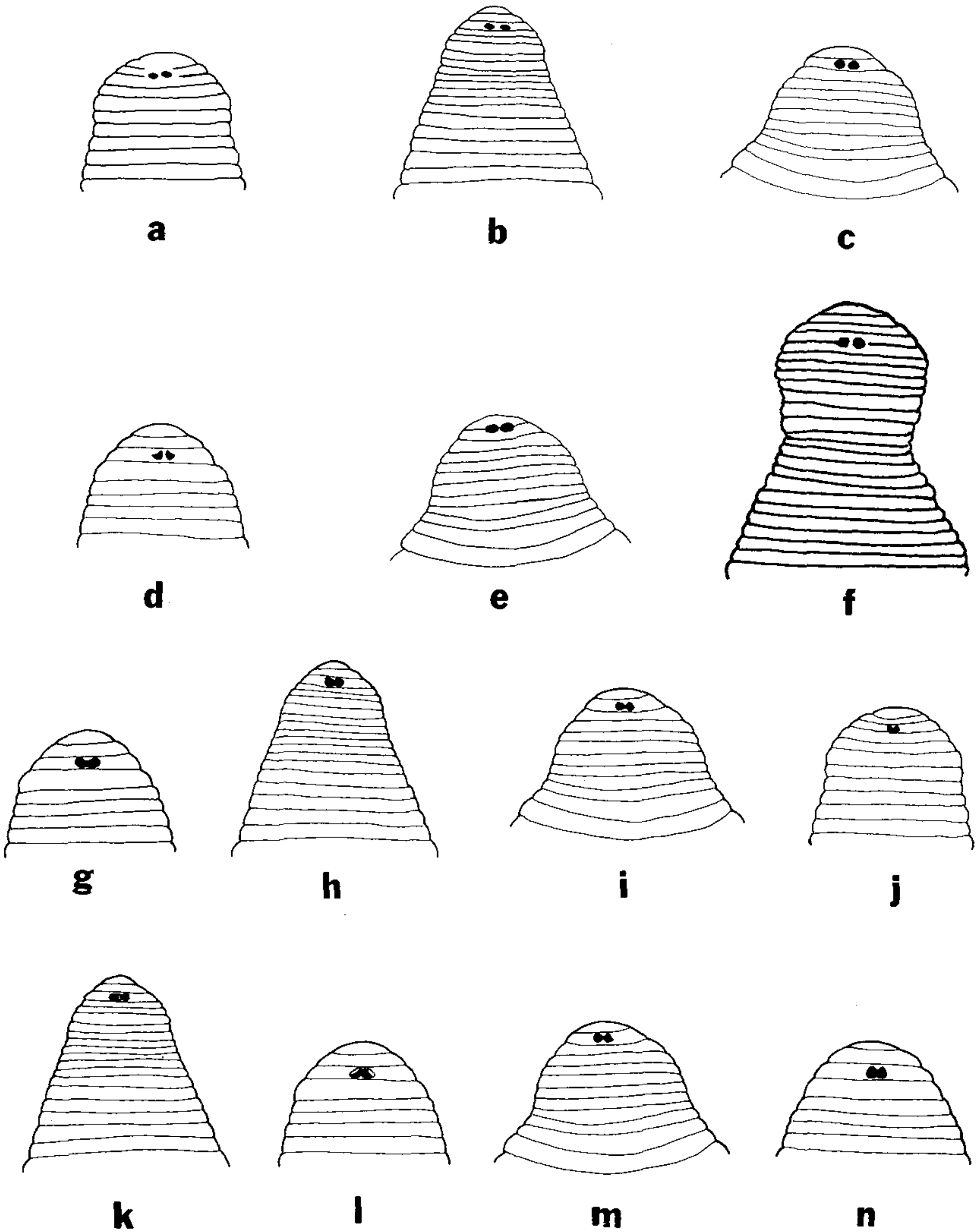


FIG. 8 Glossiphoniidae, dorsal view of eyes: (a-f) close together, less than diameter of one eye; (g-n) eyes touching, confluent (fused).

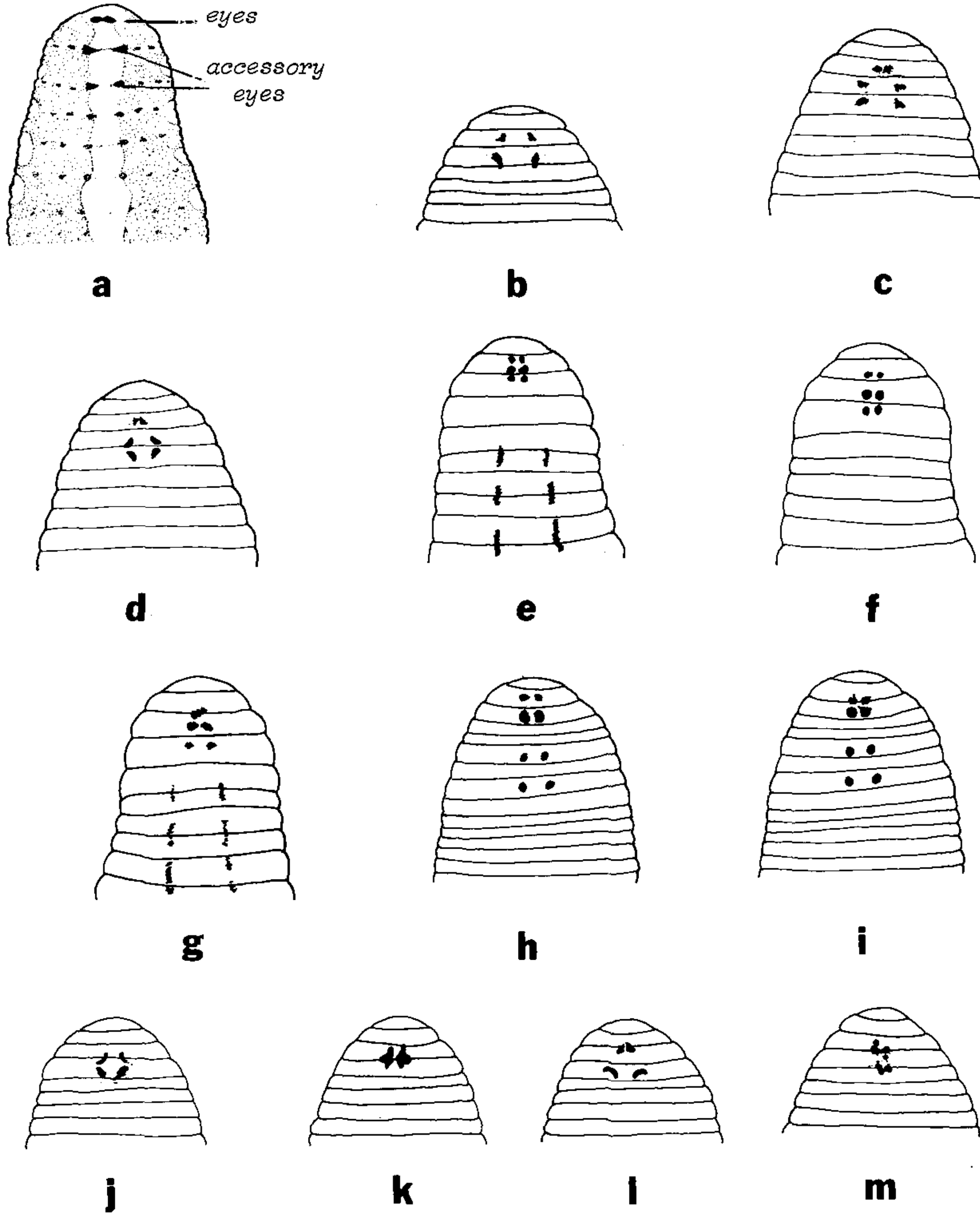


FIG. 9. Glossiphoniidae, dorsal view of eyes: (a) fused eyes with accessory eyes, Placobdella hollensis; (b) Batracobdella paludosa; (c,d) Alboglossiphonia heteroclita; (e-g) Glossiphonia complanata, Boreobdella verrcuata; (h,i) Theromyzon sp. (j-m) eyes showing variation (coalescence) in eye position.

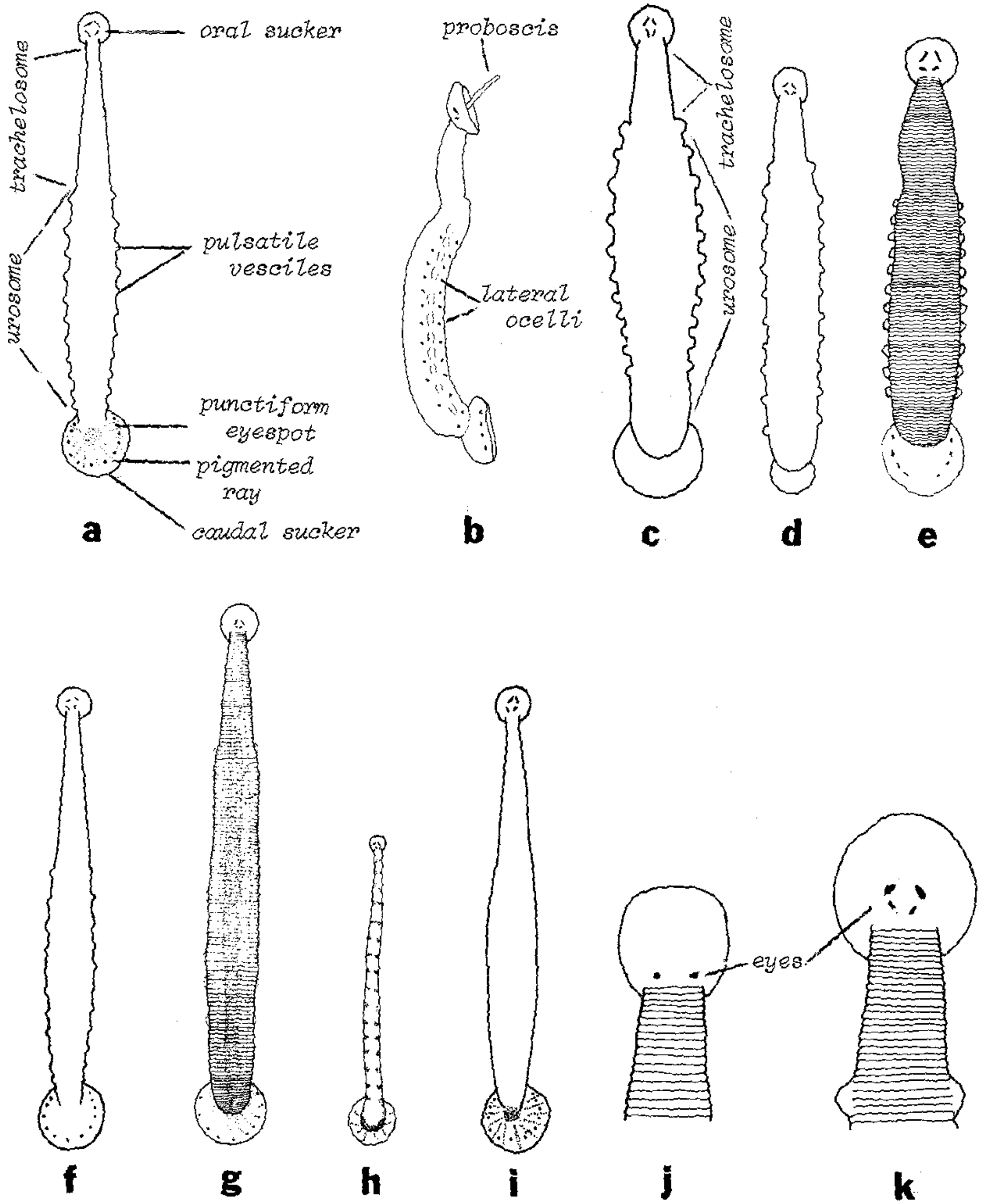


FIG. 10. General body shapes of Piscicolidae: (a-k) dorsal view showing body regions, ocelli arrangements, and external structures.

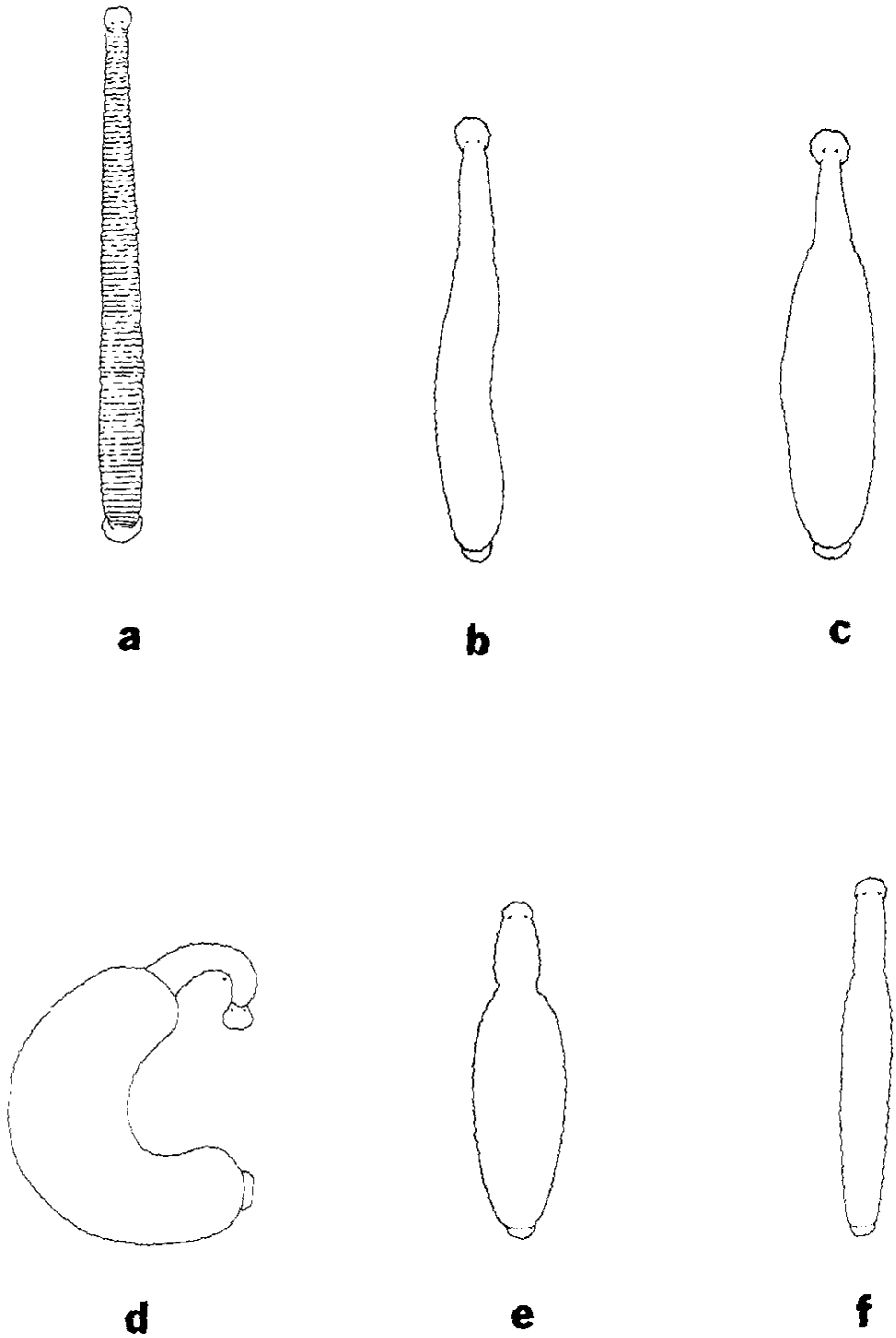


FIG. 11. General body shapes of Piscicolidae: (a-d) Myzobdella lugubris, dorsal view; (e,f) Piscicolaria reducta, dorsal view.

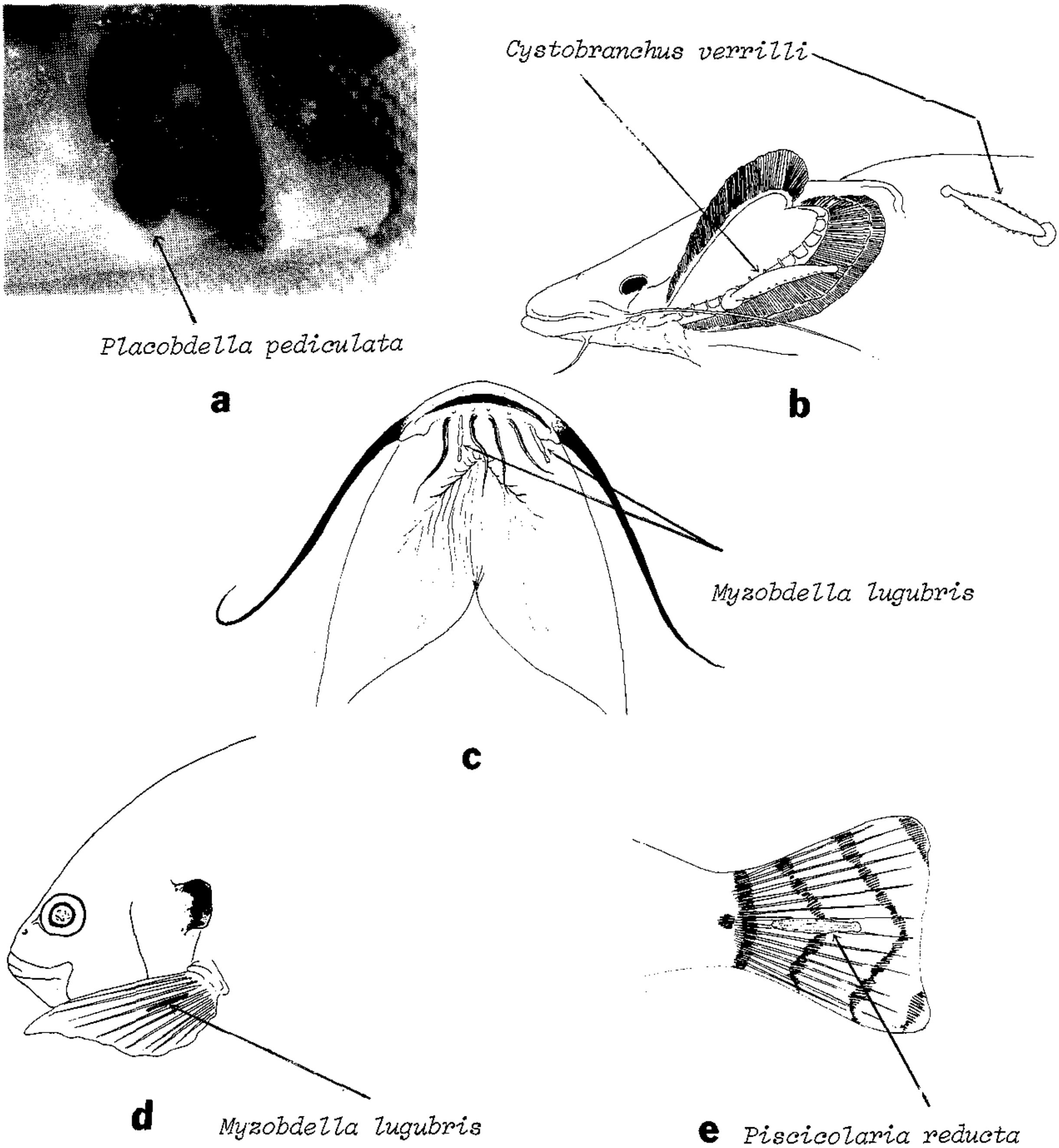


FIG. 12. Some attachment sites of fish leeches: (a) Placobdella pediculata attached under the operculum of the freshwater drum (Aplodinotus grunniens); (b) Cystobranchus verrilli attached to the gill arch and body of a flathead catfish (Pylodictis olivaris); (c) Myzobdella lugubris attached to the chin of the channel catfish (Ictalurus punctatus); (d) Myzobdella lugubris attached to the pectoral fin of a blue gill (Lepomis macrochirus); (e) Piscicolaria reducta attached to the caudal fin of a logperch (Percina caprodes). Part of the operculum and gill (a) was removed to show attachment location. Illustrations (b-e) after Poe, 1972.

4(2) Eyes, 5 pairs, forming a parabolic arch, somites II-VI (Fig. 13a); body large, linear, elongate (Fig. 14); jaws with teeth (except none in Haemopis grandis, Haemopis plumbea); muscular pharynx, short, not extending to clitellum, testisacs large, arranged in metameric pairs; free-living or predaceous and blood-sucking. Order Gnathobdellida, Family Hirudinidae. 43

Eyes, 0, 3, or 4 pairs in separate labial and buccal groups (Fig. 13b-d); body moderate size, linear, elongate (Fig. 14); lacking jaws or teeth; mouth armed with muscular pharyngeal ridges; pharynx extending to somite XIII, about 1/3 body length; testisacs small and numerous in grape-like clusters; free-living or predaceous. Order Pharyngobdellida, Family Erpobdellidae. 56

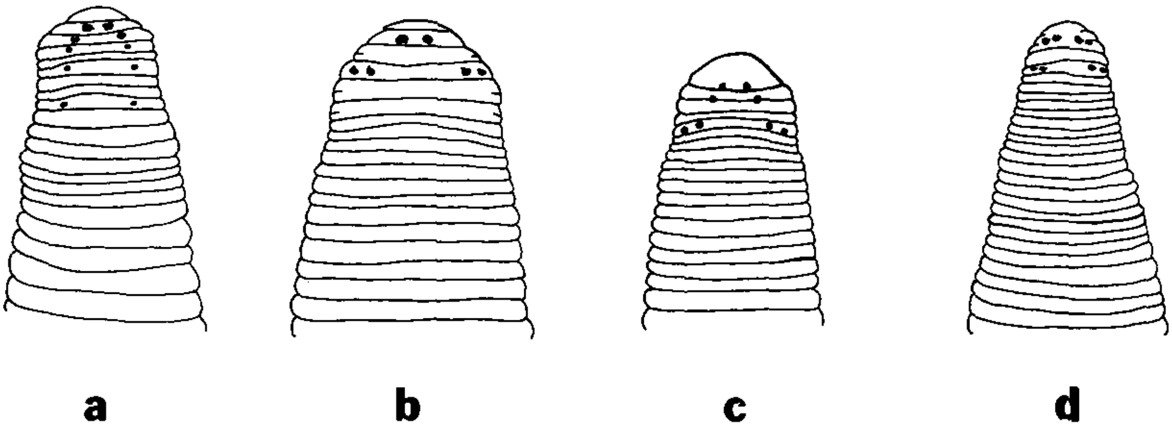


FIG. 13. Arrangement of eyes, dorsal view: (a) Hirudinidae: (b-d) Erpobdellidae.

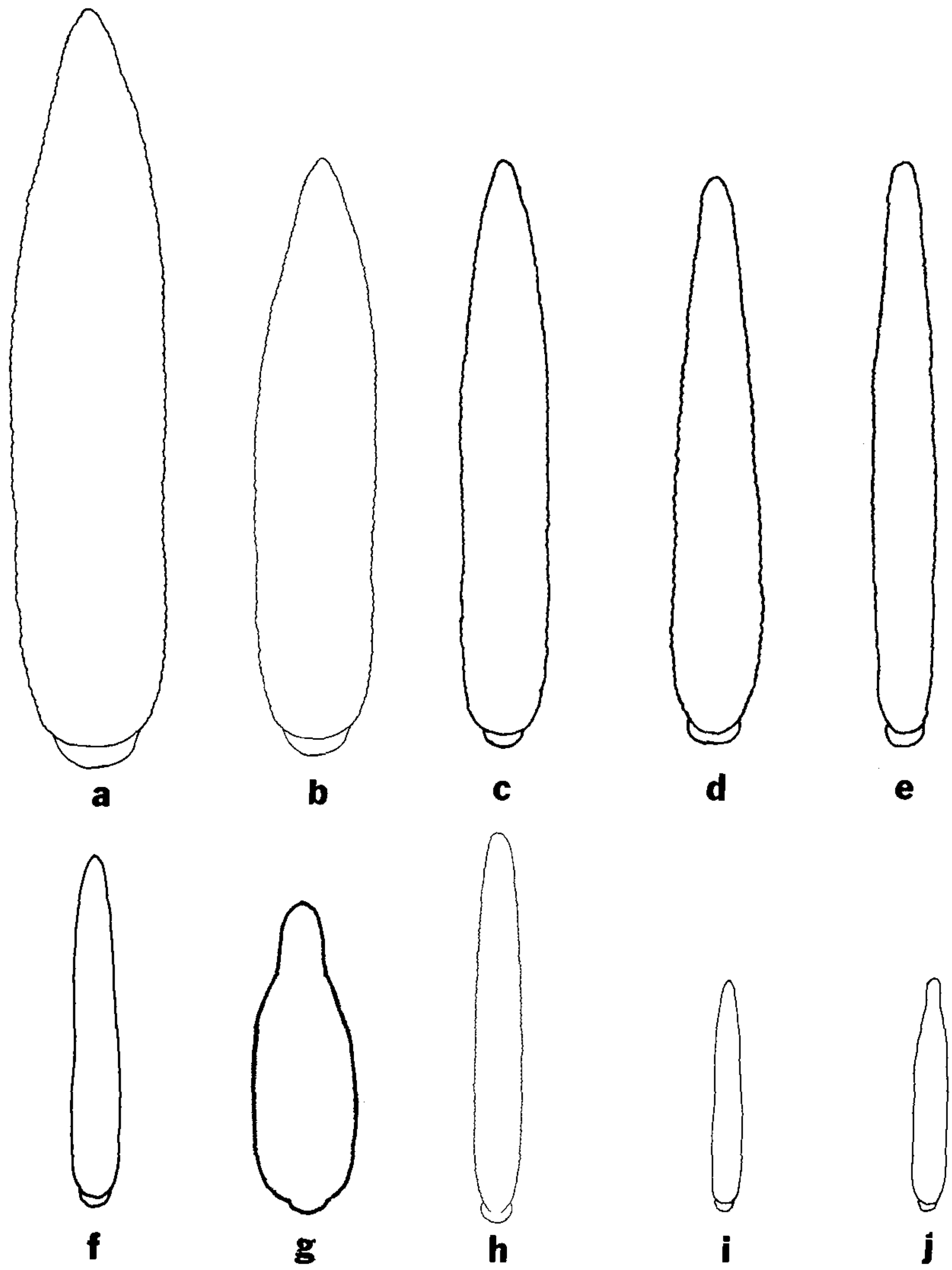


FIG. 14. General body shapes: (a-e) Hirudinidae; (f-j) small hirudinids; (f-j) Erpobdellidae.

5(3) One pair of eyes (Figs. 7,8), except Placobdella hollensis, which also has a series of paired accessory eyes (Fig. 9a). 6

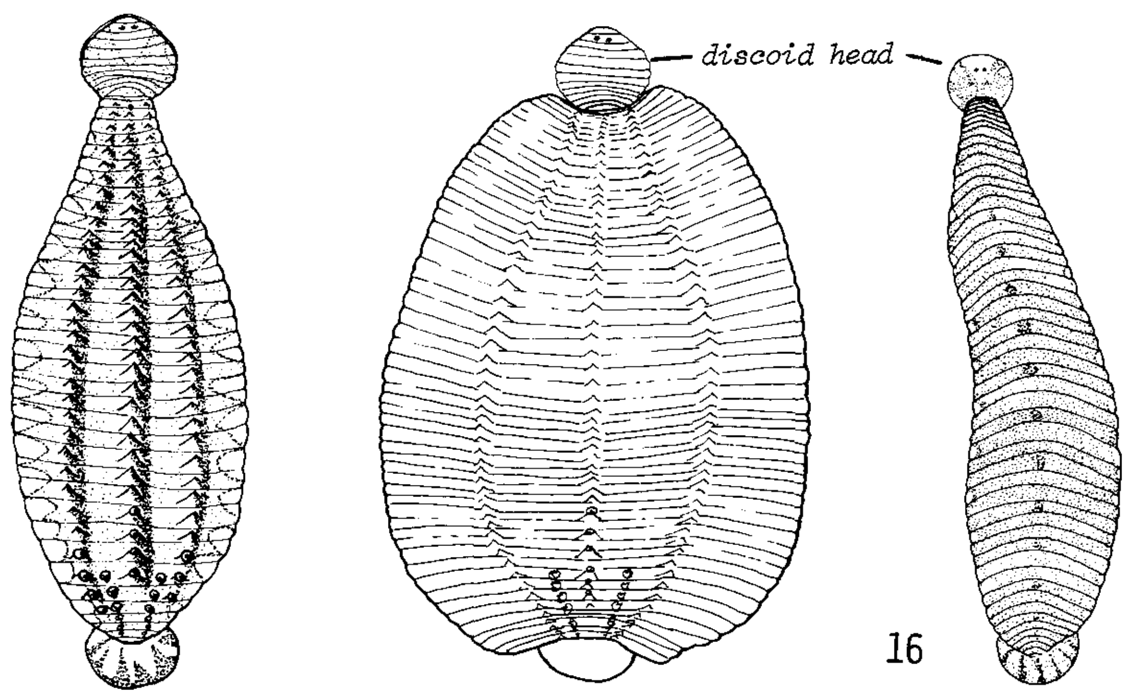
More than one pair of eyes (Fig. 9b-i). 28

6(5) Anterior somites (oral sucker) of cephalic region distinctly expanded to form a discoid head, set off from body by a narrow neck constriction (Figs. 6d,e;7g,h). 7

Anterior somites (oral sucker) of cephalic region undifferentiated, more or less continuous with body (Figs. 5,6a-c,7a-f,8,9), not distinctly expanded to form a discoid head, no narrow neck constriction. 8

7(6) Dorsum with 3 prominent pointed (tuberculate) keels or ridges (may not be decernible in live specimens); eyes one pair, separated by their diameter; color greenish-gray or pale olive-brown; free-living, parasitic on fish; length 9-16 mm (Fig. 15). Placobdella montifera Moore, 1906

Dorsum smooth; eyes one pair, separated by their diameter; color greenish-gray; free-living, parasitic on fish; length 15-25 mm (Fig. 16). . . . . . Placobdella nuchalis Sawyer & Shelley, 1976



15 a b 16

FIG. 15. Placobdella montifera: (a) normal resting shape; (b) contracted shape. FIG. 16. Placobdella nuchalis.

8(6) With a series of accessory (supplementary) eyes behind single pair of functional eyes in cephalic region (Fig. 9a); color light olive-green variegated with brown, pale yellow or colorless areas; adults often swim; feeding habits unknown; length 20-30 mm (Fig. 17). . . . . <u>Placobdella hollensis</u> (Whitman, 1892)

Without accessory eyes. 9

9(8) Eyes distinctly separated, usually by the diameter, or more of one eye (Fig. 7a-f). 10

Eyes close together, separated by less than the diameter of one eye, or confluent (fused), touching, (Fig. 8). 16

10(9) Dorsum unpigmented, uniformly pigmented, or pigmented with longitudinal or transverse bands, lines or stripes and with or without metameric whitish spots (sensillae) on every 3rd annulus in middle of body region, or dorsum with scattered chromatophores (Figs. 21-27); heavily to sparsely or not papillated, or with a chitinous scute (nuchal plate) in anterior region; crop caeca 1-6 pairs; gonopores separated by at least 1 annulus; free-living, parasitic, predaceous on invertebrates. <u>Helobdella</u>. 11

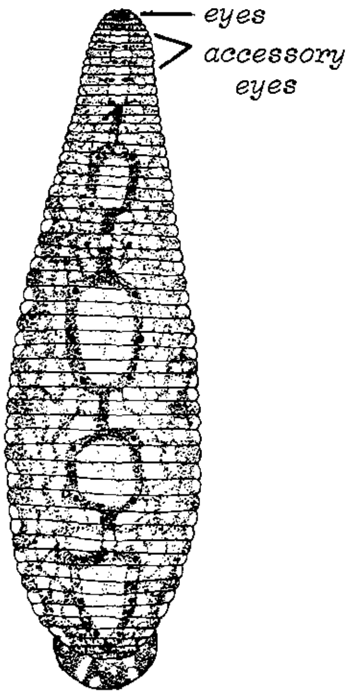
Dorsal and ventral surfaces heavily pigmented with uniform, minute, blackish chromatophores, with thin dark paramedial lines extending into anterior region; dorsal surface smooth, no papillae or scute; crop caeca 6 pairs, gonopores united; length 15-22 mm (Fig. 18). . . . . . <u>Marvinmeyeria lucida</u> (Moore, 1954)

11(10) With a dark brown chitinous scute, can be faint in juveniles (or may fall off in individuals preserved for a long time) on somite VIII of dorsum in anterior region (Fig. 19); color dusky brown, gray, green, or pink, length 9-14 mm (Fig. 20). . . . . <u>Helobdella stagnalis</u> (Linnaeus, 1758)

Without a chitinous scute in the anterior region of dorsum. . . .12

12(11) Dorsum without papillae (tubercles), smooth. 13

Dorsum papillated (few, scattered, or arranged in 3 to 9 longitudinal rows). 15



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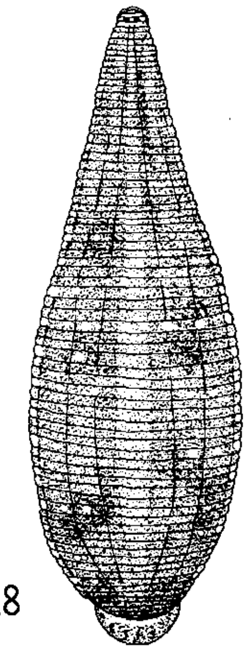

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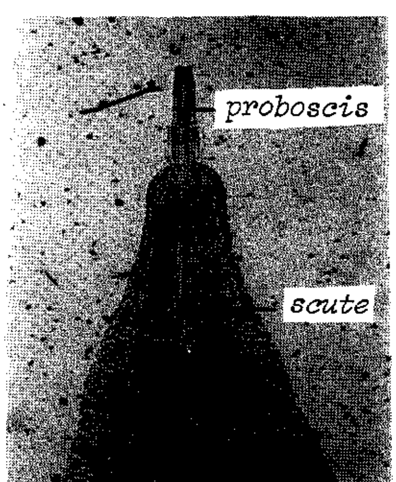

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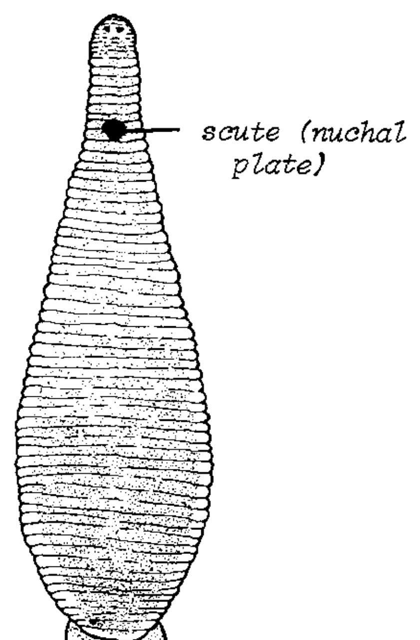

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FIG. 17. Placobdella hollensis. FIG. 18. Marvinmeyeria lucida. FIG. 19. Helobdella stagnalis, photomicrograph showing protruding proboscis and scute (X 100). FIG. 20. Helobdella stagnalis.

13(12) Body pigmented, with or without longitudinal or transverse bands, lines and/or stripes or uniform; body flat, posterior wider than tapering cephalic end; usually 6 pairs of crop caeca. 14

Body unpigmented, elongate and subcylindrical (terete) (Fig. 5c); lateral margins of body almost parallel, body smoothly rounded; posterior sucker small, terminal, translucent, sometimes opaque white or gray; 1 pair of crop caeca; length 9-25 mm (Fig. 21). . . . . Helobdella elongata (Castle, 1900)

14(13) Dorsum with transverse rusty-brown, interrupted bands alternating with irregular whitish bands, the latter consisting of 8 to 10 confluent white metameric spots on each neural annulus; length 10 mm (Fig. 22). . . . Helobdella transversa Sawyer, 1972

Dorsum without transverse pigmentation; color uniform coffee-brown or with longitudinal whitish stripes alternating with coffee-brown stripes and/or lines; with or without small whitish or pale spots in anal region, or dorsum with scattered chromatophores; occasionally preserved individuals show minute sensillae on annuli of dorsum; a variable species; length 10-14 mm (Fig. 23a-e). . . . . Helobdella fusca (Castle, 1900)

15(12) Dorsum rough, with 5 to 7 or 9 longitudinal rows of large, whitish, rounded conspicuous papillae, on each neural annulus; dorsum yellowish-brown or unpigmented; length 9-14 mm (Fig. 24). . . . . .Helobdella papillata (Moore, 1906)

Dorsum with 3 rows (typically) or fewer of small, black-tipped or uniformly pale white papillae; pigmentation uniform, or arranged in numerous longitudinal light and dark brown, gray, or black lines and/or stripes, or dorsum with 3 broad, longitudinal white stripes, one median row and one on each side submarginal, also at posterior end 2 short white stripes, few or many whitish spots on neural annuli, unaligned or if aligned, then confined to areas lateral to papillae, or color uniform with papillae few, scattered, or in 3 rows; whitish spots on neural annuli unaligned or aligned; a variable species; length 10-29 mm (Figs. 25,26,27). . . . . .Helobdella triserialis (E. Blanchard, 1849)

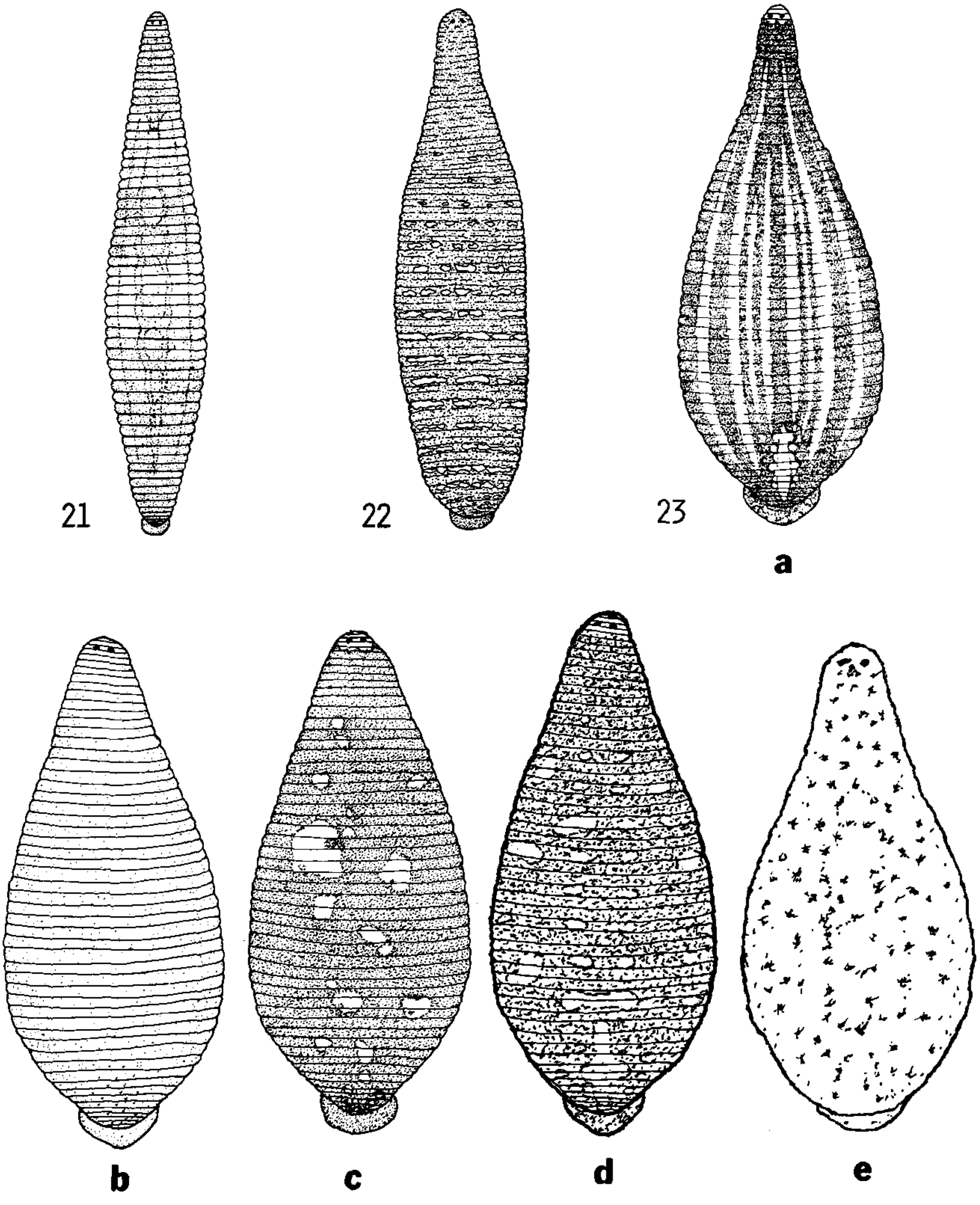


FIG. 21. *Helobdella elongata*. FIG. 22. *Helobdella transversa*. FIG. 23. *Helobdella fusca*: (a) typical pigmented form; (b) non-pigmented form; (c) scattered pigmented form; (d,e) white blotched pigmented form.

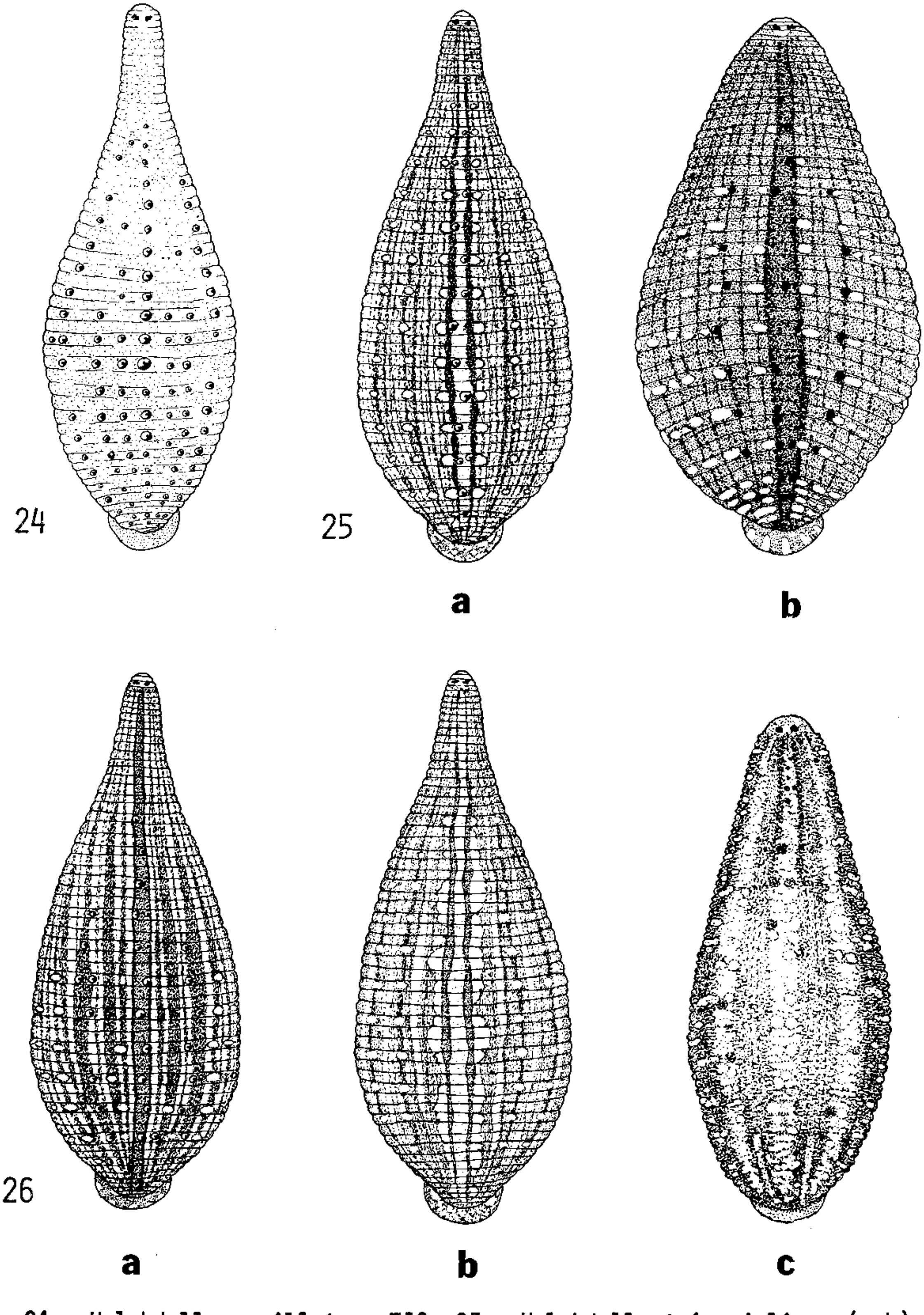


FIG. 24. *Helobdella papillata*. FIG. 25. *Helobdella triserialis*: (a,b) showing variability of papillae and pigmentation. FIG. 26. *Helobdella triserialis*: (a-c) showing variability of papillae and pigmentation.

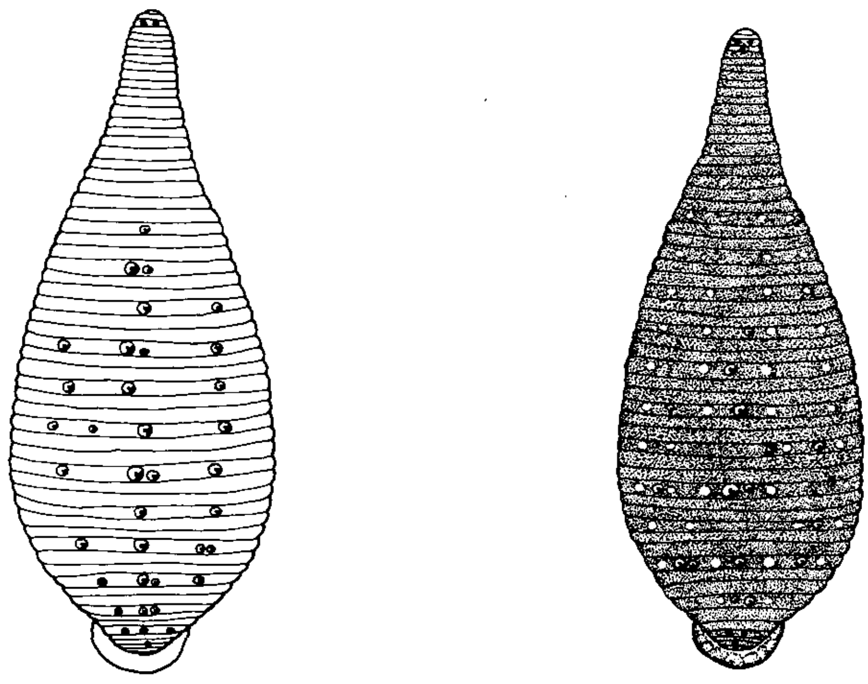


FIG. 27. Helobdella triserialis: (a,b) showing variability of papillae and pigmentation.

16(9) Dorsum with conspicuous white genital and anal patches, one or more medial white patches and a white ring (bar) in neck region (Figs. 28,29,30). 17

Dorsum without white patches and white ring (bar) in neck region 19

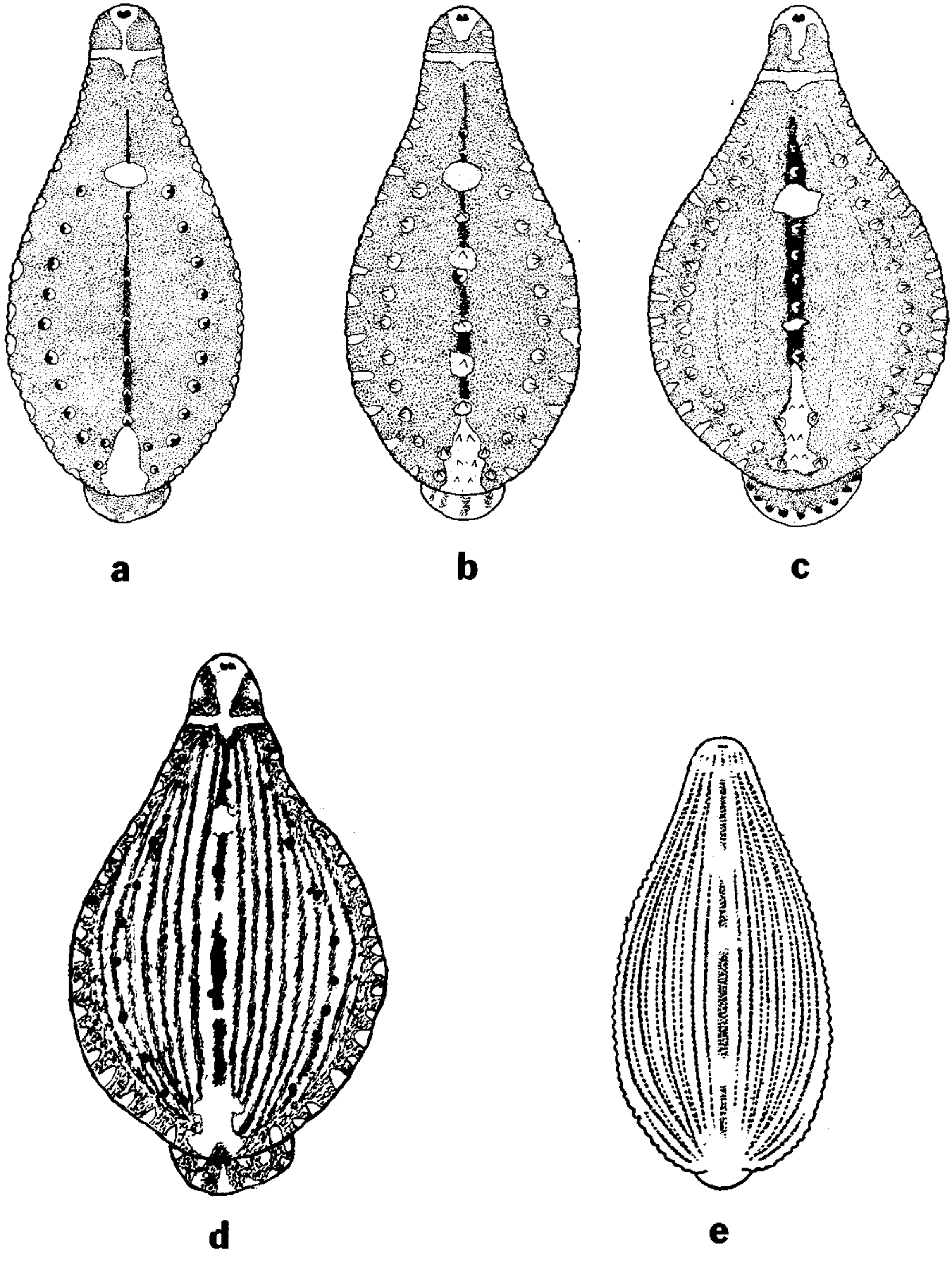


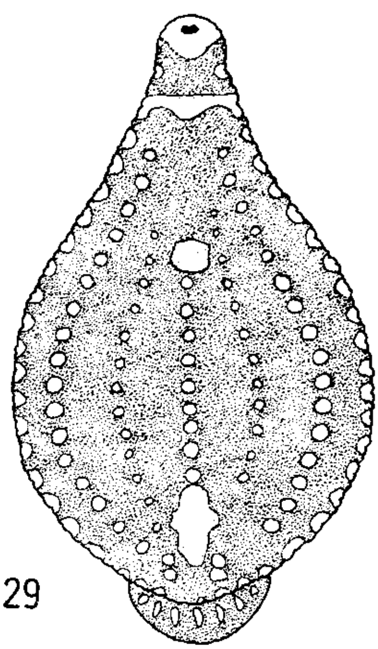
FIG. 28. Batracobdella phalera: (a-d) variable forms; (e) immature form.

17(16) Dorsum smooth, no papillae (tubercles). 18

Dorsum with three series of usually dark-tipped papillae or white pointed papillae, sometimes with a thick ban encomposing middorsal series of papillae and marginal dots; with or without white patches approximately between genital and anal patches; body convex, thick, solidly or lightly pigmented, opaque; length 6-10 mm (Fig. 28) free-living or parasitic on fish. . . . . Batracobdella phalera (Graf, 1899)

18(17) Body ovate-lanceolate, excessively flattened, thin, with 5 (sometimes raised) longitudinal rows of white prominences surrounded by yellowish dots, equidistant longitudinally and transversely; length 6-10 mm (Fig. 29). . . . . Batracobdella michiganensis Sawyer, 1972

Body lanceolate, excessively flattened, thin, lightly pigmented with small brown, cutaneous chromatophores; or pigmented with a broken longitudinal median stripe and two rows of submarginal spots; length 8-11 mm (Fig. 30). . . . . Placobdella translucens Sawyer & Shelley, 1976



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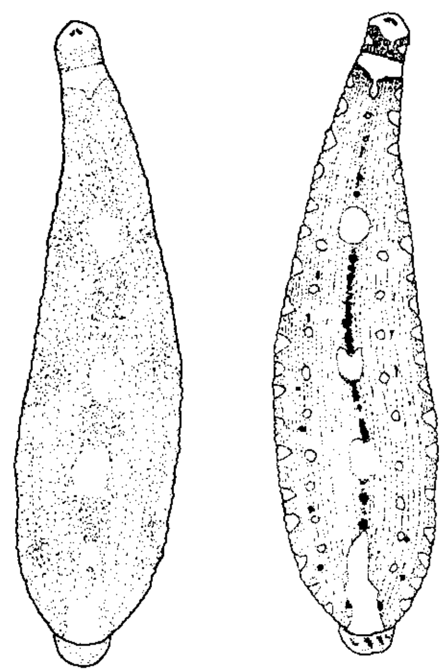

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a b

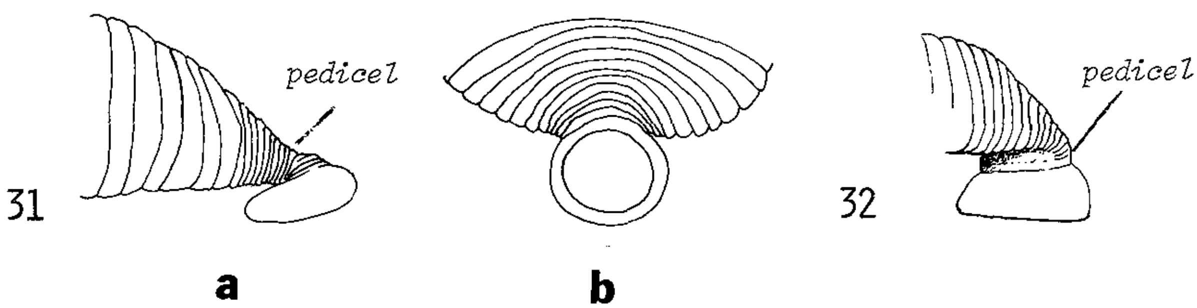
FIG. 29. Batracobdella michiganensis. FIG. 30. Placobdella translucens: (a,b) variable pigmented forms.

19(16) Caudal sucker well developed, rim moderately thick, bulbous, separated from body on a distinct pedicel (peduncle), (Figs. 31-34). 20

Caudal sucker well developed, rim thin, continuous with body, not separated on a pedicel. 23

20(19) With marginal circle of 30-60 retractile digitate processes on rim of caudal sucker, when everted, projecting (fingerlike) along inner margin of caudal sucker cavity, usually retracted in preserved specimens, position marked dorsally on outer rim by faint radiating ridges, may appear as whitish radiating bands (Figs. 33,34). Actinobdella. 21

Without digitate processes on caudal sucker. 22



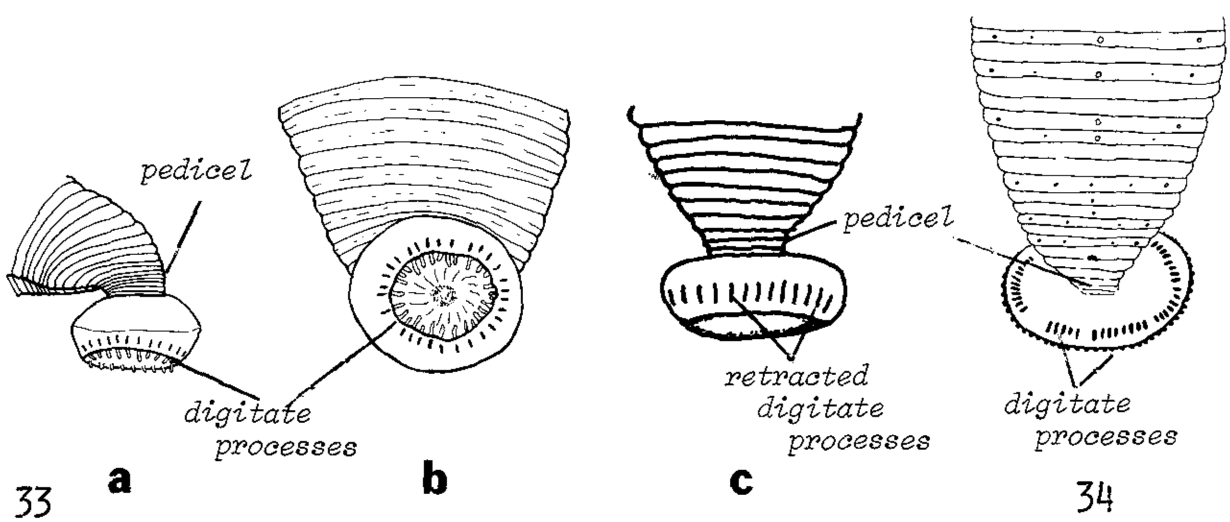


FIG. 31. Caudal sucker and slender stalk (pedicel) of Placobdella pediculata: (a) lataeral view; (b) ventral view. FIG. 32. Caudal sucker, short pedicel, of Batracobdella cryptobranchii, lateral view. FIG. 33. (a-c) Actinobdella inequiannulata, various views of caudal sucker showing digitate processes. FIG. 34. Actianobdella annectens, dorsal view of caudal sucker showing digitate processes.

21(20) Caudal sucker with about 30 digitate processes on rim, short pedicel (Fig. 33); body shape slender, round, and elongate to thick, and strongly convex dorsally in engorged adults; dorsal papillae, 1-5 series, acute, median, variable, or absent (in some individuals the papillae are replaced by a longitudinal middorsal ridge (Fig. 35) or groove; usually parasitic on fish; body somites 3-annulate, often with incipient secondary annulation; free-living, parasitic on fish; length 7-22 mm (Figs. 36,37). . . . . . Actinobdella inequiannulata Moore, 1901

Caudal sucker with about 60 digitate processes on rim, short pedicel (Fig. 34); otherwise similar to A. inequiannulata (has not been found since original description), may be a synonym of A. inequiannulata); length 7-11 mm (Fig. 38). . . . . Actinobdella annectens Moore, 1906

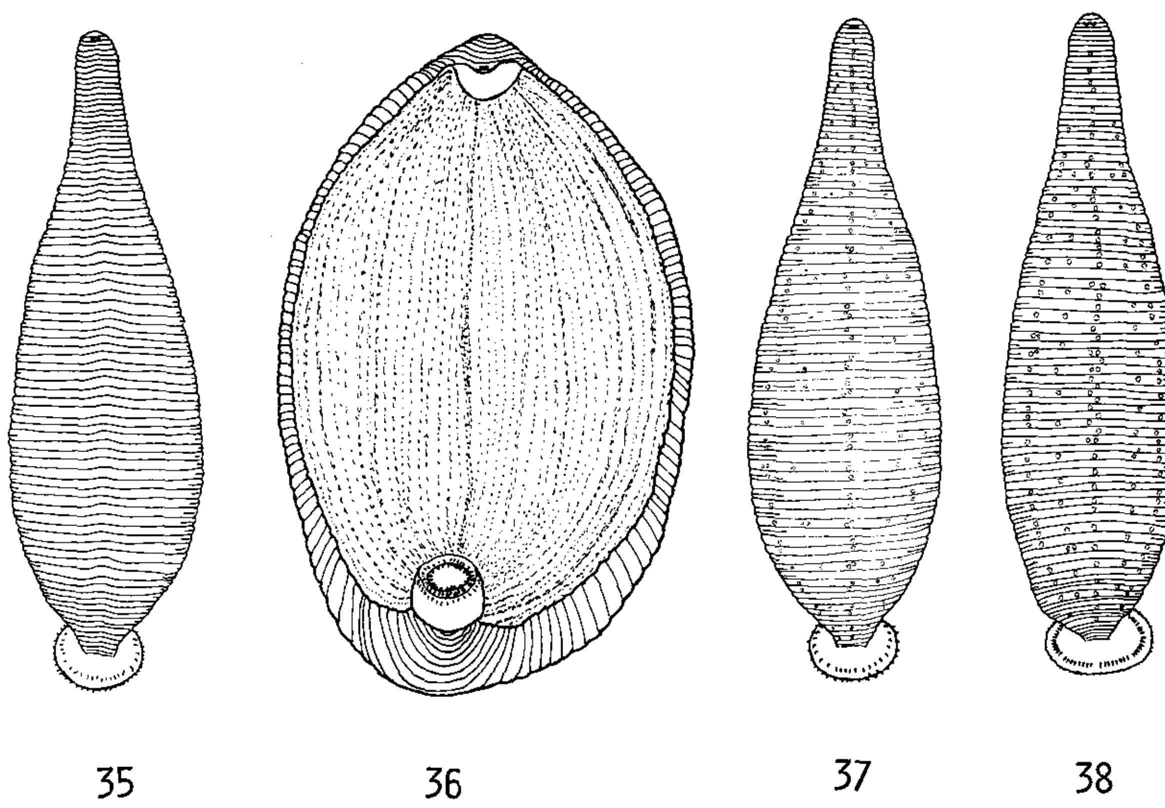


FIG. 35. Actinobdella inequiannulata, dorsal view showing middorsal ridge. FIG. 36. Actinobdella inequiannulata, ventral view of engorged adult. FIG. 37. Actinobdella inequiannulata, dorsal view with minute papillae. FIG. 38. Actinobdella annectens, dorsal view with papillae.

22(20) Body high dorsally and contractile; dorsum smooth; caudal sucker set off from body by a slender stalk (pedicel) (Fig. 31), absent or short in juveniles smaller than 1 cm (Fig. 39); body color brownish or grayish, opaque; usually encountered on gills, attached to the isthmus or inside of the opercula (gill chamber) of freshwater drum (Aplodinotus grunniens); length 20-35 mm (Figs. 40,41). . . . . Placobdella pediculata Hemingway, 1908

Body moderately flattened; dorsum smooth; caudal sucker set off from body by a short pedicel (Fig. 32); body color of preserved specimens cream to golden, live individuals reddish brown due to blood in crop, usually translucent; (some preserved specimens have 8 rows of inconspicuous sensillae on annuli of the dorsum); known only from the Ozark Hellbender (Cryptobranchus alleganiensis bishopi); length, up to 17 mm (Fig. 42). . . . . Batracobdella cryptobranchii Johnson & Klemm, 1977

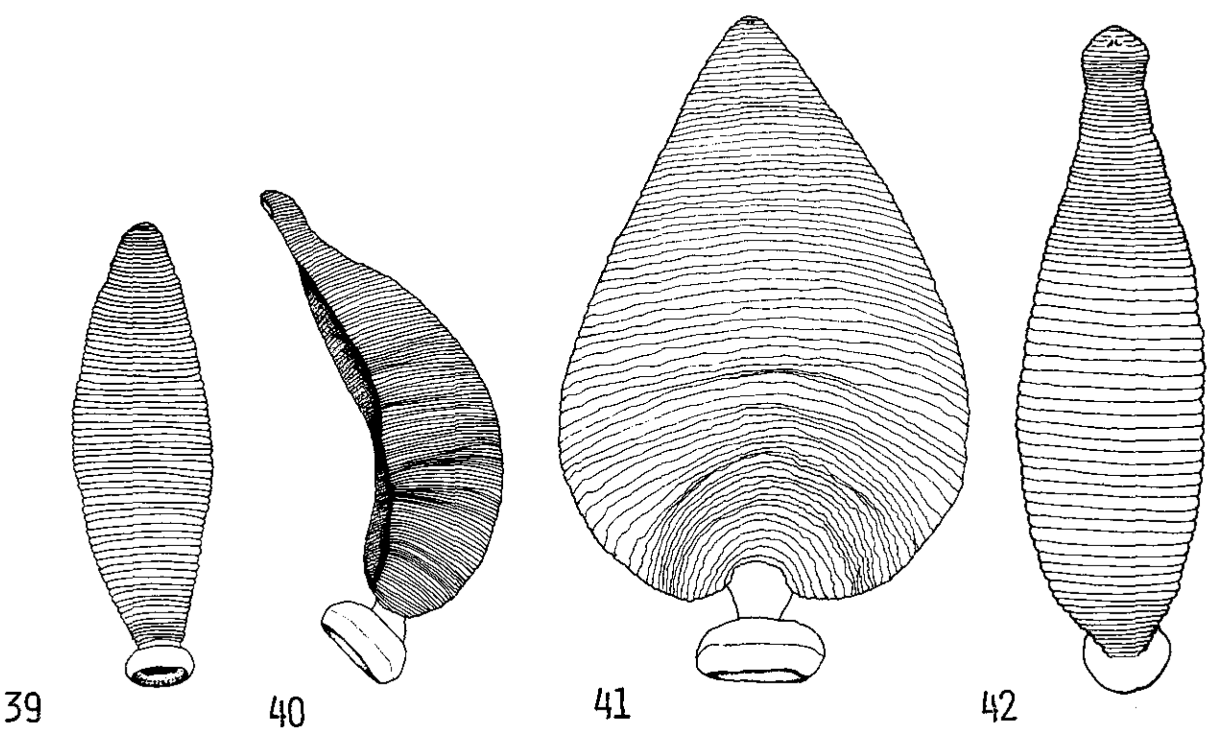


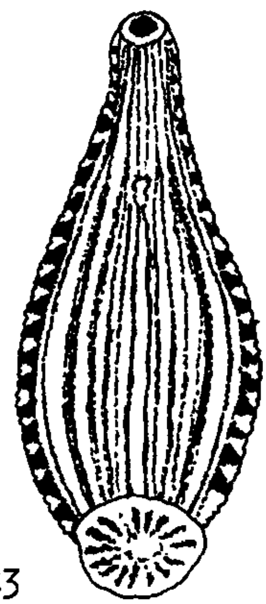
FIG. 39. Placobdella pediculata, dorsal view of juvenile without slender stalk (pedicel). FIG. 40. Placobdella pediculata, lateral view. FIG. 41. Placobdella pediculata, dorsal view of contracted adult. FIG. 42. Batracobdella cryptobranchii, dorsal view.

23(19) Dorsum not roughly papillated, usually smooth, with low smooth domes, often suppressed papillae, or without papillae (tubercles). 24

Dorsum roughly papillated. 26

24(23) Ventral surface not striped. 25

Ventral surface with 8-12 bluish, greenish, or brownish longitudinal stripes or lines (Fig. 43); dorsal pigment pattern variable and intricate, usually dark greenish-brown, with a middorsal cream colored stripe or band of variable width and with irregular lateral patches; body somites 3-annulate; usually parasitic on turtles, often found free-living; length 38-64 mm (Figs. 44,45). . . . . Placobdella parasitica (Say, 1824)



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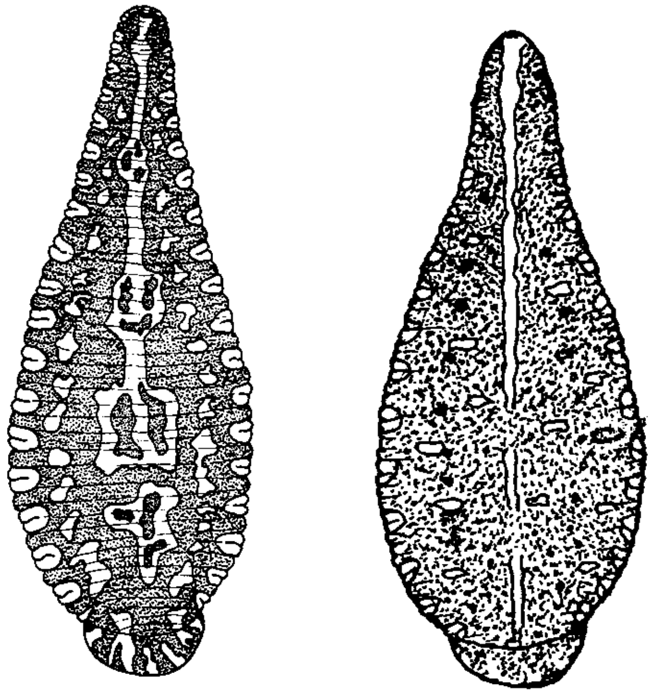

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a

b

FIG. 43. Placobdella parasitica, ventral view showing striping. FIG. 44. Placobdella parasitica: (a,b) dorsal view showing variable pigmentation patterns.

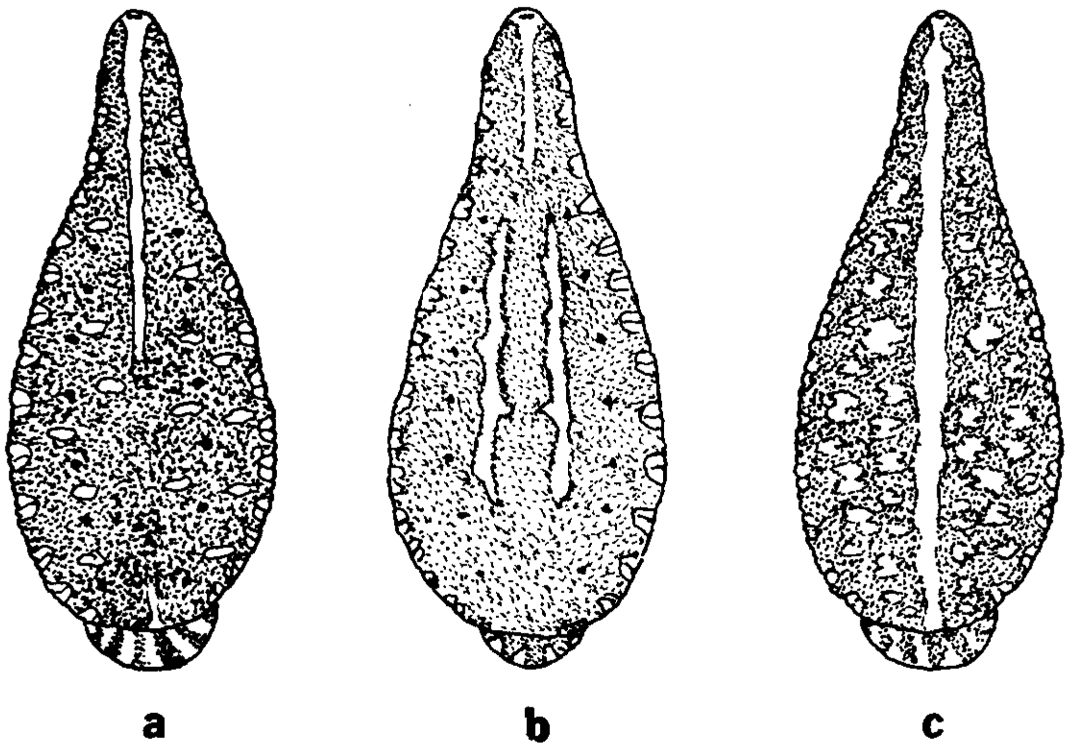

FIG. 45. Placobdella parasitica: (a-c) dorsal view showing variable pigmentation patterns.

25(24) Color of dorsum dark greenish-brown, finely variegated with orange, with a thin dark median line (can be absent in preserved individuals), with 4-5 rows of yellowish or whitish metameric dots; body somites 3-annulate; caudal sucker small; commonly encountered on mating frogs, toads, salamanders, and their larvae; often found free-living; length 13-25 mm (Fig. 46). . . . . Batracobdella picta (Verrill, 1872)

Color of dorsum pale olive-green, brown, or gray; body somites, 2-annulate; caudal sucker large, conspicuous; known from the mountains of North and South Carolinas; parasitic on desmongnathine salamanders; length 2-7 mm (Fig. 47). . . . . Oligobdella biannulata (Moore, 1900)

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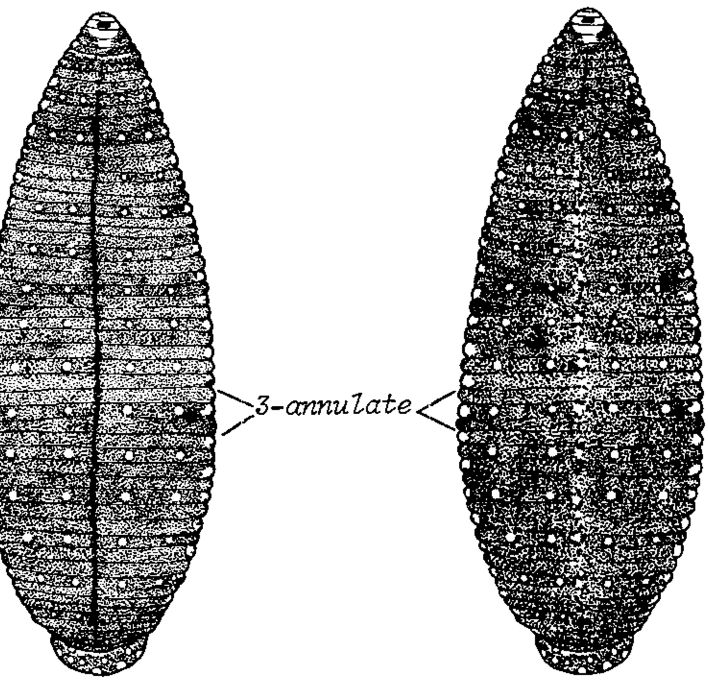

a b

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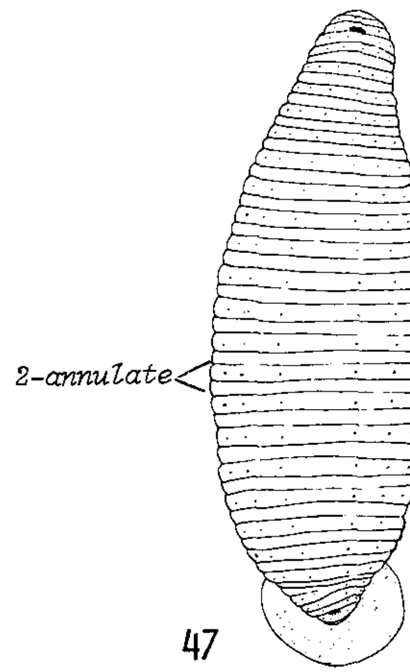
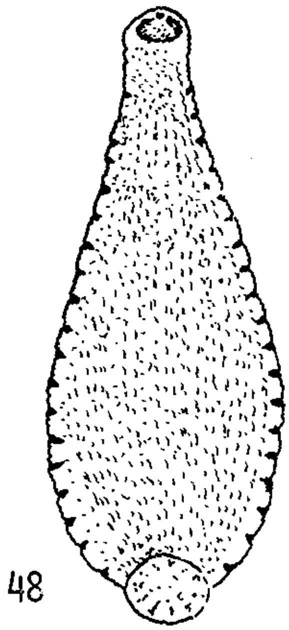


FIG. 46. Batracobdella picta: (a) form with dark median line; (b) form lacking median line. FIG. 47. Oligobdella biannulata.

26(23) Dorsum warty, entirely covered with rounded papillae, varying in size, randomly arranged, or with the larger papillae in 5 longitudinal metameric rows and numerous other papillae randomly arranged of varying size; all papillae bearing clusters of secondary, minute papillae at the apex; usually with a brown band down middorsal line, interrupted 4-5 times, sometimes with a light colored band; ventral surface unstriped, with scattered dark chromatophores or plain (Fig. 48); body usually flat, lanceolate; color of dorsum a mixture of brown, green, and yellow, but variable; free-living or parasitic on turtles; length, up to 40 mm (Fig. 49). . . . . .Placobdella ornata (Verrill, 1872)

Dorsum less rough, not entirely covered with papillae, with large and/or small more uniform simple pointed papillae, the larger ones in 5-7 longitudinal metameric rows, some bearing only one or a few secondary, minute papillae at the apex. 27



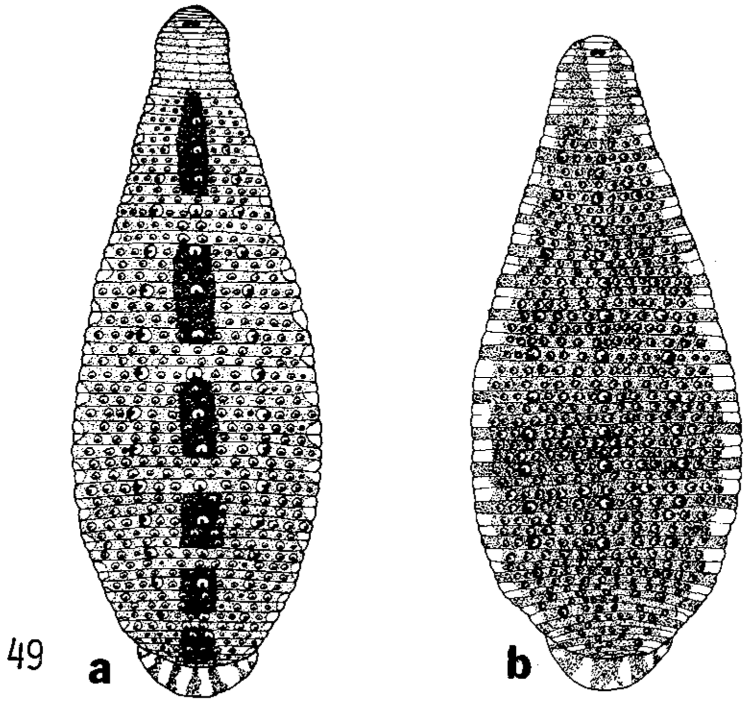
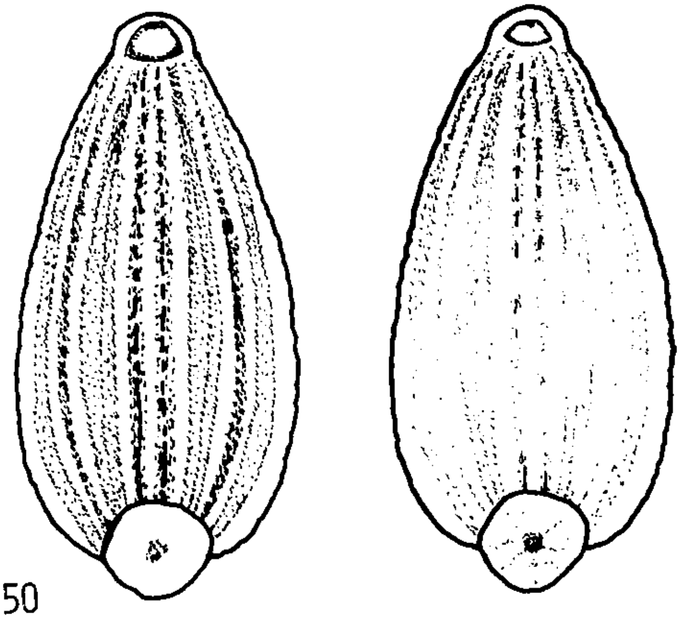


FIG. 48. Placobdella ornata, ventral view. FIG. 49. Placobdella ornata: (a,b) dorsal view showing variability of papillae and pigmentation.

27(26) Body usually ovate-lanceolate, strongly convex; dorsum with 5-7 longitudinal rows of large white pointed papillae; some bearing only one or a few secondary minute papillae at the apex; other small papillae varying in size to inconspicuous, not forming distinct rows; papillae on caudal sucker; dorsum with a vague narrow, continuous (sometimes interrupted) median longitudinal stripe, contained in a wider bluish stripe, encompassing a middorsal row of papillae; light colored stripes on each side of the middorsal row of papillae joining in neck region; color of dorsum greenish-blue with longitudinal striping or color above obscure yellowish brown, produced by alternating narrow lines of flesh-color and olive-green (giving a checkered appearance); base color usually brown in preserved individuals; ventral surface usually with 2-8 bluish longitudinal stripes, lines (Fig. 50); without scattered dark chromatophores; free-living, parasitic on turtles; length 15mm or larger (Figs. 51,52). . . . . .Placobdella papillifera (Verrill, 1872)

Body usually lanceolate, flat; dorsum with few or numerous, uniform, small papillae, with the larger ones in 5 longitudinal rows of varying degree; middorsal stripe narrow, dark, usually continuous; color of dorsum usually with brownish longitudinal lines, stripes; ventral surface plain or with dark colorerd chromatophores in vague longitudinal lines; free-living or parasitic on turtles and alligators; length 40-50 mm (Fig. 53). . . . . Placobdella multilineata Moore, 1953



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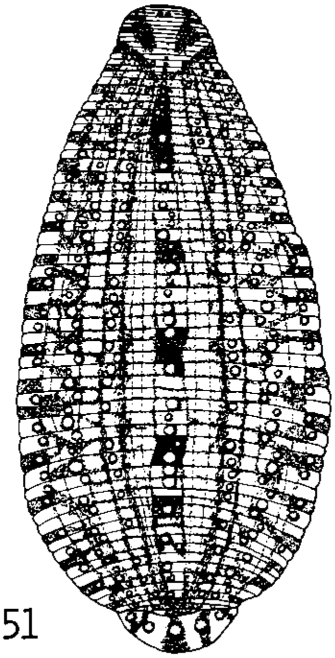

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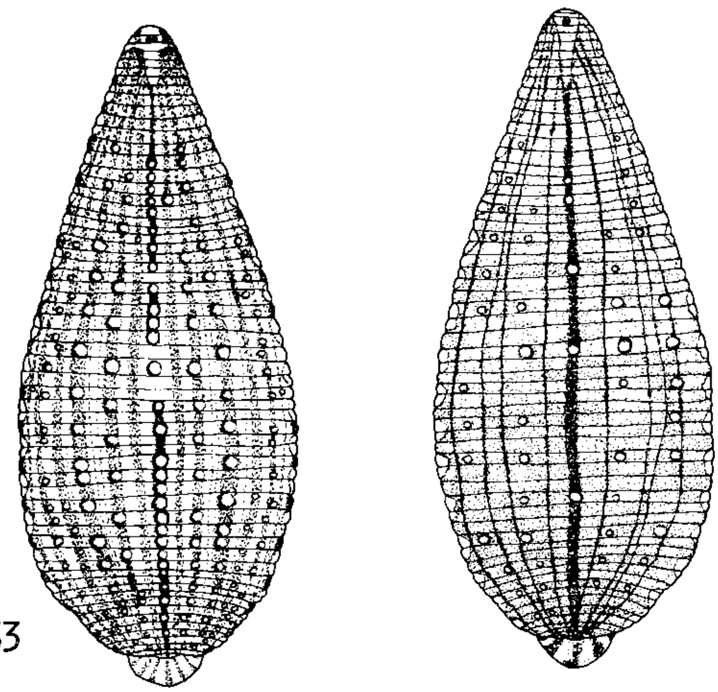

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a b

FIG. 50. Placobdella papillifera: (a,b) ventral view showing striping. FIG. 51. Placobdella papillifera. FIG. 52. Placobdella papillifera (From Sawyer and Shelley, 1976). FIG. 53. Placobdella multilineata: (a,b) dorsal view showing variability in papillae and pigmentation.

28(5) Eyes 2 pairs (Fig. 9b), arrangement modified sometimes by coalescence of eyes in various ways (Fig. 9j-m); dorsum smooth, usually with two longitudinal interrupted lines, but no large pigment spots; color variable, green or brownish; one dubious record, may not be established in North America, length 7-20 mm (Fig. 54). . . . . Batracobdella paludosa (Carena, 1924)

Eyes 3 or 4 pairs, may be coalesced (Fig. 9c-i). 29

29(28) With 3 pairs of eyes, may be coalesced of eyes in various ways (Fig. 9c-g). Alboglossiphonia, Glossiphonia, and Boreobdella. 30

With 4 pairs of eyes (Fig. 9h-i). Theromyzon. 32

30(29) Eyes equidistant in 2 paramedian rows (Fig. 9e-g). 31

Eyes in an approximately triangular pattern, the 1st pair always closer than the posterior pairs (Fig. 9c,d); body smooth, pigmentation slight, brownish-black chromatophores in sparse clusters, and often with a dark median, longitudinal stripe (sometimes interrupted) on dorsum but without paired stripes; or with small 4 to 7 middorsal irregular, transverse bars, composed of brownish-black pigmentation; body translucent; free-living, parasitic on mollusks, invertebrates; length 6-9 mm (Fig. 55,56). . . . . .Alboglossiphonia heteroclita (Linneaus, 1761)

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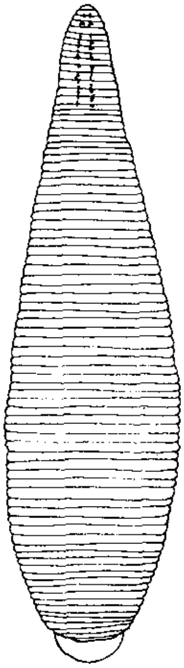

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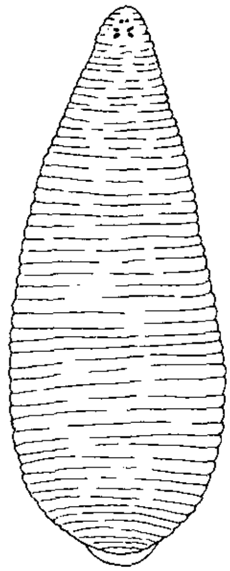

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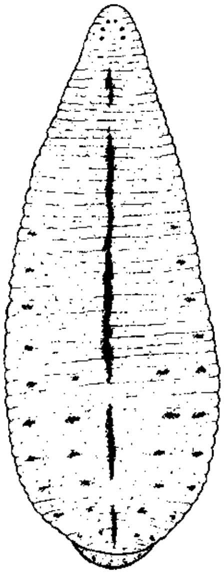

b

FIG. 54. Batracobdella paludosa. FIG. 55. Alboglossiphonia heteroclita: (a,b) variable pigmented forms.

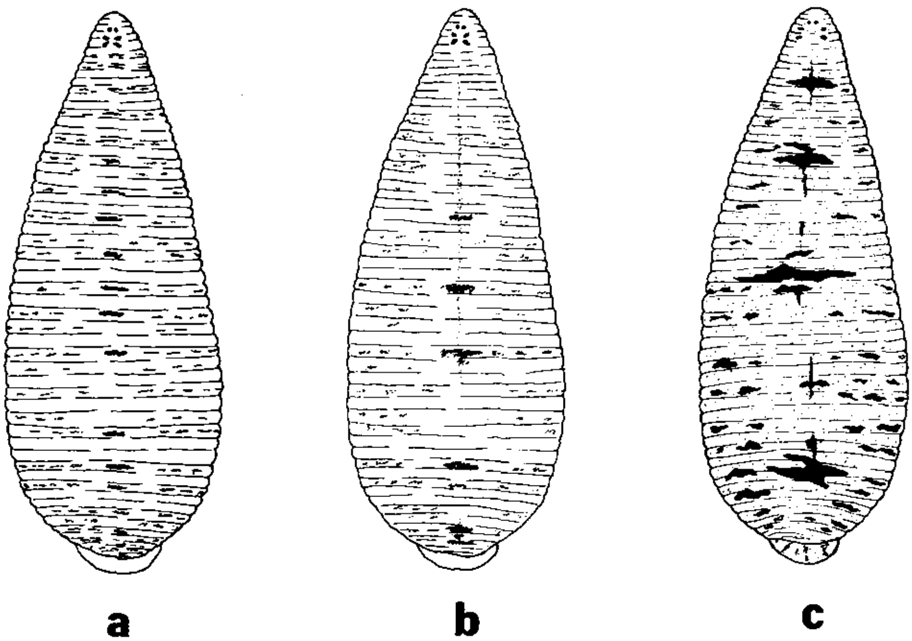

FIG. 56. Alboglossiphonia heteroclita: (a-c) variable pigmented forms.

31(30) Dorsum rarely with papillae on 2nd (middle) annulus of the triannulate somite, usually smooth (Fig. 57a); with a pair of dark paramedial stripes, dorsally and ventrally (can be absent in young), interrupted by a pair of dorsal metameric white, yellow spots (which may be slightly raised in preserved specimens), paramedially and marginally; body opaque, color brown, green, or gray; 6 or 7 pairs of crop caeca; free-living, predaceous on invertebrates; length, up to 25 mm (Fig. 58). . . . . Glossiphonia complanata (Linnaeus, 1758)

Dorsum always with large and distinct papillae at median of the 2nd and 3rd annuli of the triannulate somite (Fig. 57b), with several smaller papillae towards the margins; with large size and varying number of pale whitish spots (some irregularly shaped) which reduce the dark brown-gray ground color almost to a reticulum; on the dorsal side, on a level with the genital pores of the ventral side, two large, irregular blotches; with a pair of heavy dark paramedian stripes, dorsally and ventrally, interrupted by papillae dorsally; body opaque, color brown, green or gray, spotted with yellow; 7 pair of crop caeca; length, up to 25 mm (Fig. 59). . . . . Boreobdella verrucata (Fr. Muller, 1884)

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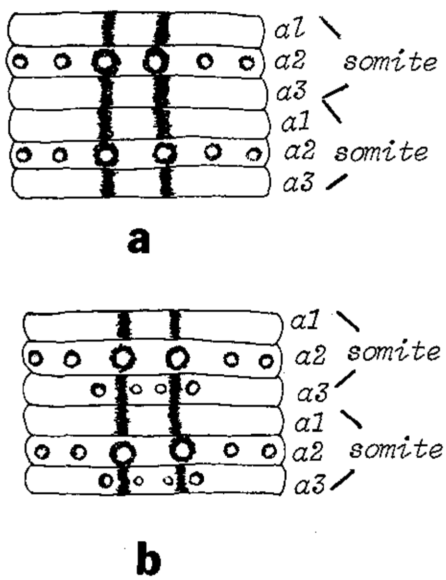

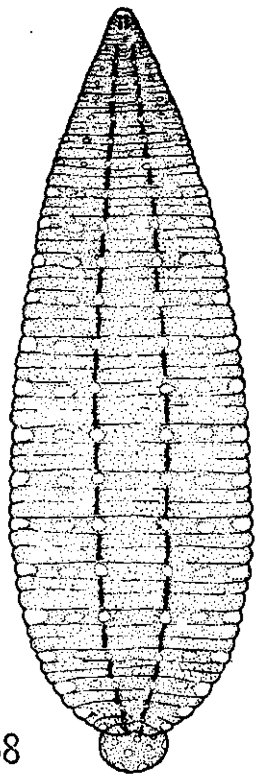

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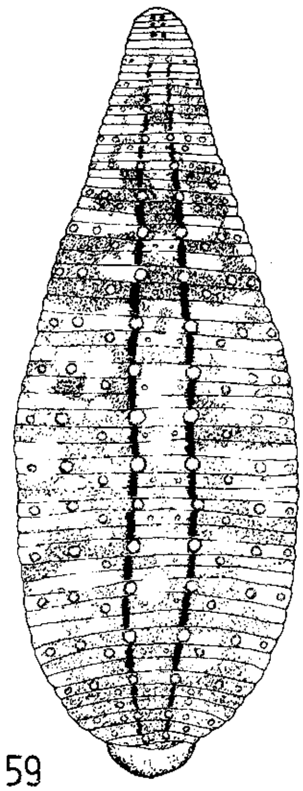

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FIG. 57. Schematic view of two middorsal segments: (a) Glossiphonia complanata; (b) Boreobdella verrucata. FIG. 58. Glossiphonia complanata. FIG. 59. Boreobdella verrucata.

32(29) Gonopores separated by 2 annuli; body shape variable, gelatious, nearly translucent; color olive-green, flecked with black chromatophores, but variable, or with longitudinal rows of cream yellow spots on dorsum; distributed in central and eastern United States and Canada; free-living or parasitic (esp. within mucosa of nasal chamber and the conjunctiva of the eyes) of waterfowl; length 20-26 mm (Fig. 60). . . . . Theromyzon biannulatum Klemm, 1977

Gonopores separated by 3 or 4 annuli. 33

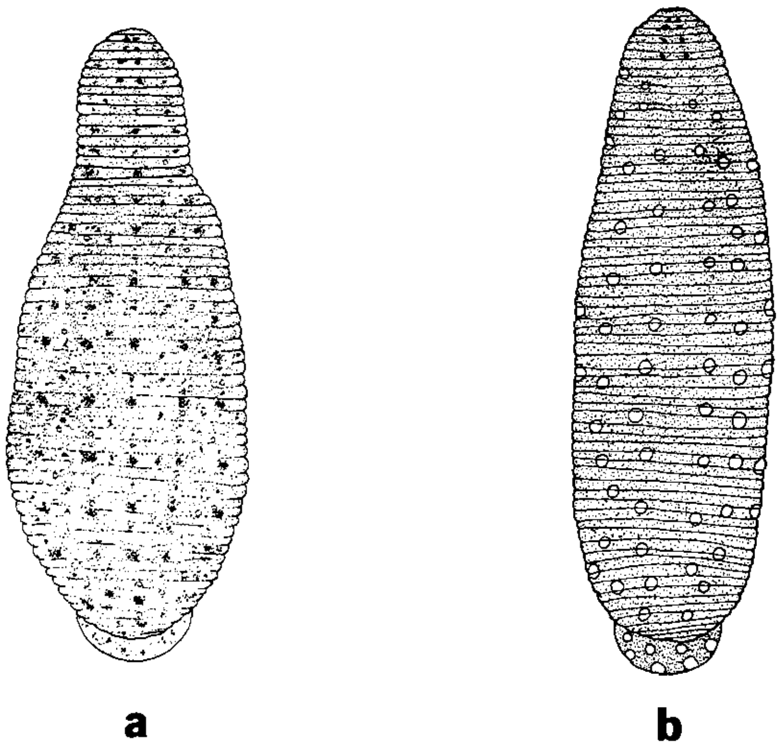

FIG. 60. Theromyzon biannulatum or Theromyzon rude: (a,b) variations in pigmentation.

33(32) With 3 annuli between gonopores; body shape variable, gelatinous, nearly translucent; color variable, with 2 paramedial pairs and marginal pairs of yellow, orange, or brown spots on dorsum; distributed in central and western United States and Canada; free-living or parasitic (esp. within mucosa of nasal chamber and conjunctiva of the eyes) of waterfowl; length 20-30 mm (Fig. 60). . . . . .Theromyzon rude (Baird, 1863)

With 4 annuli between gonopores; body shape variable, gelatinous, nearly translucent, color amber or greenish, with 2 thin paramedian black lines on dorsum or with longtudinal rows of cream colored, yellow spots, but variable; distributed in Europe but has been reported from western United States and Canada; free-living or parasitic (esp. within mucosa of nasal chamber and conjunctiva of the eyes) of waterfowl; length 15-30 mm (Fig. 61). . . . . .Theromyzon tessulatum (O.F. Muller, 1774)

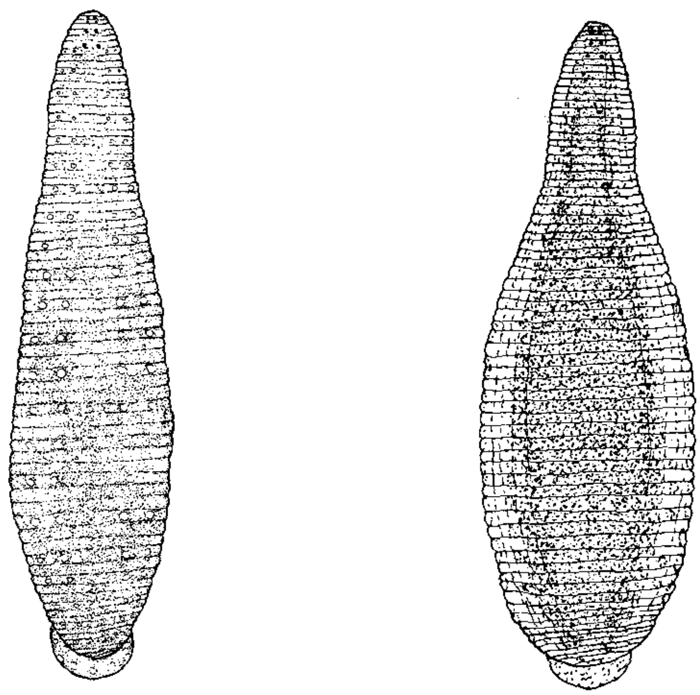

FIG. 61. Theromyzon tessulatum: (a,b) variations in pigmentation.

34(3) *With 0 or 1 pair of eyes located in posterior half of oral sucker* (Fig. 10j); without pulsatile vesicles along lateral margins of body region (Fig. 11a-f); caudal sucker concave, weakly developed, smaller than body region; body usually not differentiated into distinct neck (trachelosome) and body (urosome) regions (except in some preserved individuals of Myzobdella and Piscicolaria, Fig. 11). 35

With 0 or 2 pairs of eyes on oral sucker (Fig. 10k); with 11 pairs of pulsatile vesicles (may or may not be conspicuous in Piscicola) along lateral margins of urosome (Fig. 10); oral and caudal sucker well developed, as wide as or wider than body width; body usually separated into distinct neck (trachelosome) and body (urosome) regions (except in some preserved individual, Fig. 10). 36

35(34) Dorsum with a series of 6 brownish-black longitudinal stripes, medial pair most conspicuous, extending from eyes to anal region; other pairs submarginal; preserved individuals can be contracted into 2 body regions; small oral and caudal suckers; body stout flattened centrally and convexed dorsally; mid-body somites 3-annulate; length 6-8 mm (Fig. 62). . . . . Piscicolaria reducta Meyer, 1940

Dorsum without longitudinal stripes, body elongate, narrow, and cylindrical or separated into a distinct narrow neck (trachelosome) and a wide body (urosome) regions; morphological variance of body shape of individuals known from fresh, brackish, and marine waters; colorless or with scattered stellate pigment cells; small oral and caudal suckers; mid-body somites 12- or 14-annulate; parasitic on a variety of fishes; length 9-30 mm (Figs. 63,64). . . . . .Myzobdella lugubris Leidy, 1851

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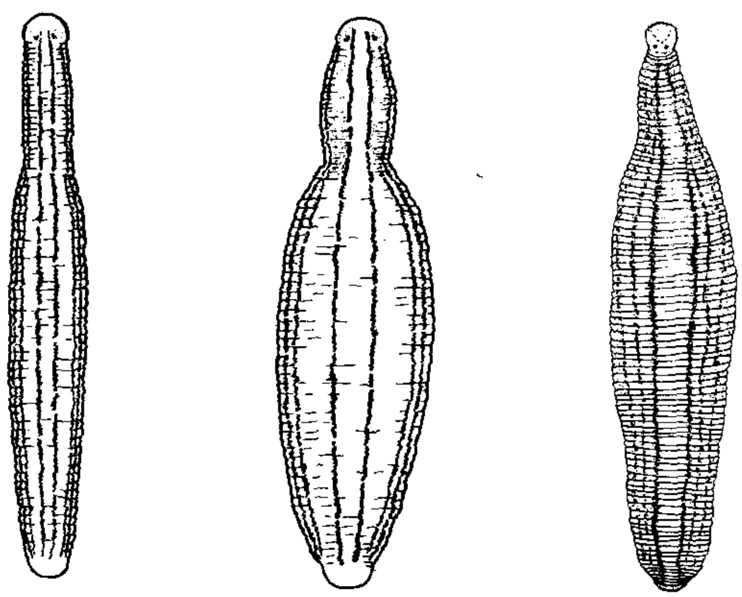

a b c

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FIG. 62. Piscicolaria reducta: (a-c) variable body shapes. FIG. 63. Myzobdsella lugubris, variable body shape.

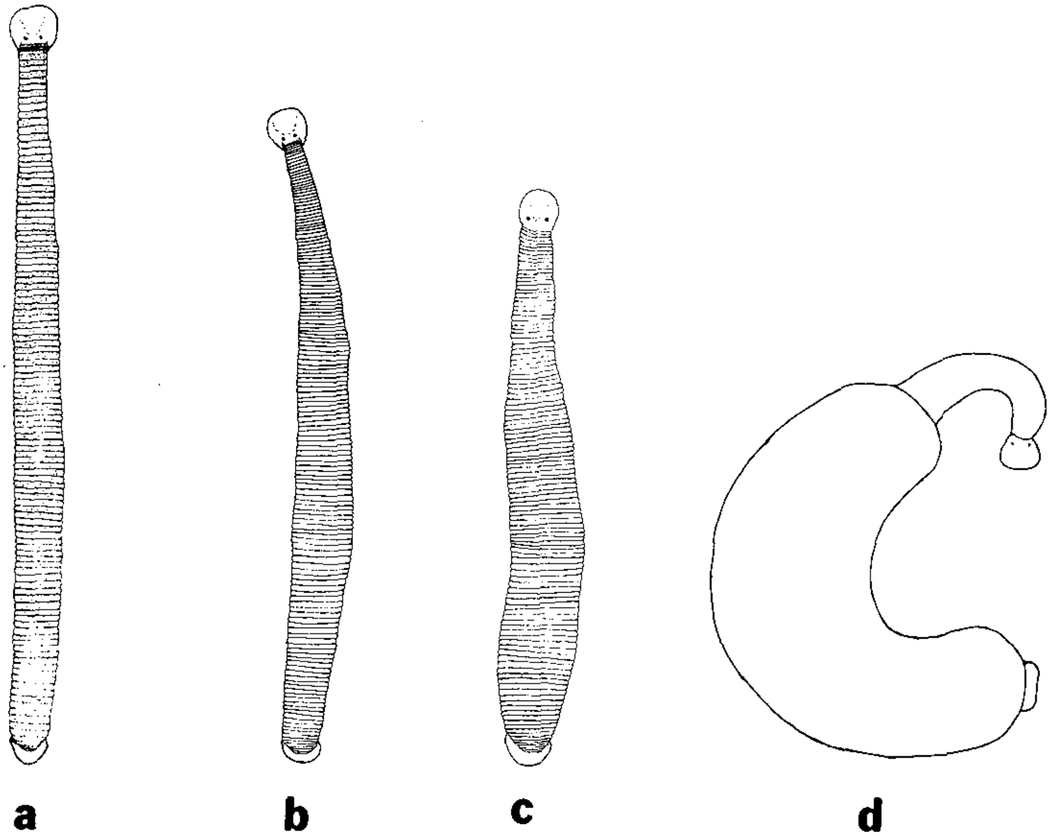

FIG. 64. Myzobdella lugubris: (a-d) variable body shapes.

36(34) Pulsatile vesicles large, each covering 4 annuli, and conspicuous even after preservation (Fig. 10a,c,d,e); body sharply separated into 2 regions (Fig. 10c,d,e,), a small narrow trachelosome and a wide urosome, body cyclindrical, may be flattened dorsoventrally; 7 annuli per segment. Cystobranchus. 37

Pulsatile vesicles usually small, each covering 2 annuli, obscure, difficult to see after preservation of specimens (Figs. 10f, g,h,i); body not clearly divided into trachelosome and urosome regions (Fig. 10a,f,g,h,i); body cylindrical or slightly flattened; 14 annuli per segment. Piscicola. 40

37(36) With eyespots (ocelli) on caudal sucker (Fig. 65a-d). 38

Without eyespots (ocelli) on caudal sucker (Fig. 65e-g). 39

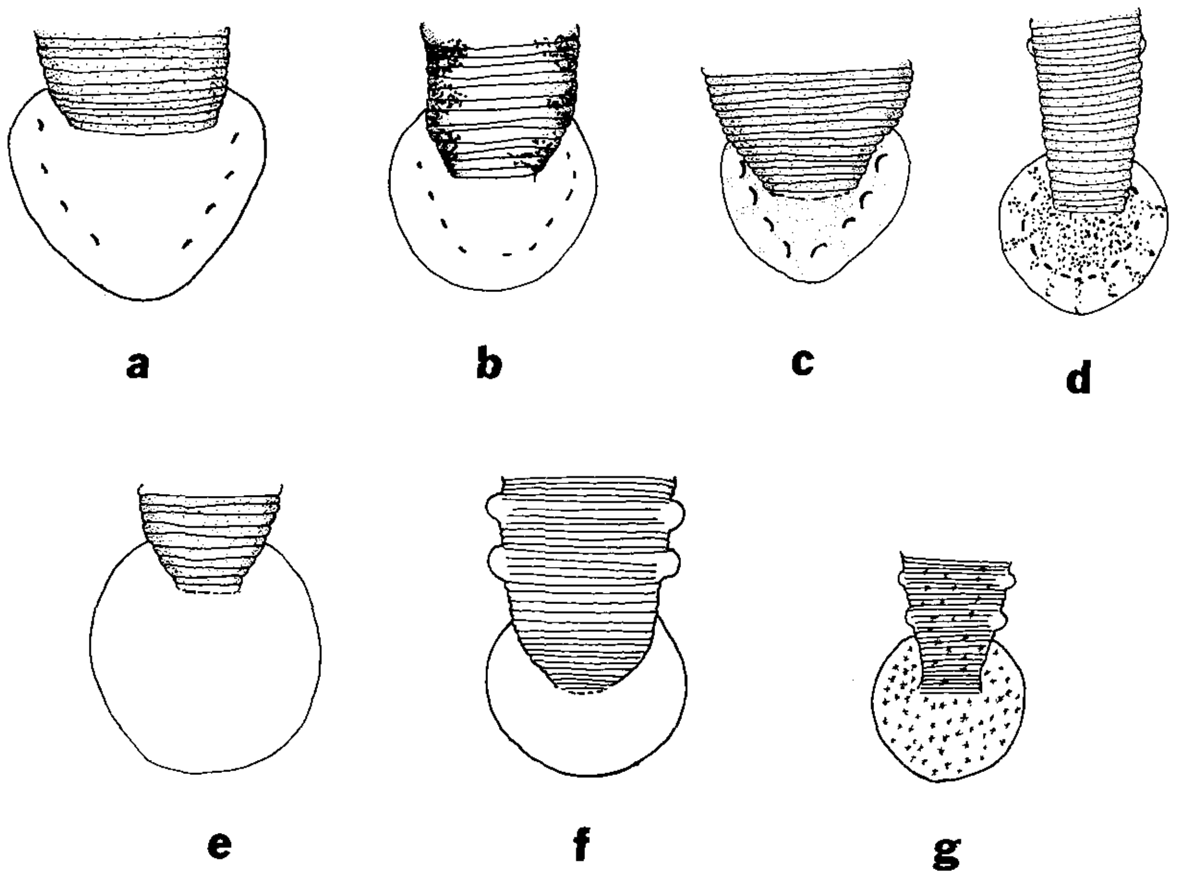

FIG. 65. Dorsal view of caudal sucker of Piscicolidae: (a,b) *punctiform* eyespots only; (c) crescentiform eyespots and pigmented rays; (d) punctiform eyespots and pigmented rays; (e-g) eyespots (ocelli) absent.

38(37) With 8 punctiform eyespots on caudal sucker (Fig. 65a); 2 rows of 12 lateral ocelli on each side of body (Fig. 10b, 66); caudal sucker approximately the same size as the body at its widest point; cephalic eyes 2 pairs; body cylindrical, slightly flattened; color, numerous dusky brown-black stellate pigment cells all over body, segmentation clearly marked by white bands or void of pigment; length 4-7 mm (Fig. 66). . . . . .Cystobranchus meyeri Hayunga & Grey, 1976

With 10 punctiform eyespots on caudal sucker (Fig. 65b); no lateral ocelli absent; caudal sucker approximately the same size as the body at it widest point; cephalic eyes 2 pairs; body cylindrical, slightly flattened, void of pigment, length 9-15 mm (Fig. 67). . . . . .Cystrobranchus virginicus Hoffman, 1964

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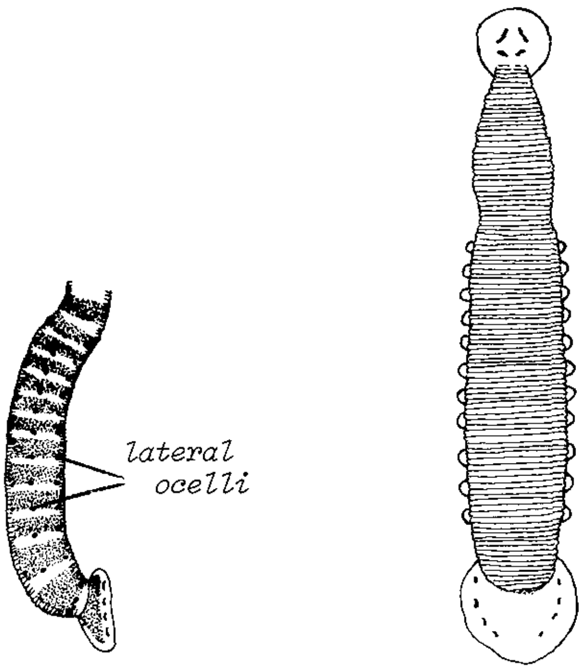

a b

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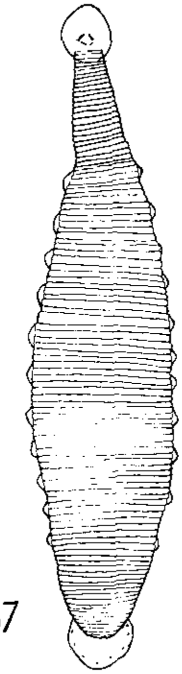

FIG. 66. Cystobranchus meyeri: (a) lateral view showing eyespots on body region and caudal sucker; (b) dorsal view. FIG. 67. Cystobranchus virginicus.

39(37) Eyes absent; caudal sucker large, as wide or wider than urosome (Fig. 65f); oral sucker small, distinct from neck region; devoid of pigment, or body tinged with brownish-gray transverse bands, and six more or less distinct bands on the neck or body tinged with brownish-gray, sprinkled with stellate flecks; body especially flattened; length up to 30 mm (Fig. 68). . . . . .Cystobranchus mammillatus (Malm, 1863)

Eyes 2 pairs; caudal sucker large, wider than urosome (Fig. 65g); oral sucker small, distinct from neck region; devoid of pigment, or with brownish-black stellate flecks profusely distributed over entire body; body not especially flattened; length 10-30 mm (Fig. 69). . . . . Cystobranchus verrilli Meyer, 1940

40(36) Caudal sucker with 8-14 eyespots (ocelli) (Fig. 65b-d). 41

Caudal sucker without eyespots (ocelli) (Fig. 65e); cephalic eyes 2 pairs (rarely 1 pair); body sucker large, clearly marked off from body; gonopores separated by 4 tertiary annuli; length 14-16 mm (Fig. 70). . . . . Piscicola punctata (Verrill, 1871)

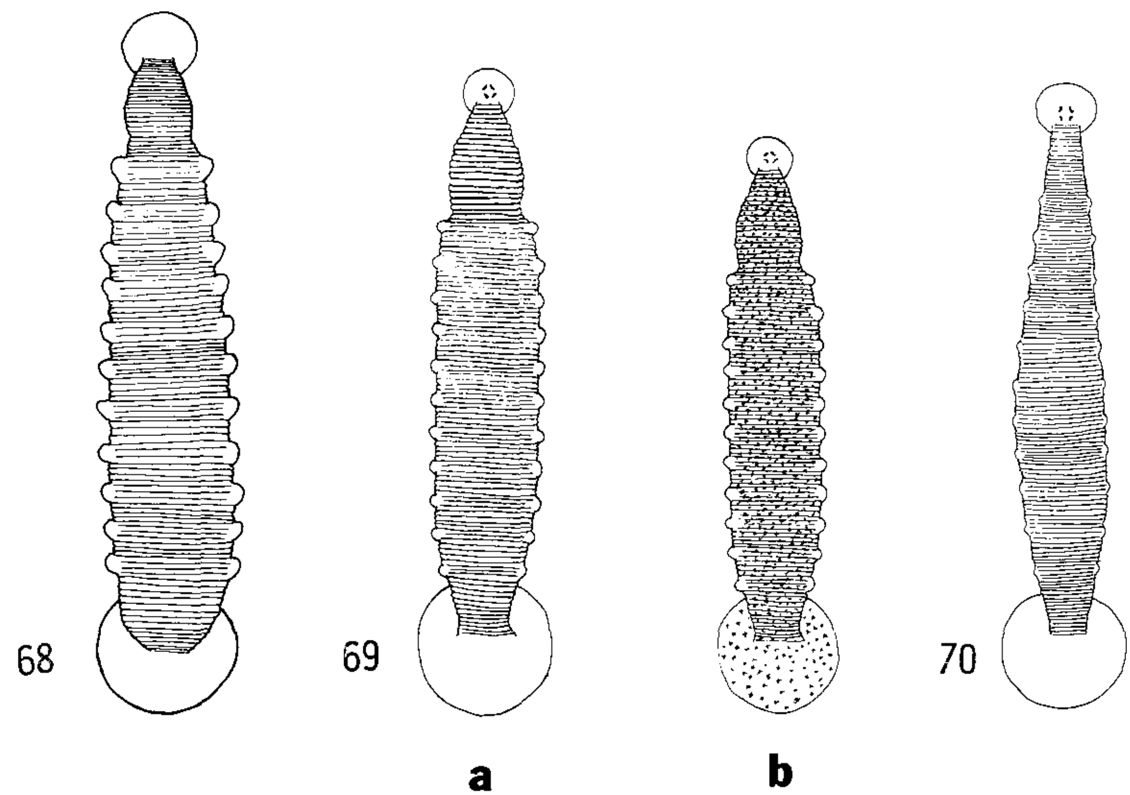

FIG. 68. Cystobranchus mammillatus. FIG. 69. Cystobranchus verrilli: (a) unpigmented form; (b) pigmented form. FIG. 70. Piscicola punctata.

41(40) With 10-14 punctiform eyespots on caudal sucker (Fig. 65b,d). . . .42

With 8-10 strongly crescentiform eyespots on caudal sucker (Fig. 65c); gonopores separated by 2 annuli; sperm duct much convoluted; known from western U.S. and Canada; parasite of salmonid fishes; length 10-31 mm (Fig. 71). . . . . .Piscicola salmositica Meyer, 1946

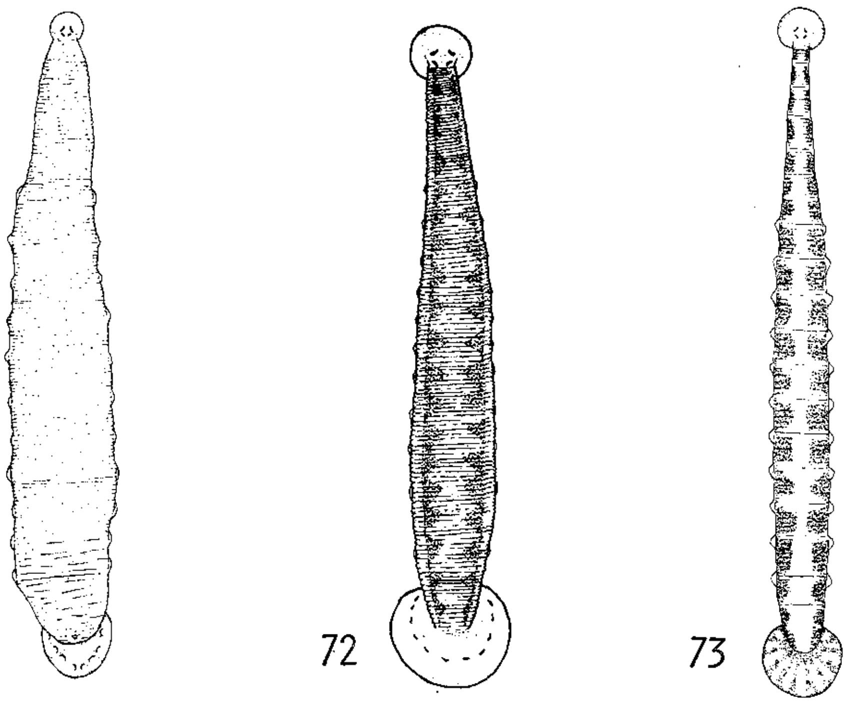

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FIG. 71. Piscicola salmositica. FIG. 72. Piscicola milneri. FIG. 73. Piscicola geometra.

42(41) With 10-12 (usually 10) punctiform eyespots on caudal sucker; dark rays absent (Fig. 65b), but variable; gonopores separated by 2 annuli; sperm duct simply looped; color in mid-body region yellowish with brownish-black stellate flecks disposed roughly in 5 longitudinal rows; dorsally these flecks form a slightly acute triangle and spread out laterally; length 16-24 mm (Fig. 72). . . . . .Piscicola milneri (Verrilli, 1874)

With 12-14 punctiform eyespots on caudal sucker, separated by dark pigmented rays (Fig. 65d); gonopores separated by 3 annuli; sperm duct simply looped; color greenish, yellowish, or brownish, usually finely sprinkled with minute brownish-black stellate flecks, disposed more or less regularly in longitudinal rows; length 20-30 mm (Fig. 73). . . . . .Piscicola geometra (Linnaeus, 1758)

43(4) With copulatory gland pores on the ventral surface, at about 10-11 annuli posterior to the male gonopore (Fig. 74a-d). Macrobdella. 44

Without copulatory gland pores on ventral surface (Figs. 74e-h) 47

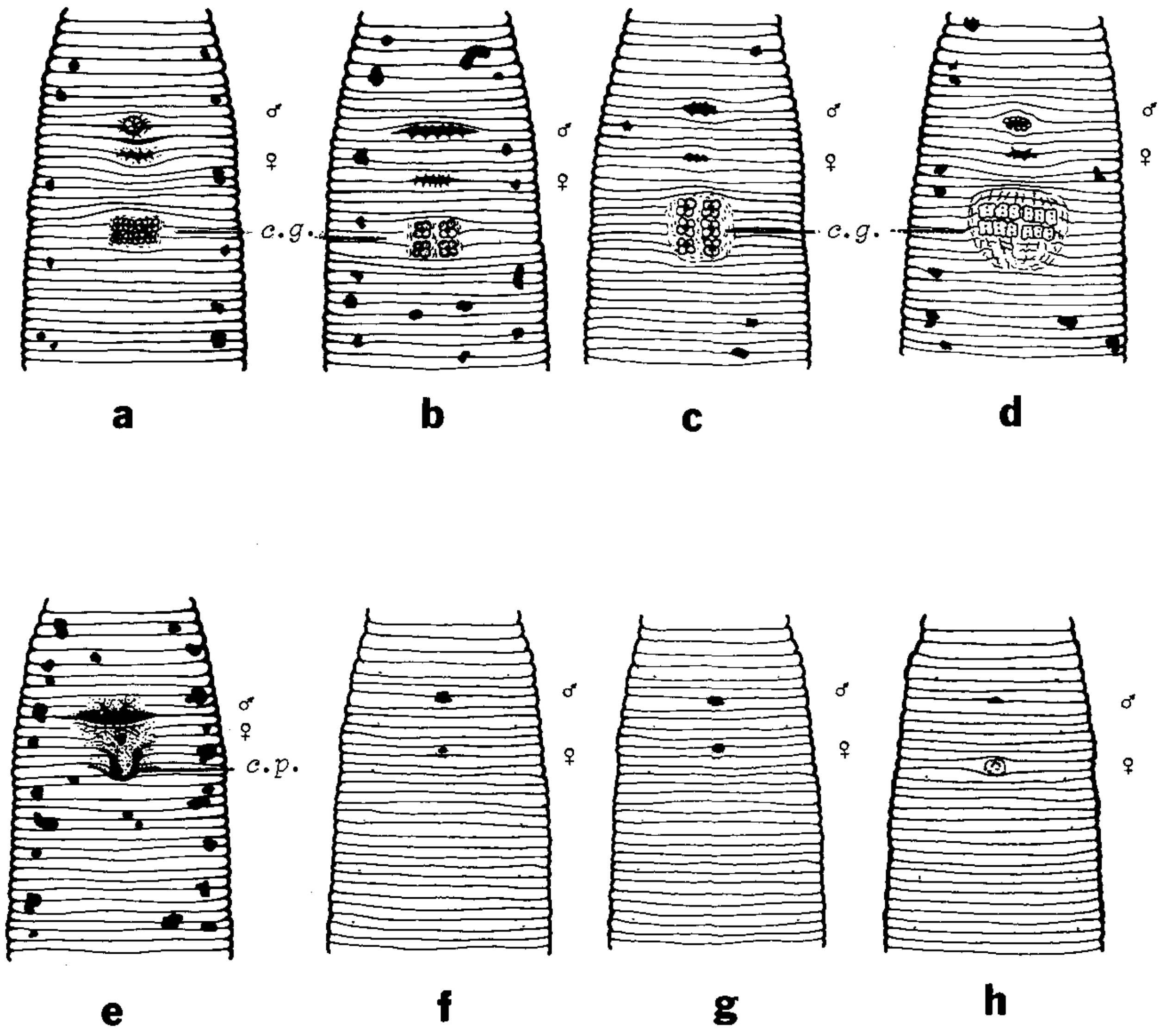


FIG. 74. Hirudinidae, external reproductive structures, ventral view: (a) Macrobdella ditetra; (b) Macrobdella decora; (c) Macrobdella diplotertia; (d) Macrobdella sestertia; (e) Philobdella gracilis; (f) Haemopis marmorata: (g) Haemopis terrestris; (h) Haemopis septagon. c.g. copulatory glands; c.p. copulatory pits; ♀♂ gonopores (male and female).

44(43) Dorsum with about 21 red or orange dots in median line. 45

Dorsum without red or orange dots; ventral surface with 8 copulatory gland pores (2 rows of 4) (Fig. 74a); 2 annuli between gonopores; color of dorsum drab brown or gray, usually with a darker median field, 1/3 body width, usually with lateral black irregular dots; ventrum yellowish with some or no black blotches; length 100 to 150 mm (Fig. 75). . . . . .Macrobdella ditetra Moore, 1953

45(44) With 4 or 6 copulatory gland pores on ventral surface (Fig. 74b,c). 46

With 24 copulatory gland pores (with rows of 2 groups, containing 6 gland pores each) situated on a raised pad in adults, (Fig. 74d); 2-2 1/2 annuli between gonopores, color of dorsum olive green with a median row of red or orange dots, with faint black irregular striping along midline, lateral margins with row of black spots; ventral surface reddish or orange, with some black spots; length 100-150 mm (Fig. 76). . . . . .Macrobdella sestertia Whitman, 1886

46(45) Four copulatory gland pores (2 rows of 2) on ventral surface (Fig. 74b); 5-5 1/2 annuli between gonopores; color of dorsum green with median of red or orange dots, lateral black spots; ventral surface red or orange with some black spots; length 110-150 mm (Fig. 77). . . . . .Macrobdella decora (Say, 1824)

Six copulatory gland pores (3 transverse rows of 2 each) (Fig. 74c); 4 1/2-5 annuli between gonopores; color of dorsum light gray with median row of red or orange dots, lateral margins with row of black spots; ventral surface light yellow or gray, lateral margins of dorsum same color as ventrum; length 100-150 mm (Fig. 78). . . . . .Macrobdella diplotertia Meyer, 1975

47(43) Glandular area around gonopores; gonopores separated by 3-4 annuli, obscured by deep copulatory depressions and pits (Fig. 74e); dorsum usually with a yellow or brown median stripe. Philobdella. 48

Lacking glandular area around gonopores; gonopores separated by 5-7 annuli (Fig. 74f-h); dorsum with a black median stripe (sometimes faint), several longitudinal stripes, or no stripes either mottled, blotched, or plain. 49

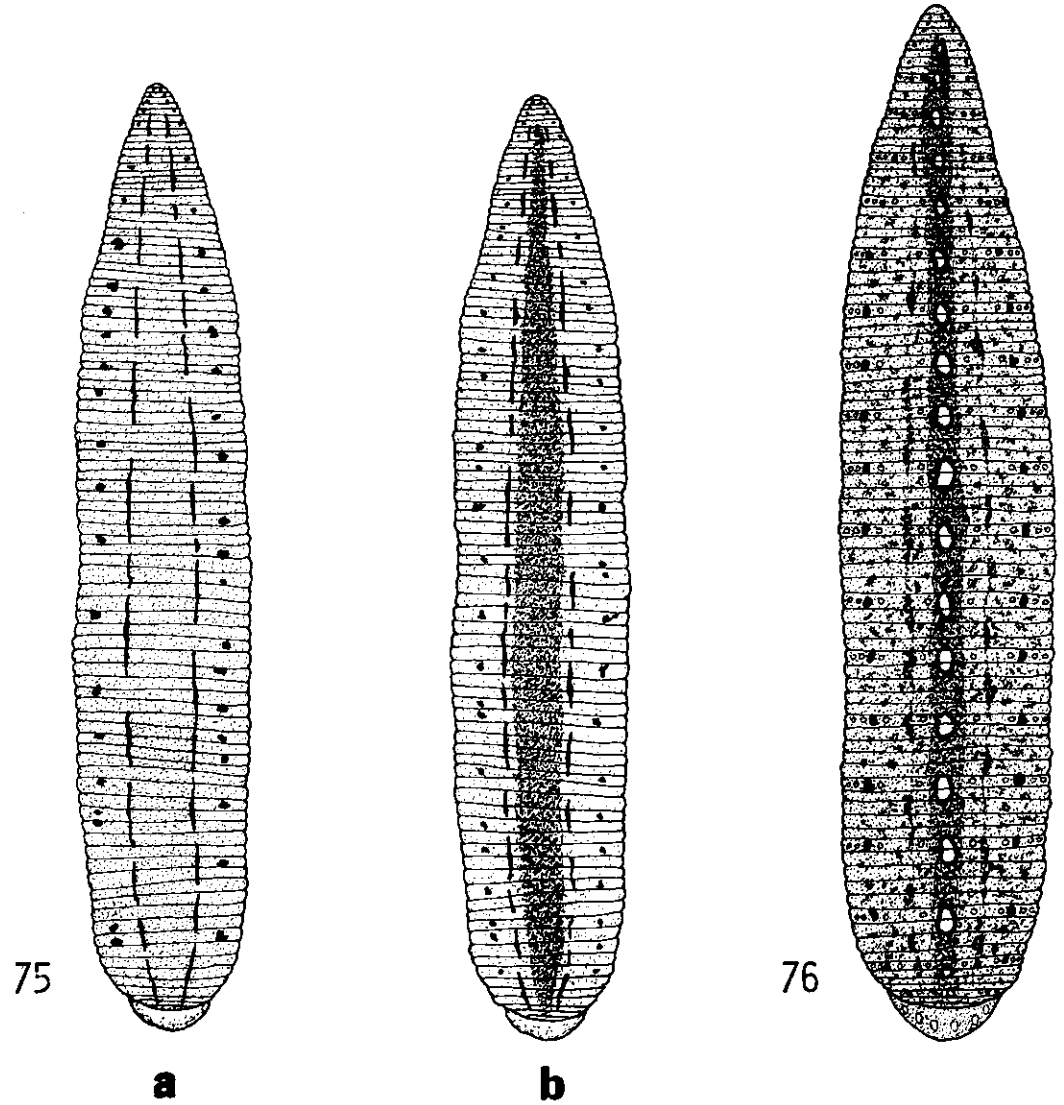
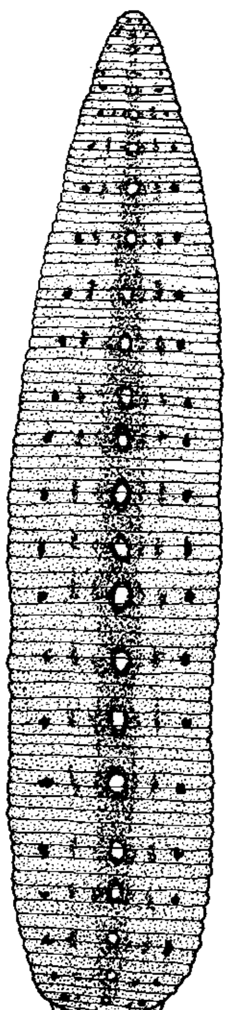


FIG. 75. Macrobdella ditetra: (a,b) variable pigmented forms. FIG. 76. Macrobdella sestertia.



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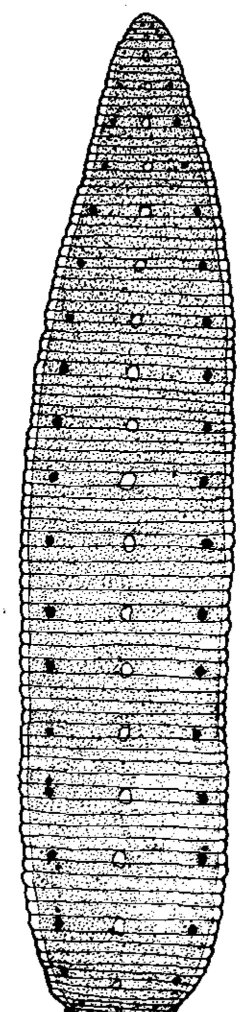

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FIG. 77. Macrobdella decora.

FIG. 78. Macrobdella diplotertia.

48(47) Middorsal stripe dark brown, if present, with two faint reddish-brown bands along each side toward margins, separated by a narrow black stripe, lateral margins with irregular black stripes, sometimes broken but no discrete spots; 20-26 teeth per jaw; length 40-85 mm (Fig. 79). . . . . .Philobdella floridana (Verrill, 1874)

Middorsal stripe light yellow, with dorsolateral brownish-black irregular flecks or spots; ventral surface light yellow with some irregular black flecks or spots near margins; about 35-48 teeth per jaw; length 40-85 mm (Fig. 80). . . . . Philobdella gracilis (Moore, 1901)

49(47) Dorsum uniformily gray with a median longitudinal black stripe; uniformly dark-olive green with faint longitudinal dark stripes along midline and numerous small irregular scattered black flecks; or with no middorsal stripes but with few, moderately to heavily blotched, spotted, mottled with olive, yellow, dark gray or black; sometimes uniform color. Haemopis. 50

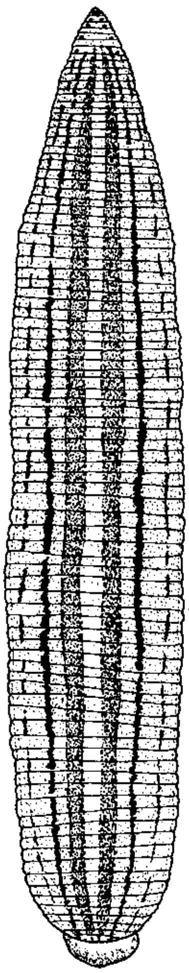
Dorsum with 4 or 6 longitudinal reddish-yellow stripes forming an ornate pattern on dorsum; color pattern variable, greenish with irregular black margins; ventral surface black with white and gray markings; probably not established in North America, sometimes purchased in drug stores; length, to 100mm (Fig. 81). . . . . Hirudo medicinalis Linnaeus, 1758

50(49) Gonophores separated by 5-5 1/2 annuli, female gonopore small (Fig. 74f,g). 51

Gonopores separated by 6 1/2-7 annuli (Fig. 74h); female gonopore large, conical (nipple-like) in adults, flattened in immatures; 15 pair of teeth per jaw; dorsum uniformly dark olive-green with faint longitudinal dark stripes along midline and numerous small irregularly scattered black flecks; dorsal portion of caudal sucker with black flecks; parts of certain annuli darker than others dorsally; ventrum, lighter olive-green without flecks; occasionally with yellow marginal band; body firm; length, to 200 mm (Fig. 82). . . . . Haemopis septagon Sawyer & Shelley, 1976

51(50) Dorsal surface with a median black stripe. 52

Dorsal surface with few, moderately to heavily blotched, spotted, or irregular scattered black flecks, mottled with olive, yellow, dark gray or black; sometimes uniform color; no middorsal black stripes. 53



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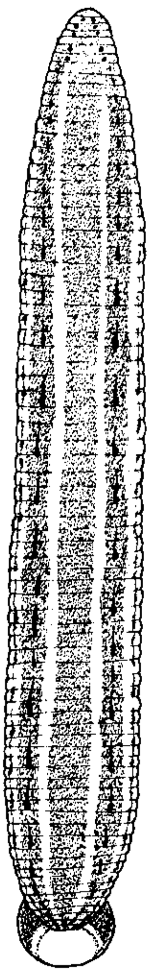

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FIG. 79. Philobdella floridana. FIG. 80. Philobdella gracilis. FIG. 81. Hirudo medicinalis.

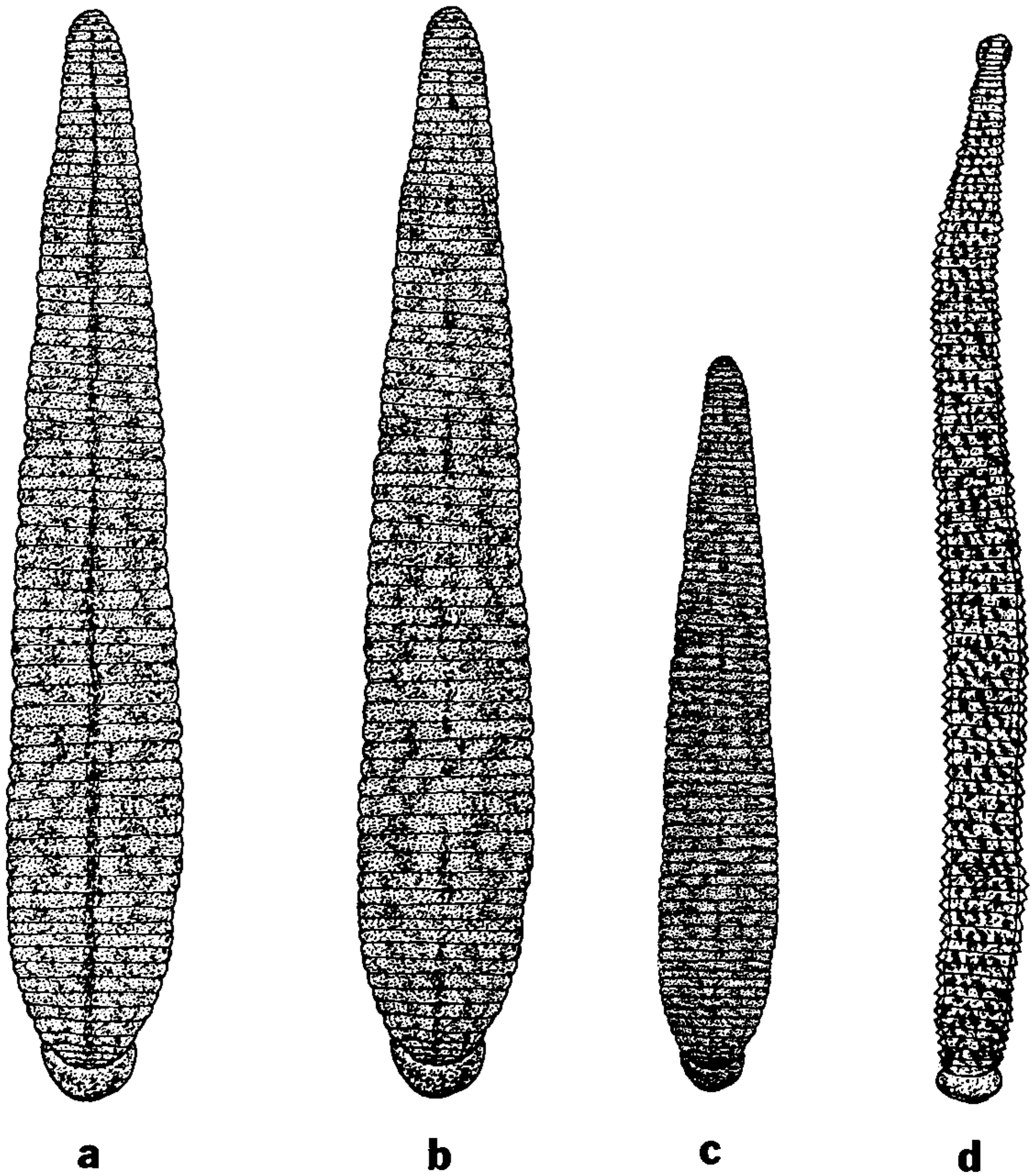


FIG. 82. Haemopis septagon: (a-d) variable pigmented forms.

52(51) Color of dorsum uniformly black or slate gray, with median longitudinal black stripe and reddish-orange or brownish-yellow band along margins; ventrally lighter, uniform, few or no dark blotches or flecks; posterior sucker smaller than body width; jaws with 20-25 pairs of teeth; body firm; length 150-200 mm (Fig. 83). . . . . *Haemopis terrestris* (Forbes, 1890)

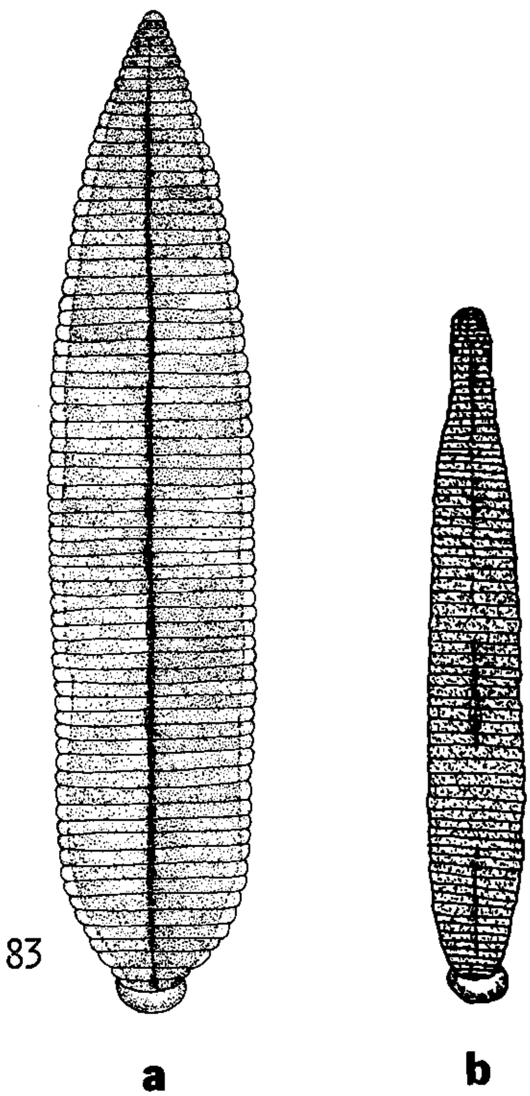
Color of dorsum brownish-green to olive, with scattered black and yellowish-orange blotches (usually more black than yellow-orange), middorsal black stripe and sometimes paired lateral longitudinal dark stripes; margins conspicuously mottled with yellowish-orange blotches forming broken longitudinal lines, ventrally darker, slate gray, uniform, occasional yellowish-orange blotches; posterior sucker as large as body width; young with metameric black transverse bands (Fig. 84a); jaws with 9-12 pairs of teeth; body firm; length 60-110 mm (Fig. 84b). . . . . *Haemopis kingi* Mathers, 1954

53(51) With jaws and teeth (Fig. 85a-d). 54

Without jaws and teeth (Fig. 85e-g). 55

54(53) Jaws with 10-12 pairs of teeth; gonopores separated by 5 annuli, color olive-green with moderately to heavy black blotching dorsally with few scattered yellow blotches; ventrally darker, uniform gray, few indistinct black or yellowish blotches; caudal sucker large, about 3/4 width of body, discoid, broadly attached by very short pedicel which tapers to direct attachment to somite (XXVII); length 50-85 mm (Fig. 86). . . . . *Haemopis lateromaculata* Mathers, 1963

Jaws with 12-16 pairs of teeth; gonopores separated by 5 annuli; color variable, usually olive-green, yellowish-gray with moderate to heavy black mottling or blotched dorsally and ventrally; or uniform slate gray with few irregular black blotches, resembling *H. grandis*; caudal sucker about 1/2 width of body; length 75-100 mm (Fig. 87). . . . . *Haemopis marmorata* (Say, 1824)



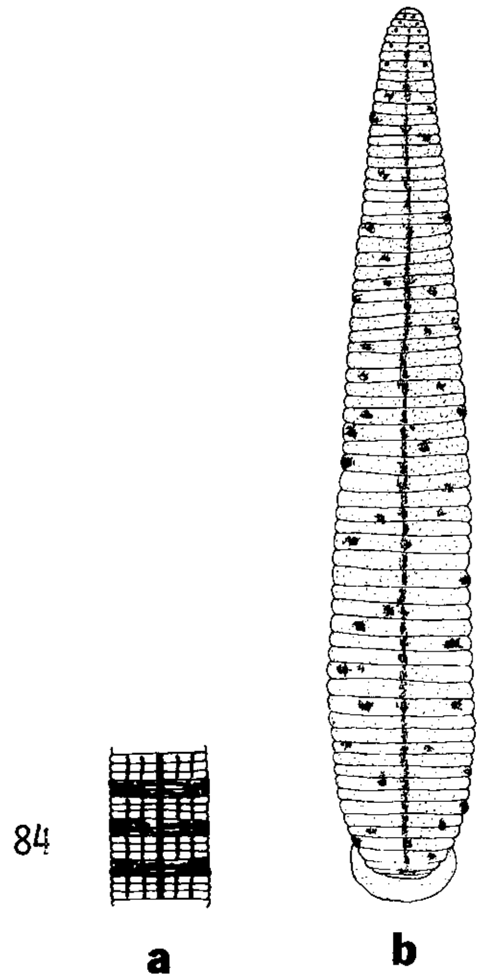


FIG. 83. Haemopis terrestris: (a) adult; (b) juvenile. FIG. 84. Haemopis kingi: (a) dorsal view of two somites showing juvenile checkerboard color pattern; (b) adult.

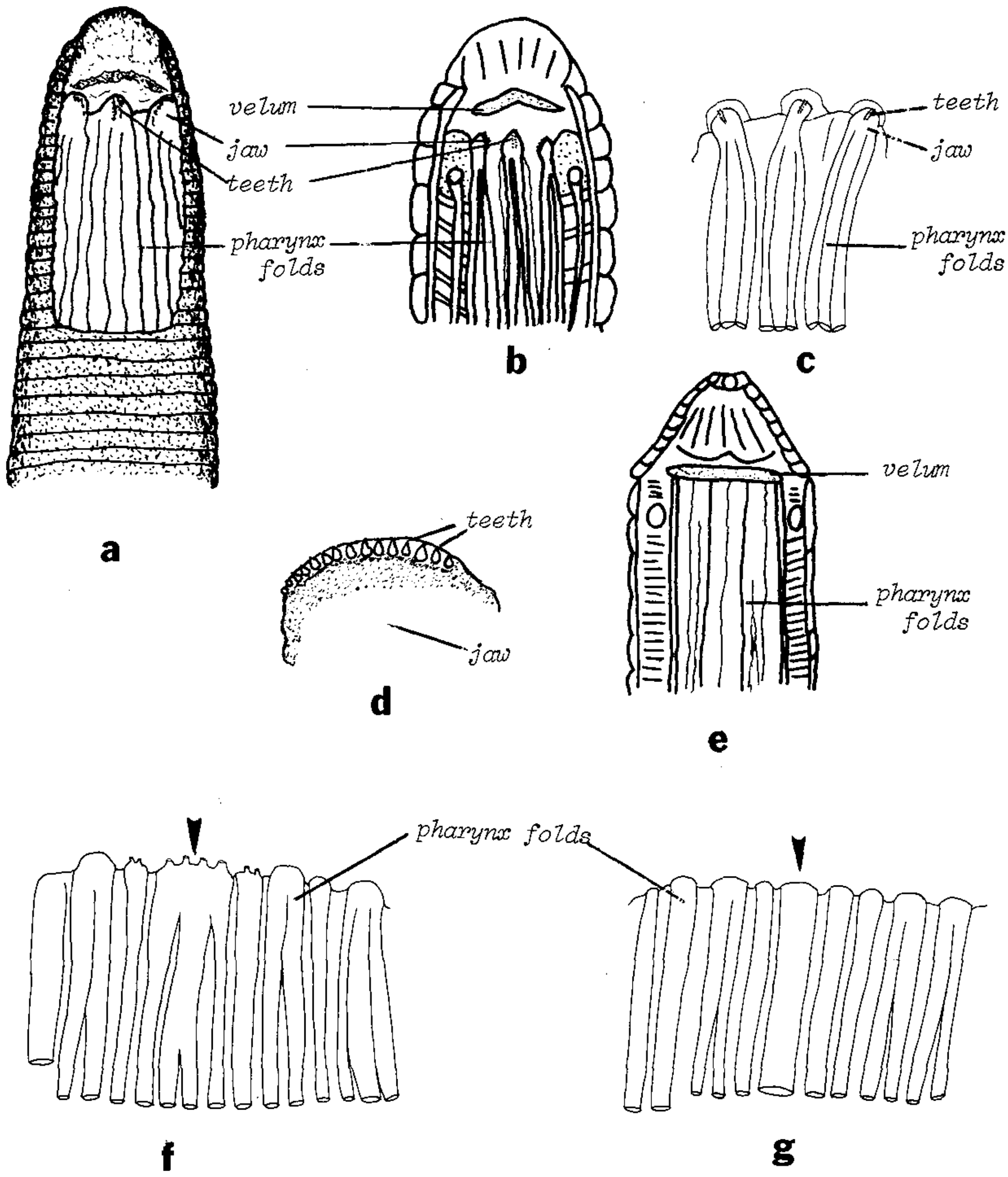


FIG. 85. Dissected mouth and buccal cavity: (a,b) Haemopis marmorata, ventral view; (c) Haemopis marmorata, pharynx and associated structures; (d) Haemopis marmorata, teeth and jaw, lateral view; (e) location of velum and pharynx, without teeth and jaws, ventral view; (f) Haemopis plumbea, dissected pharynx: (g) Haemopis grandis, dissected pharynx. The pharynx (f,g) is shown as opened along the midventral line, centered on the middorsal line.

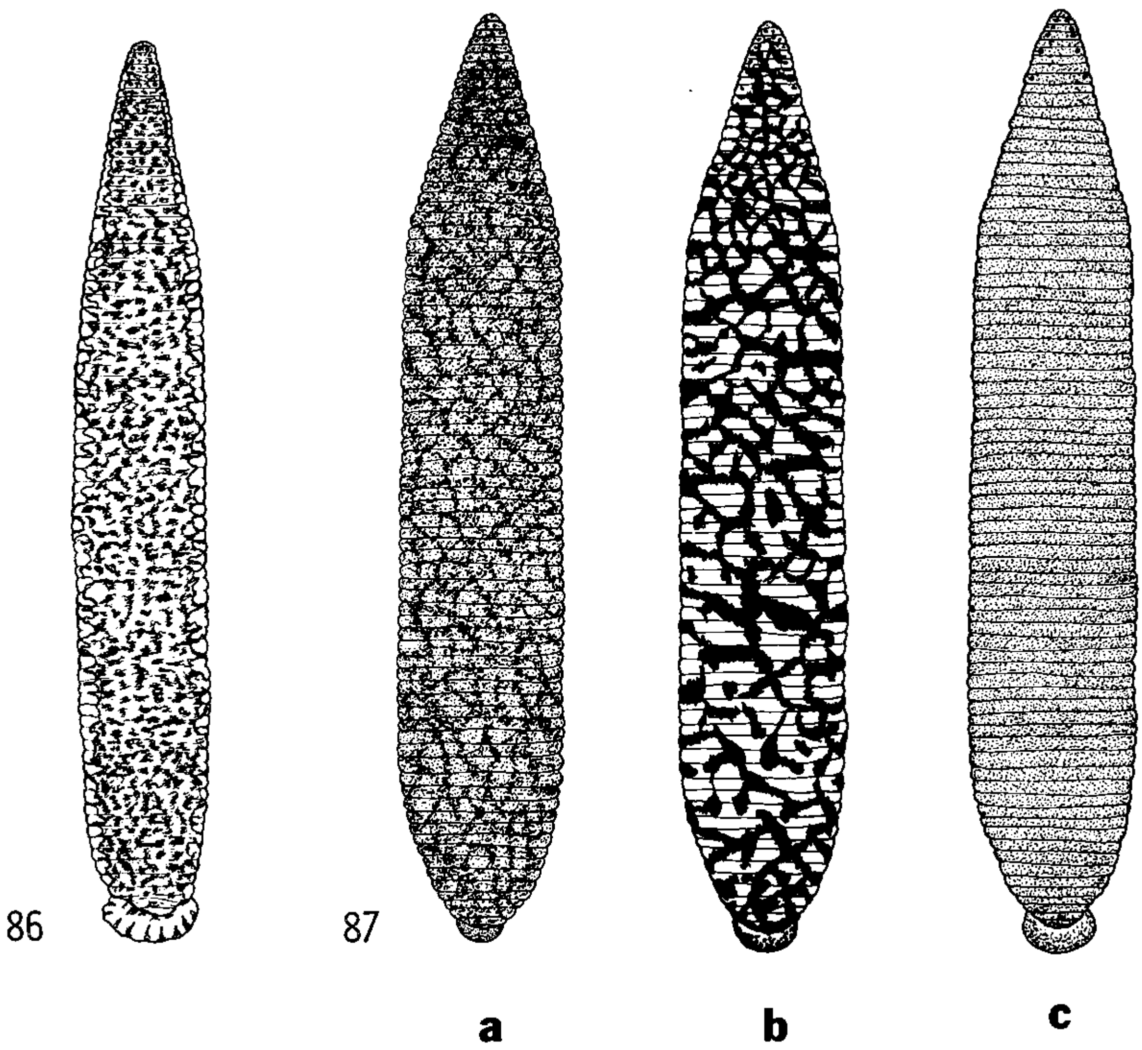
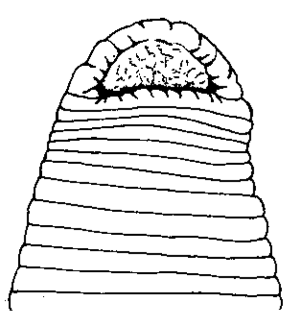


FIG. 86. Haemopis lateromaculata. FIG. 87. Haemopis marmorata, variable forms: (a) dark colored, mottled phase; (b) light colored, mottled phase; (c) dark colored, immaculate phase.

55(53) Margin of oral sucker thick, rounded, aperture transverse, the lower margin anteriorly convex (Fig. 88); lower surface of velum (Fig. 85e), closely and finely papillate; pharynx with 15 folds (Fig. 85f); color of dorsum grayish with few, or no black blotches, with reddish or yellowish-orange band along margins; gonopores in middle of annuli, separated by 5 1/2 annuli; length 140-200 mm (Fig. 90). . . . . Haemopis plumbea Moore, 1912

Margin of oral sucker thin, aperture elongate (arched), the lower margin sharply concave (Fig. 89); lower surface of velum (Fig. 85e), smooth; pharynx with 12 folds (Fig. 85g); color variable usually shades of dull green, gray, or plain, always more or less blotched with black or none; gonopores in furrows, separated by 5 annuli; length 150-300 mm (Fig. 91). . . . . Haemopis grandis (Verrill, 1874)



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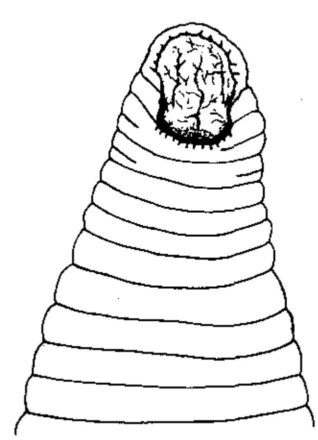

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FIG. 88. Haemopis plumbea, oral sucker. FIG. 89. Haemopis grandis, oral sucker.

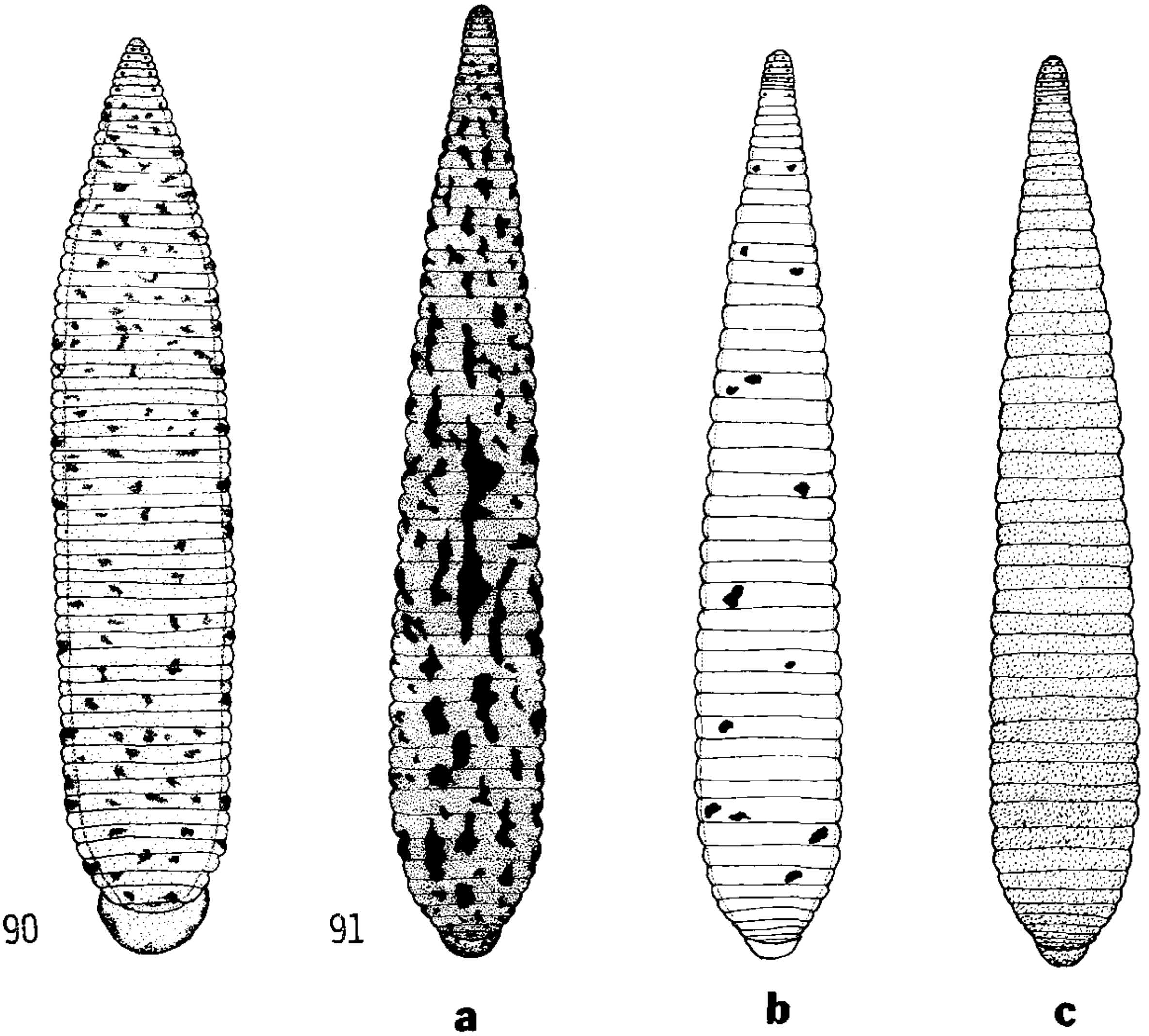

FIG. 90. Haemopis plumbea. FIG. 91. Haemopis grandis, variable forms: *(a) dark colored, heavy spotted, blotched phase; (b) light colored,* irregularly spotted, blotched phase; (c) dark colored immaculate phase.

56(4) With 0-3 pairs of eyes (Fig. 13b). 57

With 4 pairs of eyes (Fig. 13c,d). 64

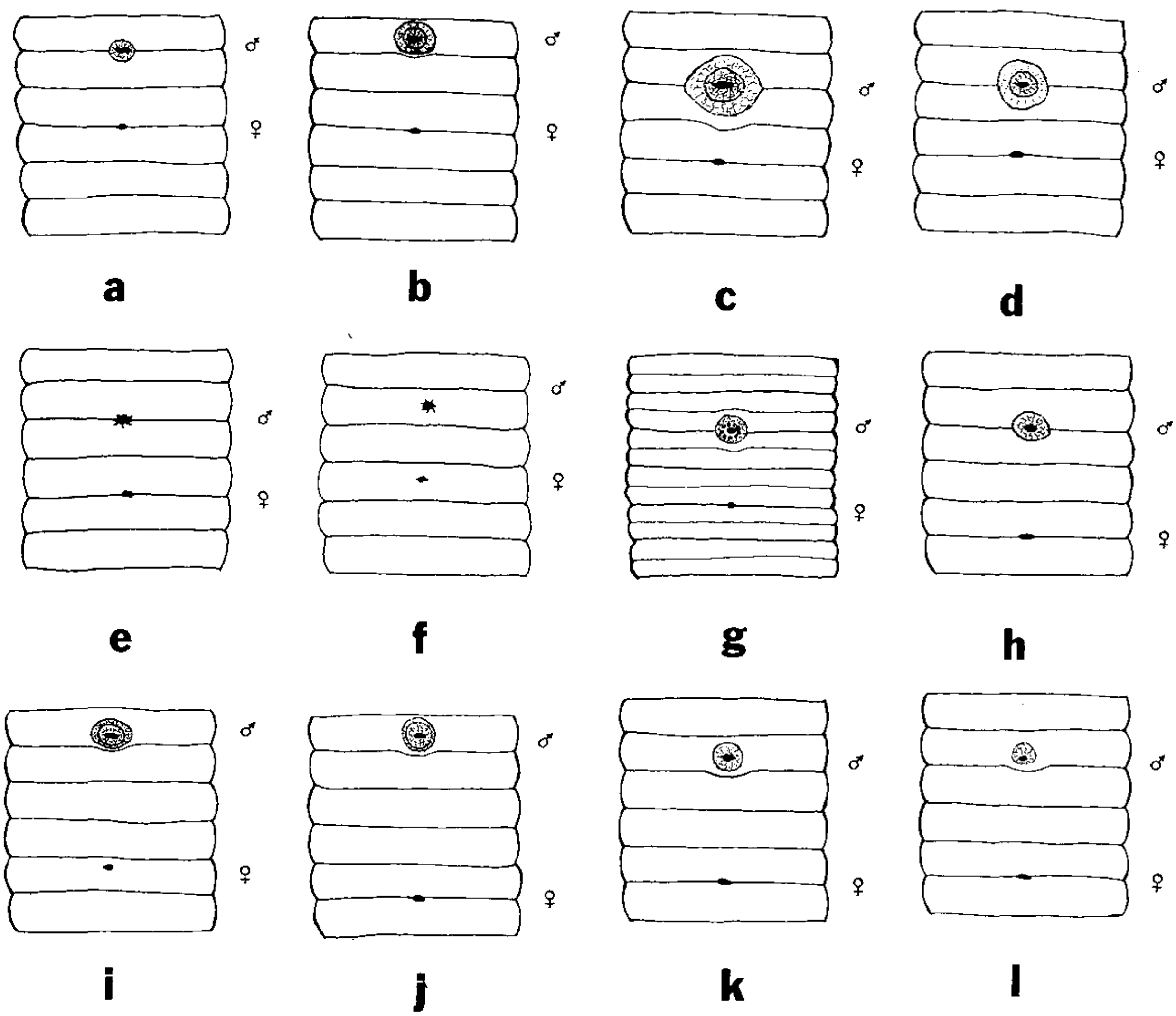

FIG. 92. Erpobdellidae, showing relative position of male and female gonopores: (a) Mooreobdella melanostoma; (b) Erpobdella punctata coastalis; (c) Erpobdella punctata punctata: (d) Mooreobdella fervida; (e,f) Mooreobdella bucera; (g) Nephelopsis obscura; (h) Mooreobdella microstoma; (i,j) Mooreobdella tetragon; (k) Dina dubia; (l) Dina parva.

57(56) Dorsum lacking pigment or color uniformly gray, black, heavily barred or with longitudinal stripes, spots, but never scattered black pigment concentrations. 58

Dorsum with scattered black pigment concentrations, body color whitish; gonopores separated by 2 annuli in furrows (Fig. 92a); atrium large, with cornua (horns) projecting anteriorly (slightly medially), sperm ducts lacking preatrial loops, ending abruptly at atrium (Fig. 93a); length, to 55 mm (Fig. 94). . . . . . . Mooreobdella melanostoma Sawyer & Shelley, 1976

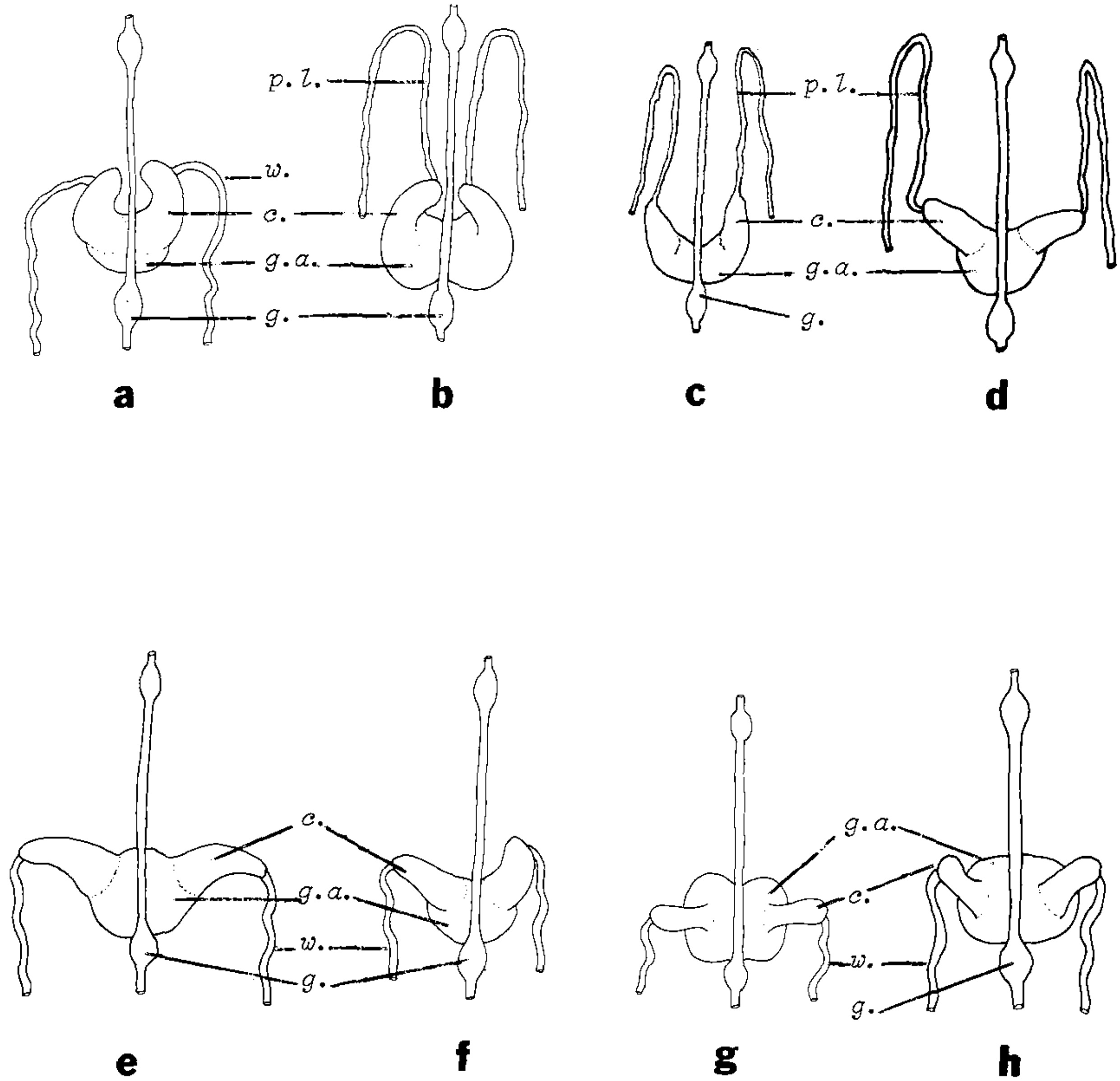

FIG. 93. Dorsal view of dissected male genital atarium and ejaculatory ducts with or without long preatrial loops: (a) Mooreobdella melanostoma; (b) Erpobdella punctata punctata or Erpobdella punctata coastalis; (c) immature, Erpobdella punctata punctata; (d) Dina anoculata; (e) Mooreobdella bucera; (f) Mooreobdella fervida; (g,h) Mooreobdella microstoma. c. cornua (paired horns); g. XII, twelfth ganglion; g.a. genital atrium; p.l. preatrial loop; w. without preatrial loop.

58(57) With 2-2 1/2 annuli between gonopores in furrows or on the rings (Fig. 92a-g). 59

With 3-4 1/2 annuli between gonopores in furrows or on rings (Fig. 92h-1). 63

59(58) Gonopores separated by 2 annuli (Fig. 92c-e,g), except <u>Mooreobdella</u> <u>bucera</u> (sometimes 2 1/2 annuli, Fig. 92f). . . . 60

Gonopores separated by 2 1/2 annuli (Fig. 92b), male gonopore on ring, female gonopore in furrow; without paired paramedial black strips and sensillae; color uniform gray; atrium longer than wide, atrial cornua (horns) simply curved, sperm ducts with preatrial loops, extending anteriorly to ganglion XI (Fig. 93b); length, to 100 mm (Fig. 95). . . . . <u>Erpobdella</u> <u>punctata</u> <u>coastalis</u> Sawyer & Shelley, 1976

60(59) Dorsum pigmented with longitudinal black flecks, stripes, spots, heavily barred, almost black, or lightly pigmented. 61

Dorsum either lacking pigment, uniform gray (pale red or darker clouding, sometimes with minute black pigment) or pigmented with two narrow or broad, dark longitudinal stripes extending over entire body, including always lighter median stripe. 62

61(60) With 2 or 4 rows of black pigment concentrations on dorsal surface, forming longitudinal stripes or irregular spots, median 2 pronounced, submarginal ones wanting in immature forms; some individuals with black bars or heavily pigmented, almost black on dorsum; occasionaly a white form with median scattered minute black chromatophores; eyes 3 pairs; sensillae on annuli may be conspicuous; gonopores in furrows, separated by 2 annuli (Fig. 92c), male gonopore in adults very large; atrium longer than wide, atrial cornua (horns) simply curved, sperm ducts with preatrial loops, extending anteriorly to ganglion XI (Fig. 93b,c); length to 100 mm (Fig. 96,97). . . . . <u>Erpobdella</u> <u>punctata</u> <u>punctata</u> (Leidy, 1870)

With 4 longitudinal stripes on dorsal surface of grayish or dull black, of which outer pairs, submarginal, duller in color, and narrower than more distinct inner pair, well separated by a median stripe of ground color or lacking pigment, uniform gray; eyes lacking or 3 pairs; no sensillae on annuli; gonopores separated by 2 annuli in furrows (Fig. 92d); male gonopore surrounded by circle of papillae; atrium longer than wide, atrial (cornua) horns simply curved, sperm ducts with preatrial loops, extending anteriorly to ganglion XI (Fig. 93d); length 10-15 mm (Fig. 98). . . . . <u>Dina</u> <u>anoculata</u> Moore, 1898

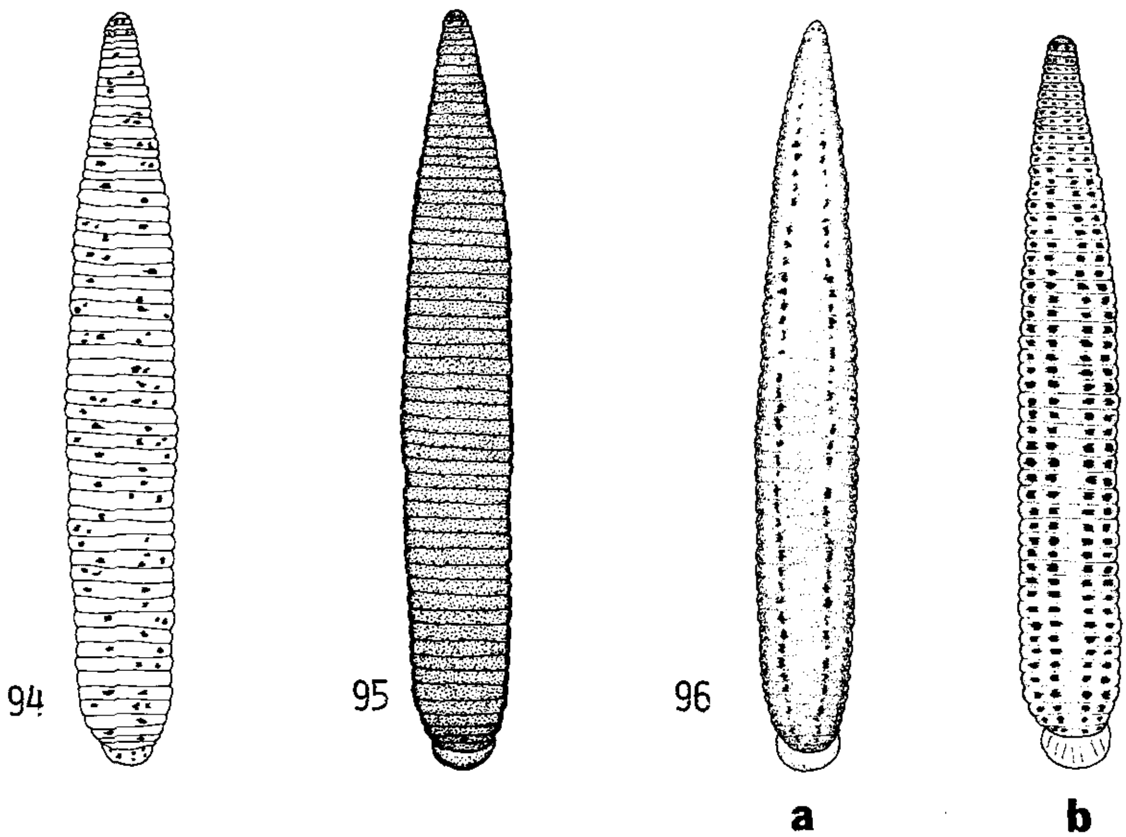

FIG. 94. Mooreobdella melanostoma. FIG. 95. Erpobdella punctata coastalis. FIG. 96. Erpobdella punctata punctata: (a) 2 rows of black pigment concentrations; (b) 4 rows of black pigment concentrations.

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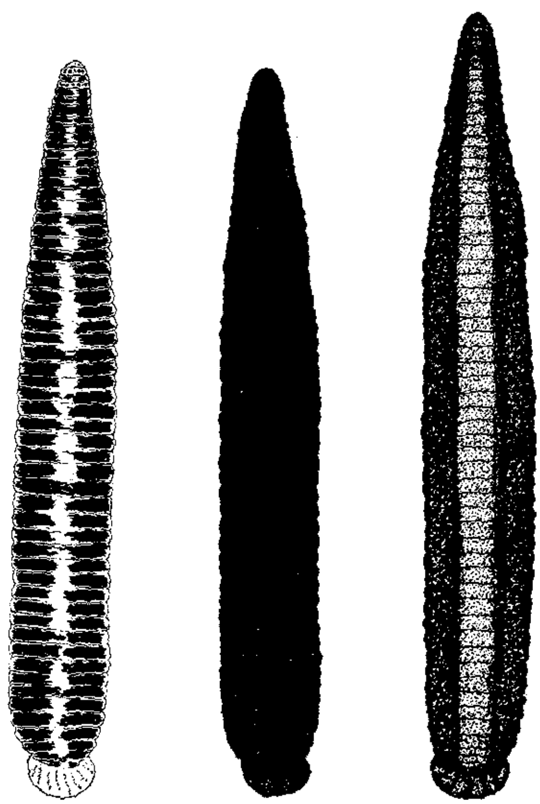

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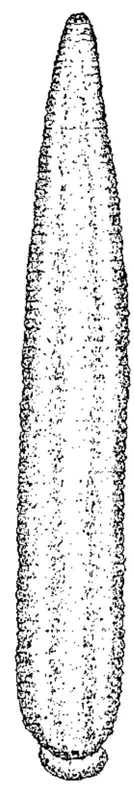

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FIG. 97. Erpobdella punctata punctata: (a) black barred phase; (b) dark pigment phase; (c) striped phase. FIG. 98. Dina anoculata. FIG. 99. Mooreobdella bucera.

62(60) Gonopores separated by 2 (sometimes 2 1/2) annuli in furrows or on rings (Fig. 92e,f); color uniform smokey gray without black pigment; live specimens reddish from cutaneous blood vessels, eyes 3 pairs; atrium globoid, with cornua (horns) projecting laterally, with sperm ducts lacking preatrial loops, ending abruptly at atrium (Fig. 93e); length 10-30 mm (Fig. 99) . . . . .Mooreobdella bucera Moore, 1949

Gonopores separated by 2 annuli, usually in furrows (Fig. 92d); color uniform smokey gray, lacking pigment entirely, or with darker clouding, sometimes with minute black pigment, or with two, narrow or broad, dark longitudinal stripes extending over dorsum, including always a lighter median stripe, eyes usually 3 (sometimes 4) pairs; atrium globoid with prominent cornua (horns) longer than its diameter projecting anteriorly, sperm ducts lacking preatrial loops, ending abruptly at atrium (Fig. 93f); length 20-50 mm (Fig. 100). . . . . Mooreobdella fervida Verrill, 1871

63(58) Gonopores separated by 3 annuli, usually in furrows (Fig. 92h); color reddish from blood showing through or in preserved specimens, light yellowish-gray or smokey-gray, no black pigment; atrium ellipsoidal, wider than long, with cornua (horns) shorter than diameter of median atrium, projecting anteriorly, with sperm ducts lacking preatrial loops, ending abruptly at atrium (Fig. 93g,h); eyes 3 pairs, length 30-50 mm (Fig. 101). . . . . .Mooreobdella microstoma (Moore, 1901)

Gonopores separated by 4-4 1/2 annuli, usually on rings (Fig. 92i,j); color of dorsal surface uniformly smokey-gray without black pigmentation; atrium wider than long, atrial cornua (horns) projecting anterolaterally to anteriorly; with sperm ducts lacking preatrial loops, ending abruptly at atrium; eyes 3 pairs; length to 40 mm (Fig. 102). . . . . Mooreobdella tetragon Sawyer & Shelley, 1976

64(56) Gonopores separated by 2 annuli (Fig. 92d,g). 65

Gonopores separated by 3 1/2 (sometimes 2 1/2-4) annuli (Fig. 92k,l). 66

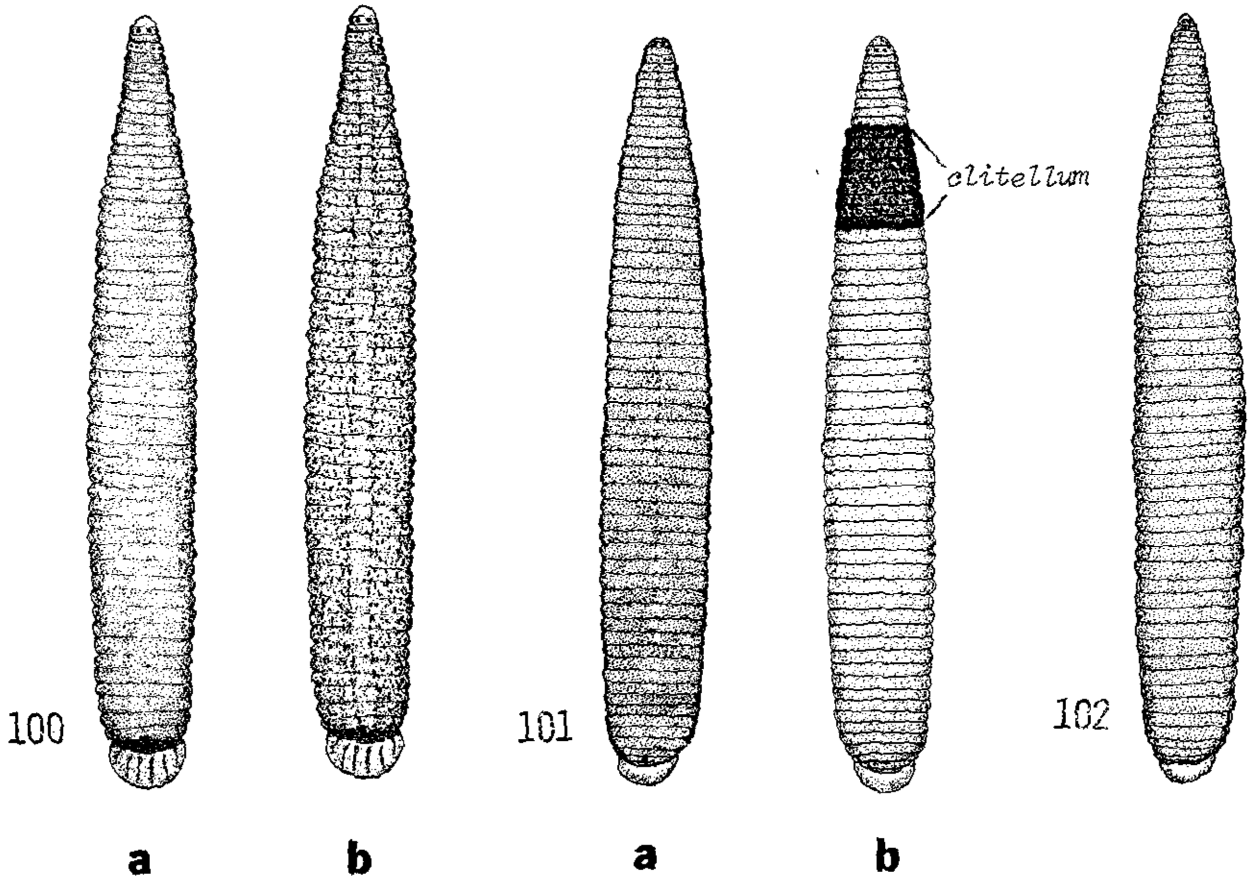


FIG. 100. Mooreobdella fervida: (a-c) variable forms. FIG. 101. Mooreobdella microstoma: (a) without developed clitellum; (b) with developed clitellum. FIG. 102. Mooreobdella tetragon.

65(64) Eyes 4 pairs, anterior 2 pairs and posterior 2 pairs arranged almost in parallel (Fig. 13d); color variable, dorsum greenish-brown, covered with sparce scattered black or light colored blotches, interlacing or irregular spots, or plain (uniform), no striping; most of mid-body annuli partially subdivided once or twice (Fig. 92g); atrial cornua (horns) spirally coiled like a ram's horn with sperm ducts forming preatrial loops, extending anteriorly to ganglion XI (Figs. 103a,b); gonopores separated by 2 annuli in furrows (Fig. 93g); length up to 100 mm (Fig. 104). . . . . .Nephelopsis obscura Verrill, 1872

Eyes 4 (usually 3) pairs, not arranged in parallel (Fig. 13c); color uniform smokey gray, lacking pigment entirely or with darker clouding, sometimes with minute black pigment, or with two, narrow or broad, dark longitudinal stripes extending over dorsum, including always a lighter median stripe; atrium globoid with prominent cornua (horns) longer than its diameter projecting anteriorly, sperm ducts lacking preatrial loops, ending abruptly at atrium (Fig. 93f); gonopores separated by 2 annuli, usually in furrows (Fig. 92d); length 20-50 mm (Fig. 100). . . . . Mooreobdella fervida Verrill, 1871

66(64) Dorsum with a variable dark brown or black middorsal stripe, obvious in anterior (cephalic) half, sometimes fading posteriorly; dorsum color greenish, heavily mottled, minutely spotted with pale yellow or white irregular transverse rows; gonopores separated by 3 1/2 annuli (sometimes 4), usually on rings, male gonopore on ring, female gonopore in furrow (Fig. 91k); 4 pairs of eyes, second pair of labial eyes behind 1st pair (Fig. 13c); atrium with median chamber wider than long, large cornua (horns) directed anteriorly and curved ventrad, with sperm ducts forming preatrial loops, extending anteriorly to ganglion XI (Fig. 103c); length 20-60mm (Fig. 105). . . . . Dina dubia Moore & Meyer, 1951

Dorsum lacking a middorsal stripe; dorsum unpigmented, or color uniformly smokey gray with varigated dark and light pigment; gonopores usually separated by 3 1/2 (sometimes 2 1/2 or 3) annuli, male on ring, rarely in furrow, female in furrow (Fig. 92l); 4 pairs of eyes, second pair of labial eyes behind 1st pair (Fig. 13c), atrium with simply curved cornua (horns), with sperm ducts forming preatrial loops, extending anteriorly to ganglion XI (Fig. 103d); length 25-30 mm (Fig. 106). . . . . Dina parva Moore, 1912

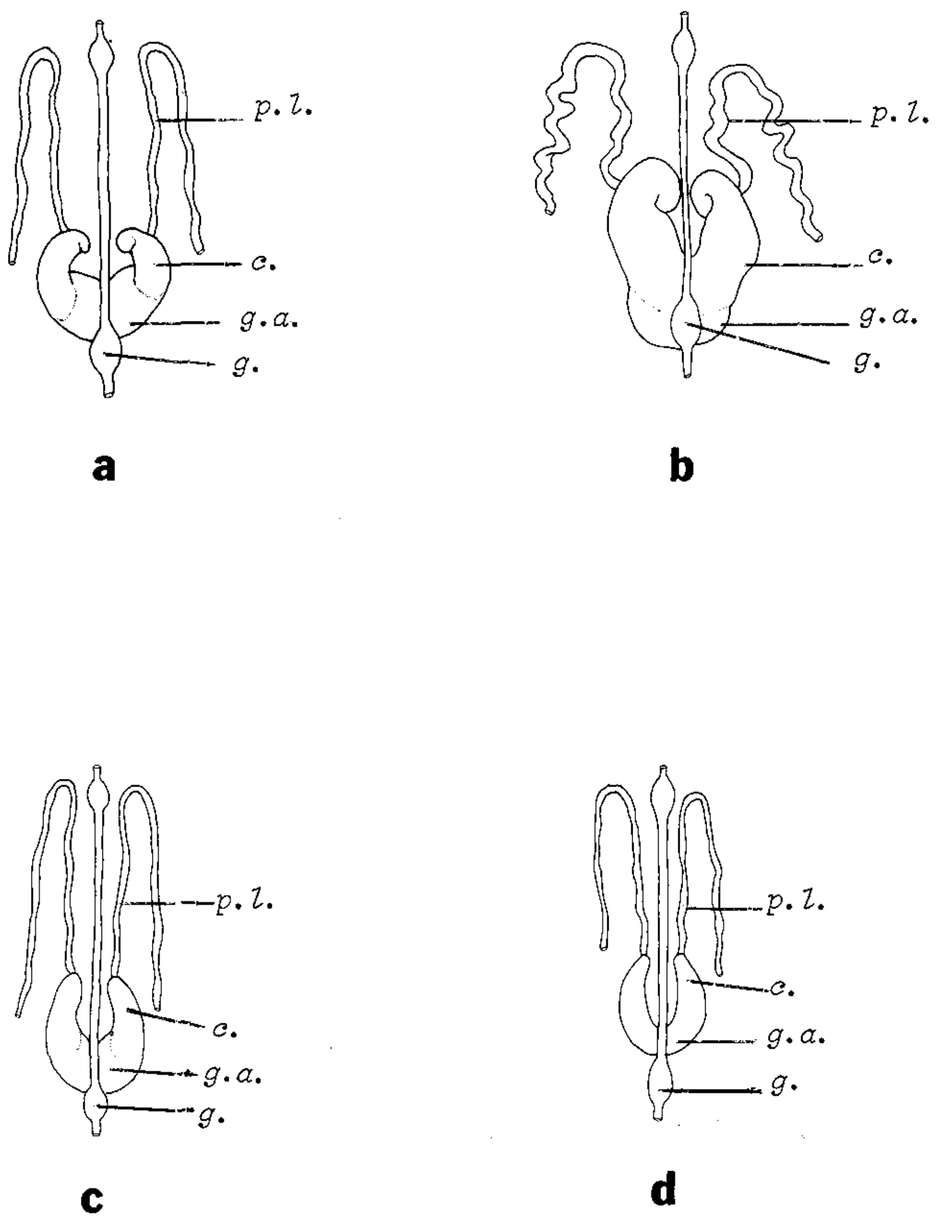
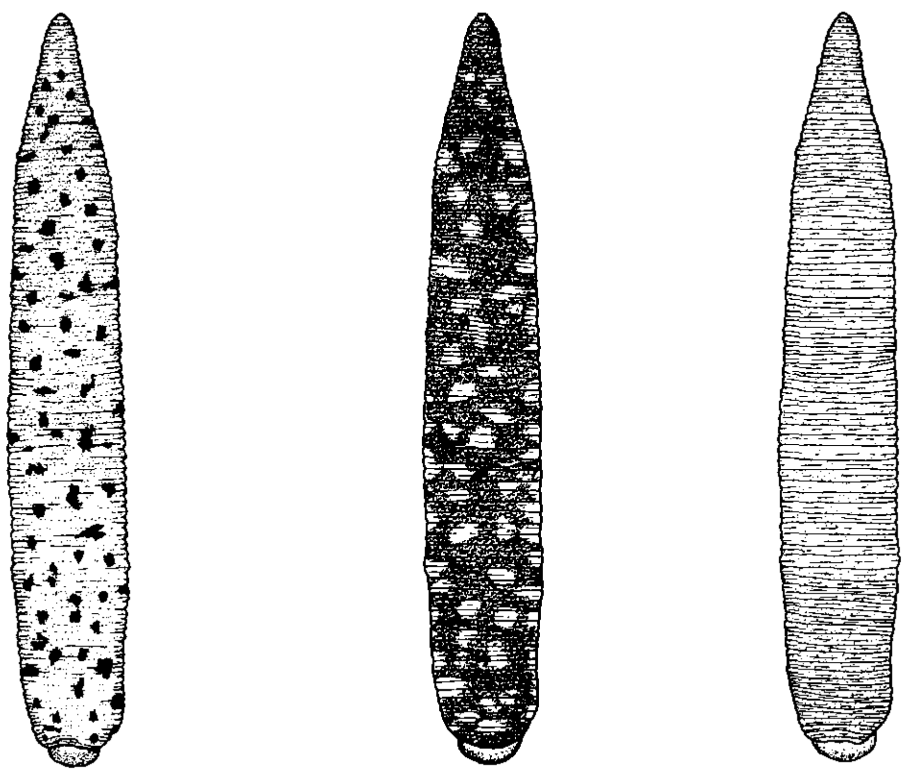


FIG. 103. Dorsal view of dissected male genital atrium and ejaculatory ducts with long preatrial loops: (a,b) Nephelopsis obscura; (c) Dina dubia; (d) Dina parva. c. cornua (paired horns); g. XII, twelfth ganglion; g.a. genital atrium; p.l. preatrial loop.



a b c

FIG. 104. Nephelopsis obscura: (a) light colored, irregularly spotted form; (b) dark colored, irregularly spotted form; (c) immaculate form.

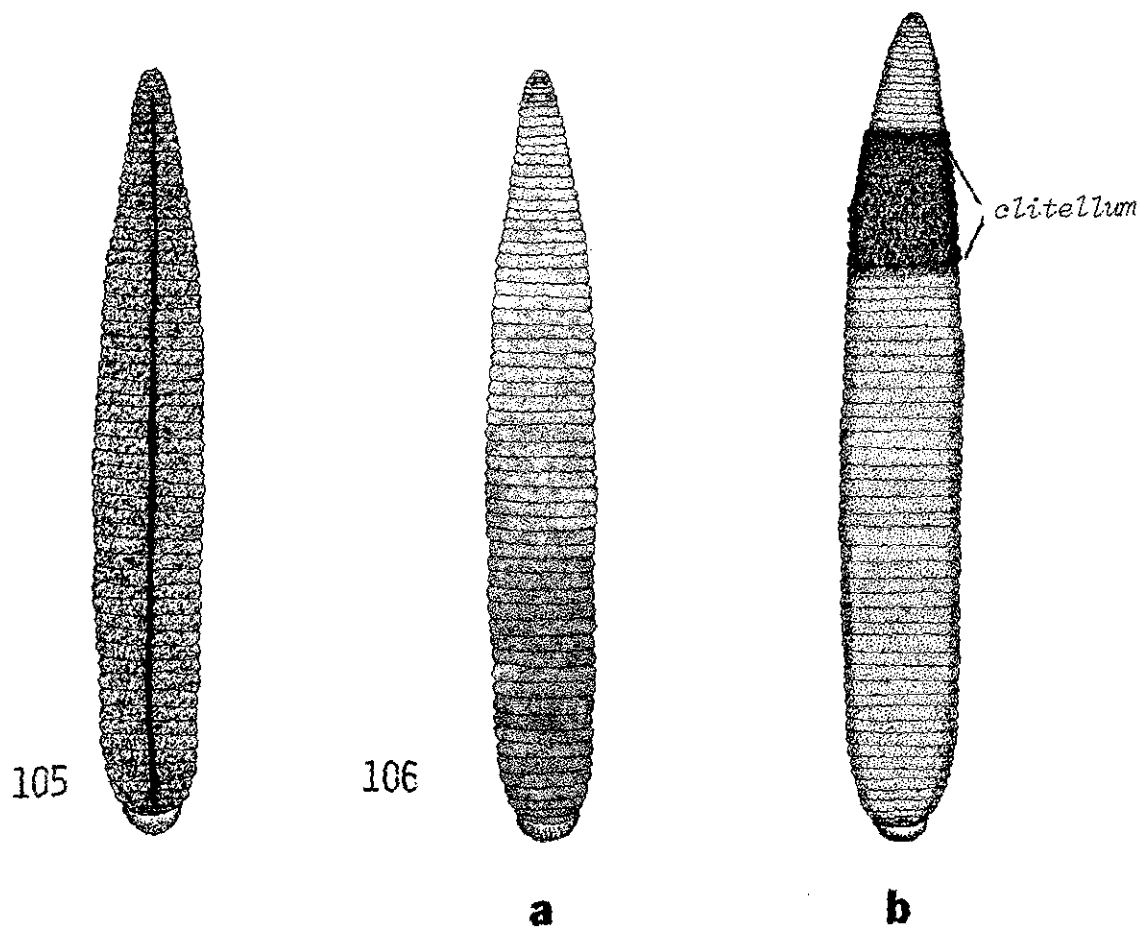


FIG. 105. Dina dubia. FIG. 106. Dina parva: (a) without developed clitellum; (b) with developed clitellum.

SECTION 7

GLOSSARY

Acanthobdellid (pl. s): A primitive leech in the family Acanthobdellidae.

Accessory Eyes: A series of supplementary eyes (ocelli) behind the single pair of functional eyes in the cephalic region of Placobdella hollensis.

Annuli (sing. Annulus): External body rings or superficial transverse furrows of the somites. Basically there are 3 primary annuli (tri-annulate) per somite, labelled by convention as a1, a2, a3 (or sometimes written a1-3), (except in Oligobdella biannulata which has biannulate somites). In some genera of leeches, each annulus may be subdivided (see Table 1) into secondary annuli, b1, b2, b3 ... b6 (or b1-6), and still further into tertiary annuli c1, c2, c3 ... (or c1-12), and rarely still further into quarternary annuli d1, d2, d3 ...d24 (or d1-24). Each somite corresponds with one ganglion in the central nervous system. The ventral nerve cord ganglia are placed in the middle annulus of the somite. Annulation can be most easily seen in the lateral margins of the middle region of the body.

Anterior sucker: Oral sucker.

Atrial cornua: Horns or hornlike prolongations of the atrium.

Atrium: A variously shaped, male reproductive organ, consisting of three parts: a thin-walled eversible bursa, a thick walled glandular and muscular medium chamber, and a pair of atrial cornua openings into the latter of similar structures of the male reproductive system. The atrium opens externally through the male gonopore.

Buccal cavity: Mouth cavity.

Bulbous: Bulb shape (Figs. 31, 32, and 33).

Caudal ocelli: Dot-like or crescent-shaped eyespots on the caudal sucker of certain piscicolids. See punctiform and crescentiform ocelli.

Caudal sucker: Posterior sucker.

Cephalic Region: Head region.

Chaetae (sing. Chaeta): Hair or bristle-like structures of some classes of Annelida. The term setae, however, seems to dominate recent English language publications.

Chromatophore: A cutaneous pigment cell or group of pigment cells which under control of the nervous system can be altered in shape and size to produce a color change in some rhynchobdellids.

Clitellum: A regional epidermal saddle or swollen glandular portion of the integument in the area of the gonopores of certain leeches, especially the Hirudinidae and Erpobdellidae, visible in adults during the breeding period. It contains gland cells that secrete material to form cocoons.

Complete somites: Segments having the full number of annuli or body rings characteristic of the genus.

Copulatory depressions: A glandular area around the gonopores and copulatory pits on the ventral surface in Philobdella.

Copulatory gland pores: Pores present in a linear or transverse pattern of either 4, 6, 8 or 24. They are located on the ventral surface, 4 or 5 annuli, posterior to the female gonopore in Macrobdella.

Copulatory pits: Thick depressions and prominences of the glandular area around the gonopores of Philobdella. See copulatory depressions.

Crescentiform ocelli: Crescent-shaped or crescentric eyespots on the caudal sucker of Piscicola salmositica.

Crop (Stomach): Sac-like dilatation or largest part of the alimentary canal adapted for storage of blood, and so on; may be a single, straight tube, or contain several paired diverticula.

Crop caeca: Segmental pouches or diverticula of the crop (stomach).

Denticles: Small teeth-like processes; two rows of teeth (distichodont) wholly or partly in Philobdella and some species of Haemopis or one row of teeth (monostichodont) in Hirudo and Macrobdella.

Digitate processes: A marginal circle of 30-60 retractable processes, fingerlike when everted on the inside rim of the sucker cavity in Actinobdella. The digitate processs are usually retracted in preserved specimens but their position is evident by faint radiating ridges or bands visible on the outer rim of the caudal sucker.

Discoid head: The oral sucker and cephalic region widely expanded, circular and demarcated from the body by a constriction; in Placobdella montifera and Placobdella nuchalis.

Erpobdellid (pl. s): A leech in the family Erpobdellidae.

Eyes (Ocelli): Photoreceptors confined to the cephalic "head" region, formed from a number of light sensitive cells (eyespots) backed by a pigmented cup. The eyes are located on the dorsal or lateral surface of the anterior segments, are segmental, vary in number and arrangement.

Eyespots (Ocelli): Photoreceptors of the cephalic region, lateral region of the urosome, or caudal sucker of certain leeches.

Ganglia (sing. Ganglion): Concentration of nerve cell bodies in the ventral nerve cord. Excluding the supra- and subesophageal mass (six ganglia) and the caudal mass (seven ganglia), there are 21 ganglia in the ventral nerve cord, labeled in Roman numerals VII-XXVII. The neural annulus of segment (somite) 10 would, therefore, be expressed as Xa2 of the triannulate somite.

Gonopores: External openings of the reproductive tracts, located on or in the furrow of the annulus on the midventral surface of somite XI and XII (about one third from tip of cephalic region). The male gonopore is anterior to, larger than, and more conspicuous than the female gonopore. The male and female gonopores generally are separated by 1-7 or more annuli but in a few species open into a common gonopore.

Glossiphoniid (pl. s): A leech in the family Glossiphoniidae.

Hirudinid (pl. s): A leech in the family Hirudinidae.

Hirudinidae: The widely accepted familial name based etymologically on the stem hirudinis, the Latin genitive singular of hirudo. It should always be used in preference to Hirudidae (Art. 29a of International Code).

Hirudofauna: All the leeches peculiar to a country, area, or period. A treatise on leeches.

Incomplete (abbreviated) somites: Occur at both ends of the body of leeches and may have any number of annuli less than the complete somites into which they grade.

Integument: A general term for the covering, or outer layers of an animal. The purpose of the integument is for defense and sensing environmental conditions.

Internal ridges: Fleshy anatomical structures of the pharynx in Hirudinidae. Sometimes called pharynx folds or pods.

Jaws: Three large, oval bladelike jaws shaped like a half circular saw occurs just within the mouth cavity of some species of Gnathobdellida. Each bears along the edge a large number of small teeth (denticles). The three jaws are arranged in a triangle, one median dorsal and the other two ventrolateral. They have a covering of cuticle, and along the free edges of the disc it is thickened to form rows of numerous, minute teeth (monostichodont or distichodont).

Lateral ocelli: Eyespots on the urosome of Cystobranchus meyeri.

Leech: Any segmented worm with terminal suckers used for attachment and locomotion; the various species may be parasites (blooding sucking), predators, or scavengers; most are aquatic in North America.

Metamere: A body segment or somite.

Metameric: Referring to metamerism or segmentation.

Metameric dots, spots, patches, or prominences: Yellowish or whitish areas usually metamerically (segmentally) arranged; some represent sensillae or segmental receptors.

Neural annulus (Sensory annulus): The annulus aligned with the ganglion in the central nervous system. In the 3- or 5-annulate somites, it is the middle annulus.

Nephridia (Sing. Nephridium): Excretory organs, usually that of macroinvertebrates.

Nuchal plate: See scute.

Ocelli (sing. Ocellus): Eyespots found in cephalic, caudal ends, or lateral margins of body of certain leeches. They may be found singly in any body part, including the caudal sucker and lateral margins, and aggregations of them in a common network of chromatophores usually form eyes of piscicolids. Eyes of leeches are confined to the cephalic "head" region and are segmental in some species. Such eyes are simple when single, and compounded, such as Placobdella, when one or two small ones are attached to the main one.

Oculiform spot: See punctiform ocelli.

Oral sucker: Anterior sucker.

Papillae: Small to large protrusible sensory organs scattered or in a metameric series on the dorsal surface of the leech and thought to be tactile in function. Large papillae are sometimes called "tubercules."

Pedicel (Peduncle): A stem or stalk of annuli supporting the caudal sucker in some leeches.

Peduncle: See pedicel.

Pharynx: A muscular tube, anterior part of alimentary canal, following the buccal cavity.

Pharynx folds: Internal muscular ridges or fleshy pods of the pharynx. See internal ridges.

Pigment: A cutaneous structure of brown, black, red, green, blue coloring in the integument of leeches. They are found in chromatophores and arranged between muscle strands and other organs to give a characteristic color pattern.

Piscicolid (pl. s): A leech in the family Piscicolidae.

Proboscis: A tubular structure with a crown-like anterior end found in leeches of the families Glossiphoniidae and Piscicolidae. It is a tube lying within the proboscis cavity, which is connected to the ventrally positioned mouth by a short narrow canal. The proboscis is highly muscular, has a triangular lumen, and is lined internally and externally with cuticle. This organ is an anatomical characteristic of the rhynchobdellids.

Posterior sucker: Caudal sucker.

Preatrial loops: Vas deferens or ejaculatory ducts conveying spermotozoa of certain erpobdellids.

Pulsatile vesicles: Eleven small hemispherical vesicular structures filled with coelomic fluid and found along the lateral margins of Cystobranchus and Piscicola species. They pulsate rhythmically and function as respiratory organs.

Punctiform ocelli: Eyespots or dot-like structures on the caudal sucker or lateral margins of some piscicolids.

Rays: Distinct pigmented areas on the caudal sucker of certain piscicolids.

Rhynchobdellid: A leech in the Order Rhynchobdellida.

Scute (Nuchal plate): A chitinous scale-like structure found on the dorsum of the "neck region" of Helobdella stagnalis; function unknown.

Segment: A somite, metamere, or a series of anatomical divisions of the body.

Sensillae (Segmental receptors): Whitish or yellowish, rounded, oval, metameric dots, spots, patches, prominences (sometime raised), which may resemble minute, inconspicuous papillae on neural annuli containing several types of sensory cells that are receptive to light and water movement.

Setae: See chaetae.

Somite (Segment, Metamere): A true body segment or metamere made up of superficial transverse annuli or rings. All leeches have 34 somites, each of which corresponds to a nerve ganglion.

Stomach: See crop.

Taxon (pl. Taxa): Any taxonomic group, for example, a race, subspecies, species, genus, family, order, and so forth.

Teeth: See denticles.

Testisacs: Coelomic sacs containing the testes.

Trachelosome: Narrow neck region of some piscicolids.

Tubercles: Large papillae.

USNM: An abbreviation, usually associated with museum specimen catalogue numbers, for the United States National Museum (National Museum of Natural History).

Urosome: The thicker or wider body region of some piscicolids.

Velum: A flap of skin which separates the buccal cavity from the cavity of the oral opening (mouth) in Hirudinidae.

White prominences: The raised, irregular-shaped areas on the dorsum of certain leeches and functioning as segmental receptors.

Whitish or yellowish dots, patches, spots (sometimes raised): Sensillae, segmental receptors usually metamerically arranged.

SECTION 8

SPECIES DISTRIBUTION

The distribution and abundance of aquatic leeches, like other groups of organisms, are affected by biological, chemical, and physical characteristics of the environment. The important ecological factors include food organisms, substrate requirements, habitat type (lentic and lotic), water depth, pH, temperature, dissolved oxygen, dissolved salts, turbidity, salinity, and organic and chemical pollutants. Information and discussions on the effects of these environmental factors and other topics at the species level can be found in Mann (1962), Herrmann (1970), Klemm (1972a, 1975, 1976) (also cf. Selected Bibliography), and in the review paper on pollution ecology of leeches by Sawyer (1974). However, relatively little has been written specifically on the natural history, ecology, pollution tolerance, and distribution for many of the North American species of leeches.

Zoogeographic information of the hirudofauna is rather sketchy because our current knowledge on the systematics and ecology of leeches is deficient. However, existing information on the zoogeography of leeches has been discussed for North America (Sawyer, 1972), for the world (Soos, 1970), for the physiogeographic provinces of North and South Carolina (Shelley, 1975; Sawyer and Shelley, 1976), for Colorado (Herrmann, 1968; 1970), and for South America and MesoAmerica (Ringuelet, 1980). Nevertheless, the zoogeography of leeches still presents numerous and enormous gaps in North America and on a world scale, and a warning should be given against making generalizations that are too broad.

The distribution records for the leech species in Maps 1-32 (pages 105-136) are based on the published literature (Herrmann, 1970; Klemm, 1972a,b, 1977; Sawyer, 1972; Davies, 1973; Sawyer and Shelley, 1976; and Klemm, et al. 1979), and the records of the authors listed with an asterisk in the Selected Bibliography. In addition, the distribution of each species is based on my unpublished personal records, on the identification or verification of specimens sent to me by the many individuals mentioned in the Acknowledgment, and the distribution data with identification or verification of voucher specimens from the reputable museums that are also listed in the Acknowledgment. Many of the distribution records on the maps are new for the species, but they will not be indicated there specifically. Information on specific locality records for some species can be found in the papers given in the Selected Bibliography.

In an earlier study (Klemm, 1972b), I erroneously reported *Glossiphonia complanata* from Florida and Mississippi, *Alboglossiphonia* heteroclita from Mississippi, Batracobdella picta, Macrobdella sestertia, and Placobdella ornata from Louisiana, and Erpobdella triannulata from California and North Dakota. Furthermore, the species, Placobdella multilineata, that I reported from Michigan (Klemm, 1972a,b), is changed to P. ornata.

The symbols on the distribution maps only indicate that the species has been reported from the state in the United States and province or territories in Canada. Information on abundance, host preference, and ecological restrictions are also given where appropriate for each species in the legion of each map.

The distribution patterns for all North American leech species are still not completely known, due primarily to inadequate collecting, to the small number of sites and different habitats sampled, and to the infrequencies in reporting the record at the species level. However, this manual has extended the ranges for many species.

The Great Lakes region of North America is probably the only area that has been extensively surveyed for leeches. There are several published records of leeches from the southern states, especially North and South Carolina (Sawyer and Shelley, 1976), but the southern states are in need of more extensive sampling for leeches. Very few records are available for the western United States, and the distribution data for leeches from this area are badly needed. In Canada, several areas have been surveyed for leeches (Davies, 1973), but not intensively, and more information is still needed on leech distribution in Canada.

At first glance, the distribution maps (1-32) will indicate that several species are widely distributed. Some are predominatly northern or southern, and others are geographically restricted. There is sufficient evidence to indicate a northern distribution for the following species: Glossiphonia complanata, Helobdella papillata, Marvinmeyeria lucida, Placobdella ornata, Theromyzon biannulatum, T. rude, T. tessulatum, Piscicola geometra, P. milneri, Haemopis grandis, H. plumbea, Macrobdella decora, Dina dubia, D. parva, Mooreobdella fervida, and Nephelopsis obscura.

Macrobdella ditetra, Oligobdella biannulata, Philobdella gracilis, Placobdella multilineata, and P. translucens appear to have a southern distribution pattern. Both Placobdella multilineata and Philobdella gracilis, however, extend northward through the Mississippi Valley. Erpobdella punctata coastalis, Mooreobdella melanostoma, and M. tetragon have an Atlantic coastal distribution pattern, but the habitat range for these recently described species (Sawyer & Shelley, 1976) is not known. The northern or southern limits of the distributional ranges for some species is not known, and some closely related species are known to have overlapping ranges.

The discontinuous or restricted distribution of some species, which have been reported only from a single collecting site or state, may be a function of low abundance or insufficient sampling. Leech species which have only been reported from a single area, may have a restricted distribution due to host preference or some unknown specific chemical, physical, or other biological factors. With proper collecting and greater sample frequency, the leech fauna for some areas will undoubtedly be found to be much richer and varied than now apparent.

Leeches may be dispersed actively or passively. Some species in the genus Theromyzon are distributed by their food source (waterfowl), which they infest. However it is not known why Theromyzon spp. are not found in the southern states since many waterfowl migrate there in winter. Fish leeches of the families Glossiphoniidae and Piscicolidae are dispersed passively by migration of the fish host from one body of water or drainage system to another. Other species of glossiphonids migrate passively by the movements of reptiles and amphibians. There have also been several reports that species of the families Hirudinidae and Erpobdellidae make seasonal upstream migrations. The maps are incomplete. As leeches are collected and identified to species, they can be added to the maps.

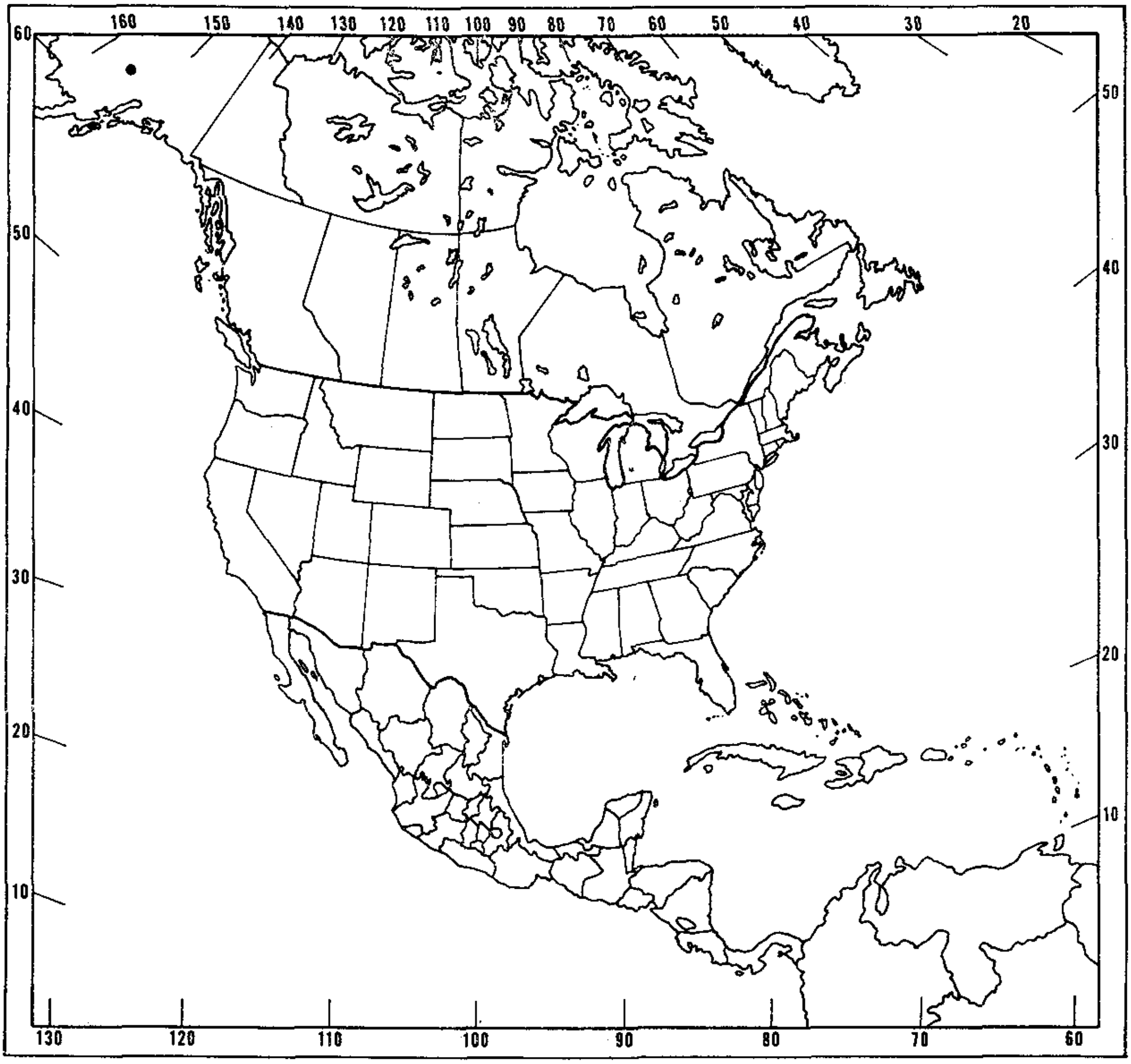
At one time Hirudo medicinalis (Linnaeus, 1758), the European and western Asian medicinal leech, was imported into the United States by the thousands for medicinal purposes specifically, phlebotomy and research. Davies (1973) indicated that H. medicinalis was available in certain drug stores in Calgary, Alberta, Canada. He reported collecting specimens from a slough north of Calgary, apparently abandoned there, presumably after being used medicinally. He never indicated, however, the establishment there of a wild population. Sawyer (1972) and I have never found or confirmed a wild population record of H. medicinalis for North America, and we do not consider it as being established here. I have included this species because it is still possible to purchase it from a few drug stores in distinct, ethnic areas of North America.

The record for Batracobdella paludosa (Carena, 1824), another European leech, is based on a single specimen from Nova Scotia (Pawlowski, 1948). The specimen is no longer available for verification. This species, however, has never been confirmed here, and Sawyer (1972) and I do not considered it as being established in North America. I have included B. paludosa in this manual only because of Pawlowski's (questionable) identification. If specimens of this species are collected, they must be confirmed and reported by someone familiar with the species before it can be considered a valid North American species.

Erpobdella triannulata Moore (1908), a poorly described species, was originally taken from Lake Amatitlan, Guatemala, Central America (Moore, 1908). Moore (1936) also reported it from the Yucatan and stated that this species was also found distributed extensively throughout Central America, Mexico and the Pacific United States. Soos (1966a, 1968) and Klemm (1972b) reported it from southern California on the basis of J.P. Moore's old record. However, for reasons unknown, Moore (1959) and Mann (1962) excluded this species, E. triannulata, from their keys to North American leeches. Ringuelet (1976) stated its distribution only as Guatemala and Mexico. I have examined the poorly preserved type material (ANSP 2389) at the Academy of Natural Sciences of Philadelphia but was not able to assess or describe its anatomy further. Furthermove, I have not been able to obtain fresh material from southen California or elsewhere. Until E. triannulata is fully described, and additional specimens of this species are confirmed by a specialist, it is best to consider Moore's record for southern California as erroneous.

Ringuelet (1976) reported Erpobdella octoculata (O.F. Muller, 1774) from Mexico and the U.S.A. from an old record. The record for the United States is erroneous. Davies (1971) included this species in his key of Canadian leeches on the basis of a questionable identification made by J.P. Moore of Erpobdella atormaria (Cavena, 1820) as reported in Rawson (1953) for the Northwest Territories. I questioned the validity of these records and considered them erroneous (Klemm, 1972b). Later, Davies (1973) concurred that the Canadian record for E. octoculata was doubtful. Soos (1966a) viewed E. atomaria as a variety of E. octoculata and recorded its distribution in Europe and Japan, and stated that E. octoculata was restricted only to the Palearctic Region, and there is no valid record of this species occurring outside of that region (Soos, 1966a, 1968).

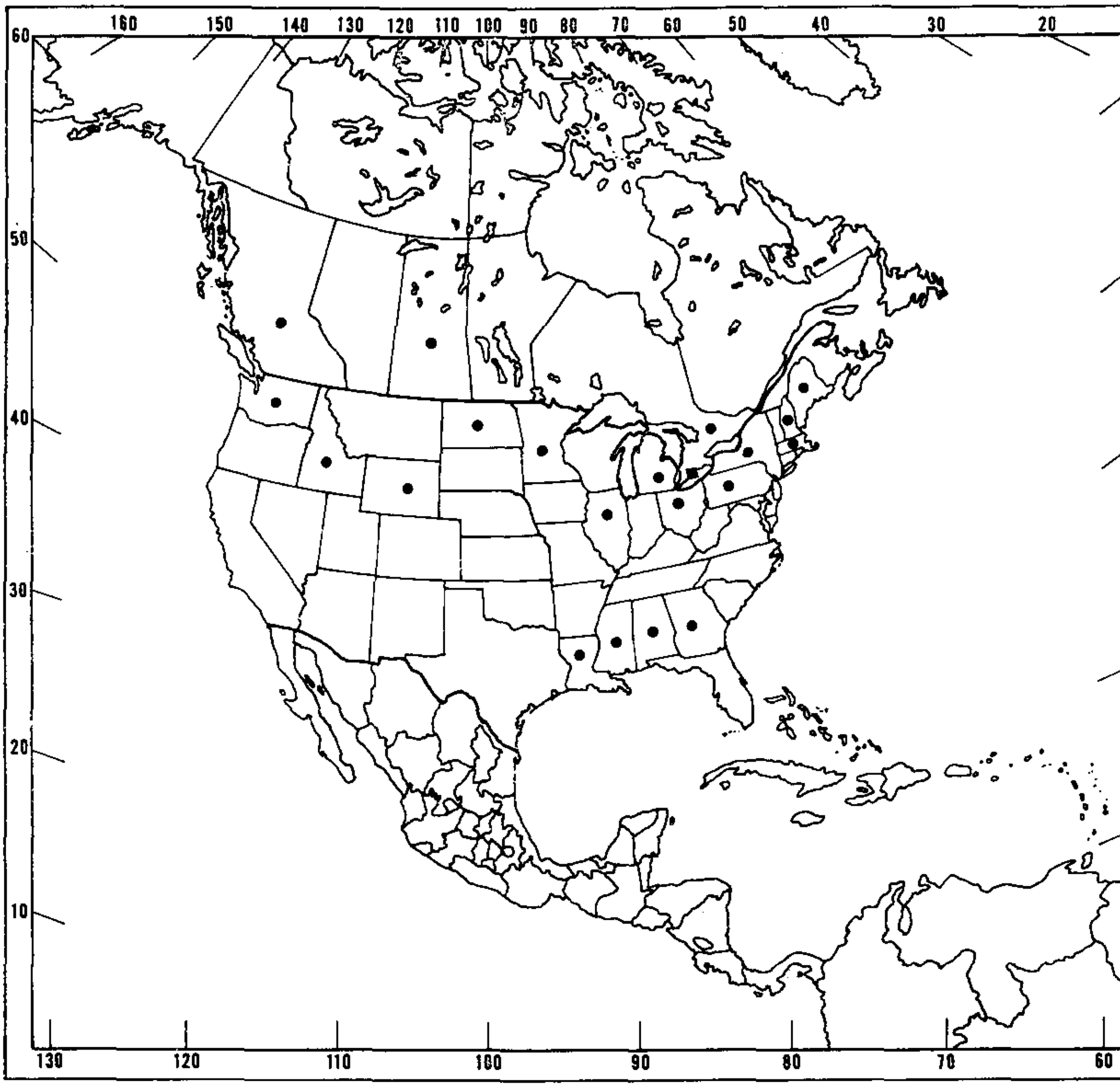
Ringuelet (1976, 1980) reported from a single old record the species, Haementeria officinalis de Fillippi (1849), from New Orleans which may be a specimen in the Paris museum. The only known distribution of this species is Paraguay, Venezuela, and Mexico. Sawyer (personal communication) suspects that the specimen might be Placobdella papillifera which it resembles. Until the specimen in the Paris museum is confirmed by examination, I consider this record erroneous.



MAP 1. • Acanthobdella peledina

Comments:

A peledina is widely distributed in the USSR and Europe, but this species is found infrequently. It has been recorded as indigenous to Norway and Sweden. Hauck, et al. (1979) reported it from Alaska, where it was found parasitizing the least cisco (Coregonus sardinella). Holmquist (1974) reported finding a juvenile specimen of an unidentified species of Acanthobdella in a benthic sample also from northern Alaska (cf. Notes on Identification). A. peledina has been collected on fish hosts of the genera Salmo, Salvelinus, Coregonus, Stenodus, Thymallus, and Lota (Koli, 1961; Anderson, 1962; Dahm, 1962; Andersson, 1965; Nurminen, 1965, 1966; Borgstrom and Halvorsen, 1972; and Solem, 1975).

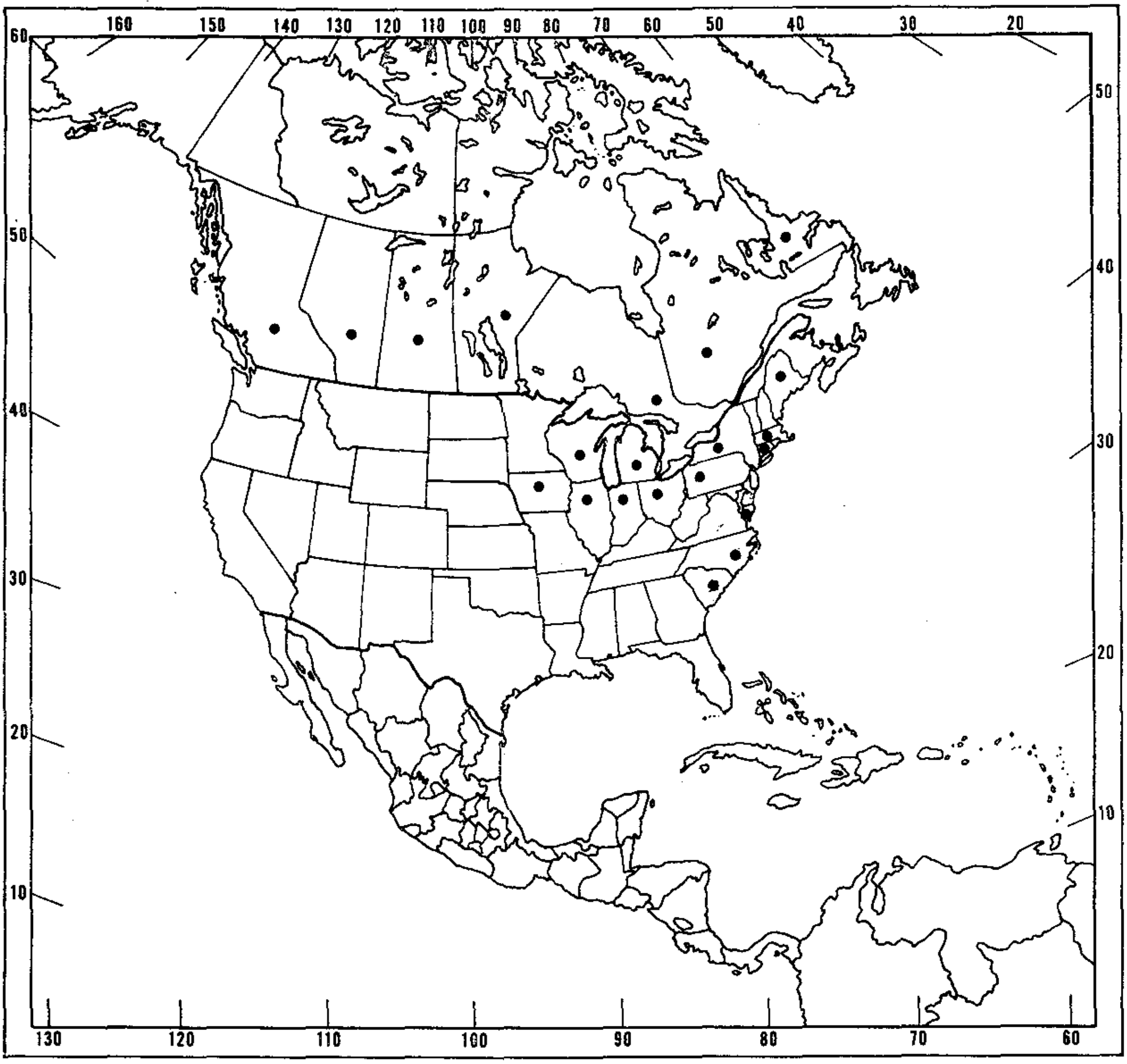


MAP 2. ■ *Actinobdella annectens* ● *Actinobdella inequiannulata*

Comments:

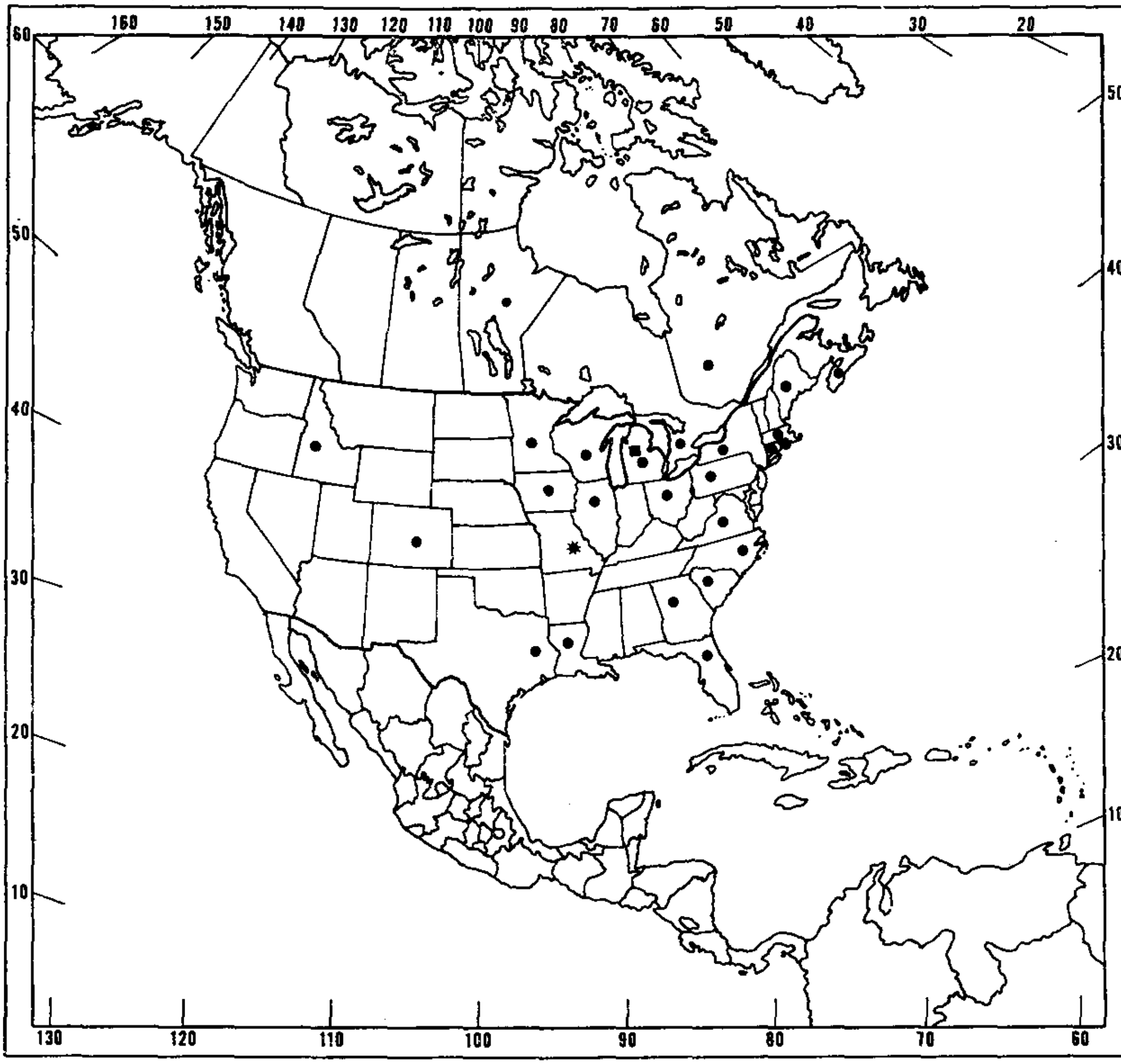
A. annectens is described from a single specimen collected on a snapping turtle (*Chelydra serpentina*) from Lake Erie, Ontario, Canada. It has not been reported since its original description (Moore, 1966).

A. inequiannulata is widely distributed but not frequently encountered. Daniels and Freeman (1976), however, found it abundantly infesting the white sucker (*Catostomus commersoni*) at Lake Louisa, Algonquin Provincial Park, Ontario, Canada.



MAP 3. • <u>Alboglossiphonia heteroclita</u>

Comments:
<u>A. heteroclita</u> is found rarely. It is usually collected in benthic grab samples, especially in the Great Lakes region. This scarcity of reports may merely reflect the difficulty in finding this small species. I have examined specimens collected from a marsh area of the Piscataway Creek in southern Maryland. This species also occurs in Eurasia. (cf. Notes on Systematics).



MAP 4. * Batracobdella cryptobranchii ▪ Batracobdella michiganensis

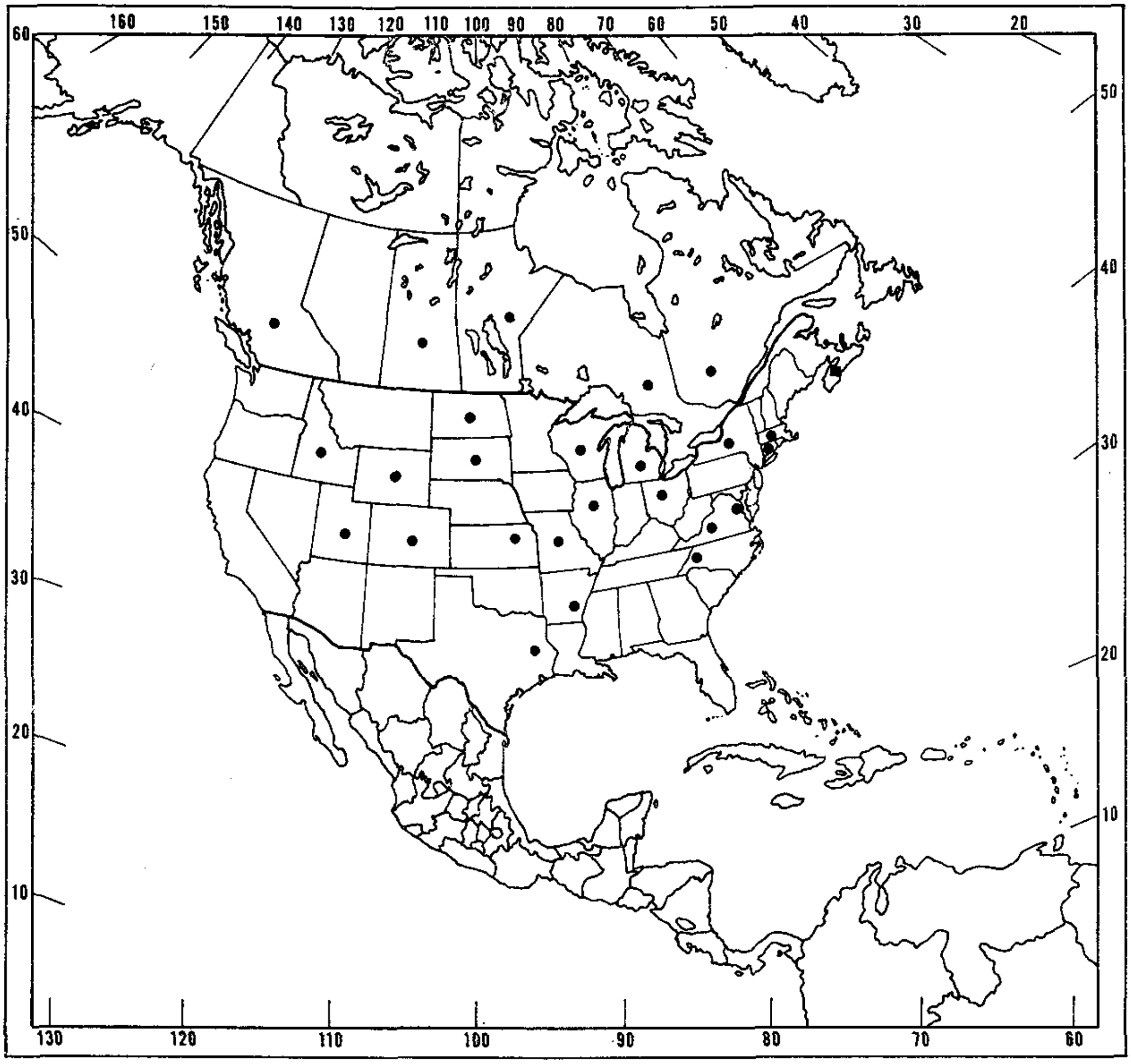
• Batracobdella phalera

Comments:

B. cryptobranchii is known only from the Ozark hellbender (Cryptobranchus alleganiensis bishopi) and reported from Ozark County in southeastern Missouri (Johnson and Klemm, 1977).

B. michiganensis has been reported by Sawyer (1972) from St. Joseph County, Michigan. I have collected several individuals (USNM 49959) from Emmet County, Michigan.

B. phalera is widely distributed but not frequently encountered. I have found this species free-living and parasitizing the bluegill (Lepomis macrochirus).

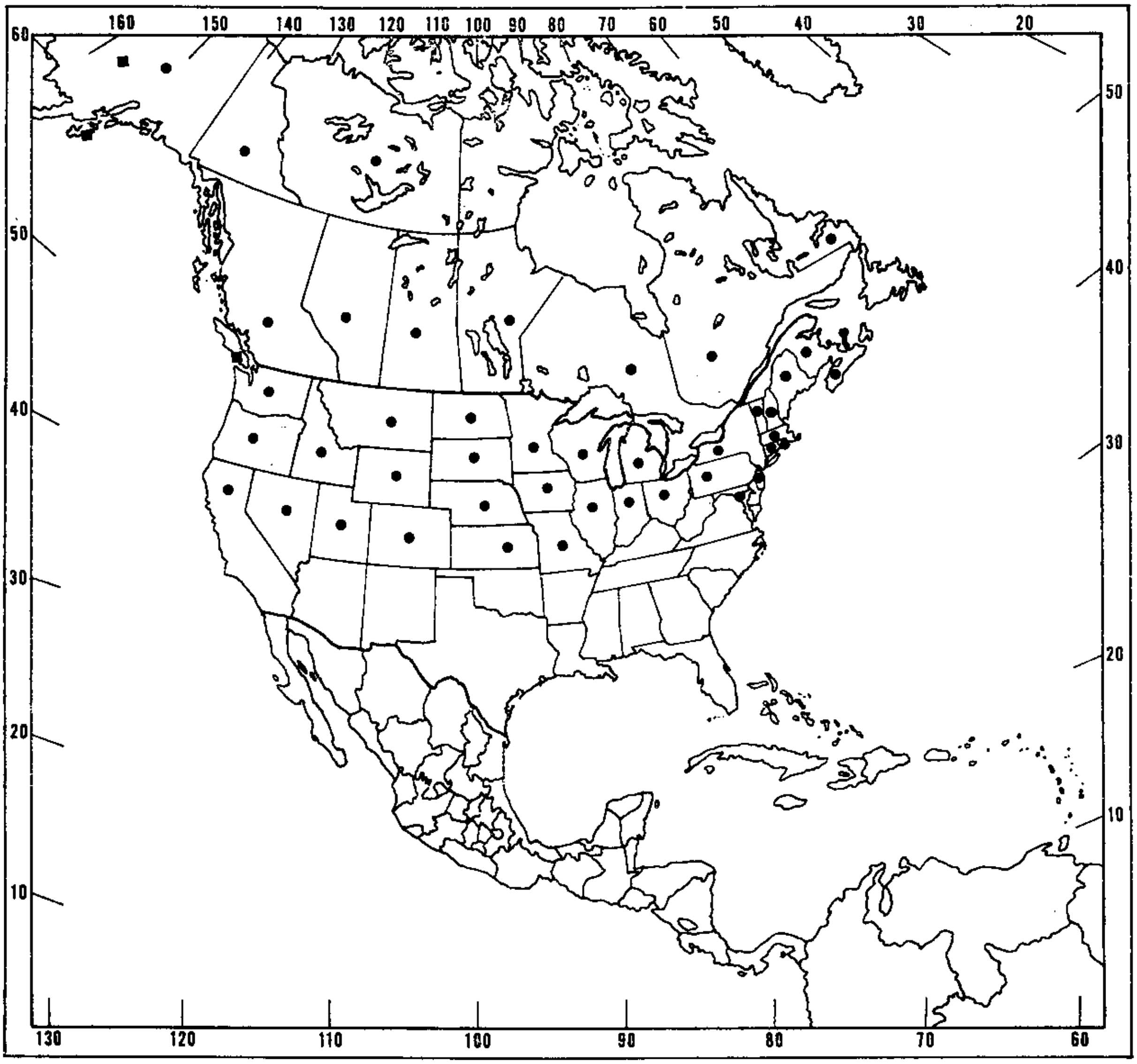


MAP 5. ▪ Batracobdella paludosa • Batracobdella picta

Comments:

B. paludosa is common in some localities of Eurasia. Pawlowski (1948), based on a single specimen which is no longer available for examination, reported it from Pottle Lake, North Sydney, Nova Scotia in Canada (nec Newfoundland reported in Sawyer, 1972; Elliott and Mann, 1979). Until additional individuals are collected, it is believed to be a doubtful species in North America. (cf. Discussion in Distribution Section).

B. picta is common in some localities and widespread in northern North America, and it is usually found inhabiting ponds which contain its favorite hosts, amphibians. Sawyer and Shelley (1976) reported that the range of this northern species also extends south in the Appalachian Mountains. I have examined specimens found parasitizing the tiger salamander (Ambystoma tigrinum) in ponds in Utah.

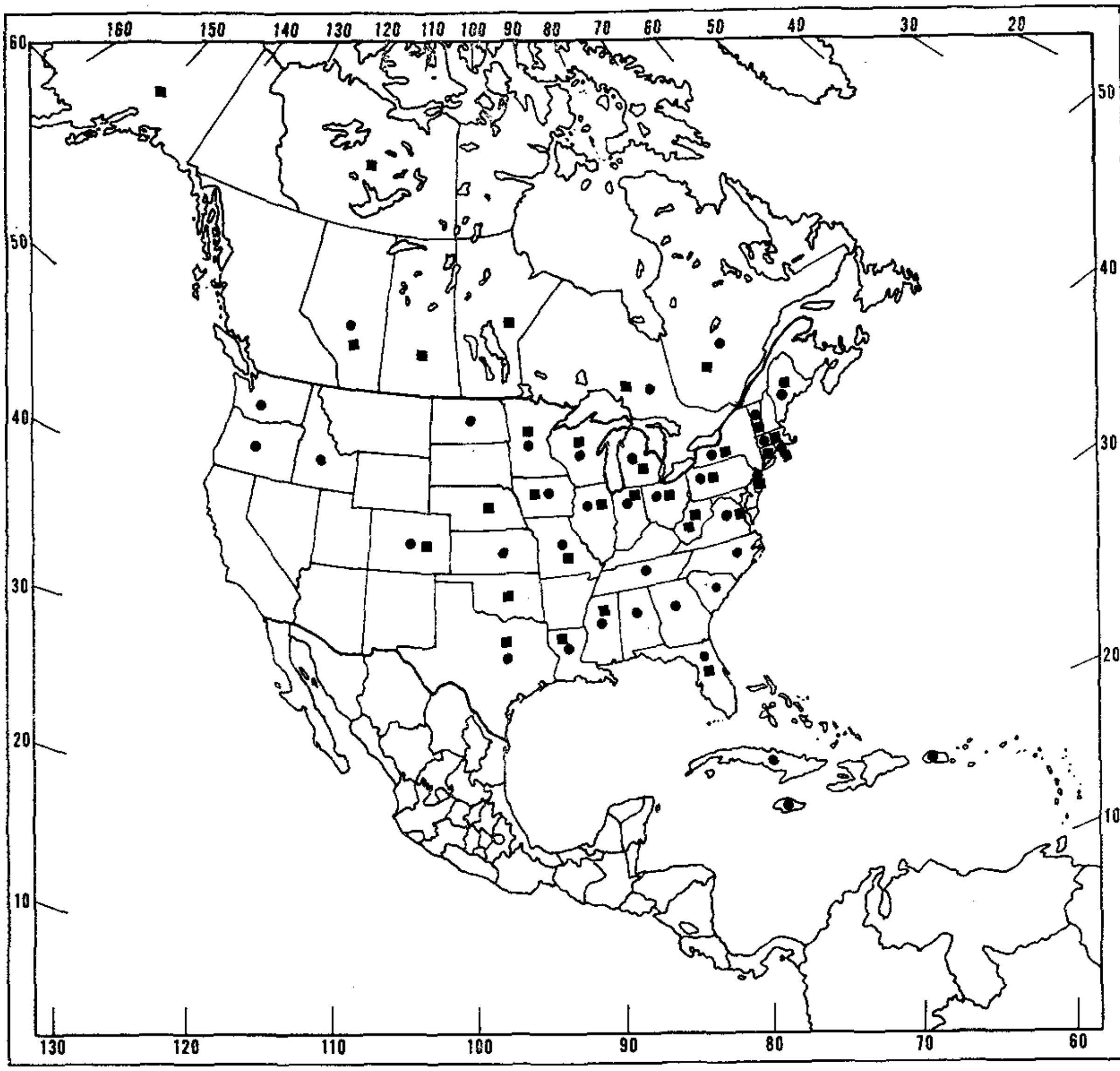


MAP 6. ▪ Boreobdella verrucata • Glossiphonia complanata

Comments:

B. verrucata is reported for the first time from North America (Alaska; Bering and Kodiak Islands, Alaska; Vancouver Island, British Columbia). Some reports of G. complanata from Alaska and northern areas of Canada may actually be B. verrucata (cf. Notes on Identification).

G. complanata is common and widely distributed in the northern half of the United States and Canada. This species also occurs in most parts of Eurasia.

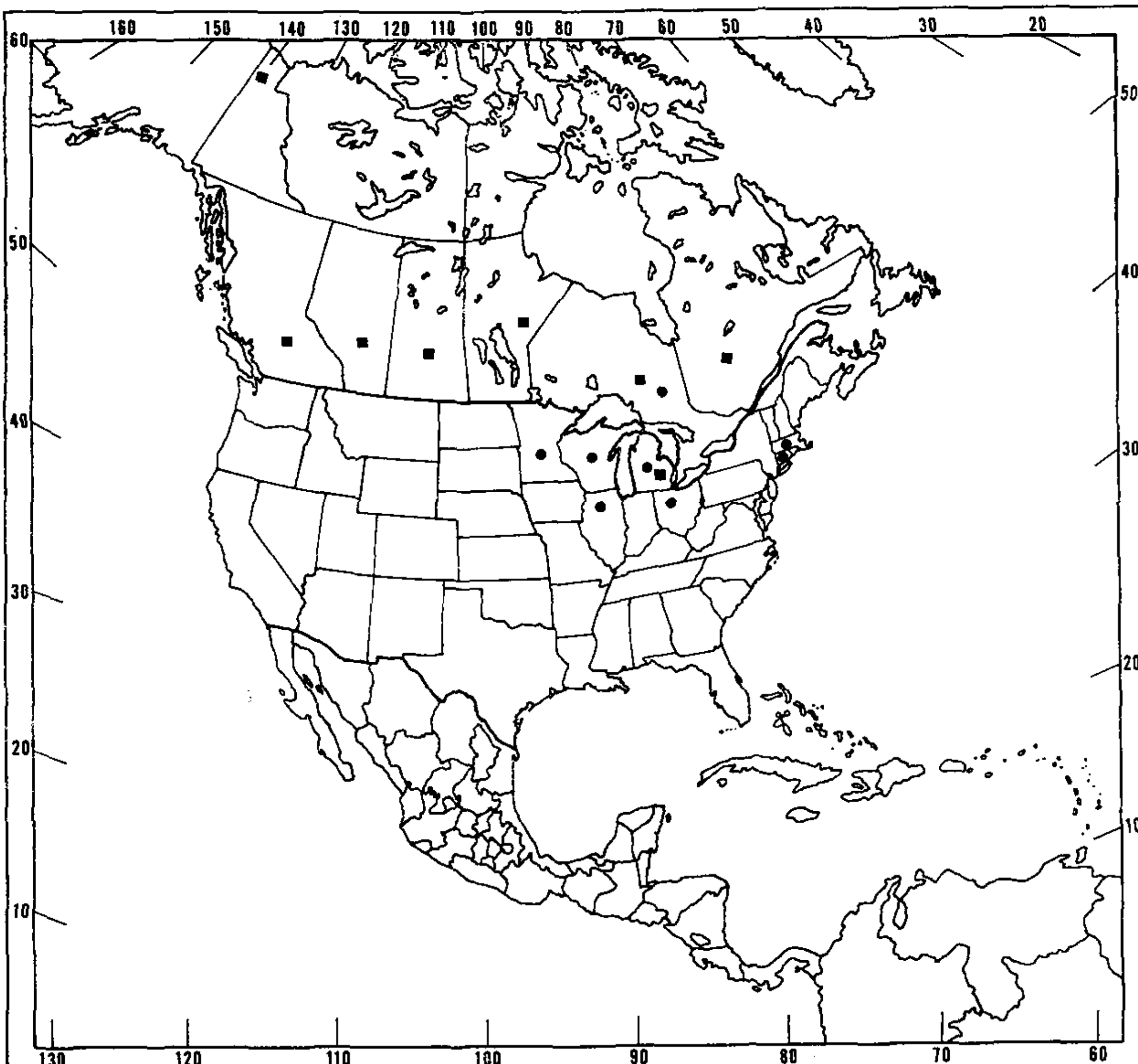


MAP 7. • Helobdella elongata ▪ Helobdella fusca

Comments:

H. elongata is widely distributed and is found infrequently throughout North America. The small size and benthic habit of the species can make it difficult to collect without the aid of grab sampling devices. Ringuelet (1976) reported it from Cuba.

H. fusca is common in the Great Lakes region and widely distributed. It is less common in the southern United States. Some published records of H. triserialis in Canada may actually be H. fusca (cf. Notes on Systematics). I have identified specimens found inside the operculate snail (Goniobasis virginica) and inside the shell of Ferrissia sp. This species also parasitizes a variety of pulmonate snails (Sarah, 1971; Klemm, 1975, 1976).

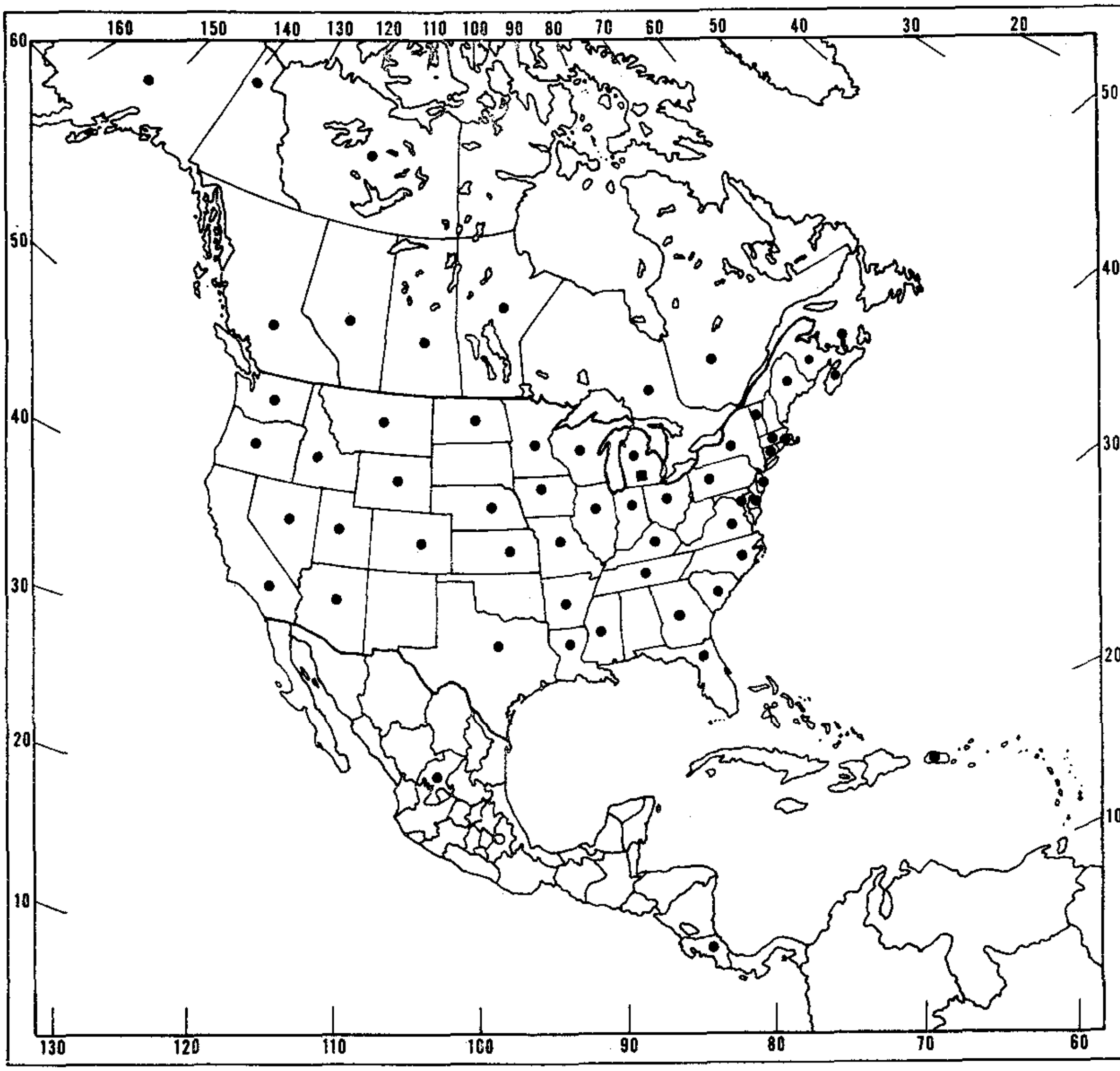


MAP 8. • Helobdella papillata ▪ Marvinmeyeria lucida

Comments:

H. papillata is uncommon and has only been collected in the Great Lakes region.

M. lucida is widely distributed in Cananda and common in some localities. The species is also common in certain localities of southeastern Michigan (Sawyer, 1968, 1972; Klemm, 1972a,b; 1975; 1977). Welch (1975) and Brook and Welch (1977) reported it from Nebraska, but I have examined some of the specimens and was unable to confirm them. Until additional individuals are collected and positively identified, the record for Nebraska is erroneous.

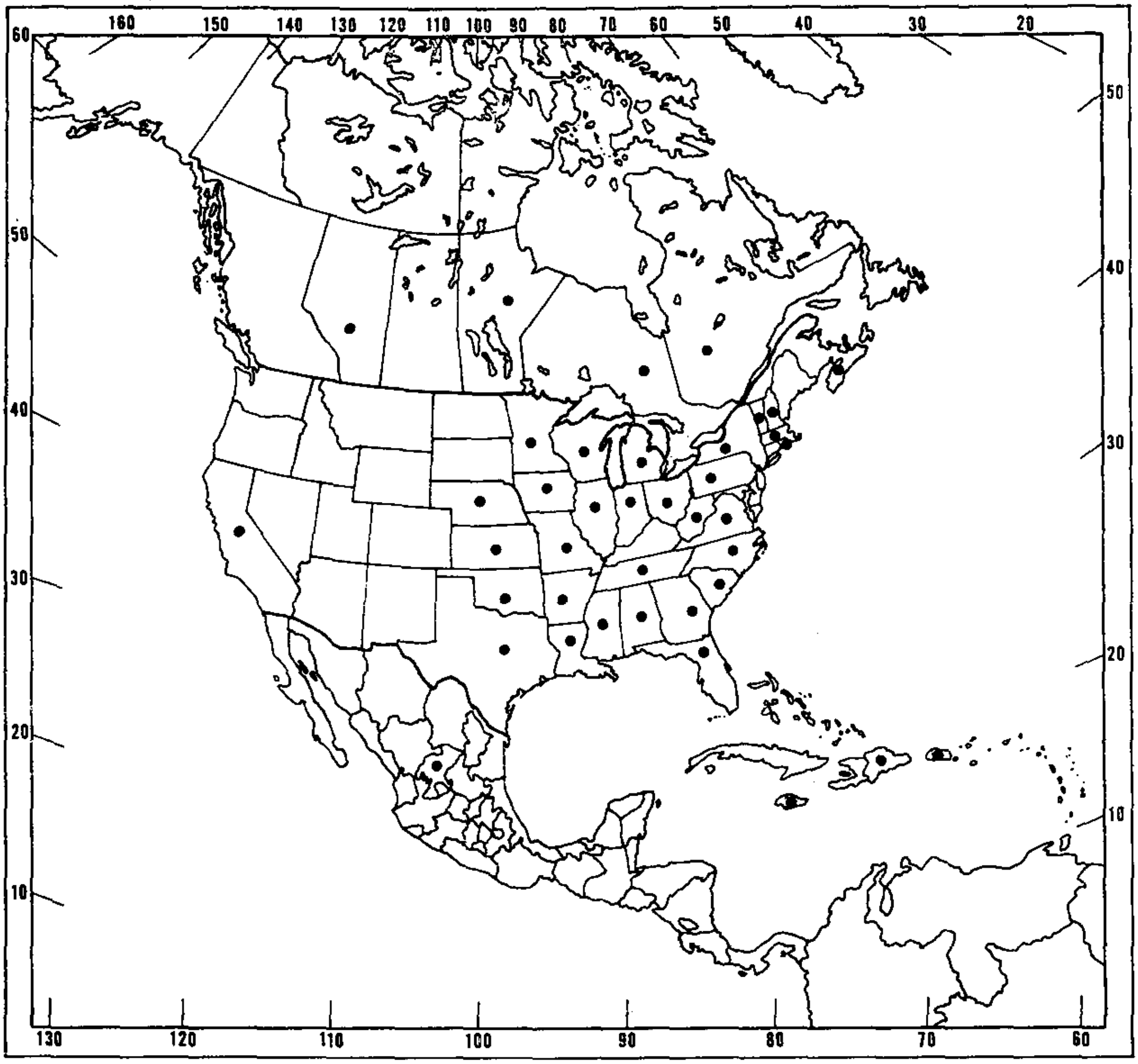


MAP 9. • Helobdella stagnalis ▪ Helobdella transversa

Comments:

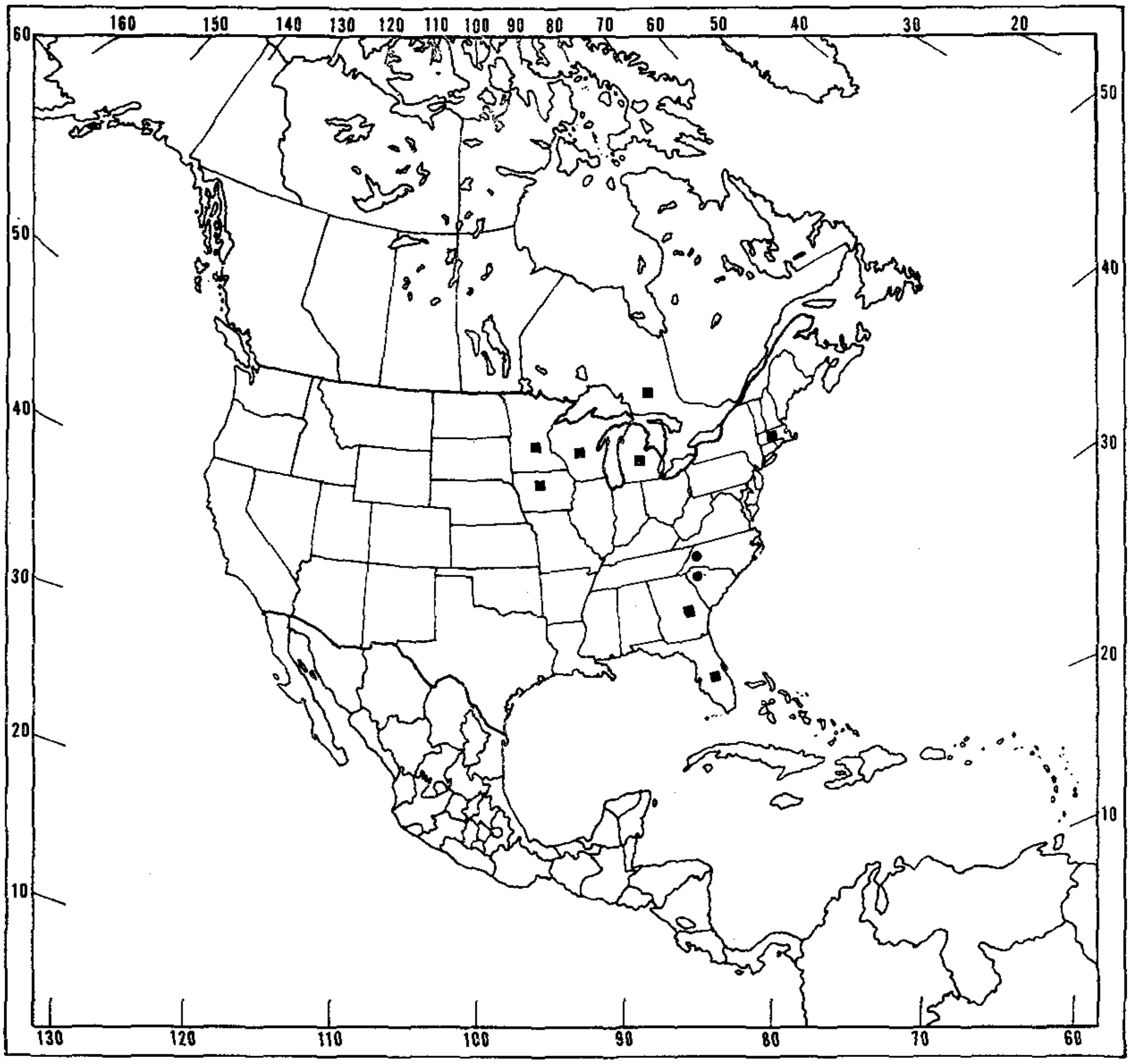
H. stagnalis is reported from every continent except Australia. It is found abundantly throughout the northern half of the United States, including Alaska and Canada, but is less common in the southern states.

H. transversa has been reported only from southern Michigan (Sawyer, 1972).



MAP 10. • Helobdella triserialis

Comments:
H. triserialis is widely distributed and is frequently collected in some localities. This species is also found abundantly in Central and South America. (cf. Notes on Systematics).

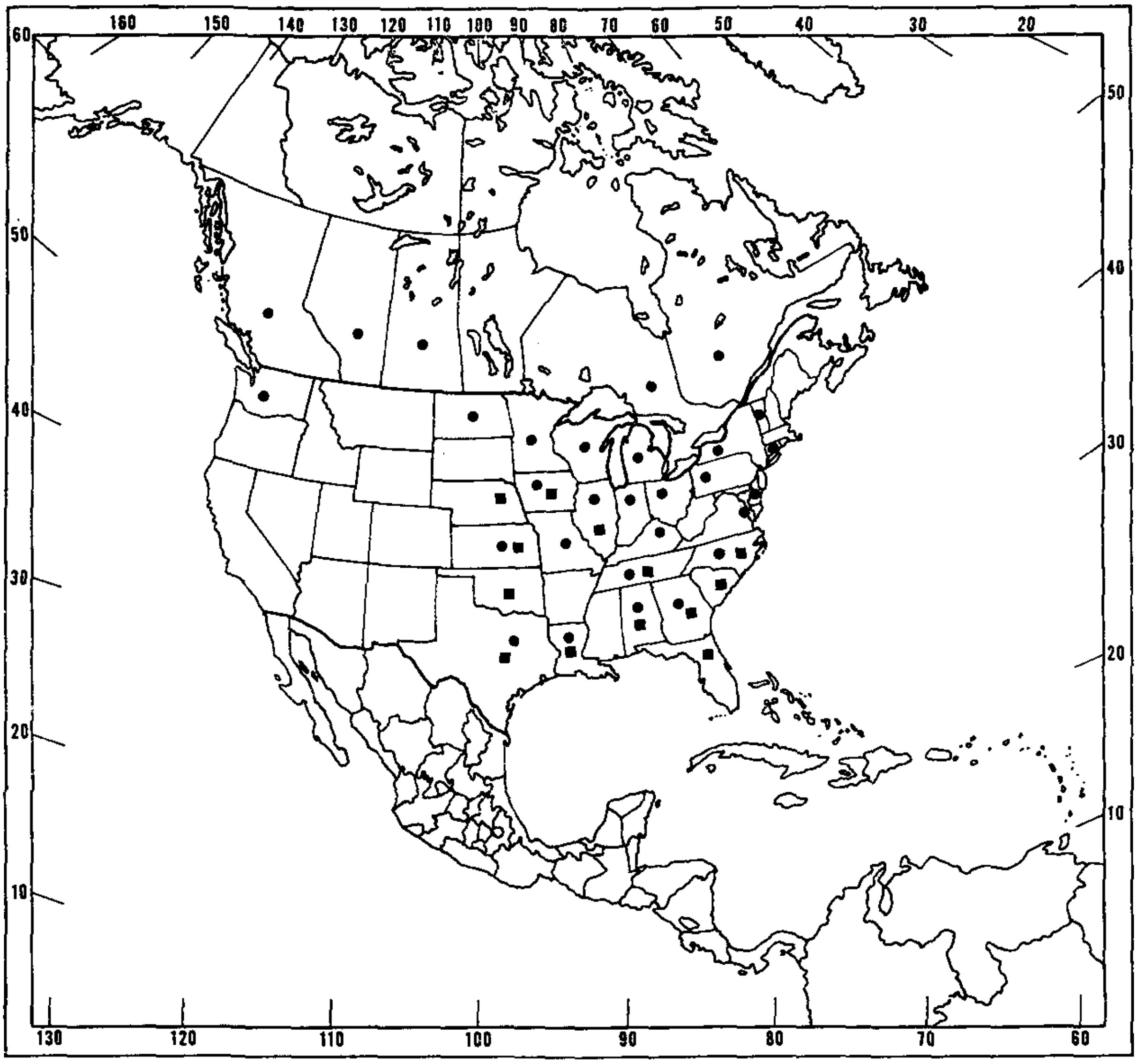


MAP 11. • Oligobdella biannulata ▪ Placobdella hollensis

Comments:

O. biannulata is rarely encountered; Sawyer and Shelley (1976) reported that it may be host specific for desmognathine salamanders and that it is restricted to small streams in the montane areas of the Carolinas.

P. hollensis is uncommon and occurs in certain woodland ponds of the Great Lakes region and is reported from a few other localities in North America. One record of a single specimen, collected on water hyacinth (Eichhornia crassipes) and identified by J. P. Moore, exists for the Withlacoochee River, Florida (USNM 44005). I have since examined specimens resembling this species from the Little Withlacoohee River, Sumter County (USNM 62828) and Taylor Creek, Okeechobee County, Florida and from Screven amd Effingham Counties, Ogeechee River, Georgia.

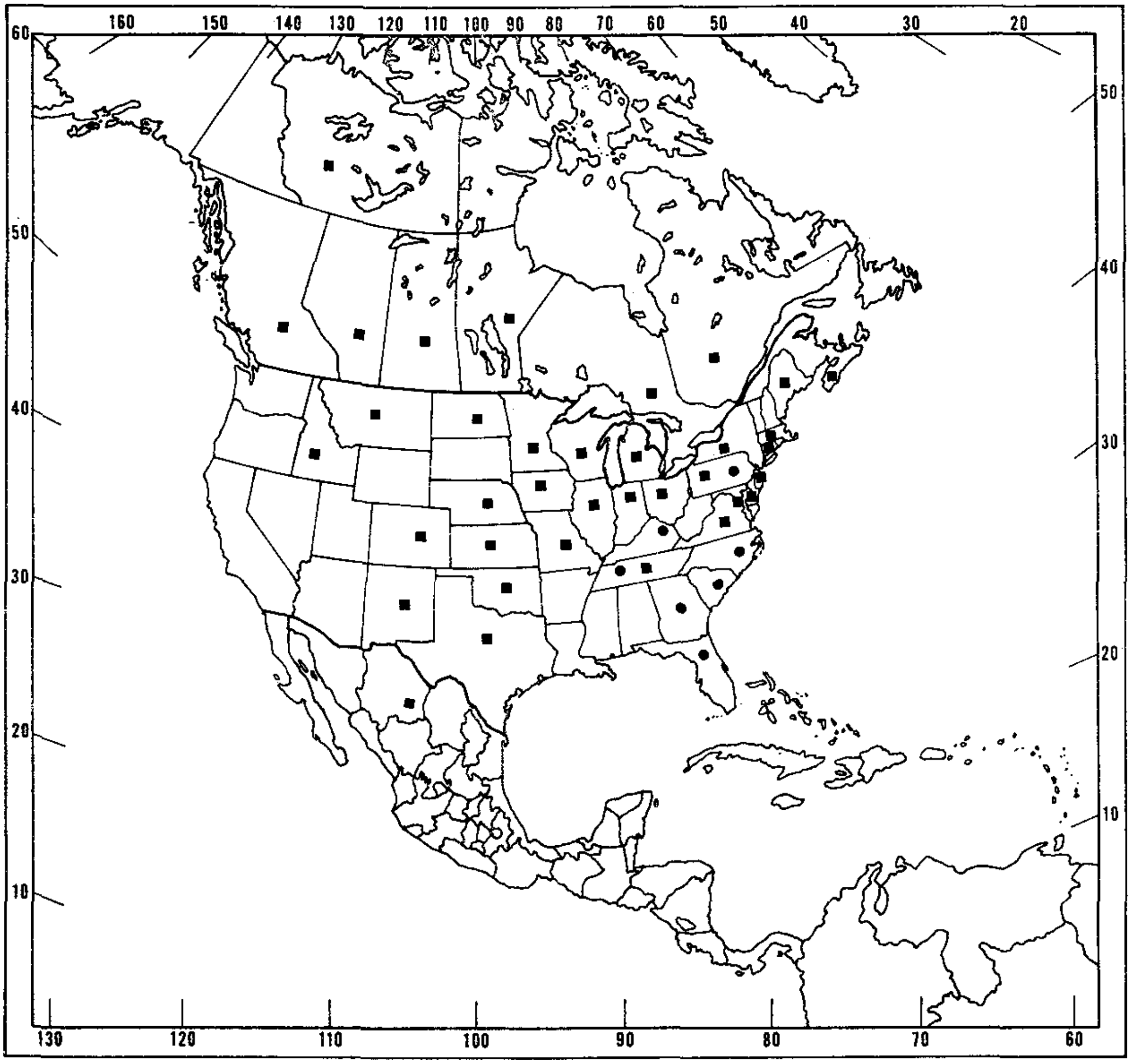


MAP 12. • Placobdella montifera ▪ Placobdella multilineata

Comments:

P. montifera is widely distributed throughout the United States and Canada, but otherwise uncommon.

P. multilineata is common in the southern half of the United States and uncommon elsewhere. Beck (1954) collected one specimen from Currant Creek, Wasatch County, Utah. The specimen is not available for verification, but the validity of this record needs to be substantiated by further collections.

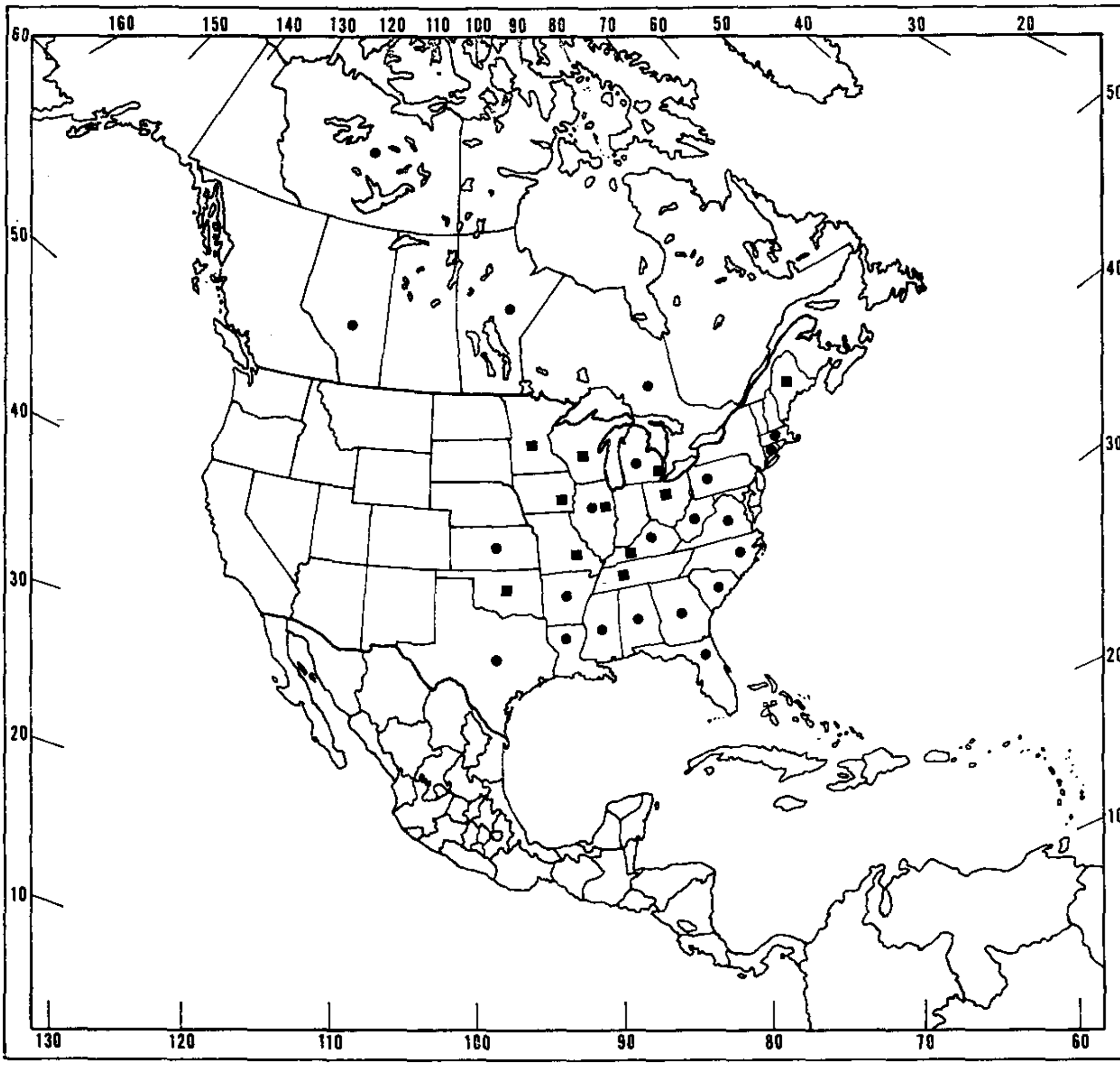


MAP 13. • Placobdella nuchalis ▪ Placobdella ornata

Comments:

P. nuchalis has been reported from several localities of the coastal plains in the Carolinas (Sawyer and Shelley, 1976). I have identified specimens of P. nuchalis, collected from the chin of a channel catfish (Ictalurus punctatus), from Kentucky Lake near Paris Landing, Tennessee. White (1977) (nec P. parasitica Say, 1824) found an individual attached to the eye of a carp (Cyprinus carpio) from the Ohio River, Kentucky. These fish are the first known hosts of the species. I have examined several specimens collected free-living from the Susquehanna River, Three Mile Island, Pennsylvania, and the Ogeechee and Canoochee Rivers in Georgia.

P. ornata is common and widespread throughout the northern half of the United States and Canada; there are few reports of this species from southern localities. It has been reported from Mexico (Caballero, 1940b; Ringuelet, 1976).

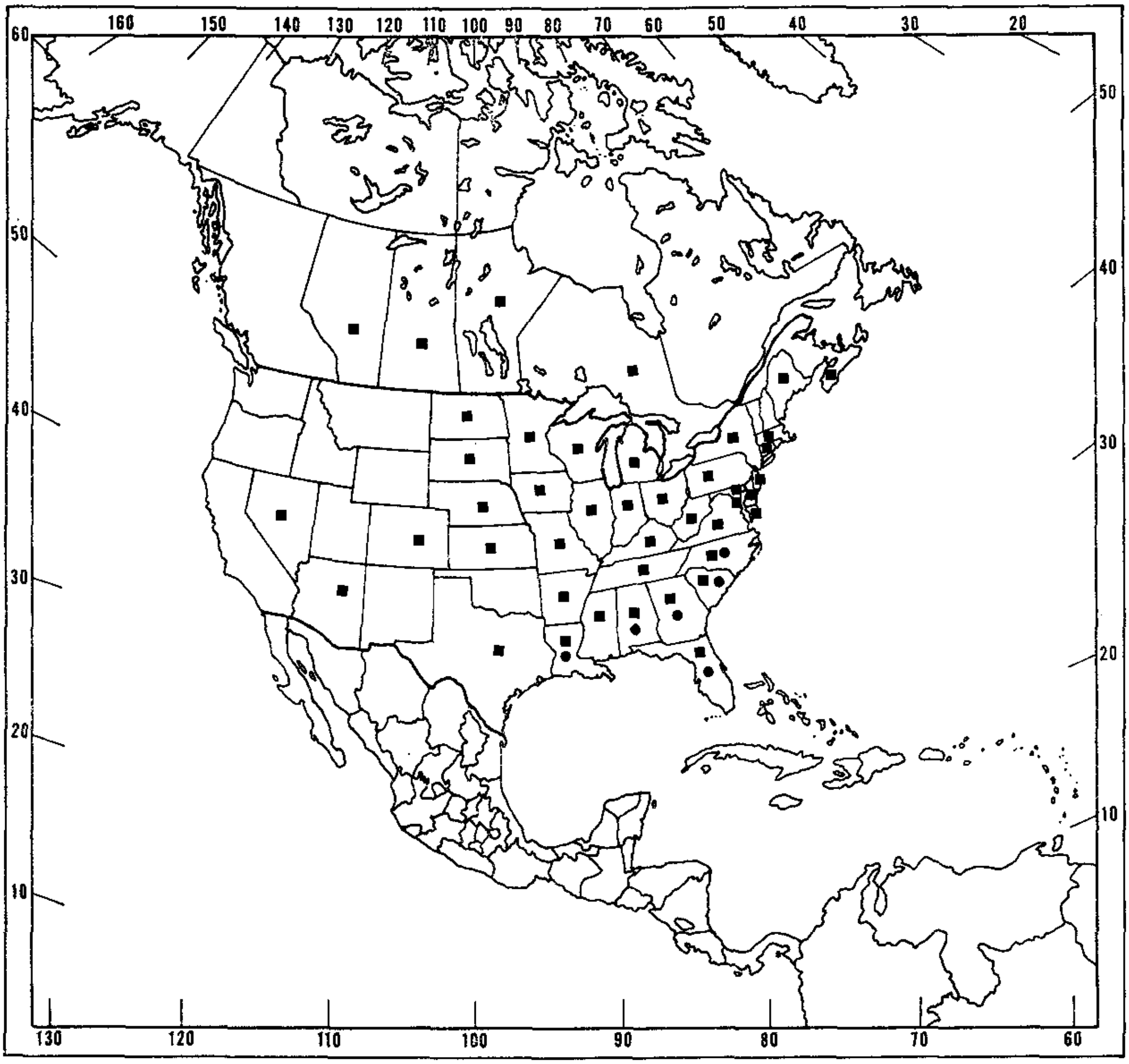


MAP. 14. • Placobdella papillifera ▪ Placobdella pediculata

Comments:

P. papillifera is widely distributed, common in some areas and uncommon elsewhere. *Sawyer (1972) reported it from the musk turtle* (Stenothaerus odoratus).

P. pediculata is uncommon and reported mainly from the Midwest. Records indicate that this species has a high degree of host specificity for the freshwater drum (Aplodinatus grunniens) and surely will be found throughout the distribution of its host. Data show that the isthmus and the inside of the opercula (Fig. 11a) are the usual sites of attachment. Adult specimens that I have examined were also found parasitizing A. grunniens from the *Mississippi River in Illinois, Kentucky Lake in southwest Kentucky and* northwest Tennessee, and Lake St. Clair in Michigan. This leech has never been collected in the free-living state.

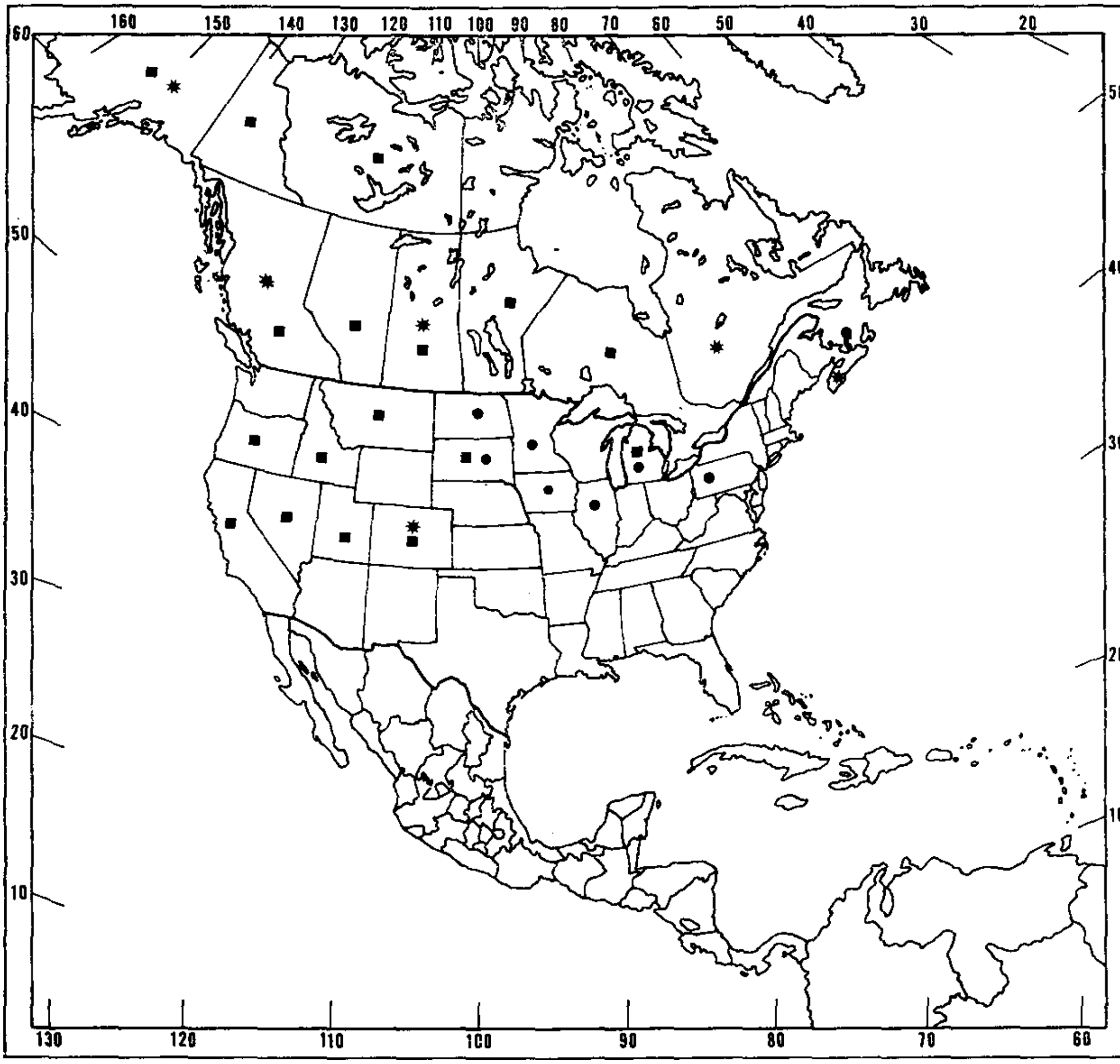


MAP 15. ■ Placobdella parasitica • Placobdella translucens

Comments:

P. parasitica is common and widely distributed throughout the United States and Canada.

P. translucens is uncommon and known only from the Gulf States and coastal areas of the southern United States. I have examined specimens from North Carolina, Georgia, Alabama, and Louisiana.



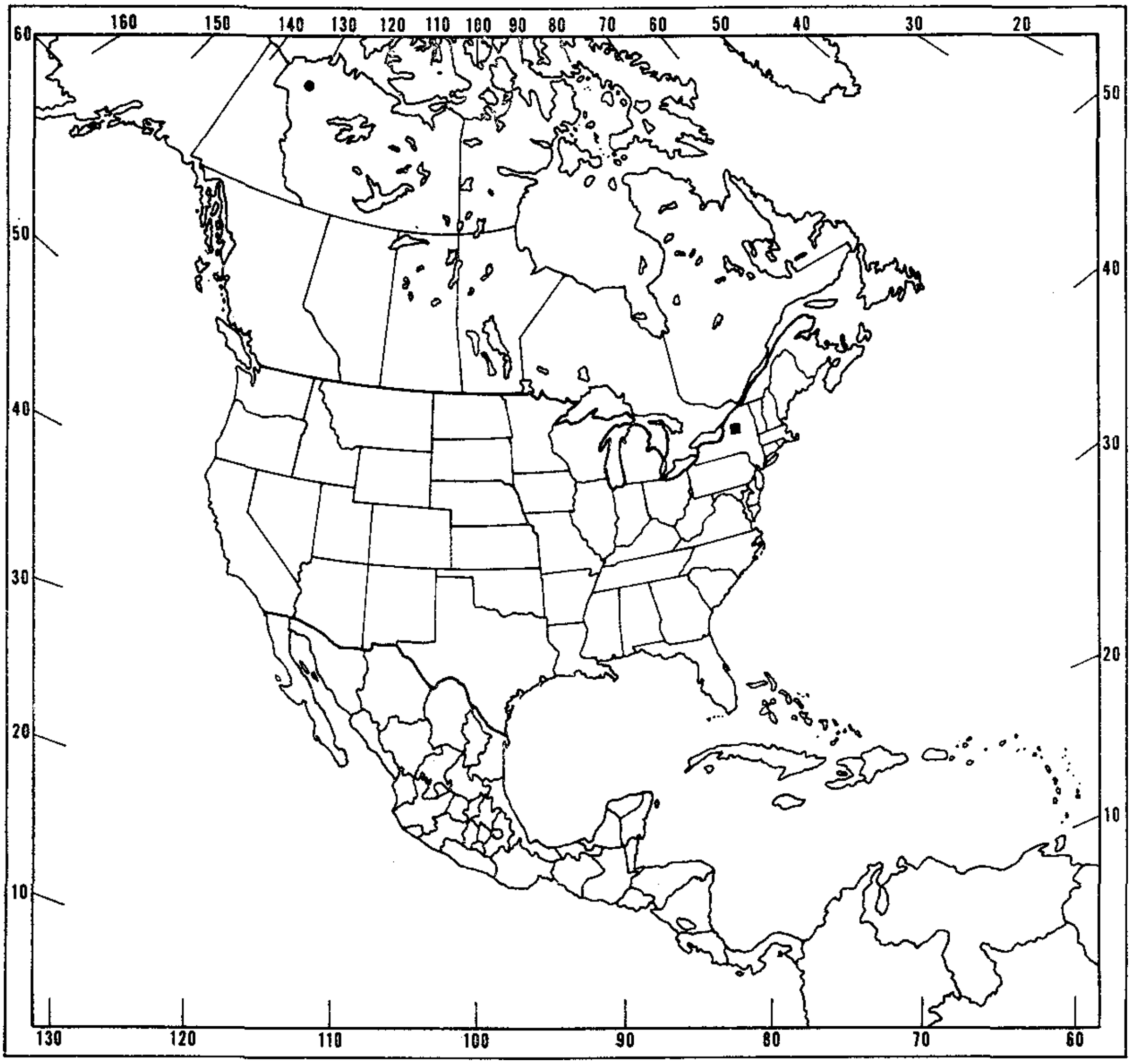
MAP 16. • Theromyzon biannulatum ▪ Theromyzon rude * Theromyzon tessulatum

Comments (cf. Notes on Systematics.):

T. biannulatum is uncommon and known only from the central and eastern United States.

T. rude is uncommon and apparently distributed in the central and western United States and Canada, including Alaska, and is infrequent elsewhere. I have examined specimens from British Columbia.

T. tessulatum is uncommon and characteristic of Eurasia but has been reported infrequently from North and South America. I have listed its distribution in North America as questionable (Klemm, 1977), but I have since examined specimens from Quebec and British Columbia in Canada. Davies (1973) has also reported it from British Columbia and Saskatchewan, and Pawlowski (1948) from Nova Scotia. Herrmann (1970) collected it from three sites near Boulder, Colorado. The South America records are Blanchard (1892) from Chile, Oka (1932) from Peru, Moore (1911) and Ringuelet (1944a) from Argentina.

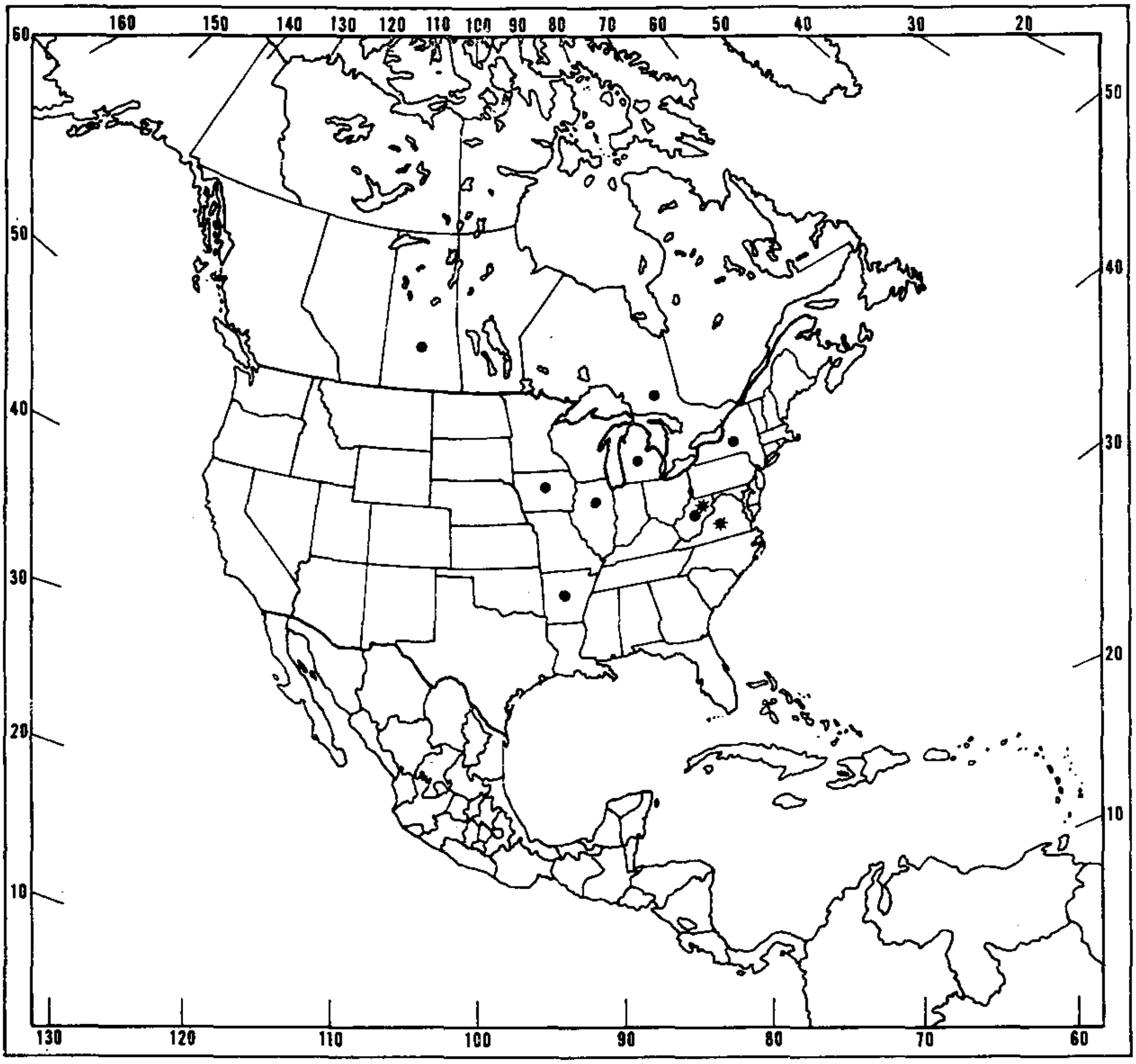


MAP 17. • Cystobranchus mammillatus ▪ Cystobranchus meyeri

Comments:

C. mammillatus is uncommon but widely distributed throughout north and central Europe. In North America this species has only been reported from the Northwest Territories of Canada (Meyer and Roberts, 1977).

C. meyeri is uncommon and reported only from eastern New York (Hayunga and Grey, 1976). I have also examined specimens collected from the fins of the white sucker (Catostoma commersoni) from southeastern Lake Ontario.

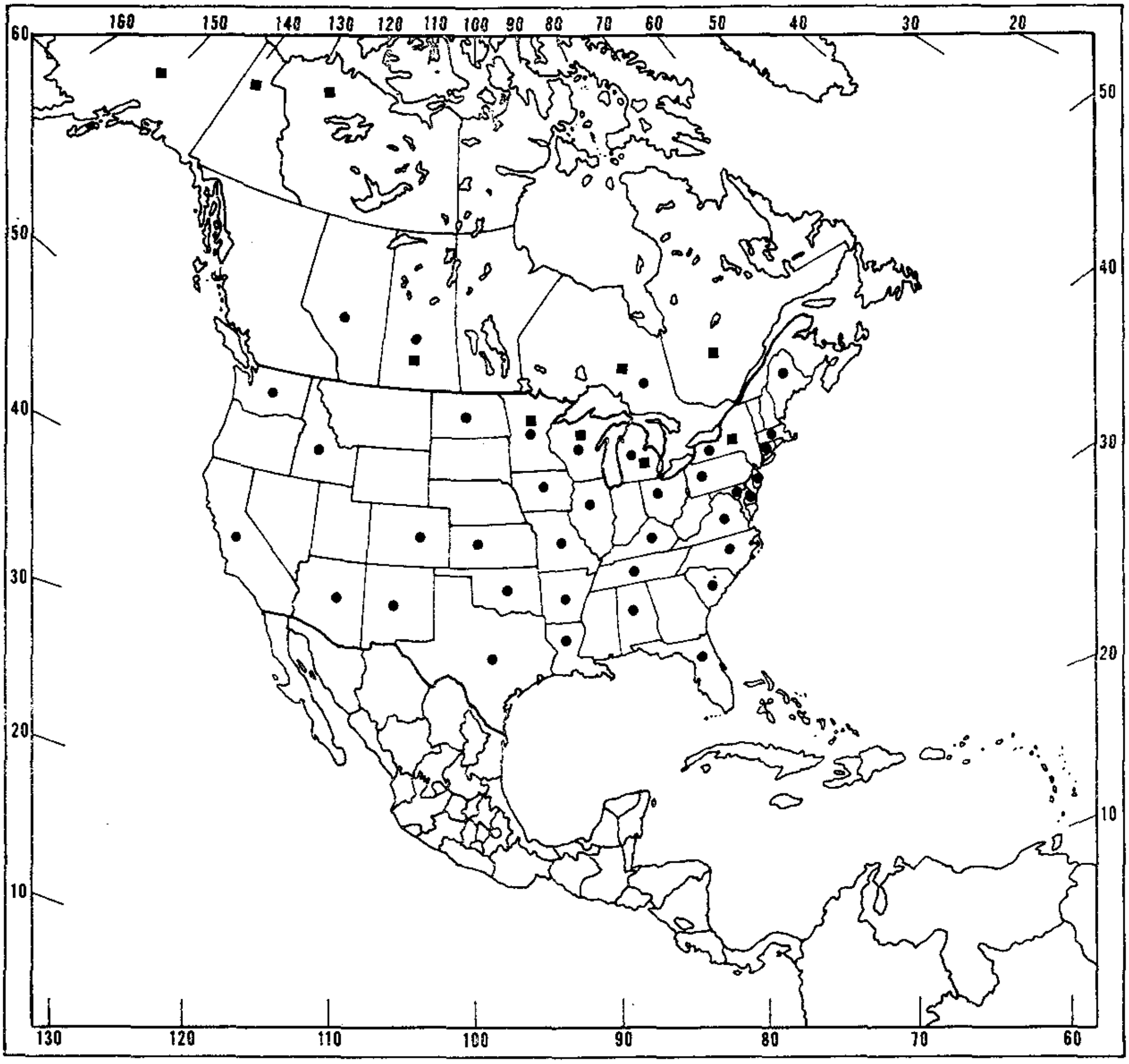


MAP 18. • *Cystobranchus verrilli* * *Cystobranchus virginicus*

Comments:

C. verrilli is uncommon with several reports from the Great Lakes region and southern Canada; the species is less common elsewhere.

C. virginicus is uncommon and has been reported from Virginia (Hoffman, 1964) and West Virginia (Putz, 1972). (cf. Notes on Systematics).

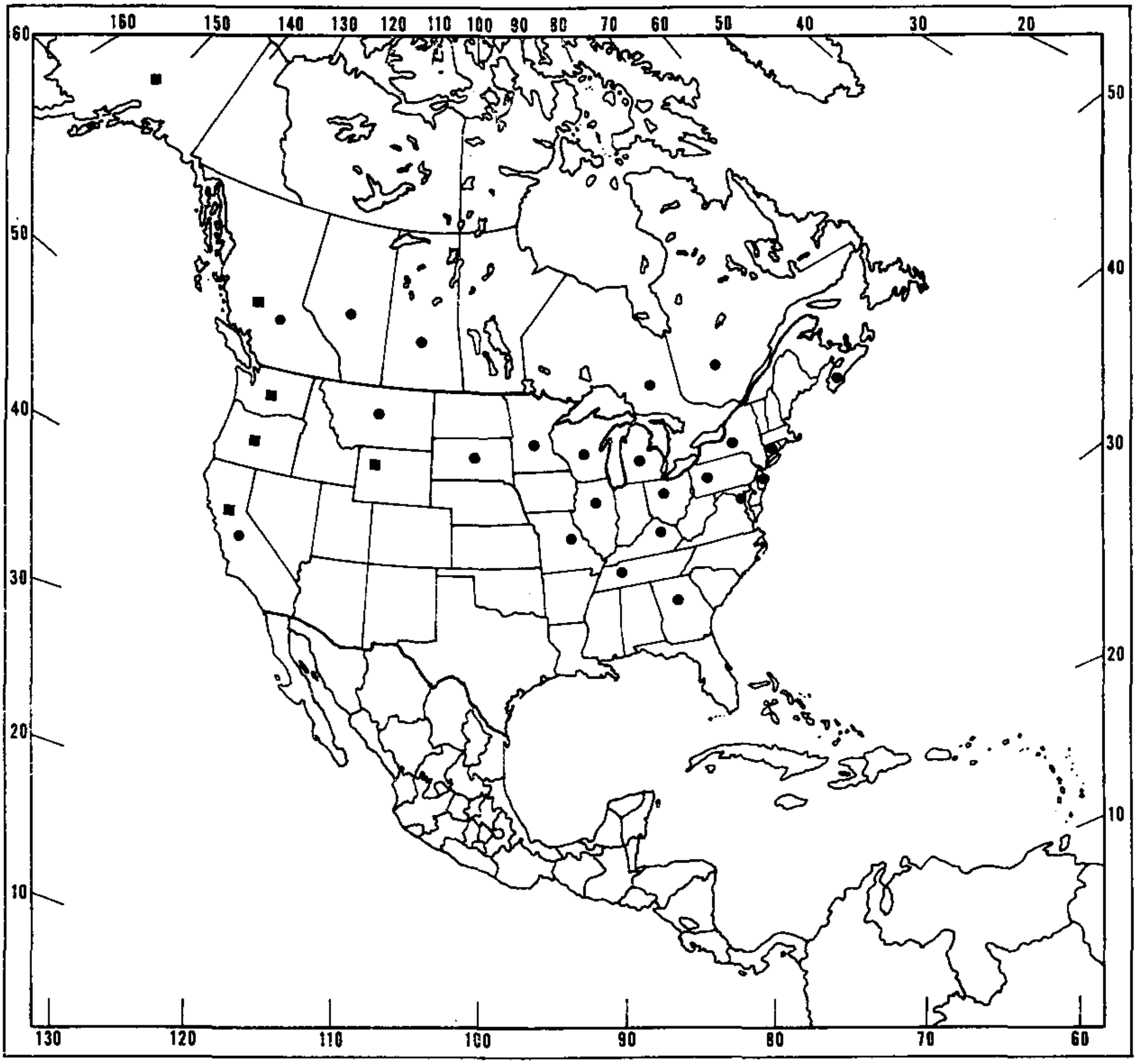


MAP 19. • Myzobdella lugubris ▪ Piscicola geometra

Comments:

M. lugubris is common and widely distributed throughout North America in both fresh and brackish waters. Also, Caballero (1940a) described a closely related species, M. patzcuarensis, from Lake Patzcuaro in Mexico.

P. geometra *is common but not found abundantly in Eurasia.* It is considered by some authors to be holarctic in distribution. The occurrence of this species in North America is open to question (cf. Notes on Systematics). Sawyer et al. (1975) reported that this species also occurs in brackish waters of the upper Baltic Sea and in many types of freshwater habitats throughout Eurasia.

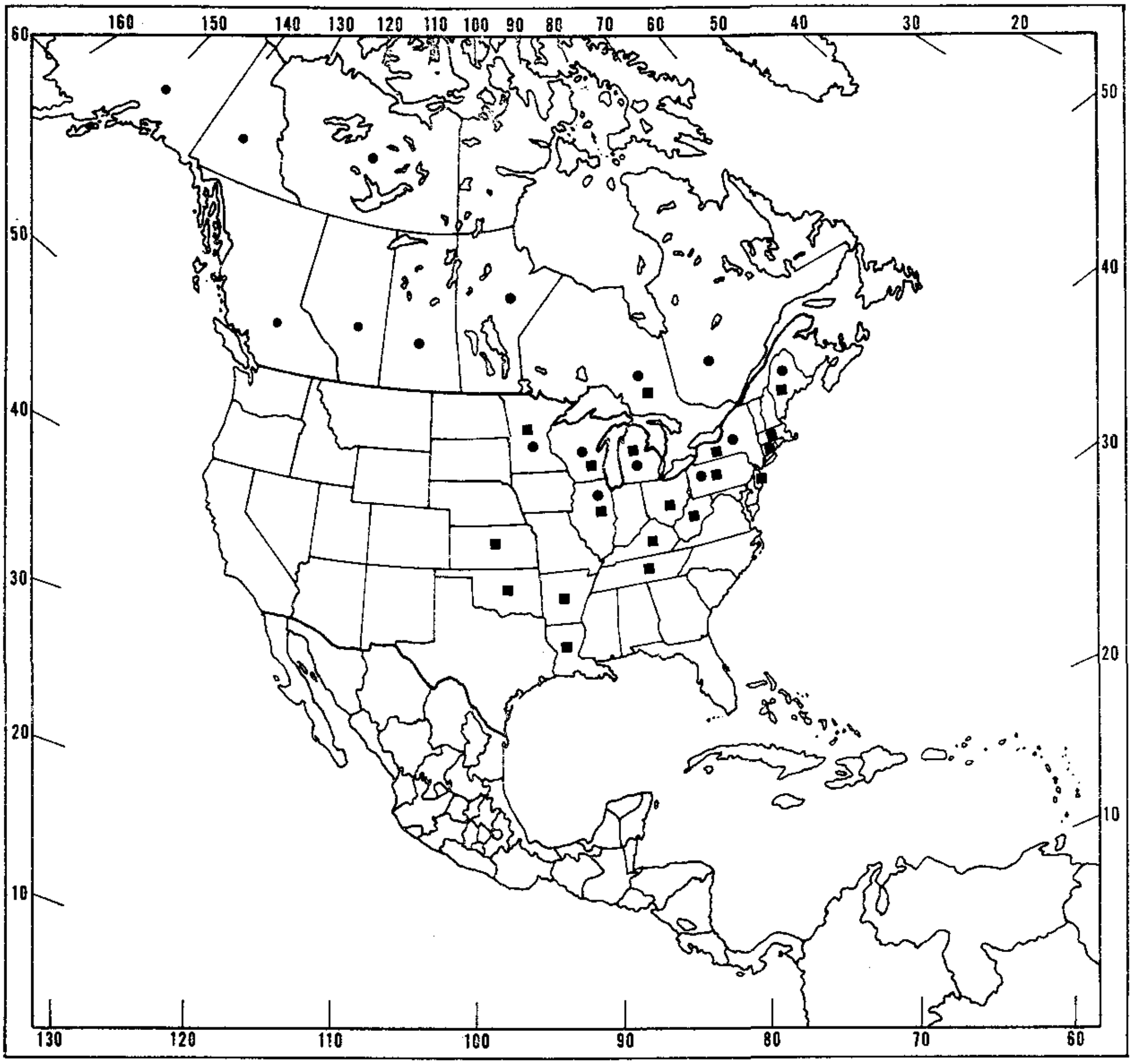


MAP 20. • Piscicola punctata ▪ Piscicola salmositica

Comments:

P. punctata is widely distributed in North America, chiefly reported from the northern United States and Canada, but infrequently encountered elsewhere.

P. salmositica is locally abundant in western United States, including Alaska, as well as British Columbia in Canada, and uncommon elsewhere.

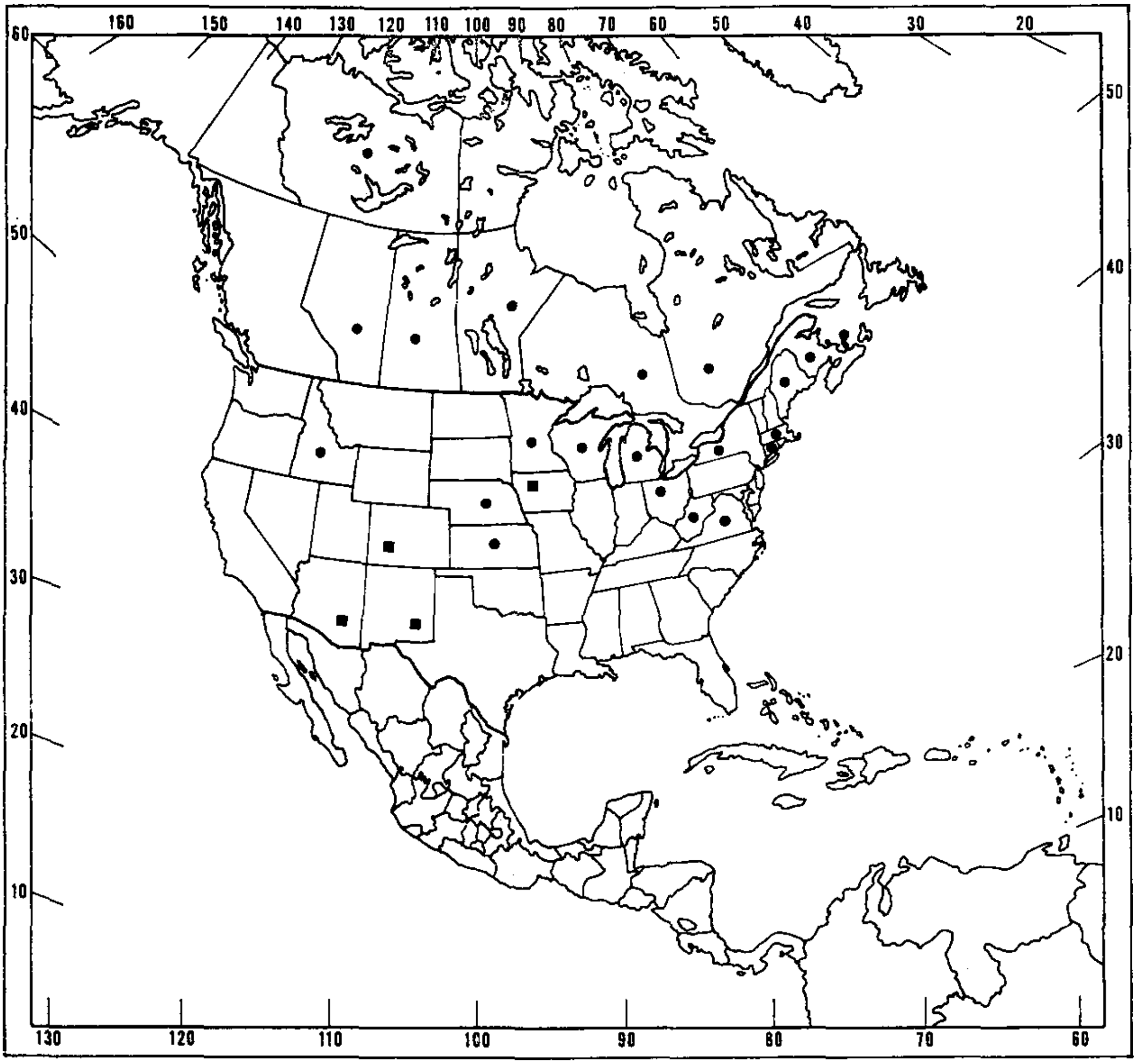


MAP 21. • Piscicola milneri ▪ Piscicolaria reducta

Comments:

P. milneri is uncommon and reported from the Great Lakes region, the eastern United States, including Alaska, and throughout Canada. (cf. Notes on Systematics).

P. reducta is uncommon in some localities, elsewhere common, especially in the Great Lakes region. I examined a specimen collected on the arrow darter, Etheostoma sagitta, from the Poor Fork of the Cumberland River in Kentucky. Pearse (1936) reported a juvenile Piscicolaria sp. from Carteret County, North Carolina, but Sawyer and Shelley (1976) considered it a dubious record.

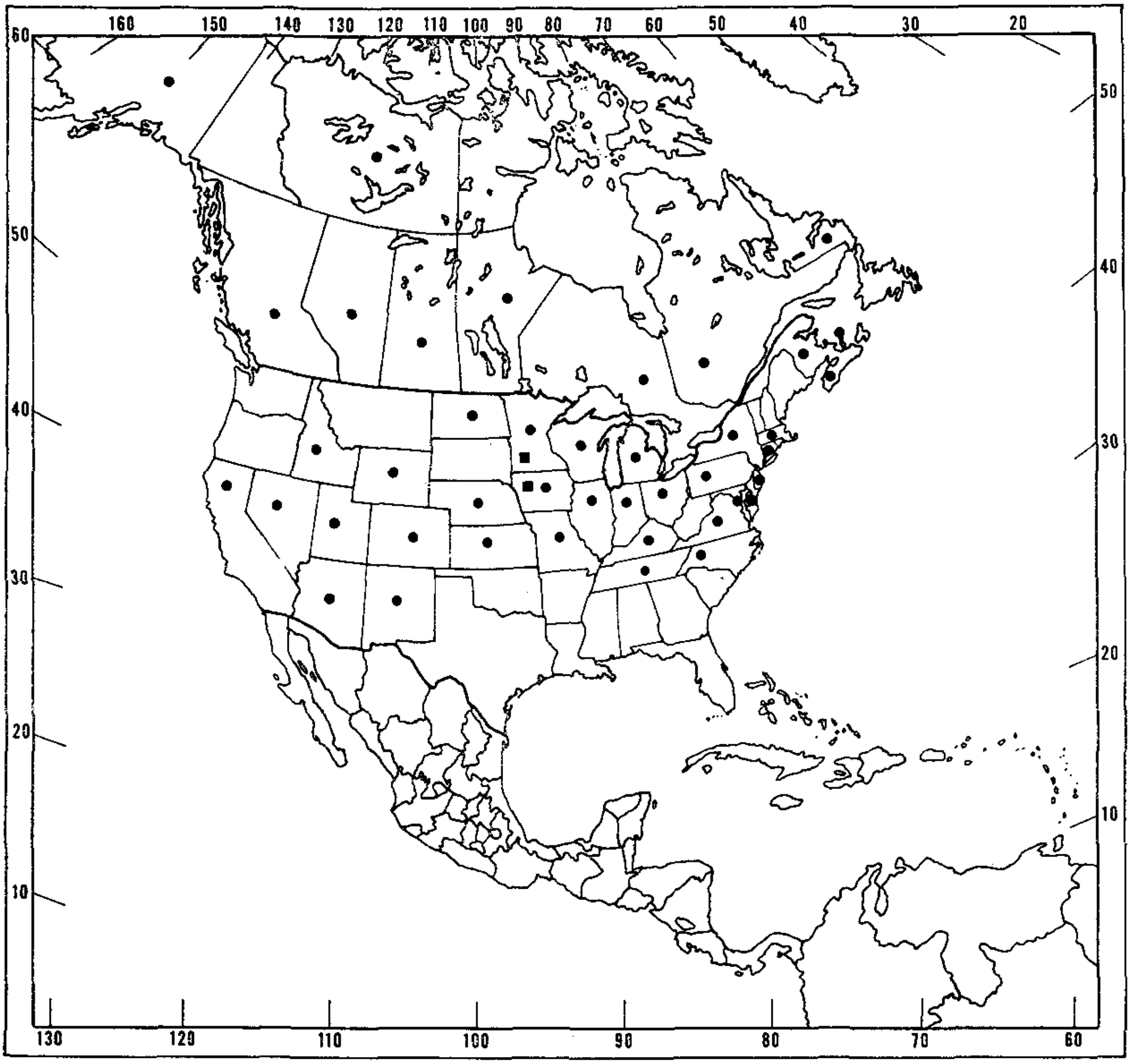


MAP 22. • *Haemopis grandis* ▪ *Haemopis kingi*

Comments:

H. grandis is common in the Great Lakes region, eastern United States and Canada; there are few records of this species elsewhere.

H. kingi is uncommon and known only from northwest Iowa (Mathers, 1954) and southwest Colorado (Herrmann, 1970). I have examined specimens, resembling this species, from Seven Springs, Arizona and the Guadalupe Mountains, New Mexico.

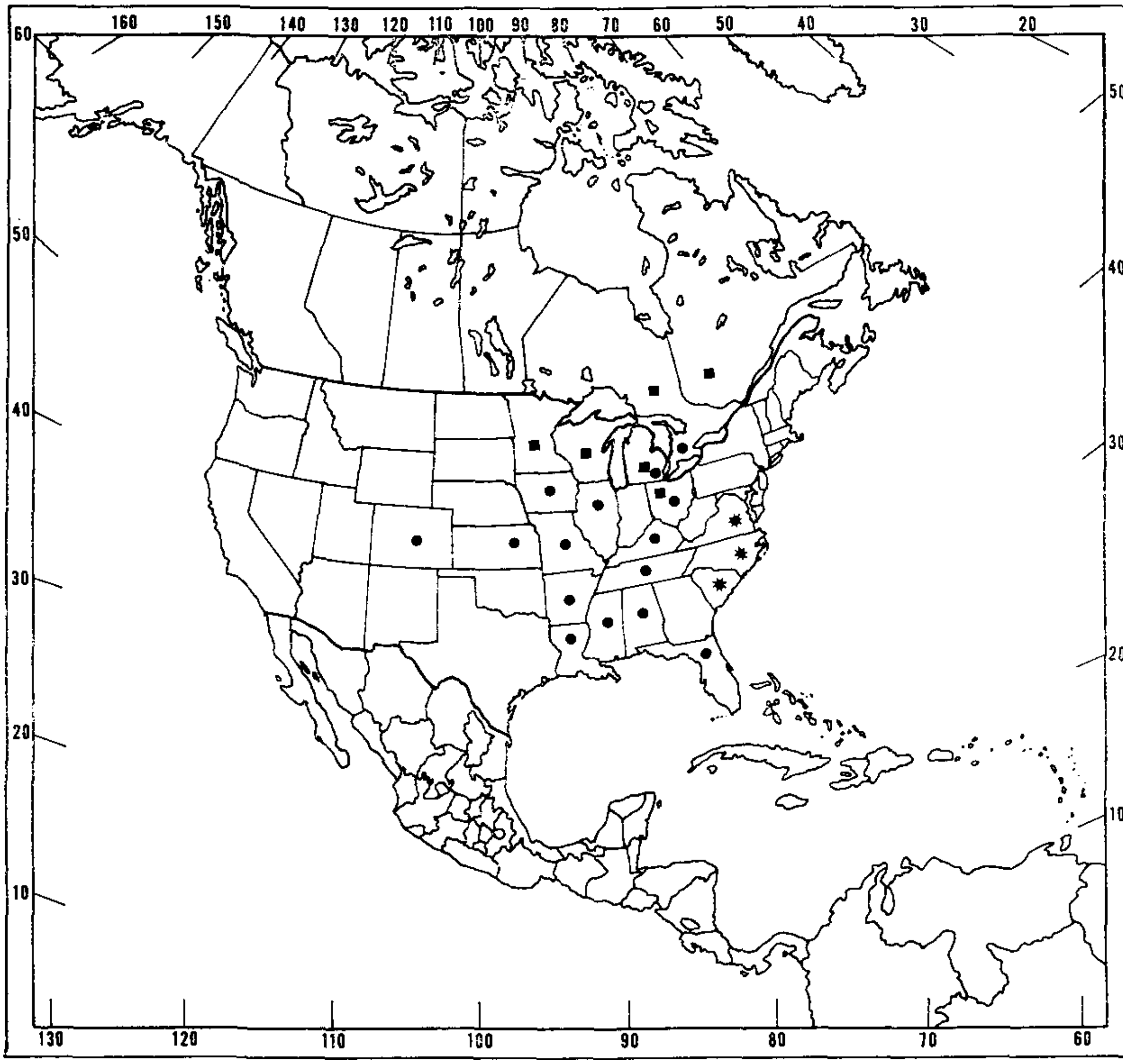


MAP 23. ▪ Haemopis lateromaculata • Haemopis marmorata

Comments:

H. lateromaculata is uncommon and recorded only from northwest Iowa (Mathers, 1963) and Minnesota (Mathers, 1963; Fish and Vande Vusse, 1976).

H. marmorata is common in some localities and widely distributed throughout North America. Richardson (1971) described a new species, Percymoorensis caballeroi, from Mexico that closely resembles the North American H. marmorata.



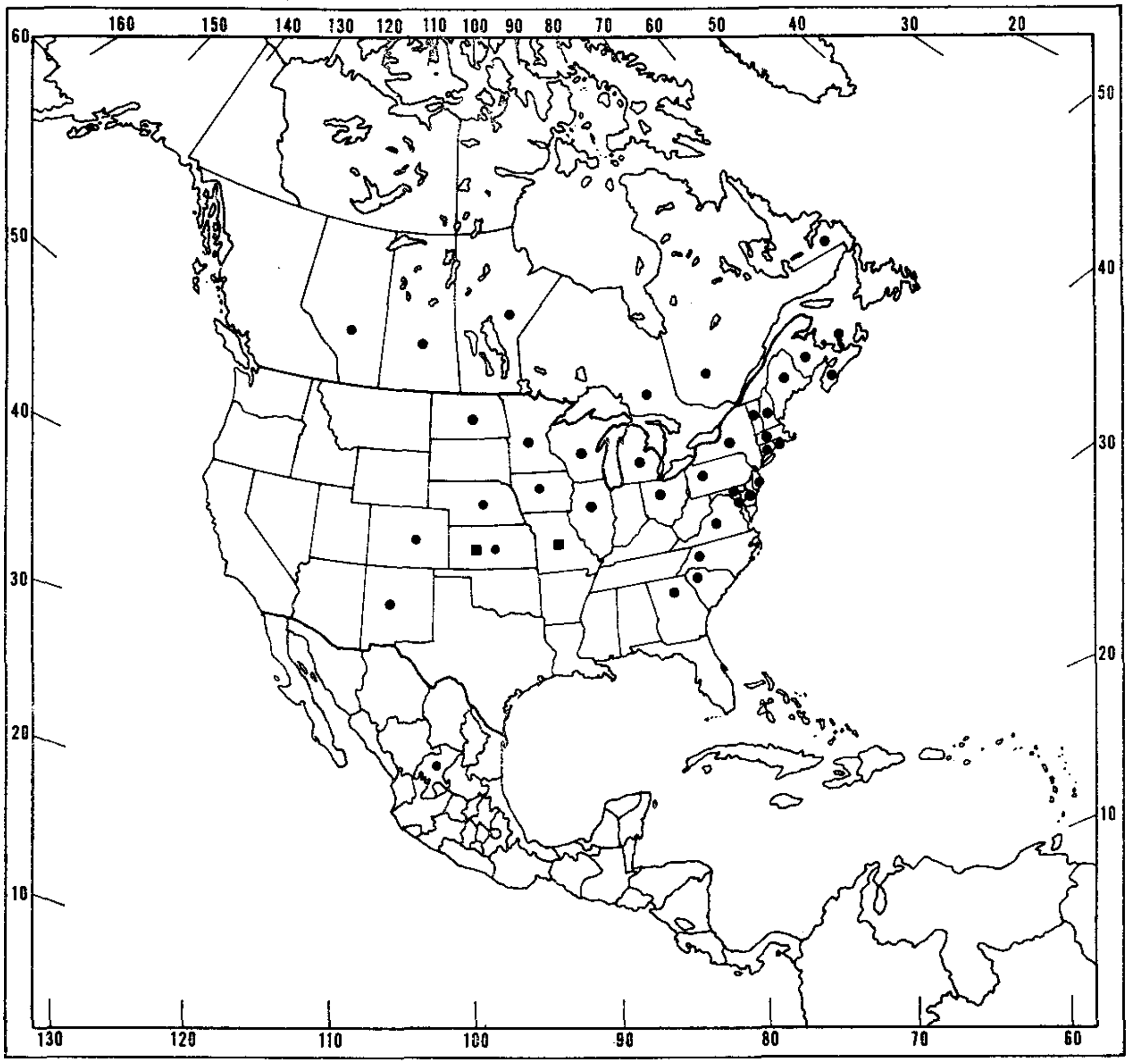
MAP 24. ▪ Haemopis plumbea * Haemopis septagon • Haemopis terrestris

Comments:

H. plumbea is uncommon and known from Minnesota, Wisconsin, Michigan and Ohio in the United States; Ontario and Quebec in Canada. I have examined specimens from Michigan, but old records of this species occurring in Wisconsin, Ohio, and Ontario need to be substantiated by new records.

H. septagon has been reported from the coastal plain and eastern piedmont areas of the Carolinas and Virginia (Sawyer and Shelley, 1976). I have identified specimens also collected in North Carolina. This species may be difficult to find because of its terrestrial existance.

H. terrestris is uncommon and known from the southern Great Lakes region, Mississippi Basin to Colorado, and southward to the Gulf States. This species has been reported from both aquatic and terrestrial habitats.

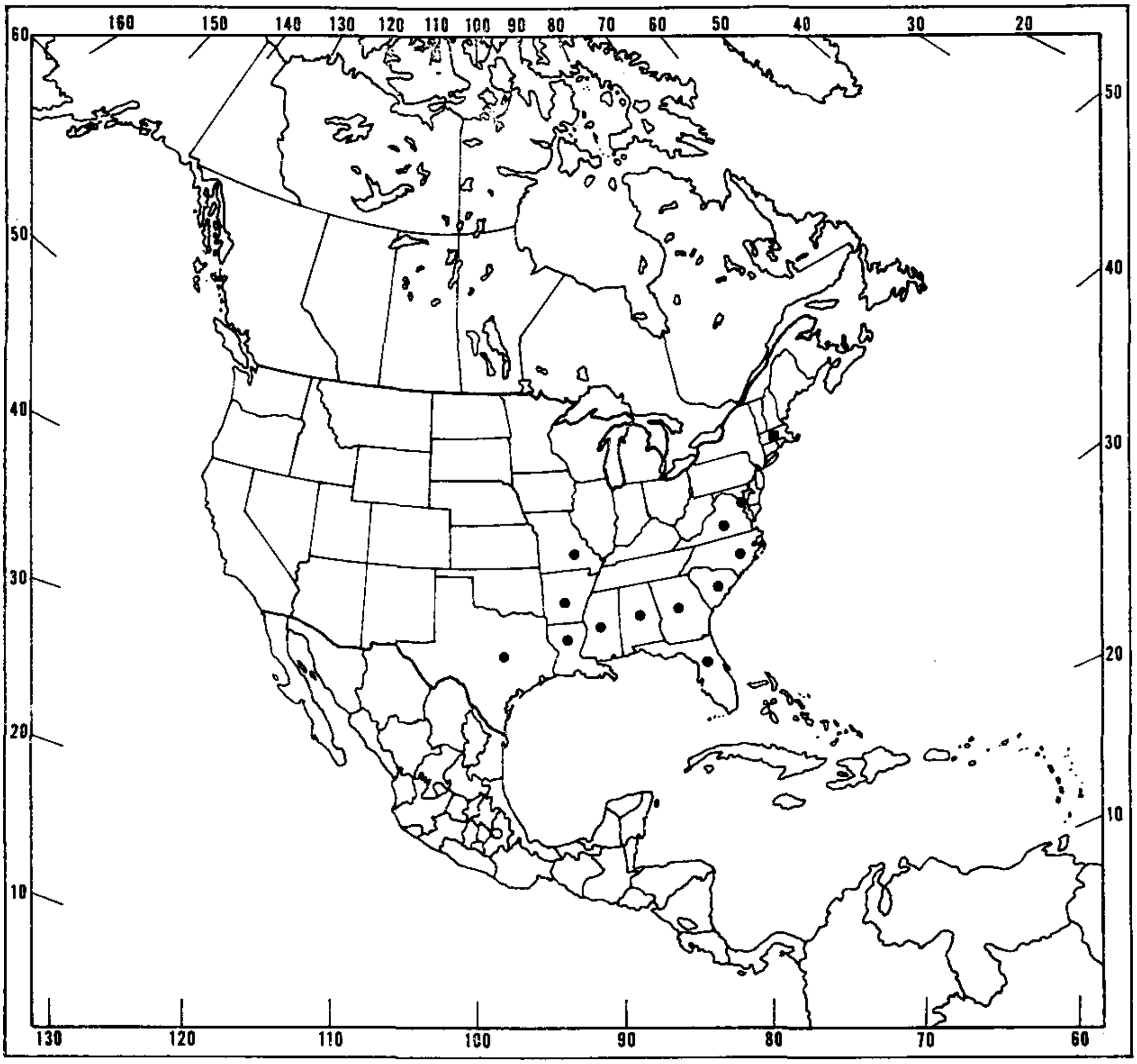


25. • Macrobdella decora ▪ Macrobdella diplotertia

Comments:

M. decora is common in ponds in the northern half of the United States and Canada. This species is less common in the southern states; Sawyer and Shelley (1976) regarded it as being restricted to the piedmont and montane areas of the Carolinas and Georgia. This species is also known to occur in northern Mexico (Caballero, 1952).

M. diplotertia has been reported only from western Missouri (Meyer, 1975). Klemm, et al. (1979) identified several specimens of this species from Chautauqua County in southeastern Kansas, thus extending its range.

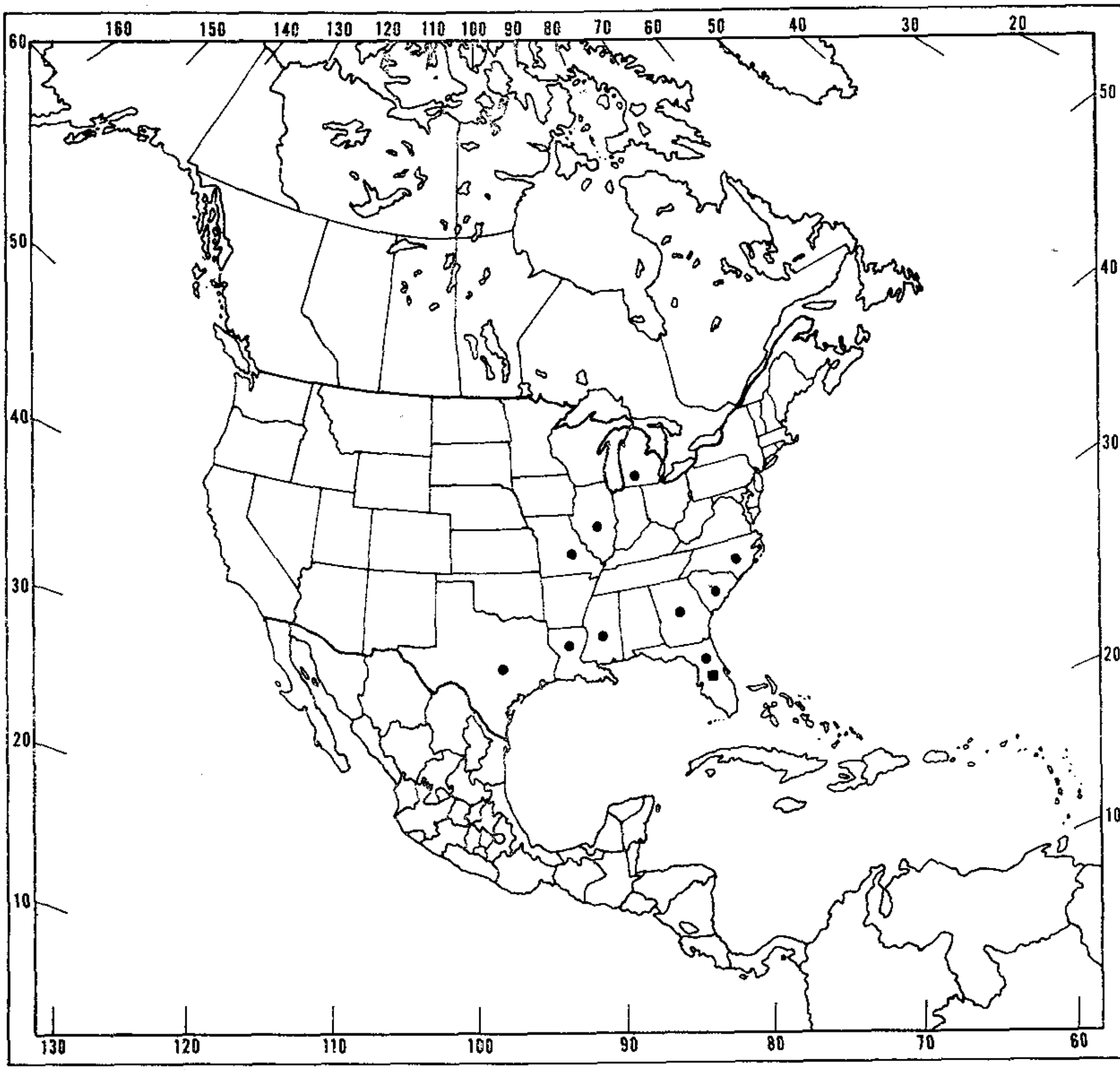


MAP 26. • Macrobdella ditetra ▪ Macrobdella sestertia

Comments:

M. ditetra is common and widely distributed in the Gulf States and coastal plain areas of the Carolinas; it appears less common elsewhere.

M. sestertia is uncommon and known only from eastern Massachusetts (Whitman, 1886; Moore, 1959; Klemm, 1972b; Sawyer, 1972; Smith, 1977).

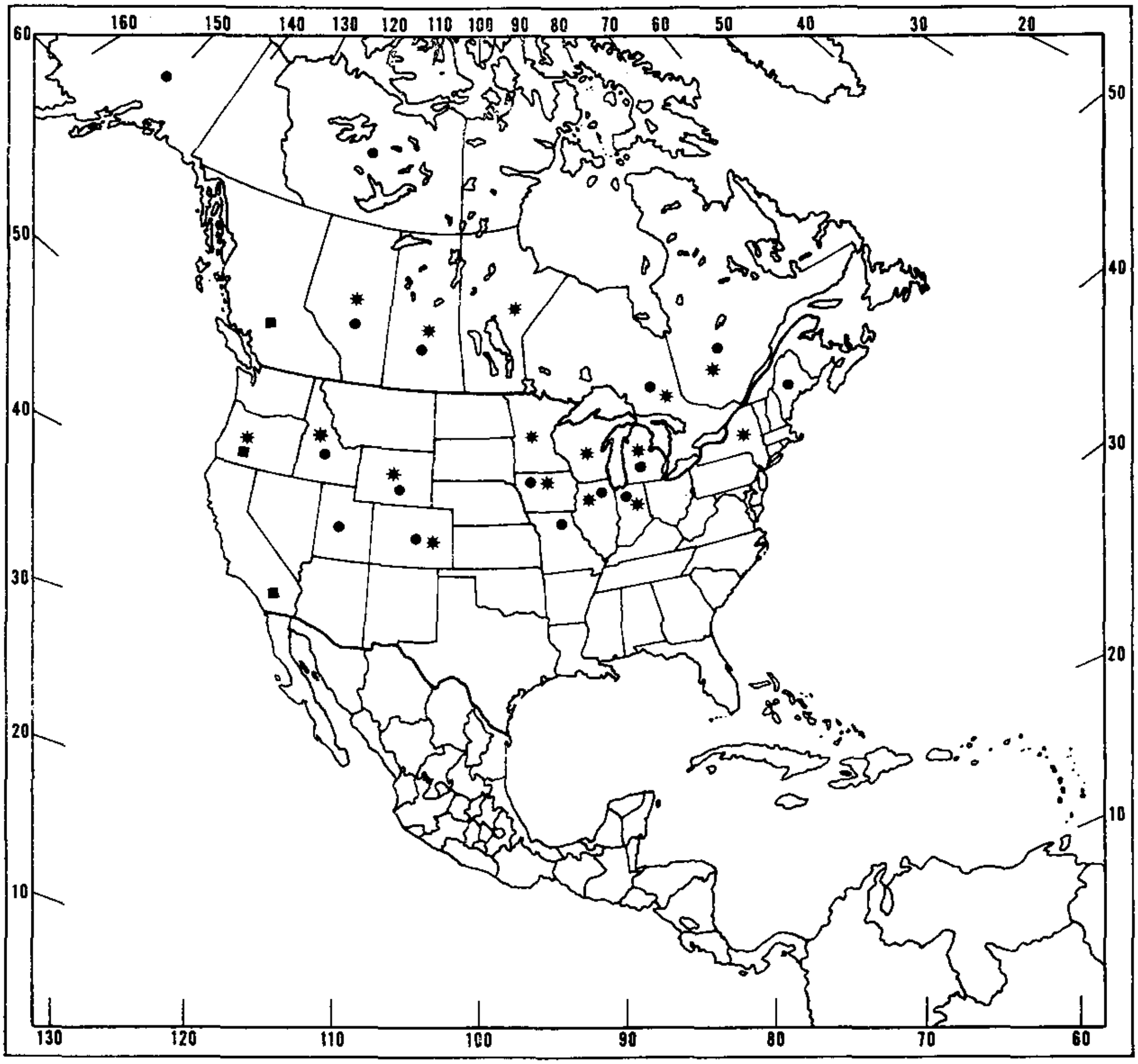


MAP 27. ▪ Philobdella floridana • Philobdella gracilis

Comments:

P. floridana has been reported from Lake Okeechobee in Florida (Verrill, 1972). I have examined specimens that resemble this species from Jacksonville and West Palm Beach, Florida. (cf. Notes on Systematics).

P. gracilis is common and widely distributed throughout the southern United States and is less common elsewhere. Individuals of this species have been reported from Otis Lake, Barry County, Michigan (Kopenski, 1969; Klemm, 1972a,b, 1977), and I have examined specimens collected in southern Illinois. (cf. Notes on Systematics).



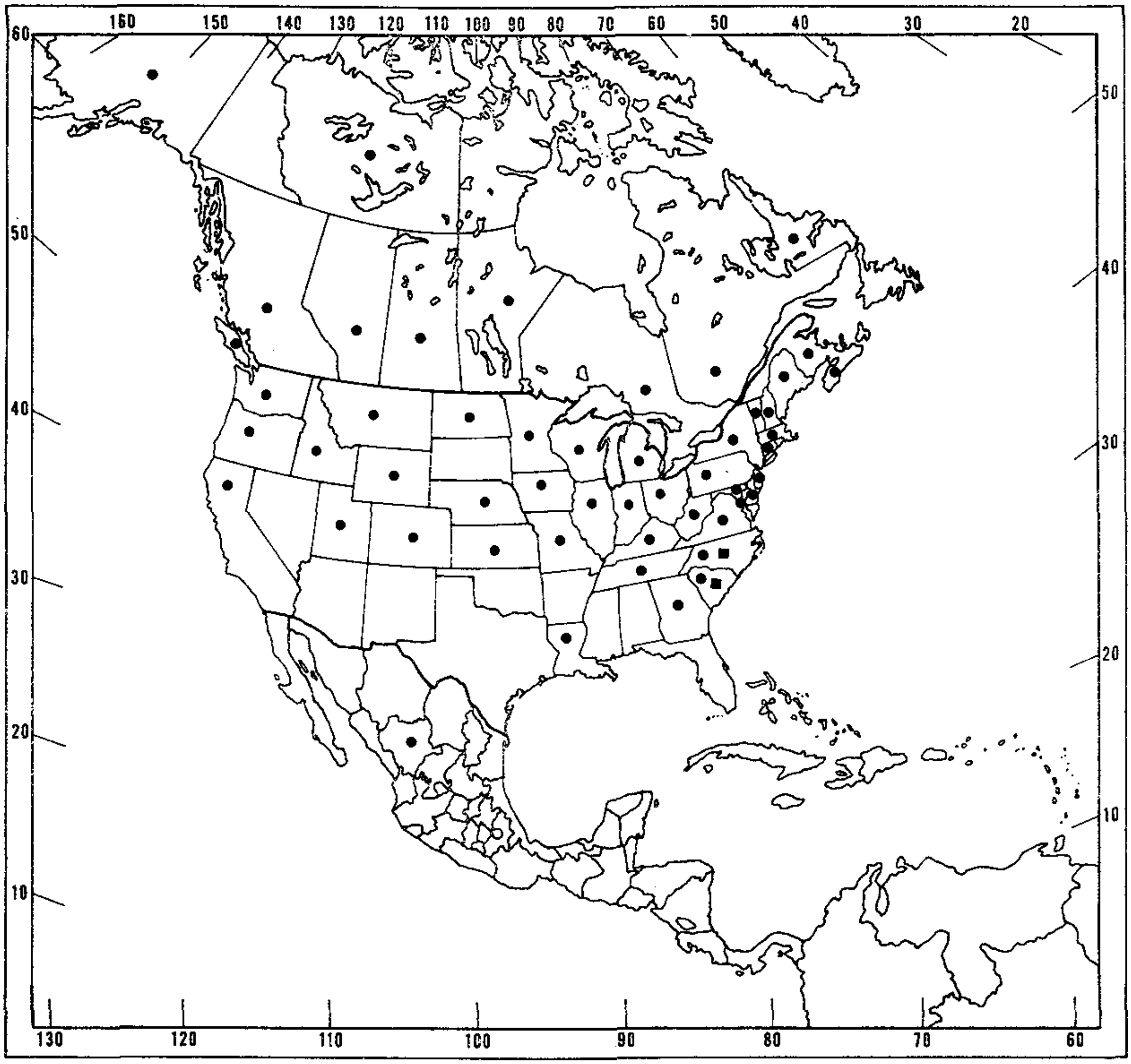
MAP 28. ▪ Dina anoculata • Dina dubia ✱ Dina parva

Comments:

D. anoculata is not a well known species (cf. Notes on Systematics). Moore (1898) collected specimens (USNM 4844) from a mountainous area of San Diego County, California. He also identified specimens (USNM 36938 and USNM 36874) from Oregon at elevations of 2,830 and 3,287 feet. Scudder and Mann (1968) collected a single specimen from a lake in the Southern Interior Plateau region of British Columbia, but I consider this a doubtful record.

D. dubia is widely distributed throughout the northern United States, including Alaska and Canada, but it is collected infrequently.

D. parva is widespread throughout the northern United States and Canada, but it is not frequently encountered.

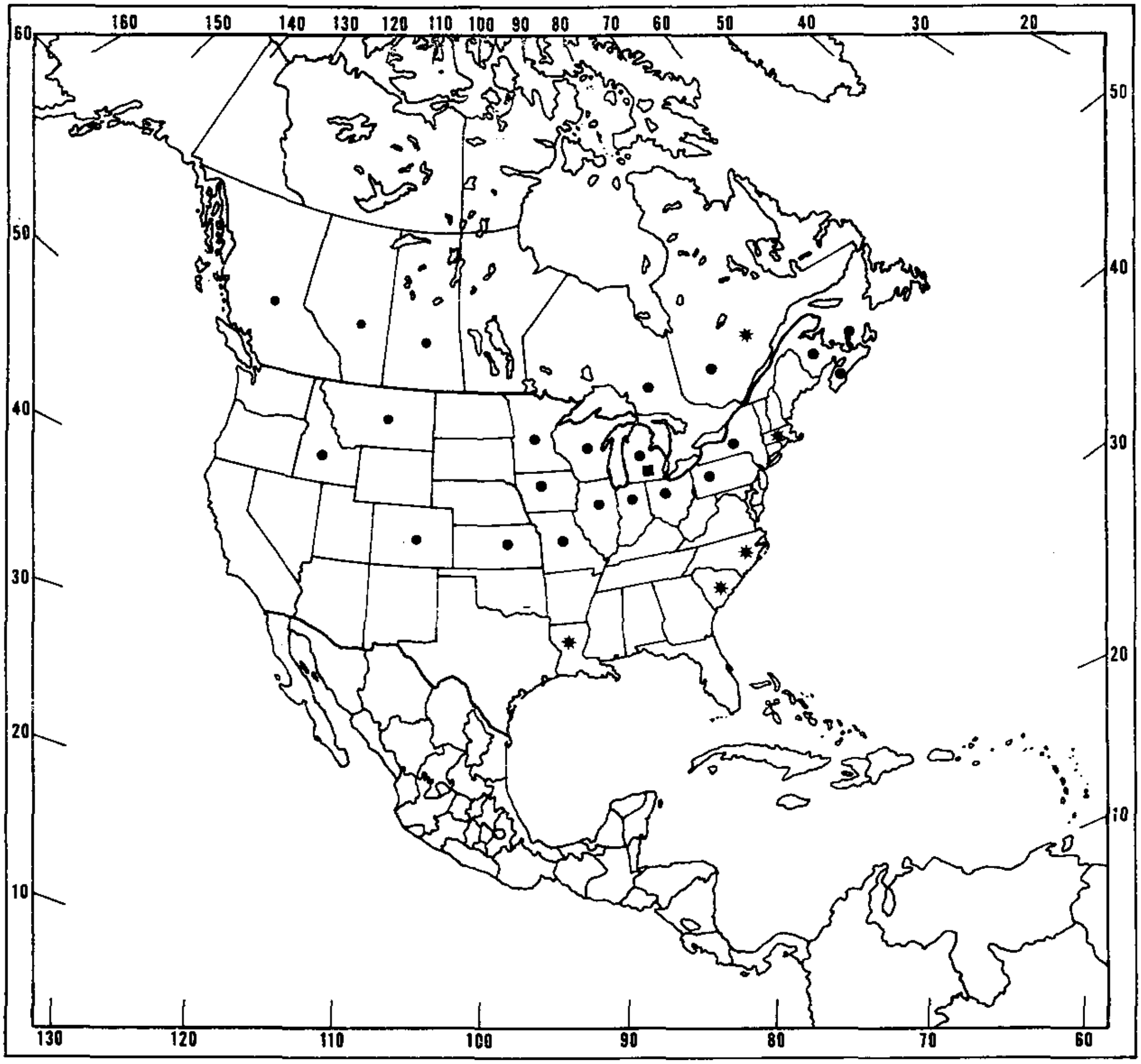


MAP 29. ▪ Erpobdella punctata coastalis • Erpobdella punctata punctata

Comments:

E. p. coastalis is known only from the coastal areas of the Carolinas (Sawyer and Shelley, 1976).

E. p. punctata is common throughout most of the United States and Canada, especially the Great Lakes region. This species is also reported from Mexico (Caballero, 1941; Sawyer, 1972).



MAP 30. ■ Mooreobdella bucera • Mooreobdella fervida

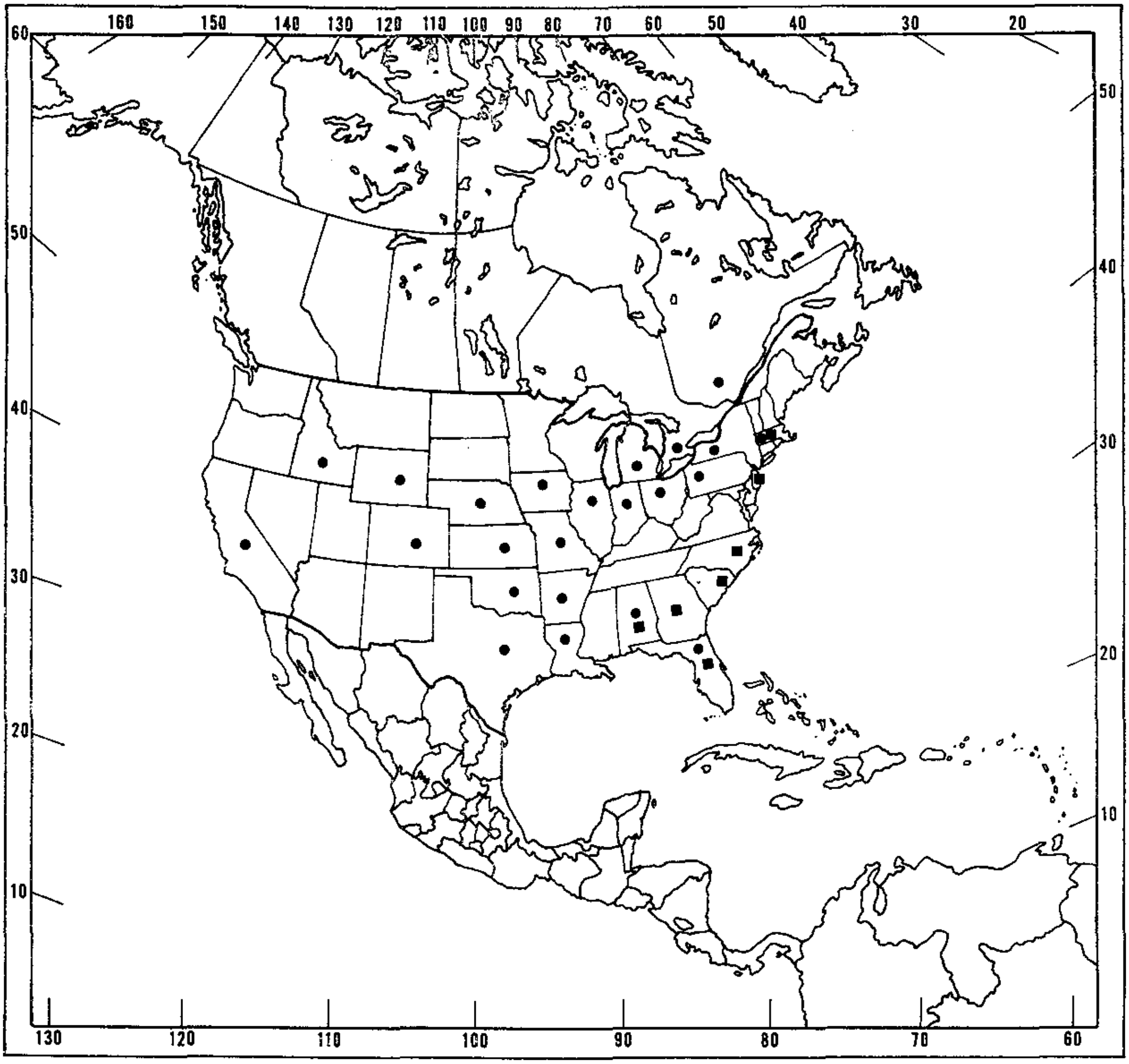
* Mooreobdella melanostoma

Comments:

M. bucera is uncommon and reported only from one locality in southeastern Michigan (Kenk, 1949; Klemm, 1972a,b, 1977; Sawyer, 1972).

M. fervida is common in some localities but widely distributed in the northern half of the United States and over much of Canada.

M. melanostoma has been reported from the Carolinas (Sawyer and Shelley, 1976). I have examined specimens from Massachusetts, North Carolina and Louisiana in the United States and Quebec in Canada.

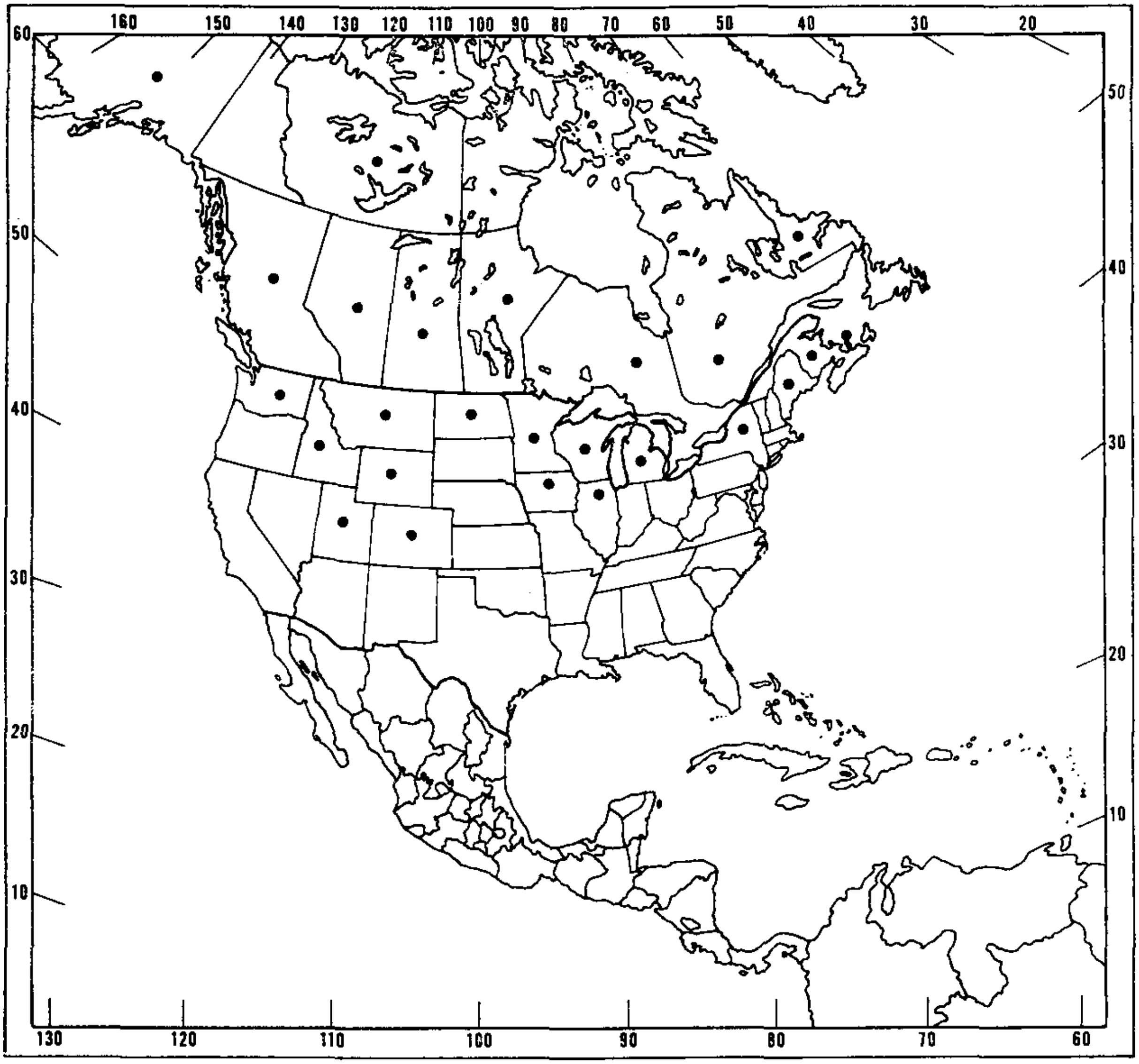


MAP 31. • Mooreobdella microstoma ▪ Mooreobdella tetragon

Comments:

M. microstoma is common and widespread throughout the southern United States; it is less common in the northern United States and Canada. The species, Mooreobdella ochotherenai (Caballero, 1932) which closely resembles M. microstoma, lives in Mexico (Sawyer & Shelley, 1976).

M. tetragon is known only from the Atlantic Coast areas and Gulf States of the United States. I have examined specimens from Massachusetts, New Jersey, North Carolina, Georgia, Florida, and Alabama.



MAP 32. • Nephelopsis obscura

Comments:
N. obscura is widely distributed in the northern half of the United States, Alaska, and Canada, and it is common in some localities.

SECTION 9

PARTIAL SYNONYMY

The section which follows contains the majority of important and widely used synonyms found in the literature. An authority on which the synonymic placement is based is listed beside each species name. The primary sources for the synonyms are adopted from Harding (1910), Autrum (1936), Klemm (1972b, 1977), Sawyer (1972), Sawyer, et al. (1975), Soos (1965, 1966a, 1966b, 1969a, 1969b).

FAMILY GLOSSIPHONIIDAE

Actinobdella annectens Moore, 1906

Actinobdella inequiannulata Moore, 1901

Actinobdella triannulata Moore, 1924
Actinobdella triannulata Daniels and Freeman, 1976; Klemm, 1977; Ringuelet, 1980

Alboglossiphonia heteroclita (Linnaeus, 1761)

Hirudo heteroclita Linnaeus, 1761
Hirudo hyalina O.F. Muller, 1774
Hirudo swampina Bosc, 1802
Hirudo papillosa Braun, 1805
Hirudo trioculata Carena, 1820
Hirudo arcuata Fabricius, 1826
Clepsine hyalina Moquin-Tandon, 1827
Clepsine carenae Moquin-Tandon, 1827
Glossobdella hyalina de Blainville, 1827
Glossobdella trioculata de Blainville, 1827
Glossobdella carenae de Blainville, 1828
Clepsine carenae de Filippi, 1839
Clepsina hyalina Brightwell, 1842
Glossiphonia heteroclita Moquin-Tandon, 1846
Glossopora hyalina Johnston, 1846
Glossiphonia carenae Moquin-Tandon, 1846
Glossiphonia arcuata Moquin-Tandon, 1846
Clepsine swampina Diesing, 1850
Clepsine papillosa Grube, 1851
Glossiphonia hyalina Thompson, 1856
Clepsine pallida var. a Verrill, 1874
Clepsine heteroclita Whitman, 1878

Clepsine striata Apathy, 1888
Clepsine palonica Lindenfeld and Pietrusuzynski, 1890
Glossiphonia trioculata Blanchard, 1893
Glossosiphonia heteroclita Blanchard, 1894
Glossiphonia heteroclita Castle, 1900
Glossosiphonia heteroclita Harding, 1910
Glossiphonia heteroclita Ryerson, 1915
Glossiphonia papollosa Pawlowski, 1936
Glossiphonia hyalina Pawlowski, 1936
Glossiphonia striata Pawlowski, 1936
Glossiphonia swampina Sawyer, 1973
Glossiphonia swampina Sawyer & Shelley, 1976; Ringuelet, 1980
Glossiphonia [Alboglossiphonia] heteroclita Luken, 1976

Batracobdella cryptobranchii Johnson and Klemm, 1977

Batracobdella michiganensis Sawyer, 1972

Batracobdella paludosa (Carena, 1824)

Hirudo paludosa Carena, 1824
Clepsine paludosa Moquin-Tandon, 1827
Glossobdella paludosa de Blainville, 1828
Clepsine succinea de Filippi, 1837
Clepsine paludosa de Filippi, 1839
Glossiphonia paludosa Moquin-Tandon, 1846
Glossiphonia succinea Moquin-Tandon, 1846
Glossiphonia paludosa Blanchard, 1894
Glossiphonia smargadina Oka, 1910
Hemiclepsis geei Oka, 1926
Clepsinides paludosa Augener, 1892
Hemiclepsis smargadina Oka, 1928
Batrachobdella paludosa Johansson, 1929
Batracobdella paludosa Autrum, 1936

Batracobdella phalera (Graf, 1899)

Clepsine phalera Graf, 1899
Placobdella phalera Moore, 1906
Placobdella phaleria Mullin, 1926
Haementeria [Placobdella] phalera Autrum, 1936
Batracobdella phalera Moore, 1959

Batracobdella picta (Verrill, 1872)

Clepsine picta Verrill, 1872
Placobdella picta Moore, 1906
Placobdella picta Ryerson, 1915
Glossiphonia picta Moore, 1923
Haementaria [Placobdella] picta Autrum, 1936
Batrachobdella picta Richardson, 1949; Moore, 1952; Beck, 1954
Batrachobdella picta Meyer and Moore, 1954

Bactacobdella picta Mann, 1962

Boreobdella verrucata (Fr. Muller, 1844)

Clepsine verrucata Fr. Muller, 1844
Glossiphonia verrucata Johnston, 1865
Glossiphonia mollissima Moore, 1898
?Glossiphonia granifers Johnston, 1865
?Glossiphonia verrucata Johansson, 1909
Boreobdella verrucata Pawlowski, 1936
Batracobdella verrucata Autrum, 1936
Glossiphonia complanata mollissima Moore & Meyer, 1951; Klemm, 1972b
Borebodella verrucata Soos, 1969

Glossiphonia complanata (Linnaeus, 1758)

Hirudo sexoculata Bergmann, 1757
Hirudo complanata Linnaeus, 1758
Hirudo lateribus attenuatis Hill, 1759
Hirudo crenata Kirby, 1794
Hirudo crinata Pennant, 1816
Glossiphonia tuberculata Johnson, 1816
Glossiphonia complanata Johnson, 1816
Glossopora tuberculata Johnson, 1817
Erpobdella complanata de Blainville, 1818
Gossopora complanata Fleming, 1822
Clepsine complanata Savigny, 1822
Sanguisuga complanata Bruguiere, 1824
Glossobdella complanata de Blainville, 1828
Erpobdella crenata Templeton, 1837
Glossipora tuberculata Thompson, 1841
Glossiphonia sexoculata Moquin-Tandon, 1846
Gossiphonia cimiciformis Baird, 1869
Clepsine pallida var. b Verrill, 1872
Clepsine elegans Verrill, 1872
Clepsine patelliformis Nicholson, 1873
Clepsine elegans Verrill, 1874
Clepsine pallida Verrill, 1875
Clepsine sex-puncto-lineata Sager, 1878
Clepsine sabariensis Orley, 1886
Clepsine sexoculata Apathy, 1888
Glossiphonia pallida Vaillant, 1892
Glossiphonia complanata Blanchard, 1894
Glossiphonia elegans Castle, 1900
Glossiphonia concolor Johansson, 1909
Glossosiphonia complanata Harding, 1910
Glossosiphonia elegans Pinto, 1923
Glossiphonia complanata Moore, 1901
Glossosiphonia mollissina Pinto, 1923
Glossiphonia paludosa Ussing, 1929
Glossophiona complanata Mason, et al., 1970

Glossiphonia [Glossiphonia] complanata Lukin, 1976

Helobdella elongata (Castle, 1900)

Clepsine nepheloidea Graf, 1899 (nomen nudum)
Glossiphonia elongata Castle, 1900
Glossiphonia nepheloidea Moore, 1906
Glossosiphonia elongata Pinto, 1923
Helobdella nepheloidea Moore, 1924
Helobdella elongata Autrum, 1936
Glossiphonia nepheloidae Miller, 1937

Helobdella fusca (Castle, 1900)

Glossiphonia fusca Castle, 1900
Glossiphonia fusca fusca Moore, 1906
Glossiphonia [Helobdella] fusca Moore, 1922 (? in part)
Helobdella fusca Moore, 1959
Helobdella triserialis Soos, 1969; Davies, 1971 (in part)

Helobdella papillata (Castle, 1900)

Clepsine papillifera var. b Verrill, 1824
Helobdella fusca var. papillata Moore, 1906
Helobdella fusca Moore, 1918 (in part)
Helobdella papillata Moore, 1952

Helobdella stagnalis (Linnaeus, 1758)

Hirudo biocluata Bergmann, 1757
Hirudo stagnalis Linnaeus, 1758
Hirudo bioculata O. F. Muller, 1774
Hirudo pulligera Daudin, 1800
Hirudo circulans Sowerby, 1806
Helluo [Hirudo] bioculatus Oken, 1815
Glossiphonia perata Johnson, 1816
Glossopora punctata Johnson, 1817
Erpobdella bioculata de Blainville, 1818
Clepsine bioculata Savigny, 1822
Glossopora bioculata Fleming, 1822
Clepsine sowerbyi Moquin-Tandon, 1827
Hirudo [Glossobdella] pulligera de Blainville, 1827
Glossobdella bioculata de Blainville, 1828
Erpobdella stagnalis Templeton, 1836
Clepsina stagnalis de Filippi, 1837
Glossiphonia circulans Moquin-Tandon, 1846
Glosopora circularis Johnston, 1846
Glossiphonia bioculata Moquin-Tandon, 1846
Glossipora bioculata Thompson, 1856
Clepsine filippi Polonio, 1863
Clepsine modesta Verrill, 1872
Clepsine submodesta Nicholson, 1873

Clepsine viridissima Picaglia, 1877
Clepsine bioculata Levinsen, 1883
Glossiphonia modesta Vaillant, 1890
Glossosiphonia stagnalis Blanchard, 1894
Helobdella stagnalis Blanchard, 1896
Helobdella bioculata Bayer, 1898
Glossiphonia stagnalis Moore, 1898
Glossiphonia sraagnalis Castle, 1900
Glossiphonia [Helobdella] stagnalis Moore, 1922
Glossopora punctata Johnston, 1925
Helobdella stagnalis Andre, 1930
Bakedebdella gibbosa Sciacchitana, 1939
Erpobdella stagnalis Oliver, 1958
Helobdella stagnalis Moore, 1952

Helobdella transversa Sawyer, 1972

Helobdella triserialis (E. Blanchard, 1849)

Glossiphonia triserialis Blanchard, 1849
Clepsine triserialis Grube, 1859
Clepsine lineolata Grube, 1871
Clepsine papillifera var. b Verrill, 1872
Clepsine papillifera var. lineata Verrill, 1874
Glossiphonia lineolata Vaillant, 1890
Helobdella triserialis Blanchard, 1896
Glossiphora lineata Moore, 1898
Glossiphonia fusca Castle, 1900
Glossiphonia fusca lineata Moore, 1906
Anoculobdella tritubercülata Weber, 1915
Placobdella triserialis Apathy, 1917
Glossiphonia fusca Moore, 1918 (in part)
Glossiphonia [Helobdella] fusca Moore, 1922 (in part)
Glossosiphona fusca Pinto, 1923
Helobdella fusca Moore, 1924
Helobdella punctata-lineata Moore, 1939
Helobdella nigricans Ringuelet, 1943
Helobdella triserialis lineata Ringuelet, 1943; 1980
Helobdella striata Ringuelet, 1943
Helobdella unilineata Ringuelet, 1943
Helobdella lineata Soos, 1969; Davies, 1971 (in part)
Helobdella fusca Soos, 1969 (in part)
Helobdella trialbolineata Klemm, 1974
Helobdella lineata Klemm, 1977
Helobdella punctata-lineata Moore, 1939; 1959
Helobdella punctatalineata Klemm, 1972b; 1976;1977
Helobdella punctatolineata Sawyer and Kinard, 1980

Marvinmeyeria lucida (Moore, 1954)

Oculobdella lucida Moore, 1954
Marvinmeyeria lucida Soos, 1969

Oligobdella biannulata (Moore, 1900)

Microbdella biannulata Moore, 1900
Oligobdella biannulata Moore, 1918

Placobdella hollensis (Whitman, 1892)

Clepsine hollensis Whitman, 1892
Placobdella hollensis Moore, 1906
Haementeria [Parabdella] hollensis Autrum, 1936
Parabdella hollensis Meyer and Moore, 1954
Placobdella hollensis Moore, 1952

Placobdella montifera (Moore, 1906)

?Glossiphonia trisulcata Baird, 1869
Clepsine papillifera var. carinata Verrill, 1874
Hemiclepsis carinata Moore, 1901
Placobdella montifera Moore, 1906
Haementaria [Placobdella] montifera Autrum, 1936
Placobdella montifera Moore, 1952
Placobdella parasitica Amin, 1977 (Specimen examined) (nec P. parasitica (Say, 1824))

Placobdella multilineata Moore, 1953

Placobdella multilineata Sawyer, 1972; Sawyer and Shelley, 1976 (southern variety)

Placobdella nuchalis Sawyer and Shelley, 1976

Placobdella parasitica White, 1977 (Specimen examined) (nec P. parasitica (Say, 1824))

Placobdella ornata (Verrill), 1872

Clepsine ornata Verrill, 1872
Clepsine ornata var. rugosa Verrill, 1874
Clepsine ornata var. stellata Verrill, 1874
Glossiphonia parasitica var. rugosa Castle, 1900
Placobdella rugosa Moore, 1901
Haementaria [Placobdella] rugosa Autrum, 1936
Placobdella ornata Moore, 1952 (northern variety)
?Placobdella multilineata Beck, 1954
Placobdella multilineata Klemm, 1972a

Placobdella papillifera (Verrill, 1872)

Clepsine papillifera Verrill, 1872
Placobdella papillifera Moore, 1952
Placobdella papillifera Meyer and Moore, 1954
Placobdella papillifera Sawyer and Shelley, 1976

?Haementeria officinalis Ringuelet, 1976

Placobdella parasitica (Say, 1824)

Hirudo parasitica Say, 1824
Clepsine parasitica Diesing, 1850
Clepsine ornata var. rugosa Verrill, 1872
Clepsine marmarata Sager, 1878
Clepsine chelydrae Whitman, 1889
Clepsine plana Whitman, 1891
Glossiphonia parasitica Moore, 1898
Glossiphonia parasitica var. plana Castle, 1900
Placobdella parasitica Moore, 1901
Glossosiphonia parasitica Pinto, 1923
Haementaria [Placobdella] parasitica Autrum, 1936
Placobdella parasitica Moore, 1952

Placobdella pediculata Hemingway, 1908

Haementeria [Placobdella] pediculata Autrum, 1936
Placobdella pediculata Moore, 1952

Placobdella translucens Sawyer and Shelley, 1976

Theromyzon biannulatum Klemm, 1977

Hemiclepsis occidentalis Moore, 1912
Protoclepsis occidentalis Moore, 1922
Theromyzon occidentale Autrum, 1936
Theromyzon occidentalis Sooter, 1937
Theromyzon meyeri Moore, 1959, Sawyer, 1972
Theromyzon maculosum Klemm, 1972a,b; Davies, 1971, 1973
Theromyzon biannulatum Klemm, 1977

Theromyzon rude (Baird, 1869)

Glossiphonia rudis Barid, 1869
Clepsine occidentalis Verrill, 1874
Glossiphonia occidentalis Vaillant, 1890
Theromyzon occidentalis Bere, 1929
Theromyzon rude Moore and Meyer, 1951
Theromyzon occidentale Meyer and Moore, 1954

Theromyzon tessulatum (O. F. Muller, 1774)

Hirudo tessulata O. F. Muller, 1774
Hirudo tessulata Gmelin, 1788
Hirudo tesselata Bosc, 1802
Hirudo tessulatum Braun, 1805
Erpobdella tessulata Fleming, 1822
Nephelis tessellata Savigny, 1822
Ichthyobdella tesselata de Blainville, 1828

Erpobdella vulgaris var. tessellata de Blainville, 1828
Clepsine sanguinea Filippi, 1837
Clepsine tessulata Fr. Muller, 1844
Erpobdella tessulata Thompson, 1844
Glossiphonia tesselata Thompson, 1846
Glossiphonia eacheana Thompson, 1846
Glossiphonia tessellata Moquin-Tandon, 1846
Gossiphonia sanguinea Moquin-Tandon, 1846
Clepsine tessulatum Diesing, 1850
Hirudo vitrina Dalyell, 1853
Glossiphonia eacheana Thompson, 1856
Haemocharis eacheana Thompson, 1856
Glossiphonia vitrina Johnston, 1865
Theromyzon pallens Philippi, 1867
Hemiclepsis tessellata Vejdovsky, 1884
Clepsine tesselata Weltner, 1887
Gossiphonia tessulatum Blanchard, 11892
Hemiclepsis tesselata Scharff, 1898
Protoclepsis tesselata Livanow, 1902
Protoclepsis tessellata Harding, 1910
Theromyzon tessulatum Pawlowski, 1936
Theromyzon tessulata Autrum, 1936
Protoclepsis granata Endrigkeit, 1940

FAMILY PISCICOLIDAE

Cystobranchus mammillatus (Malm, 1863)

Cystobranchus [Platybdella] mammillatus Malm, 1863

Cystobranchus meyeri Hayunga and Grey, 1976

Cystobranchus verrilli Meyer, 1940

Cystobranchus virginicus Hoffman, 1964

Myzobdella lugubris Leidy, 1851

Ichthyobdella punctata Verrill, 1871 (in part)
?Ichthyobdella funduli Verrill, 1872
Piscicola funduli Pratt, 1935
Illinobdella alba Meyer, 1940
Illinobdella elongata Meyer, 1940
Illinobdella richardsoni Meyer, 1940
Illinobdella moorei Meyer, 1940
Mysobdella lubrigis Pearse, 1948
Myzobdella funduli Moore, 1952
Myzobdella moorei Meyer and Moore, 1954
Ichthyobdella rapax Wass, 1972
Cystobranchus virginicus Paperna and Zwerner, 1974 (Specimen examined)(nec C. virginicus, Hoffman, 1964); Sawyer, Lawler, Overstreet, 1975

Myzobdella lugubris Sawyer, Lawler, and Overstreet, 1975

Piscicola geometra (Linnaeus, 1758)

Hirudo alba perexigua piscibus adhearens Aldrovandus, 1602
Hirudo ore caudaque ampla Frisch, 1729
Hirudo teres extremitatibus dilatis Linn., 1746
Hirudo piscium Roesel, 1747
Hirudo geometra Linn, 1758
Hirudo galearia Braun, 1805
Piscicola piscium Blainville, 1818
Hacinocharis piscium Savigny, 1820
Piscicola geometra Moquin-Tandon, 1826
Ichthyobdella geometra Blainville, 1827
Ichthiobdella piscium Egidy, 1844
Piscicola percae Johnston, 1846
Piscicola piscium Tauber, 1879
Piscicola lavereti Tauber, 1879
Piscicola perspicax Olsson, 1893
Piscicola lippa Olsson, 1893
Piscicola volgensis Zykoff, 1903
Piscicola geometra Harding, 1910

Piscicola milneri (Verrill, 1874)

Ichthyobdella milneri Verrill, 1874
Piscicola milneri Ryerson, 1915
Piscicola milneri Meyer, 1940

Piscicola punctata (Verrill, 1871)

Ichthyobdella punctata Verrill, 1871 (in part)
Piscicola punctata Moore, 1912

Piscicola salmositica Meyer, 1945

Piscicola salmositica Meyer, 1946
Piscicola salmonsitica Moore, 1959

Piscicolaria reducta Meyer, 1940

FAMILY HIRUDINIDAE

Haemopis grandis (Verrill, 1874)

Semiscolex grandis Verrill, 1874 (in part)
Haemopis grandis Moore, 1912
Mollibdella grandis Richardson, 1969; Davies, 1971; Klemm, 1972a,b; Ringuelet, 1980

Haemopis kingi Mathers, 1954

Percymoorensis kingi Richardson, 1969; Klemm, 1972b

Haemopis lateromaculata Mathers, 1963

Haemopis latero-maculata Mathers, 1963
Percymoorensis lateromaculata Richardson, 1969; Davies, 1971; Klemm, 1972b

Haemopis marmorata (Say, 1824)

Hirudo marmoratis Say, 1824
Democedes maculatus Kinberg, 1867
Aulastomum lacustris Leidy, 1869
Aulastomum lacustre Verrill, 1872
Hexobdella depressa Verrill, 1872
Aulostoma lacustris Forbes, 1893
Haemopis sanguisuga Blanchard, 1896
Haemopis marmoratis Moore, 1912
Haemopis marmoratus Hankinson, 1908
Haemopis marmorata Moore, 1923
Haemopis marmoratis Mullin, 1926
Percymoorensis marmoratis Richardson, 1969
Haemopis marmorate Gates and Moore, 1970
Haemopis marmorata Moore, 1952
Percymoorensis marmorata Davies, 1971; Ringuelet, 1980
Percymoorensis marmoratis Klemm, 1972a,b

Haemopis plumbea Moore, 1912

Haemopis plumbeus Moore, 1912
?Haemopis plumbeus Mullin, 1926
Haemopis plumbeous Miller, 1937
Haemopis plumbea Moore, 1959
Bdellarogatis plumbeus Richardson, 1969; Davies, 1971
Bdellarogatis plumbea Klemm, 1972a,b; Ringuelet, 1980

Haemopis septagon Sawyer and Shelley, 1976

Haemopis terrestris (Forbes, 1890)

?Hirudo lateralis Say, 1824
?Aulacostomum oenops Grube, 1871
Semiscolex terrestris Forbes, 1890
Haemopis lateralis Moore, 1898
Haemopis lateralis terrestris Moore, 1918
Haemopis lateralis Miller, 1937
Percymoorensis lateralis Richardson, 1969; Davies, 1971; Klemm, 1972a,b
Haemopis terrestris Sawyer, 1972
Percymoorensis terrestris (Forbes, 1890) Ringuelet, 1980

Hirudo medicinalis (Linnaeus, 1758)

Hirudo major et varia Gesner, 1558
Hirudo varia Aldrovandus, 1602
Hirudo minor variegata Muralto, 1685
Hirudo medicinalis Ray, 1710
Hirudo medicinalis Linnaeus, 1758
Hirudo venesector Braun, 1805
Hirudo venaestector Carena, 1820
Hirudo verbana Carena, 1820
Hirudo provincialis Carena, 1820
Sanguisuga medicinalis Savigny, 1822
Sanguisuga officinalis Savigny, 1822
Hirudo officinalis Derhein, 1825
Sanguisuga officinalis Moquin-Tandon, 1826
Sanguisuga obscura Moquin-Tandon, 1826
Sanguisuga verbana Moquin-Tandon, 1826
Sanguisuga meridionalis Risso, 1826
Sanguisuga carena Risso, 1826
Iatrobdella [Hirudo] medicinalis de Blainville, 1827
Sanguisuga chlorgaster Brandt, 1833
Sanguisuga provincialis Brandt and Ratzeburg, 1833

Macrobdella decora (Say, 1824)

Hirudo decora Say, 1824
Hirudo ornata Ebad, 1857
Macrobdella decora Verrill, 1872

Macrobdella diplotertia Meyer, 1975

Macrobdella ditetra Moore, 1953

Macrobdella sestertia Whitman, 1886

Macrobdella testertia Moore, 1953

Philobdella floridana Verrill, 1874

Macrobdella [Philobdella] floridana Verrill, 1874
Philobdella floridana Moore, 1901

Philobdella gracilis Moore, 1901

Philobdella floridana Moore, 1898 (in part)
Philobdella gracilis Moore, 1901
Philobdella gracilis Moore, 1952
Philobdella gracilis Viosca, 1962
Philobdella gracilis Richardson, 1972

FAMILY ERPOBDELLIDAE

Dina anoculata Moore, 1898

Dina dubia Moore and Meyer, 1951

Dina parva Moore, 1912

Erpobdella punctata coastalis Sawyer and Shelley, 1976

Erpobdella punctata punctata (Leidy, 1870)

Nephelis punctata Leidy, 1870
Nephelis lateralis Verrill, 1871 (in part)
Nephelis quadrestriata Verrill, 1872 (in part)
Nephelis marmorata Verrill, 1872
?Nephelis vermiformis Nicholson, 1873
?Nephelis 4-striata Forbes, 1893
Nephelis alterais Bristol, 1898 (in part)
Herpobdella punctata Moore, 1898
Erpobdella punctata Moore, 1901
Erpobdella punctata annulata Moore, 1922
?Dina fervida Miller, 1929
Herpobdella punctata Meyer, 1937
Dina lateralis Moore, 1952
Erpobdella lateralis Moore, 1952; 1959
Erpobdella puctata Mann, 1961
Erpobdella annulata Mason and Gates, 1970
Erpobdella punctata annulata Klemm, 1972a,b; Sawyer, 1972; Ringuelet, 1980
Erpobdella punctata punctata Sawyer and Shelley, 1976

Mooreobdella bucera (Moore, 1949)

Dina bucera Moore, 1949
Mooreobdella bucera Moore, 1959
Dina [Mooreobdella] bucera Klemm, 1972a,b

Mooreobdella fervida (Verrill, 1781)

Nephelis fervida Verrill, 1871
Nephelis vermiformis Nicholson, 1873 (in part)
Dina fervida Moore, 1901
Dina fervida Mathers, 1945
Mooreobdella fervida Pawlowski, 1955
Dina [Mooreobdella] fervida Klemm, 1972a,b

Mooreobdella melanostoma Sawyer and Shelley, 1976

Mooreobdella microstoma (Moore, 1901)

Dina microstoma Moore, 1901
Erpobdella [Mooreobdella] microstoma Pawlowski, 1955
Mooreobdella microstoma Moore, 1959
Mooreobdella microstoma Soos, 1966
Dina [Mooreobdella] microstoma Klemm, 1972a,b

Mooreobdella tetragon Sawyer and Shelley, 1976

Nephelopsis obscura Verrill, 1872

?*Nephelis obscura* var. *maculata* Forbes, 1892
?*Nephelis maculuta* Forbes, 1893.

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