THE AQUATIC AND SEMI-AQUATIC HEMIPTERA OF VIRGINIA

PUBLICATIONS in this series are intended to serve as scientific contributions for a better understanding of the **living environment** in Virginia.

Recognizing the basic economic importance of faunistic studies, our goal is to survey methodically the local insect fauna through preparation of inventories designed to show the geographic and seasonal occurrence of insects in the Commonwealth, and to provide keys, descriptions, and illustrations to facilitate their recognition.

Insofar as possible, these studies will include data on biology and life cycles to aid in the formulation of control recommendations and information on ecological interactions — including host relationships, parasites, and predators — and the potential of various species as possible biological control agents. Knowledge gained from such studies will be used to evaluate the impact of future changes in our environment.

COMPOSITION AND PRESSWORK BY
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
BLACKSBURG, VIRGINIA

5543/2.2M

The Insects of Virginia No. 7

THE AQUATIC AND SEMI-AQUATIC HEMIPTERA OF VIRGINIA

by

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RESEARCH DIVISION BULLETIN 87

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

BLACKSBURG, VIRGINIA 24061

1974

* Partly from a dissertation submitted to the Graduate School of the University of Virginia in 1950 in partial fulfillment of the requirements for the Ph.D. degree.

CONTENTS

ABSTRACT

The physiographic and climatic diversity found in Virginia accounts for a variety of aquatic habitats and the occurrence of a rich fauna of aquatic and semi-aquatic Hemiptera composed of both boreal and austral elements. A comprehensive study of these insects was begun in 1947 to elucidate the extent of the state fauna and the distribution and biology of its component species. More than 11,000 specimens were personally collected, from all the counties in each of the physiographic provinces of the state represented. Material from a number of public collections was also examined.

A classification of aquatic habitats is provided, with a physical description of each type and a list of the most characteristic taxa.

At the present time, the state list for the families included in the study comprises 97 species dispersed among 30 genera, and published distribution records suggest that at least 18 additional species will eventually be discovered within the Commonwealth.

Keys are provided to the fourteen families, and for the genera and species of each family (including expected but not yet recorded forms); a brief statement of diagnostic characters, distribution, and biology is given for each level of taxon.

For each species, the following information is given: a brief description, overall and local distribution, habitat, biological notes, a list of any associated confamilial species in the field, differential characters of immature stages, and other pertinent comments.

Rheumatobates rileyi palosi (Blatchley, 1926) is elevated to the rank of full species. *Rhagovelia flavicincta* Torre-Bueno (1907) is regarded a junior synonym of *R. obesa* Uhler 1871.

Sigara stigmatica (Fieber, 1851), heretofore known only from the type material labeled "Amer. Nord", is recorded from Charlottesville, Virginia, apparently the first definite record for the species.

Twenty plates with numerous drawings of key characters are included as an aid to the identification of genera and species.

Selected references to descriptions, distributional records, and biological studies are cited.

INTRODUCTION

Where water is near land exposed to a moderate amount of light, aquatic and semi-aquatic Hemiptera are to be found. Among these are representatives of fourteen families of insects, with the members of each more or less intimately associated with water in the Commonwealth of Virginia.

Within the political boundaries of Virginia, the diversity of terrain has provided a wide variety of aquatic and semi-aquatic habitats which are occupied by these animals. In addition to the range of habitats afforded them, the diversity of temperature (correlated with topography) within the Commonwealth has permitted both northern and southern elements of the Hemipteran fauna to exist, if not flourish, in broad or restricted areas.

Only a cursory survey of literature dealing with faunistic studies is needed to reveal that knowledge of the fauna of Virginia lags far behind that of most states, and except for a very few animal groups, this knowledge rests on the occasional locality records published in studies made by taxonomists to whom only a few collections from widely scattered areas were available. Until recently, only the butterflies (Clark and Clark, 1951) and those insects having a direct bearing on the Virginia economy, or those of medical and veterinary importance, have been studied from ecological and zoogeographic standpoints. However, during the past several years, through the initiative of Dr. Michael Kosztarab of Virginia Polytechnic Institute and State University, several important papers have been published on the insect fauna of Virginia. These include four families of Scutelleroidea (Hoffman 1971), the genus *Culicoides* (Battle & Turner, 1971), the Coccidae (Williams & Kosztarab, 1972), and the Tabanidae (Pechuman, 1973).

As a result of the casual collections made in Virginia prior to my work, only 39 species (22 of them members of the family Corixidae) of aquatic and semi-aquatic hemipterans had been recorded from the Commonwealth. A survey of the literature involving the fauna of neighboring states indicated that an additional 41 species would probably be found occurring here.

While some species have now been recorded from all Virginia counties, some counties are represented only by collections on a single date. Undoubtedly some species are missing from county records only because of inadequate collecting. Nevertheless, the state list now comprises 97 species dispersed among 30 genera, and judged

from published records pertaining to neighboring areas, 15 other species probably occur in the state — *these are marked with an asterisk* (*) *in this publication.*

Among the fourteen families referred to, the aquatic and semi-aquatic Hemiptera the Gelastocoridae, Ochteridae, and Saldidae live upon the shores of ponds or streams; the Hebridae, Hydrometridae, and Mesoveliidae live along the water's edge and upon floating mats of vegetation and debris; the Veliidae occur along the shore upon floating mats of vegetation, or upon the surface of open water; the Gerridae inhabit the water surface; and the Belostomatidae, Pleidae, Nepidae, Notonectidae, Naucoridae, and Corixidae spend the greater part of their lives beneath the surface of the water.

This diversified group exhibits several remarkable structural adaptations that appear closely correlated with requirements for the habitat in which each lives. Most species are predatory in habit, with front legs modified for grasping. The other legs may be modified for swimming, as are the hind legs of members of the families Notonectidae and Corixidae and the middle legs of *Rhagovelia*; for jumping, as in the Gelastocoridae; or for running, as in the members of the family Ochteridae. Perhaps the most spectacular adaptations, however, are to be found in the respiratory mechanisms of the aquatic forms. Three types may be distinguished: the dorsal reservoir and pile type (Corixidae, Naucoridae, and Belostomatidae), the abdominal channel type (Notonectidae), and the anal tube type (Nepidae).

Those insects possessing the dorsal reservoir and pile type of mechanism carry most of the air under the wings where the spiracles are located, but some species have the entire body enveloped in air. The members of this group may remain below the water's surface for extended periods; but when active, must come to the surface from time to time to renew their supply of air. The backswimmers, Notonectidae, have the abdominal channel type of respiration, which consists of concave channels to each side of the median longitudinal carina on the venter of the abdomen. Long hairs arising from the median carina and from the lateral margins of the abdomen close over these concave areas to form air chambers. The insect fills the channels by projecting the tip of the abdomen through the surface film of the water. The spiracles are located along the lateral margins of the channels. In the anal tube type of respiration, the insect possesses a long caudal tube made up of two long filaments, each with a groove on its mesal side. By means of this

apparatus the members of the family Nepidae are able to rest on the bottom in a body of shallow water, or among plants, and project the tip of the caudal tube through the surface film. Thus, a continuous supply of air is conducted to the two spiracles situated at the base of the tube.

The aquatic and semi-aquatic Hemiptera are not directly of any great economic importance, but they must not be overlooked in considering the balance of nature. A few of these insects serve as a source of food for fish; but probably the majority are detrimental to fish culture, since both the insects and the young fish are contenders for the same food supply, and the larger Belostomatidae have been reported to feed on young fish. It seems likely that many species may prove useful as indicators in bioassay studies of water quality.

The bibliography of the "water bugs" is extremely extensive, but the majority of the publications are concerned with descriptions, distribution records, or brief observations; comparatively few are concerned with life history studies.

This paper results from a number of years spent collecting and studying the aquatic and semi-aquatic Hemiptera of Virginia. An attempt has been made to give the geographical and ecological distribution, seasonal collecting data, and brief life-history observations on each species. Keys, with accompanying figures illustrating the characters used, are provided for the identification of the species known from Virginia and also for those which probably occur but are, so far, unrecorded.

MATERIALS AND METHODS

Material Studied

Much of the material on which this paper is based is contained in my own collection of approximately 5,000 pinned specimens and about 6,000 alcohol-preserved specimens. The majority of the pinned specimens were recently donated to the Virginia Polytechnic Institute and State University collection. Also, I have freely used the collections of the Virginia Truck Experiment Station, the Virginia Department of Agriculture, Virginia Polytechnic Institute and State University, and the United States National Museum. The personal collection of Dr. James F. Matta, Old Dominion University, Norfolk, which consisted of several hundred specimens, was borrowed for study, as was a large number of specimens of *Rhagovelia*

from the collection of Dr. George E. Gould.

Collections were made throughout the State, usually in late summer, since it has been observed that the greatest number of mature specimens were present at that time of year.

Methods of Collecting

Since the aquatic and semi-aquatic Hemiptera occupy varied habitats, it was necessary to employ several methods of collecting to efficiently sample the population of any environment. The most useful collecting device was an aquatic dipnet with a heavy 12-inch circular frame and a net bag of heavy scrim with canvas top. Insects were collected by dipping and dragging the net through the water or along the bottom. All the aquatic as well as some of the semi-aquatic forms were collected this way. This net was also used in capturing individuals of the family Saldidae, although the lighter butterfly net was used more successfully in collecting these swift-flying insects.

In collecting the medium-sized forms near the shores, such as members of the families Mesoveliidae and Hydrometridae, a 6-inch wire strainer was used successfully; and for the small Veliidae, the most useful device was a coffee strainer. Members of the families Gelastocoridae and Ochteridae, which inhabit the shores, were obetained by picking them up by hand.

Many of the semi-aquatic forms hibernate during the winter months under leaves and debris on the shores of ponds or streams. These were collected by raking up the debris and confining it in the hopper of a Berlese-type funnel. To the inverted apex of the funnel a screw-type jar top was attached into which a pint fruit jar was screwed. The insects leaving the debris fell down the funnel and into the jar. This was the only successful method found for collecting nymphs of *Ochterus banksi*.

Field Notes

Detailed field notes were kept on 3 x 5-inch library cards for each collection. The front of the field data card contained the following: the collection number (upper left hand corner), date and county (upper right hand corner), the description of the habitat, exact location of collection in the county, and the families collected, along with brief notes that might be of value. The back of the field data card contained the identification of all species collected in the locality.

Methods of Preservation

As soon as the specimens were caught they were dropped into a jar or vial containing 70% ethyl alcohol, and the number of the collection was included. Then a field card was filled out for the particular locality.

As soon as possible after collecting, the contents of each vial was studied under the binocular microscope. Representatives of each species were mounted on insect pins, either directly or on card points. These mounted specimens were much more satisfactory for detailed studies, because they are easily handled; also, in wet specimens the colors, for the most part, are obliterated because of the cutting-down by liquids of the reflection of light from pilose areas.

In studies of the genitalia of the Corixidae and Ochteridae, the alcohol-preserved specimens were most satisfactory, since the genital capsule could be easily withdrawn. After removal of the genital capsule, both the insect and the capsule were mounted on card points for future studies.

PHYSIOGRAPHIC PROVINCES

The state of Virginia may be divided into five physiographic provinces: Coastal Plain, Piedmont, Blue Ridge, Ridge and Valley, and Alleghany Plateau. Hoffman (1969) has discussed these in considerable detail. Some species occur in one province only, limited by the ecological situations which that province afford; other species ignore physiographic boundaries and occur in several of the provinces. The provinces and the number of collections made in each county are illustrated in figure 1.

ECOLOGY

LOTIC SITUATIONS:

The streams and rivers in Virginia may be divided into two groups; namely, those of the Ridge and Valley Province which contain hard waters, and those of the Piedmont and Coastal Plain provinces which contain soft waters. Since the aquatic and semi-aquatic Hemiptera appear to recognize no difference between the two types, the lotic situations are discussed without further reference to hard and soft waters.

CREEKS

Mountain brooks.—These are small, spring-fed streams tumbling over a rocky course down the sides of mountains. Occasionally there are small pools with little or no debris; and vegetation, except for mosses, is almost completely absent. These streams flow for the most part through wooded areas; the water is very clear and varies from cool to cold. Common species occurring in this habitat are *Rhagovelia obesa, Gerris remigis, Sigara modesta, Micracanthia humilis* and *Microvelia americana.*

Trout streams.—Under this category are the large, swift mountain streams which flow through wooded areas of hemlock, oak, hickory, maple, chestnut, and other hardwood trees. Beds of such streams consists of rocks over and around which the water flows, and water-falls of varying heights occur along their courses. Quiet shallow pools may lie behind large boulders and below cascades. Vegetation in the streams is usually absent — except for algae and mosses growing on the rocks. This type of stream is characteristic of the Allegheny Mountains and the Blue Ridge provinces. Species occurring in this habitat are *Rhagovelia obesa, Trepobates inermis, Limnogonus hesione, Micracanthia humilis, Pentacora ligata,* and *Rheumatobates rileyi.*

Minnow streams.—Such streams are typical of the Piedmont and Great Valley provinces, and flow with a moderate current over beds comprised of sand and clay. Occasional outcropping of rocks are found along their entire course, with here and there a riffle area occurring where a rocky outcropping is present, or an accumulation of rocks and gravel. There are occasional pools and quiet, shallow areas near the banks or at bends; the latter often have some aquatic vegetation such as *Juncus,* sedges, *Nitella,* and watercress on the lee side. Debris accumulates along the quiet reaches of the banks where overhanging branches of shrubs along the shore form the nucleus for the amassment of leaves, sticks, and other objects. The majority of these streams flow alternatingly through woods and cleared land; but when flowing through open terrain, they usually have shrubs along their banks. Common species collected in this habitat were *Gerris marginatus, G. remigis, Trepobates pictus, Buenoa margaritacea, Ochterus banksi,* and *Trichocorixa calva.*

Sand-bottomed streams.—Sand-bottomed streams occur in the lower Piedmont and Coastal Plain provinces, and have a moderate flow of clear or coffee-colored water. They are shallow, with bottom composed of sand with small pebbles — but without large rocks and

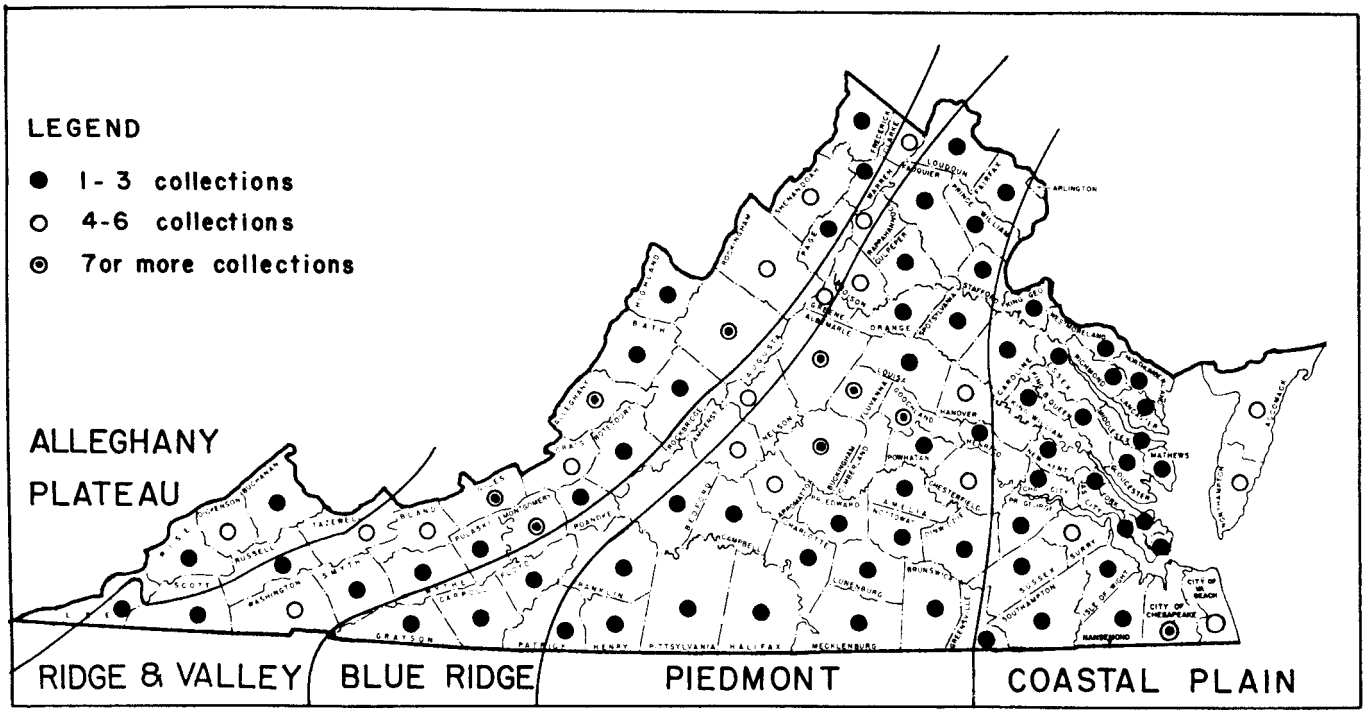


Figure 1. Physiographic provinces of Virginia, and the number of collections made in each county.

waterfalls. Sandbars are common in the stream bed. Pools are not conspicuous, although wide, deep, sluggish areas may be present; and where the stream passes through culverts under highways, there may be a deep pool on the lower side caused by water falling from the culvert and disturbing the sandy bottom. Many of these streams run through open pasture lands, with grass growth continuing to the edge of the stream. Aquatic vegetation is never abundant, but blades of grass hang into the water, and overhanging branches of shore-line shrubs may be submerged to cause an accumulation of leaves and other debris along the shore. Silt deposits are usually sparse, but may occur on the bottom of the sluggish wide parts of a stream or in backwater niches. Typical species occurring in this habitat are *Gelastocoris oculatus, Gerris remigis, G. conformis, Rheumatobates rileyi, Metrobates hesperius, Trichocorixa calva, Palmacorixa buenoi, Sigara depressa, S. pectenata,* and *S. modesta.*

Silt-bottomed streams.—These meandering, sluggish streams occur in the lower Piedmont and Coastal Plain provinces. The silt is usually soft and fluffy, and when disturbed, clouds the water. The terrain is flat, and the streams flow within shallow banks alternately through open and wooded areas. Aquatic vegetation is abundant, and numerous emergent grasses grow in the shallow waters near the shore. Backwater niches are common, and these are often filled with algae and other submerged and emergent vegetation. Characteristic flora of the forest lands through which these streams flow are *Pinus, Quercus, Liquidambar,* and *Nyssa.* Species occurring in this habitat are *Gerris argenticollis, Ranatra kirkaldyi, Hydrometra australis, Belostoma testaceum, Trichocorixa calva, Sigara depressa,* and *S. stigmatica.*

Dark-water streams.—The dark-water streams occur in the Coastal Plain province and are most numerous near the coast where they flow through swamps. The surrounding territory is very flat and wooded, and puddles of standing water are present most of the year. The water of these streams is very sluggish and brown in color. The bottom, in most places, is covered with a deep layer of black, decaying organic matter. Vegetation is abundant along the banks, and blades of grass hang into the water. In some of these streams there is little or no vegetation growing in the water, but most often there is an abundance of aquatic vegetation growing in the shallow waters or floating on the surface. Common species occurring in this habitat are *Ranatra buenoi, Notonecta irrorata, Gerris remigis, Trichocorixa calva, Sigara hydatotrephes* and *S. zimmermanni.*

RIVERS

This category includes all larger flowing bodies of water (creeks and rivers) that occur in the Ridge and Valley, Piedmont, and Coastal Plain provinces of Virginia. Their current is moderate to sluggish and they drain extensive areas. In the Great Valley (Hoffman, 1969, p. 32), these rivers often have a rocky, clay bottom, but as they proceed from the mountains toward the coast, the rocks disappear and the bottom is mostly sand and silt. The large creeks and rivers are frequently very muddy following heavy rains in their drainage, owing to the large amount of silt in the water. This silt is deposited in protected areas and along the shore where the current is sluggish; near the coast, the entire bottom may be covered with varying amounts. Vegetation is limited to the shores or protected areas where the current is sluggish and is often more characteristic of standing water than of streams. Species common in this habitat are *Rhagovelia obesa, Gerris comatus, G. conformis, G. remigis, Metrobates hesperius, Ranatra nigra, Trepobates pictus, T. inermis, Trichocorixa calva,* and *Sigara modesta.*

LENTIC SITUATIONS:

LAKES AND PONDS

Except for a relatively few bodies of standing water in Virginia the majority of the lakes and ponds owe their origin to the activities of man.

Temporary ponds.—These ponds are found in depressions, chiefly in the spring of the year, and result from melting snow or excessive rainfall. During the summer the water in these ponds may disappear, but usually the ground remains moist. There is an abundant growth of grasses around these ponds; and often, algae are so abundant in the water that it takes on a greenish appearance. Common species occurring in this habitat are *Gerris marginatus, Microvelia americana, Notonecta undulata,* and *Sigara modesta.*

Fluctuating permanent ponds.—These constitute a common type of pond in Virginia. They result from water filling depressions in the land or from dams across small streams. The water level varies with the amount of rainfall in the immediate area. True aquatic

vegetation is never abundant, although moderate amounts may be present below the low-water level. As the water retreats from the shallow margins, numerous grasses spring up in the moisture-saturated border. Species occurring in this habitat are *Gerris comatus, Rheumatobates palosi, Hydrometra martini, Trepobates pictus, Metrobates hesperius, Microvelia hinei, Notonecta undulata, N. indica, Lethocerus americanus, Trichocorixa calva, Palmacorixa nana,* and *Hesperocorixa brimleyi.*

Non-fluctuating permanent ponds.—Ponds of this type are quite common in the foothills, where they are fed from mountain streams, and in other areas where dams have been constructed across moderate to large streams. At all seasons of the year there is a supply of water entering the pond and passing out by means of an overflow. The bottom is usually covered with several inches to one or more feet of silt and decayed organic matter. Submerged, emergent, and sometimes floating aquatic vegetation are abundant. Species found inhabiting this situation were *Gerris canaliculatus, G. argenticollis, G. comatus, Ranatra nigra, Notonecta undulata, N. uhleri, N. raleighi, Limnogonus hesione, Belostoma fluminea, Benacus griseus, Trichocorixa macroceps, T. louisianae, Hesperocorixa obliqua, H. kennicottii, H. lucida, H. brimleyi,* and *Pelocoris femoratus.*

Swamp pools and ponds.—In the Coastal Plain Province, pools and ponds in swamps are numerous. These are usually shallow depressions in wooded areas, and water stands in them most of the year. The soil in and around these pools is black and very mucky from decayed organic matter. Aquatic vegetation, especially the emergent type, is very abundant. Common species found in this habitat are *Notonecta indica, N. uhleri, Ranatra fusca, Buenoa margaritacea, Belostoma fluminea, B. lutarium, Hesperocorixa interrupta, Palmacorixa buenoi, Trichocorixa louisianae, Sigara modesta,* and *S. compressoidea.*

Rock quarries.—Numerous old abandoned rock quarries are found in Virginia. These are excavations which were left when mining of rocks ceased. The sides are vertical, or nearly so, and the water is sometimes 30 to 50 feet deep. Usually, the water is clear, but

may be greenish due to an abundant growth of algae. In many of these quarries there is little or no emergent vegetation; but in some, the shallow shoreline resembles those of the small ponds by having a luxuriant growth of vegetation. Common species occurring in this habitat are *Gerris canaliculatus, Pelocoris femoratus,* and *Limnogonus hesione.*

ROADSIDE DITCHES AND CANALS

In this category are included roadside and drainage ditches, and canals which contain permanent standing water. The water level fluctuates; but usually, roadside ditches have shallow water, and emergent, submerged, and floating vegetation are extremely abundant. Species occurring in this habitat are *Gerris marginatus, G. canaliculatus, G. argenticollis, Notonecta indica, N. irrorata, Buenoa confusa, Ranatra fusca, R. drakei, R. australis, Hydrometra australis, Belostoma fluminea, Hesperocorixa interrupta, H. obliqua, H. nitida, Trichocorixa calva, T. louisianae, Microvelia buenoi,* and *Pelocoris femoratus.*

MARSHES

Pools of salt marshes.—These occur in the marshes along the coast, where the land is overgrown with a thick mat of grasses. These grasses are so thickly matted together that they will support the weight of a man; but as one walks over the surface, the mat sinks so that an inch or two of water may cover the depressed portion of the mat. Pools of clear water in these matted marshes range from 15 to 50 feet in diameter, drop off abruptly from the edge of the mat, and are quite deep. These pools support very little aquatic vegetation, other than large masses of green algae, although blades of grass hang into the water around the periphery. Species occurring in this habitat are *Belostoma fluminea, B. lutarium, B. testaceum, Trichocorixa naias,* and *T. v. verticalis.*

Sawgrass marshes.—This type of marsh is found bordering the large coastal-plain rivers. The water is shallow, and vegetation extends over wide areas. The predominant plants are emergent and include various grasses and sedges. Common species occurring in this habitat are *Rheumatobates tenuipes, Notonecta irrorata, Belostoma testaceum, Ranatra buenoi, R. drakei, R. australis, Sigara hydatotrephes,* and *S. zimmermanni.*

KEYS TO SERIES AND FAMILIES OF AQUATIC AND SEMI-AQUATIC HEMIPTERA

KEY TO SERIES

1. Antennae as long as or longer than head, always plainly visible; hind coxa nearly globose (except in Saldidae), partly received in cavities or sockets and capable of rotatory movement; osteola usually present ---------- Series Gymnocerata

   Antennae shorter than head and concealed in grooves or pockets on its under side (except in Ochteridae); hind coxa usually somewhat elongate and not set in cavities (except in Nepidae), but hinged to metasternum; osteola absent --- Series Cryptocerata

KEY TO FAMILIES OF SERIES GYMNOCERATA

1. Claws all apical; last tarsal segment with tip entire--- 2

   Claws of at least the front tarsi distinctly anteapical; the apex of last tarsal segment more or less cleft or bifid ---------- 5

2. Head shorter than pronotum, including the scutellum; scutellum sometimes minute ---------- 3

   Head as long as entire thorax, body linear, legs and antennae very long, filiform; scutellum and elytra usually wanting; length 8-11 mm--Hydrometridae, p. 39

3. Rostrum 4-segmented, the first segment often very short; tarsi 2-segmented; length not more than 2.5 mm ---------- Hebridae, p. 33

   Rostrum 3-segmented; tarsi 3-segmented; length more than 2.5 mm ---------- 4

4. Membrane of hemelytra, when present, without veins; clavus of same texture as membrane; corium somewhat thickened; color more or less greenish ---------- Mesoveliidae, p. 44

   Membrane of hemelytra with distinct veins, these forming 3 to 5 long closed cells; clavus and corium similar in texture; color brownish to blackish---- ---------- Saldidae, p. 20

5(1). Hind femora much surpassing apex of abdomen; middle and hind coxae approximate, distant from front ---------- Gerridae, p. 46

   Hind femora but little if at all surpassing tip of ab-

domen; middle coxae (except in *Rhagovelia*) equally distant from front and hind ___ Veliidae, p. 80

KEY TO FAMILIES OF SERIES CRYPTOCERATA

1. Ocelli present ---------- 2
   Ocelli absent ---------- 3
2. Antennae exposed; front and middle legs similar; front tarsi 2-segmented; rostrum reaching or surpassing hind coxae ---------- Ochteridae, p. 16
   Antennae concealed; front legs raptorial; front tarsi 1-segmented; rostrum very short--Gelastocoridae, p. 13
3(1). Hind tarsi with two distinct claws ---------- 4
   Hind tarsi with small indistinct claws, except in the family Pleidae, the species of which are less than 3 mm long ---------- 6
4. Membrane of hemelytra without veins--Naucoridae, p. 127
   Membrane of hemelytra with reticulate veins ------- 5
5. Caudal appendages of abdomen long and slender, not retractile; tarsi 1-segmented; hind coxae rotatory; body usually long and slender ---- Nepidae, p. 102
   Caudal appendages short and flat, retractile; tarsi 2-segmented; hind legs distinctly flattened, the coxae hinged; body broad and flat ---------- ---------- Belostomatidae, p. 93
6(3). Base of head inserted in thorax; front tarsi 2-segmented; body convex and obtusely keeled above; animals swim upside down ---------- 7
   Base of head overlapping apex of pronotum; front tarsi 1-segmented, palaeform; body flattened dorsally ---------- Corixidae, p. 131
7. Hind tibiae and tarsi simple, not ciliated, hind tarsi with two claws; rostrum with 3 joints; abdomen not carinate beneath ---------- Pleidae, p. 110
   Hind tibae and tarsi ciliated, hind tarsi with one claw; rostrum with 4 segments; abdomen with a midventral carinate ridge -------- Notonectidae, p 111

Family 1. GELASTOCORIDAE Kirkaldy, 1897

Description: More or less flat, compact, toad-shaped insects with mottled, rough warty appearance. Pronotum large, wider than head. Eyes very protuberant, directed upward and outward. Antennae 4-segmented, shorter than head, and concealed beneath eyes. Rost-

rum short, stout, 4-segmented. Ocelli usually present. Legs spinous; front ones raptorial, femora strongly swollen. Tarsi 1-segmented on front and middle legs, and 2-segmented on hind legs.

Distribution: The members of the family are primarily neotropical; however, one species extends northward into southern Canada.

Habitat: The species of this family are littoral, dwelling along the muddy or sandy shores of streams and ponds.

Genus *GELASTOCORIS* Kirkaldy, 1897

Description: Broad, flat, warty insects, exceedingly variable in color. Front of head triangular. Eyes protuberant, caudoventral surfaces concave. Pronotum with cephalolateral angles expanded, concave beneath, forming with the eye concavity a pocket for reception of the antennae. Tarsi with 2 long, stout terminal claws; fore tarsus not fused to tibia, articulate. Genital plate of male asymmetrical, dextral; sternum of sixth abdominal segment of female convex. Length 6.3 to 9.0 mm.

Distribution: The distribution of members of the genus coincides with that of the family.

Habitat: Same as that of the family.

GELASTOCORIS OCULATUS (Fabricius) (Fig. 2)

Naucoris oculatus Fabricius, 1798; *Galgulus oculatus*, Uhler, 1886; *Gelastocoris oculatus*, Van Duzee, 1917; Hungerford, 1919, 1922a; Blatchley, 1926; Todd, 1955, 1961.

Description: Body broadly oval, depressed. Color exceedingly variable, from reddish-yellow to grayish-black. Dorsal surface of head cephalic to base of eyes as wide as or wider at base than long. Pronotum and scutellum elevated above level of hemelytra; both with rough, irregular surface. Hemelytra warty, opaque; divisions scarcely discernible, except for membrane which is transparent. Claws of front legs contiguous, subequal in length to tarsal segment, the claws and tarsus united ½ as long as tibia. Length 7.1 to 9.0 mm.

Distribution: Within the United States this species has been recorded from 37 of the contiguous states and from the District of Columbia. It has been collected from 48 counties in Virginia and probably occurs in the others, since it is known from all physiographic provinces.

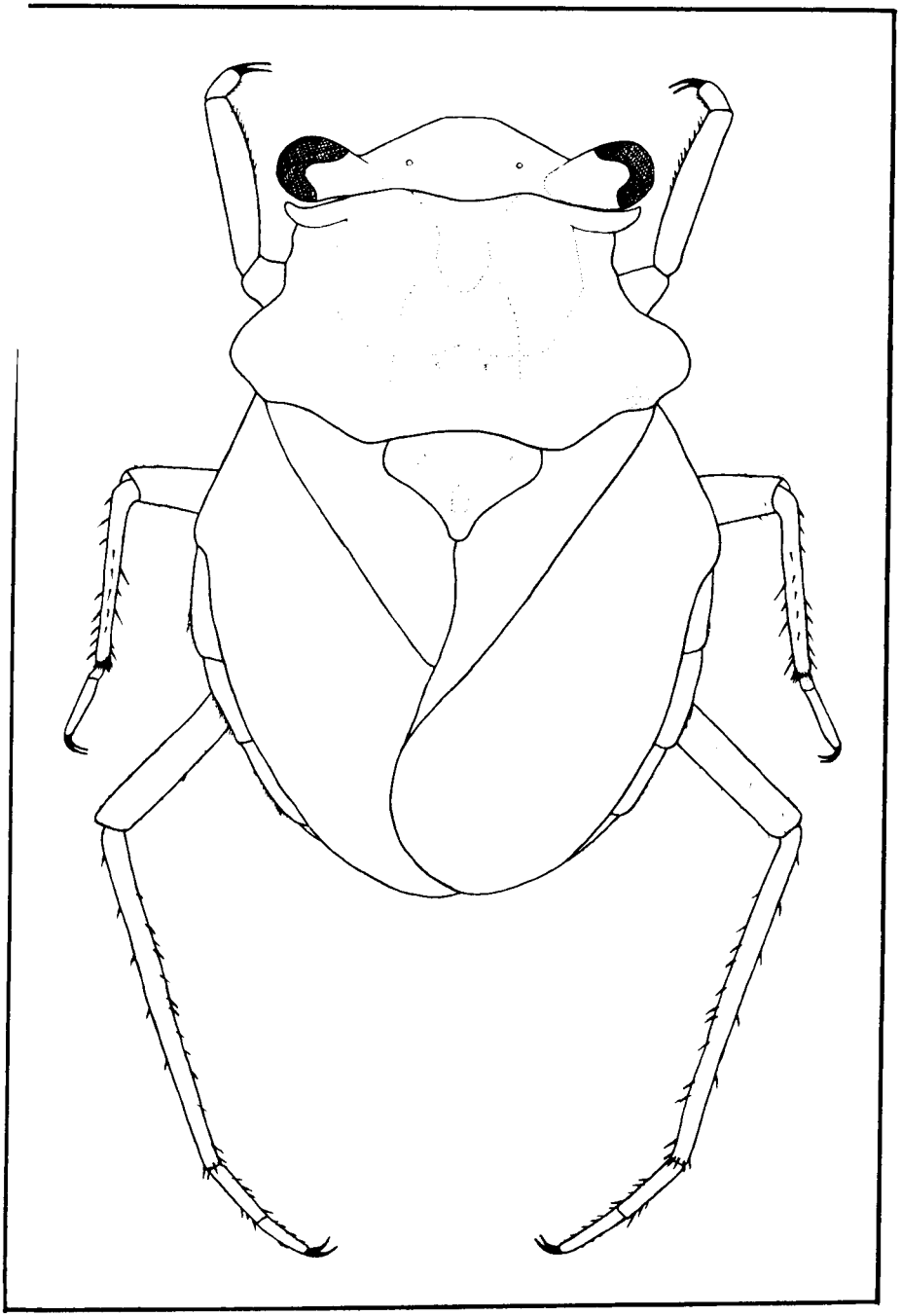


Figure 2. Adult of *Gelastocoris oculatus* (Fabricius)

Habitat: This species lives upon the muddy or sandy shores of ponds and streams. Individuals harmonize so well with their surroundings that they are very difficult to see, except when they move. They are gregarious and, along the margins of ponds and streams, may be found to occupy only restricted areas, although similar niches along the same shore may be devoid of this species.

Biology: The life history of *Gelastocoris oculatus* has been studied in Kansas by Hungerford (1922a), who stated that the total period of development varied from 60 to 100 days. The average length of developmental stages in Virginia is as follows: egg, 13 days; first instar, 14 days; second instar, 10.5 days; third instar, 21 days; fourth instar, 21.5 days; fifth instar, 21 days — a total development time of 101 days.

In Virginia, oviposition begins in early May and continues for several months. Nymphs are present from mid-May until early September. There is but one generation per year, and adults hibernated along the banks of streams and ponds. They are often found a considerable distance from the water under leaves and other debris, or in decayed matter among rocks.

Remarks: This species has been collected several times in association with a shore-dweller, *Ochterus banksi,* although the two do not appear to be very congenial companions. *Ochterus* has much the longer proboscis, but in combat *Gelastocoris* usually overpowers its smaller rival. I have never observed *Gelastocoris oculatus* feeding on its own kind, but have seen them holding and feeding on *Ochterus* adults.

Uhler (1886) recorded *Gelastocoris variegatus* (Guerin) from Maryland, and Blatchley (1926) gave its range as from Maryland to Florida, etc. These records probably refer to *G. oculatus,* since only two specimens of *G. variegatus* are known from the United States and these are from Brownsville, Texas.

Family 2. OCHTERIDAE Kirkaldy, 1906

Description: Small brown or black littoral insects with inner margin of eyes strongly concave; ocelli present. Antennae 4-segmented, shorter than head, not concealed. Rostrum 3-segmented, long and slender, reaching hind coxae. Legs slender, all fitted for running. Hemelytra present and covering abdomen. Tarsi of front and middle legs 2-segmented, those of hind legs 3-segmented. Males with asymmetry in abdominal segments.

Distribution: Members of this family have recorded from Europe; North, Central, and South America; the West Indies; and Formosa.

Habitat: The species in this family inhabit the shores of ponds and streams, where they may be found among weeds and grasses, and upon sandy shores.

Genus *OCHTERUS* Latreille, 1807

Description: Third and fourth antennal segments slender; hemelytra with embolium comparatively wide, membrane with 7 cells arranged in 2 rows: 4 in basal row and 3 in apical row. This is the only genus of this family in North America. All species are remarkably similar, and the most accurate means of separating them is by examination of the genital capsule of the male.

Distribution: The species of this genus have been recorded from North, Central, and South America and from the West Indies.

Habitat: Same as that of family.

Key to Virginia Species of *Ochterus*

1. Pronotum at least 2½ times as wide as long, the lateral margin dark, but with a pale, almost spherical spot near anterior angle; membrane of hemelytra broad and well-developed ---------- * *americanus*, p. 20

   Pronotum about twice as wide as long, the lateral margin entirely pale; membrane of hemelytra long and narrow ---------- *banksi*, p. 17

OCHTERUS BANKSI **Barber** (Fig. 3, a - i)

Ochterus banksi Barber, 1913; Blatchley, 1926; Schell, 1943; Bobb, 1951b.

Description: Broadly ovate, brownish-black. Head behind vertex opaque; anterior to vertex polished; obliquely, finely rugulose and tricarinate. Anterior margin of pronotum subtruncate, the cephalolateral angles rounded and not projecting beyond exterior margin of eyes; lateral margins broadly expanded, pale. Costal margins of corium either mostly pale or in part suffused with fuscous, without a series of pale marginal spots. Right paramere of male genital capsule with subcordate lobe on outer margin. Length 4.1 to 4.5 mm.

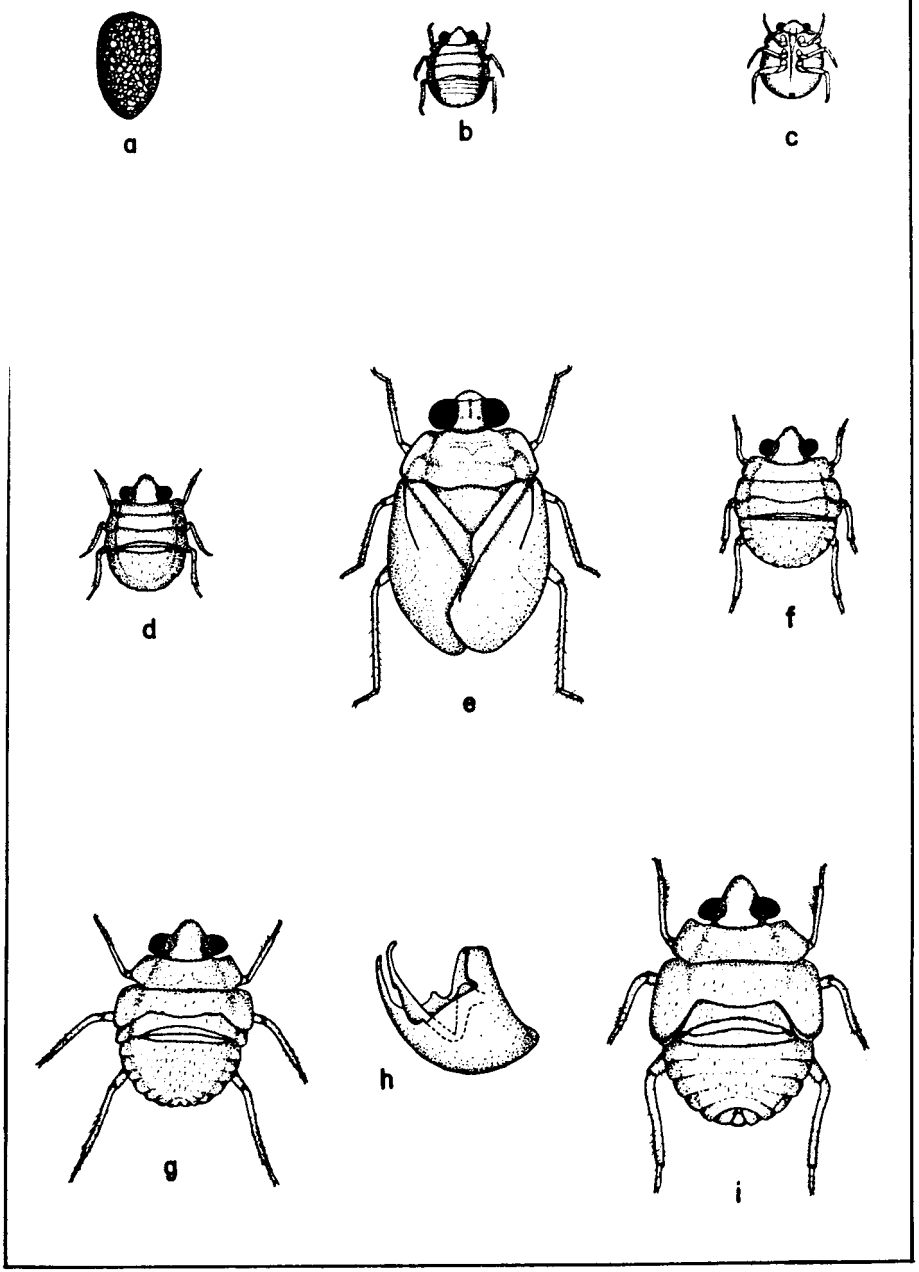
Distribution: This species has been recorded from New York to Florida and west to Indiana. It was described by Barber from specimens collected by Nathan Banks at Glencarlyn, Arlington County, Virginia. Schell recorded the species from Vienna, Fairfax County, and I have collected it from the following additional Virginia localities: Albemarle County, "Old Reservoir" at University of Virginia, old fish hatchery 1 mile S. of Charlottesville on U.S. Hwy. 29, stream 2.1 miles S. of Crozet on St. Hwy. 230, pond 1.1 mile west of intersection of U. S. Hwys. 250 & 29 at Charlottesville on U. S. Hwy. 250, stream in Batesville; Alleghany County, Smith creek near Clifton Forge (R. L. Hoffman). The lack of locality data for the Coastal Plain so far is noteworthy but may reflect only the apparent scarcity of populations and difficulty of collection generally.

Habitat: *O. banksi* lives along the shores of ponds and streams. Specimens have been collected from among shoreline plants and from sandy beaches along stream banks.

Biology: The life history of *Ochterus banksi* in Virginia has been studied in detail by Bobb (1951b). The eggs were found to be deposited singly on semi-exposed roots of grass clumps and on plant detritus, and hatched in 15 to 22 days. The first nymphal instar lasts from 11 to 17 days, the second instar from 8 to 21 days, the third instar from 22 to 41 days, the fourth instar from 181 to 229 days, and the fifth instar from 18 to 28 days. The winter is passed in the fourth nymphal instar period; the individuals hibernated under leaves, among mosses, and in other debris along the shores of ponds and streams. The nymphs do not progress beyond the fourth instar until subjected to a minimum period of 2 weeks of temperatures of 7° C or less. The adults and nymphs are predacious, feeding on various insects and crustaceans found in their habitat. Several times they were observed feeding on *Gelastocoris oculatus*, a much larger insect.

Figure 3. *Ochterus banksi Barber*

a. Egg
b. First instar nymph (dorsal view)
c. First instar nymph (ventral view)
d. Second instar nymph
e. Adult
f. Third instar nymph
g. Fourth instar nymph
h. Genital capsule of male
i. Fifth instar nymph


a
b
c
d
e
f
g
h
i

* *OCHTERUS AMERICANUS* (Uhler)

Pelogonus americanus Uhler, 1876; *Ochterus americanus*, Britton, 1923; Blatchley, 1926.

I have not collected *Ochterus americanus* in Virginia, and the species has not been recorded from the state. However, it has been recorded from Massachusetts, New York, New Jersey, Pennsylvania, Maryland, North Carolina, Florida, Mississippi, Texas, Kansas, Nebraska, Arizona, Illinois, and Cuba, and it must certainly be present in Virginia. In addition, specimens from South Carolina are in the Clemson University Museum. Most of the records of *Ochterus* are referred to this species, but undoubtedly some of these are confused with *O. banksi*.

Family 3. SALDIDAE Amyot and Serville, 1843

Description: Oval to elongate-oval insects of dark color, usually spotted with yellow. Eyes large, strongly exserted, inner edge emarginate. Ocelli present. Rostrum 3-segmented, the first segment very short. Antennae 4-segmented, more or less filiform, or ultimate and penultimate segments enlarged. Scutellum large and triangular. Hemelytra covering abdomen and extending beyond caudal segments, without cuneus; membrane with longitudinal nervules joining on with a curved terminal to form 4 or 5 long cells. Legs slender; tarsi 3-segmented, the first very short; all with 2 apical claws.

Distribution: The members of this family have been recorded from all continental land masses (except Antarctica) and island groups from the north polar region to Patagonia and New Zealand.

Habitat: The members of this family inhabit damp and marshy soils along the margins of ponds and streams, and they are often seen resting upon rocks in swiftly flowing streams. They also frequent the salt and brackish marshes of our sea coasts.

Key to Virginia Genera of *Saldidae*

1. Antennae with segments 3 and 4 strongly swollen; pronotum with 2 prominent conical tubercles on cephalic lobe ---------- *Saldoida*, p. 32
   Antennae with segments 3 and 4 only slightly swollen, if at all; pronotum without tubercles ---------- 2

2. Membrane of hemelytra with five elongate cells (Fig. 4e) ---------- *Pentacora*, p. 21
Membrane of hemelytra with four elongate cells ------ 3

3. Mesal margin of membrane straight; corium without veins or with median vein not forked apically; embolium pale ---------- *Micracanthia*, p. 30
Mesal margin of membrane slightly convex; corium with two distinct veins, the branches of vein forked apically and extending to membrane; embolium partly black ---------- *Saldula*, p. 25

Genus *PENTACORA* Reuter, 1912

Description: This genus includes the larger members of the family. Antennal segment 2 longer than width of head across eyes. Membrane of hemelytra with five elongate cells. Length 4.8 to 8.0 mm.

Distribution: *Pentacora* seems to be endemic to North America.

Habitat. The species of this genus are found along rivers and along the sea coasts, where they are seen on rocks in the streams or upon the pilings of bridges and piers.

Key to Virginia Species of *Pentacora*

1. Dorsal surface shining, without appressed pubescence, but with numerous long erect dark hairs---------- * *hirta*, p. 25
Dorsal surface dull, with appressed pubescence, and with short erect or inclined dark hairs on hemelytra ---------- 2

2. Narrow lateral margins of pronotum and hemelytra with a row of very short erect setae; antennal segment 2 much longer than 3 and 4 united ---------- * *signoreti*, p. 24
Lateral margins of pronotum and hemelytra without setae; antennal segment 2 equal to, or shorter than, 3 and 4 united ---------- 3

3. Pronotum at base 4 times as wide as median length; color mostly black ---------- *ligata*, p. 22
Pronotum at base 3 times as wide as median length; color dull yellow ---------- *sphacelata*, p. 24

PENTACORA LIGATA (Say) (Fig. 4e)

Acanthia ligata Say, 1832; *Salda ligata*, Uhler, 1876; *Pentacora ligata*, Van Duzee, 1917; Hungerford, 1919; Blatchley, 1926; Drake & Hottes, 1950, 1955.

Description: General color black, thickly clothed with fine yellowish gray pubescence; narrow reflexed margins of pronotum and hemelytra yellow, as are 2 spots on caudal portion of pronotum, 4 on margins of scutellum, 1 on apical third of clavus, and 6 or 8 on corium and embolium; membrane brown with several lighter spots between nervules; ventral surface black, except for caudal margins of segments which are pale. Pronotum at base 4 times as wide as median length. Length 5.8 to 6.7 mm.

Distribution: This species has been recorded from Quebec and Maine, west to Iowa and Manitoba, and south in the Appalachians to Georgia. Specimens from South Carolina are in the Clemson University Museum.

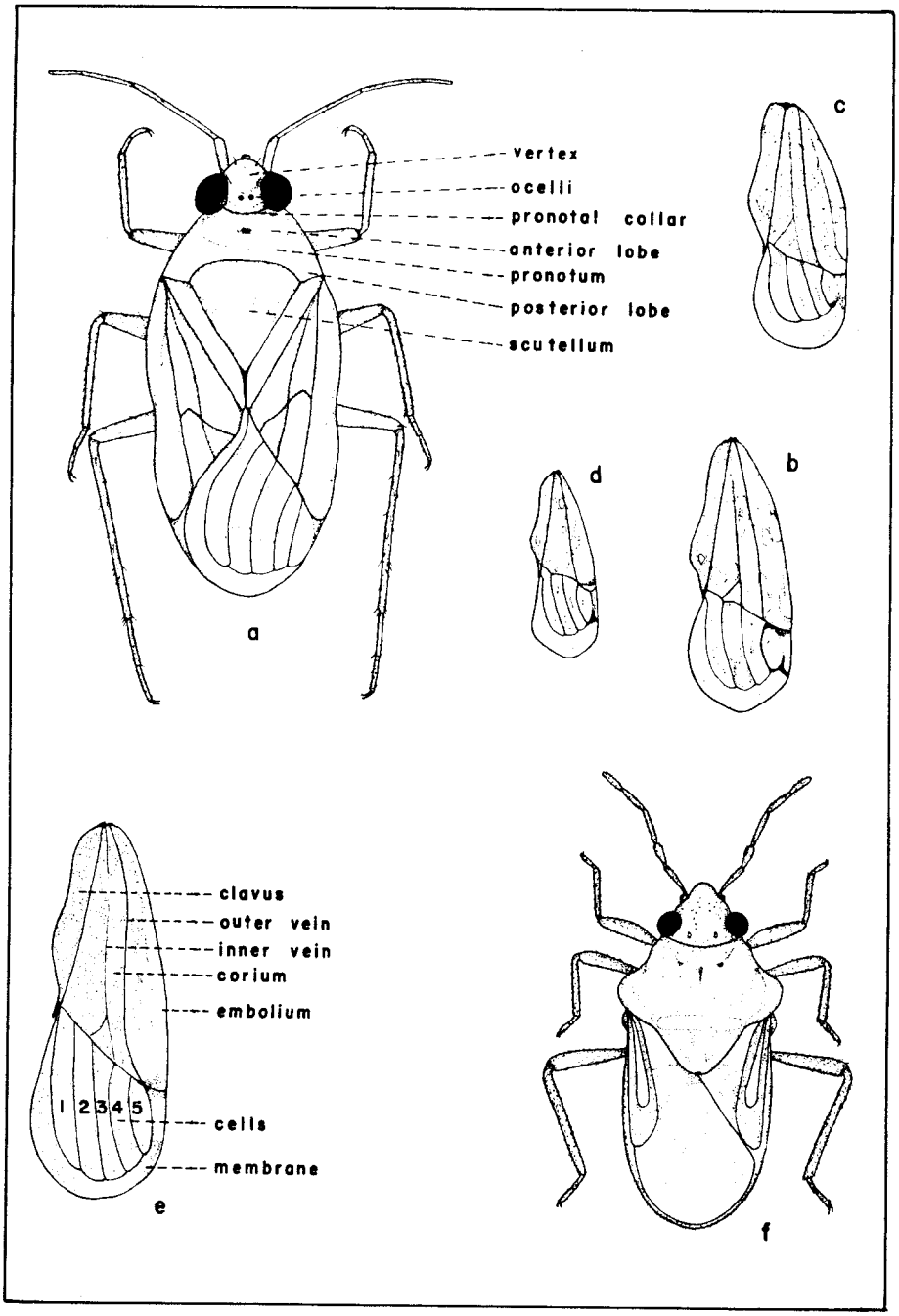
This species has not previously been recorded from Virginia.

My specimens have been collected from the following counties in Virginia: Albemarle, Alleghany, Amherst, Augusta, Bath, Charles City, Rockingham, Shenandoah, and Washington. In addition, specimens collected at Natural Bridge, Rockbridge County, Va., are in the U. S. National Museum collections.

Habitat: My specimens from the interior of the state were found on large gray rocks in rapidly flowing streams; those from eastern Virginia (Charles City County), on pilings of a bridge. In locations where there are rock-bottomed streams, these insects may be seen resting on rocks projecting above the water or on those lying along the shore. Unless disturbed, these insects may sit motionlessly for long periods of time. If disturbed, they will rapidly fly to a nearby rock and immediately orient themselves so their head is directed toward the source of disturbance. In the coastal plain where rocks are absent from the stream beds, I have been unable to locate this species, except on pilings of docks and bridges.

Figure 4.

a. Adult of *Pentacora sphacelata* (Uhler)
b. Hemelytron of *Saldula pallipes* (Fabricius)
c. Hemelytron of *Saldula saltatoria* (Linnaeus)
d. Hemelytron of *Micracantha humilis* (Say)
e. Hemelytron of *Pentacora ligata* (Say)
f. Adult of *Hebrus burmeisteri* Lethierry & Severin


vertex
ocelli
pronotal collar
anterior lobe
pronotum
posterior lobe
scutellum
a
c
d
b
clavus
outer vein
inner vein
corium
embolium
1 2 3 4 5
cells
membrane
e
f

Biology: The life history of this species is not known. Males and females have been collected during June, July, and August, and two females were collected in October. None have been observed during the winter months.

Remarks: *Pentacora ligata* has not been collected in association with any other species of Saldidae.

PENTACORA SPHACELATA **(Uhler)** (Fig. 4a)

Salda sphacelata Uhler, 1877; *Saldula sphacelata*, Hungerford, 1919; *Pentacora sphacelata*, Blatchley, 1926; Schuh, 1967.

Description: Form more elongate than allied species. Color dull yellow, tinged with pale fuscous; callus of protonum mottled with black and yellow; base of scutellum black; membrane generally light with brownish areas betwen nervules. Pronotum at base 3 times as wide as median length. Length 4.2 to 5.3 mm.

Distribution: This species has been recorded from Maine, Massachusetts, Rhode Island, New Jersey, Maryland, Florida, Texas, and Cuba. Schuh (1967) states that this species has a wide distribution: from Massachusetts to the Gulf Coast, southern California, Peru and the Caribbean and Mediterranean areas. The Virginia specimens were collected at Yorktown, York County, August 15, 1948 (R. L. Hoffman).

Habitat: My specimens were collected from pilings of river piers. Blatchley (1926) and Schuh (1967) stated that this is a submaritime species occurring along the coasts.

Biology: The life history of this species is not known. Uhler (1877) stated that *Pentacora sphacelata* was exceedingly abundant on the discolored sandy and marshy "brown spots" of the tidewater districts of Massachusetts and Maryland. The salt mud seems to afford the conditions best suited to their development. In such spots, they were found in all stages of development and in unnumbered multitudes. All my specimens were adult, and were collected in August.

Remarks: This species was not collected in association with any other Saldidae.

* *PENTACORA SIGNORETI* **(Guerin-Meneville), 1857**

I have not collected this species and it has not been recorded from Virginia; but it must occur along the coast, since it has been re-

corded from Massachusetts, New York, New Jersey, Maryland, North Carolina, Missouri, Georgia, Florida, Texas, Kansas, Utah, California, Mexico, and Cuba. In addition, there are specimens from South Carolina in the Clemson University Museum.

Uhler (1877) stated that "it lives on the pale sands not remote from the beach, and the darker varieties may be met with running briskly over the gray or blackish sandy mud, neglecting the dry spots, but often swarming on the moist places." Schuh (1967) stated that this species is usually found in saline situations.

* *PENTACORA HIRTA* **(Say), 1832**

I have not collected this species, and it has not been reported from Virginia but has been recorded from Connecticut, New York, New Jersey, Florida, Texas, Indiana, Iowa, and Quebec, and specimens are in the U. S. National Museum from Mississippi, North Carolina, and Massachusetts. Torre-Bueno (1923a) stated that it was commonly found on the muddy tidal flats and beaches.

Genus *SALDULA* Van Duzee, 1914

Description: Antennal segment 2 shorter than width of head across eyes. Hemelytra often variegated; membrane with 4 elongate cells; 2 corial veins present; mesal margin of membrane slightly convex; embolium partly black. Length 3.5 to 8.0 mm.

Distribution: The members of this genus have been recorded from Europe, North and Central America, the West Indies, and China.

Habitat: The species of this genus inhabit the shores of ponds and streams.

Key to Virginia Species of *Saldula*

1.	Sides of pronotum convex	2
	Sides of pronotum straight	5
2.	Dorsal surface of hemelytra black with a few small pale spots; embolium black ——— *major*,	p. 26
	Dorsal surface of hemelytra mostly black but with some large pale areas; embolium yellowish-white with dark areas	3

3. Hemelytra with long erect hairs; form elongate, surface shining; length 6 mm. or more ---------- *confluenta*, p. 28

Hemelytra without long erect hairs; form orbicular, surface dull; length 5 mm. or less ---------- 4

4. Corium with large whitish spots, broadly joined to marginal ones; front tibia with dark stripe, extending from base for about ¾ its length, and a small dark spot at distal end ---------- *pallipes*, p. 27

Corium with small, obscure spots, not joined to marginal ones; front tibia with dark spots at proximal and distal ends, and a short stripe at midlength ---------- *saltatoria*, p. 29

5.(1) Margin of hemelytra with 2 long flavous spots, and a broad C-shaped pale subbasal spot; front tibia with dark spots at proximal and distal ends, and a short stripe at midlength ---------- *c-album*, p. 30

Margin of hemelytra entirely flavous; front tibia with dark spots at proximal and distal ends only ---------- * *opacula*, p. 30

SALDULA MAJOR (Provancher)

Salda major Provancher, 1872; *Saldula major*, Van Duzee, 1917; Hungerford, 1919; Wiley, 1922; Blatchley, 1926; Drake & Hottes, 1950, 1955.

Description: Elongate-oval in shape. Color a uniform dull black, thickly clothed with very fine yellowish pubescence; hemelytra with a number of small dirty-white spots; membrane dusky white, clouded with brown. Length 6.5 to 8.0 mm.

Distribution: This species has been recorded from Maine, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, North Carolina, Georgia, Indiana, Illinois, Missouri, Kansas, Texas, New Mexico, Michigan, Minnesota, Wisconsin, Quebec, Ontario, and British Columbia, and specimens from South Carolina are in the Clemson University Museum.

The species has not previously been recorded from Virginia. I collected the species from reeds along St. Hwy. 170 in Great Bridge, City of Chesapeake, June 1, 1949.

Habitat: My specimens were collected from the muddy shores of a swampy area near a stream.

Biology: The life history of this species has been studied in Kansas by Wiley (1922). She gives the following measurements and length of developmental period for the immature stages: egg, 1.2 mm. long, and 12 days incubation period; first instar, 1.1 mm. long and molt in 4 days; second instar, 1.8 mm. long and molt in 3 days; third instar, 2.24 to 2.50 mm. long and molt in 3 days; fourth instar, 3.25 to 3.50 mm. long and molt in from 2 to 3 days; fifth instar, 4.5 to 4.8 mm. long and molt in 4 days. The total period of development from egg to adult was 28 days. She stated that the eggs were deposited at the base of grass blades, or thrust with the aid of the sharp ovipositor into the blades of grass. The nymphs stayed hidden most of the time, but would come out to feed quite readily.

Remarks: I did not take *Saldula major* in association with any other species of the family, but Wiley (1922) reported it in association with *S. pallipes.*

SALDULA PALLIPES **(Fabricius)** (Fig. 4b)

Acanthia pallipes Fabricius, 1794; *Acanthia interstitialis,* Say, 1825; *Saldula interstitialis,* Van Duzee, 1917; Hungerford, 1919; Blatchley, 1926; *Saldula pallipes,* Van Duzee, 1917; Hungerford, 1919; Wiley, 1922; Drake, 1950; Drake & Hottes, 1950, 1955; Chapman, 1962.

Description: Color generally black with fine golden-yellow pubescence. Hemelytra with small yellowish spot at apex of clavus; corium irregularly spotted with, or largely, whitish-yellow; membrane light brown with darker areas in each cell (Fig. 4b). Front tibia with dark stripe extending from base for about ¾ its length, and a small dark spot at distal end. Length 4.0 to 4.2 mm.

Distribution: This species has been recorded from Quebec and Ontario south to Florida, west to California, and north to Alaska. It has also been taken in Cuba, Haiti, and Santo Domingo.

The species has not previously been recorded from Virginia, but specimens from Natural Bridge, Rockbridge County are in the U. S. National Museum. I have collected specimens from the following localities: Amherst County, stream crossing U. S. Hwy. 29 near entrance to Sweet Briar College; Buckingham County, lake on U. S. Hwy. 15, about 4 miles N. of Dillwyn, July 31, 1947; Dickenson County, below dam of John Flannagan reservoir; Shenandoah County, stream 10 miles S. of Strasburg on U. S. Hwy. 11, August 22, 1948.

Habitat: My specimens were collected from the muddy shores of a pond and a stream and from the rocky shores of a rapidly flowing stream. Schuh (1967) stated that this species is found along open stream and pond margins and does not occur along the sea coast.

Biology: The life history of *Saldula pallipes* has been studied in Kansas by Wiley (1922). She gives the following measurements and periods of time required for development of the immature stages: egg, 0.6 mm. long and hatch in 8 to 10 days; first instar, 0.8 mm. long and molt in 4 days; second instar, 1.0 mm. long and molt in 3 days; third instar, 1.5 mm. long and molt in 3 days; fourth instar, 2.0 mm. long and molt in 3 days; fifth instar, 2.7 mm. long and molt in 3 days. This gave a total period of development from egg to adult of 25 days. She reared 2 generations in one summer.

My specimens were collected in June, July, and August.

Remarks: This species has been collected in association with *Pentacora ligata* and *Micracanthia humilis* in Virginia, and Wiley (1922) reported it in association with *Saldula major* in Kansas.

Blatchley (1926) considered *Saldula pallipes* a synonym of *S. interstitialis.* Drake (1950) concurred in this opinion but pointed out that the former is the older name and thus the correct binomial is *S. pallipes* (Fabricius) and not *S. interstitialis* (Say).

SALDULA CONFLUENTA **(Say)**

Acanthia confluenta Say, 1832; Torre-Bueno, 1908; *Salda confluenta,* Uhler, 1877; *Saldula confluenta,* Van Duzee, 1917; Hungerford, 1919; Blatchley, 1926.

Description: Head, pronotum, and scutellum black, shinning. Clavus black, with a pale spot at apex; corium with large marginal whitish spots at apex and base, separated by brown, pale spot between forks of inner vein and another between the 2 veins; embolium whitish with black median area; membrane yellowish-white wtih brown median transverse band across cells. Tip of tibia and tip of third tarsal segment black, remainder of leg yellowish. Hemelytra with numerous long hairs. Length about 6.1 mm.

Distribution: This species has been recorded from Ontario and throughout most of the northeastern states to Texas.

Saldula confluenta has not previously been recorded from Virginia. I have only one specimen of this species in my collection from Virginia: a female collected by R. L. Hoffman and L. M.

Carter, with the data "Sussex Co. — Warwick Swamp, 10 miles southeast of Petersburg on U. S. Hwy. 460, May 8, 1949." I have also seen one specimen of the species in the Old Dominion University collection from Rocky Mount, North Carolina.

Habitat: My specimen was taken from swampy ground, but specimens have been recorded as occurring on rocks and logs in streams.

Biology: The life history of *S. confluenta* is not known.

Remarks: *S. confluenta* has not been taken in association with any other members of the family.

SALDULA SALTATORIA **(Linnaeus)** (Fig. 4c)

Cimex saltatoria Linnaeus, 1758; *Lygaeus saltatoria*, Fabricius, 1794; *Saldula saltatoria*, Van Duzee, 1917; Hungerford, 1919; Blatchley, 1926; Drake & Hottes, 1950, 1955; Schuh, 1967.

Description: Color, dull black with pale markings on hemelytra; clavus with a pale spot near apex; corium with several small whitish spots; membrane with a brownish area in each cell and a small one on lateral margin; dorsal surface clothed with fine yellowish pubescence. Front tibia with dark spots at proximal and distal ends and a short stripe at midlength. Length 3.8 to 4.2 mm.

Distribution: This species was described from Europe and is holarctic. It has been reported from Maine, Massachusetts, Rhode Island, Connecticut, New York, Illinois, Nebraska, Guatemala, British Columbia, England, and China.

The species has not been recorded previously from Virginia. However, specimens are in the U. S. National Museum collection from Fairfax County, and I have collected it at the "Old Reservoir" at Charlottesville, Albemarle County.

Habitat: This is a shade-loving species which prefers damp areas along the margins of ponds and streams. My specimens were collected from among the leaves and debris on the shore of a small, woodland pond.

Biology: The life history of this species is not known. My specimens were taken in April and May.

Remarks: *Saldula saltatoria* has been found in associaiton with *Micracanthia humilis* and *Saldula c-album*.

SALDULA C-ALBUM (Fieber), 1859

Salda c-album, Fieber, 1859; *Saldula c-album*, Drake & Hottes, 1950.

Description: Margin of hemelytra with two flavous spots, and a broad C-shaped pale subbasal spot, pronotal edge of side margin straighter than in *S. saltatoria;* front tibia with dark spots at proximal and distal ends and a short stripe at mid-length. Often found in short-winged form.

Distribution: *Saldula c-album* has not reviously been recorded in Virginia. According to the late C. J. Drake (correspondence) this species is widespread in North America, but has been universally confused with *S. reperta* and *S. saltatoria* in collections. I have taken the species at the "Old Reservoir" at Charlottesville, Albemarle County, April 4, 1947, and below the John H. Flanagan Dam near Haysi, Dickenson County, July 30, 1972. The VPI&SU collection has a single male from 3 miles N. W. of Clifton Forge, Alleghany County, July 6, 1954 (R. L. Hoffman).

Habitat: The Virginia specimens were found along the banks of small ponds and streams, except in Dickenson County where they were taken along an open river margin.

Biology: Nothing appears to be known of the biology of this form, at least as it occurs in North America.

Remarks: Specimens have been taken in association with *Micracanthia humilis* and *Saldula saltatoria* — two species which it very closely resembles.

* *SALDULA OPACULA* (Zetterstedt), 1838

I have not collected this species, and it has not been recorded from Virginia. However, the species is Holarctic and has been taken in small numbers from several eastern states, so it may occur in the marshes and bogs of Tidewater Virginia.

Genus *MICRACANTHIA* Reuter, 1912

Description: Antennal segment 2 shorter than width of head across eyes; only about twice as long as segment 1. Inner vein of corium absent. Mesal margin of membrane straight; membrane with 4 elongate cells. In general very similar to the smaller species of *Saldula*, and perhaps two genera cannot be justified.

Distribution: Species of this genus occur in Europe, North America, and the West Indies.

Habitat: These small bugs occur on muddy or sandy shores of streams and ponds, but may often be found on large rocks in mountain streams. They fly very swiftly from place to place, or hide behind pebbles or grass stems, and are difficult to capture.

MICRACANTHIA HUMILIS (Say) (Fig. 4d).

Acanthia humilis Say, 1832; *Saldula humilis*, Uhler, 1876; *Micracanthia humilis*, Van Duzee, 1917; Hungerford, 1919; Blatchley, 1926; Drake & Hottes, 1950, 1955; Schuh, 1967.

Description: Head, pronotum, and scutellum black, clothed with yellowish pubescence; clavus and corium mostly black; embolium yellowish white; membrane whitish, clouded with brown areas in each cell. Corium with inner vein absent. Distal half of all femora a uniform brown. Length, 3.0 to 3.7 mm.

Distribution: This species is widespread over much of North America, recorded from Ontario and Maine west to Colorado and Texas, south through Florida to St. Vincent and Grenada; also California.

M. humilis has not been previously reported from Virginia, but it appears to be statewide, having been collected in Accomac, Albemarle, Alleghany, Augusta, Buckingham, Fairfax, Louisa, Rockingham, and Smyth counties.

Habitat: My specimens have been collected from the shores of ponds and streams and from the marshy area of a "wet-weather spring."

Biology: The life history of the species is not known. Seasonal data show the adults present throughout the summer, with mature nymphs in July.

Remarks: Within the family, *Micracanthia humilis* has been collected in association with *Saldula saltatoria, S. pallipes,* and *S. c-album.*

* *MICRACANTHIA HUSSEYI* **Drake & Chapman, 1952**

This species has not yet been collected in Virginia, but seven specimens are in the U. S. National Museum collection from Maryland and Florida, and it doubtless will be found in the Commonwealth.

Genus *SALDOIDA* Osborn, 1901

Description: Small oblong oval insects, with antennal segments 3 and 4 swollen. Pronotum with 2 very prominent paramedian conical tubercules on anterior lobe which is narrow and cylindrical. Membrane of hemelytra surpassing abdomen by ⅔ its length. Antennae and hemelytra brightly colored.

Distribution: Two of the three species of this genus occur in southeastern United States (*slossonae, cornuta*), and the third, in southeast Asia (*armata*).

Habitat: "The members of this genus inhabit favorable situations in low, permanently wet, secluded areas near the shores of lakes, ponds, bogs, swamps, marshes, and roadside and drainage ditches." (Drake & Chapman, 1958).

SALDOIDA SLOSSONAE Osborn

Saldoida slossoni Osborn, 1901; Blatchley, 1926; Usinger, 1945; *Saldoida slossonae*, Drake & Chapman, 1958.

Description: Head with vertex black, margins next to eyes reddish-brown, front and beak testaceous; pronotum with tubercules reddish-brown, front margin and band behind tubercules black, posterior lobe brownish-yellow; scutellum black, its apex piceous; elytra pale brown, claval suture and apical margin of corium black; corium with two triangular whitish spots, the bases of which merge into the hyaline costal margin; membrane fuscous at base, hyaline toward apex; legs yellowish-brown, apical third of femora, base and apex of tibiae and third tarsal, fuscous. First and fourth antennal segments whitish; third, and all but apex of second, brownish. Length, about 3 mm.

Distribution: This species is recorded from New Jersey, Virginia Georgia, Florida, Mississippi, and Texas — all records for the coastal plain, except one at Stone Mountain near Atlanta, Georgia. It has been reported from Virginia by Usinger (1945) and Drake & Chapman (1958).

I have not collected *S. slossonae,* but have seen a number of specimens in the Norfolk Truck Experiment Station and in U. S. National Museum collections from 0.6 mile N. of Diamond Springs, City of Chesapeake, and Cape Henry, City of Virginia Beach.

Habitat: In Virginia, found in grass clumps behind sand dunes. Elsewhere, in low wet meadows, characterized by the presence of sphagnum moss and sundews.

Biology: Virginia specimens were collected in abundance in August, 1946, but the same site did not yield a single specimen a month later. Numerous specimens were taken in New Jersey during September and October. Drake & Chapman (1958) state that, in captivity, adults live only 7 to 10 days, but mate readily (coupling for a duration of about 8 minutes) and deposit numerous eggs. None of the eggs hatched under laboratory conditions, however.

Remarks: In New Jersey and Florida, *S. slossonae* has been found in association with *Micracanthia husseyi, M. humilis, Saldula saltatoria,* and *Saldoida cornuta.*

Drake & Chapman (1958) regard this genus as separable from all others of the family as comprising a monotypic subfamily Saldoidinae. Their paper gives a complete review of the knowledge of the genus up to that time.

Family 4. HEBRIDAE Amyot & Serville, 1843

Description: Very small, plump-bodied insects. Head shorter than pronotum; eyes large, coarsely granulated; ocelli present; antennae 4- or 5-segmented; rostrum slender, 4-segmented, reaching caudally to hind coxae. Pronotum as broad, or broader, than abdomen; scutellum small, triangular, its apex obtuse. Hemelytra usually present, though sometimes absent in members of the genus *Merragata;* membrane very large, without veins. Legs short, subequal in length; tarsi 2-segmented, their claws apical.

Distribution: The members of this small family are represented in all parts of the world.

Habitat: Species of the family Hebridae live along the margins of pools, ponds, swamps, and upon floating vegetation in shallow water. Considerable numbers are often found in clumps of mosses growing at the edge of the water.

Key to Virginia Genera of *Hebridae*

1. Antennae 5-segmented, segments 3 to 5 very slender ---------- *Hebrus,* p. 34
   Antennae 4-segmented, all segments subequal in thickness ---------- *Merragata,* p. 37

Genus *HEBRUS* Curtis, 1833

Description: Antennae 5-segmented, segments 3 to 5 very slender, 1 and 2 stout distally. Both macropterous and brachypterous forms are known.

Distribution: Members of this genus have been recorded from North, Central, and South America, and the West Indies.

Habitat: These insects are found in moss clumps, grasses, and debris along shores, and upon moist earth near the edge of the water of ponds and streams.

Key to Virginia Species of *Hebrus*

1.	Apex of scutellum obtusely angled, not notched or very feebly	2
	Apex of scutellum subtruncate, distinctly notched	3
2.	Antennae slender; membrane of hemelytra dark brown, without pale spots *concinnus*,	p. 35
	Antennae stout; membrane of hemelytra light brown, with 4 distinct pale spots * *consolidus*,	p. 37
3.	Pronotum deeply punctate and with a deep median furrow *buenoi*,	p. 36
	Pronotum smooth or minutely punctate and with, at most, a shallow median furrow *burmeisteri*,	p. 34

HEBRUS BURMEISTERI Lethierry & Severin (Fig. 4f)

Hebrus burmeisteri Lethierry & Severin, 1896; Parshley, 1916; Hungerford, 1919, 1925b; Drake & Harris, 1943; *Naeogeus burmeisteri*, Blatchley, 1926.

Description: Oblong, hemelytra subparallel. General color dark fuscous; rostrum, first antennal segment, and legs yellow; tibiae and tarsi tinged with fuscous. Clavus with milky-whtie spot on basal half; corium with narrow pale line; membrane with 4 white spots on lines. Segment 3 of antennae longer than either 4 or 5. Pronotum with ill-defined medial longitudinal furrow, and minutely, sparsely punctate. Length 1.8 to 2.1 mm.

Distribution: This species has been recorded from New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, South Carolina, Kentucky, Missouri, Iowa, Kansas, Michigan, Wisconsin, Illinois, and Indiana. *Hebrus burmeisteri* has previously been recorded from Virginia by Drake & Harris (1943), but no specific localities were mentioned. However, specimens from Fairfax County, Virginia are in the U. S.

National Museum. I have a total of 13 specimens from Virginia; all collected from the shores of the "Old Reservoir" at the University of Virginia, Albemarle County.

Habitat: In the above mentioned locality this species has been collected in early spring in clumps of moss growing on the rocks along the banks of the pond. Here they were also collected while in hibernation, from moist, rotten leaves and debris.

Biology: The life history of this secies is not known. I have collected adults only in early spring, and no nymphs have been observed. At the "Old Reservoir," they pass the winter as adults in dead grass, leaves, and other debris near the water. All of my specimens are macropterous.

Remarks: Within the family Hebridae, *Hebrus burmeisteri* has been taken in association with *H. buenoi* and *H. concinnus.*

HEBRUS CONCINNUS Uhler

Hebrus concinnus Uhler, 1894; Champion, 1898; Drake & Harris, 1943; Hungerford, 1919; *Naeogeus concinnus,* Blatchley, 1926.

Description: Oblong, robust, minutely pubescent. General color reddish-brown; head, basal lobe of pronotum, scutellum and apical third of corium darker. Clavus of hemelytra with pale spot on basal half; corium with long, narrow, pale line; membrane fuscous with a vague yellowish spot each side at base. Segment 1 of antennae about ½ again as long as 2, segments 3 to 5 very slender, thinly beset with fine erect hairs. Pronotum coarsely, sparsely, irregularly punctate, with an ill-defined longitudinal median depression. Length 2.0 to 2.3 mm.

Distribution: This species has been recorded from New York, New Jersey, Pennsylvania, Maryland, District of Columbia, North Carolina, South Carolina, Florida, Mississippi, Louisiana, Texas, Oklahoma, Indiana, Colorado, Illinois, California, Washington, Guatemala, Grenada, Mexico, Costa Rico, Peru, Quebec, and Ontario.

The species has not previously been recorded from Virginia, but specimens from Cape Henry, City of Virginia Beach, are in the U. S. National Museum. I have collected a total of only 5 individuals from Virginia, all from the following localities in Albemarle County: the "Old Reservoir" at the University of Virginia; banks of the South Fork of the Rivanna River 5 miles N. of Charlottesville on U. S. Hwy. 29.

Habitat: This species has been collected from clumps of moss growing on rocks along the banks, and from moist, rotten leaves and debris along the shores of the pond and stream just mentioned.

Biology: Hungerford (1919) has published life history notes on *Hebrus concinnus*. He stated that the insects were observed mating in numbers at Ithaca, New York on June 22. In the laboratory the eggs were deposited in what closely approximated leaves of moss, and hatched in about a week. Hungerford stated that the eggs are elongate oval, pearly white, and measure 0.625 mm. long and 0.325 mm. wide. The first instar nymphs measured 0.608 mm. long and 0.352 mm. wide, but no reference was made to nymphs of later instars. On the basis of my meager data, it appears that individuals of this species hibernate as adults during the winter.

Remarks: Within the family Hebridae, this species has been collected in association with *Hebrus burmeisteri* and *H. buenoi*.

HEBRUS BUENOI Drake & Harris

Hebrus buenoi Drake & Harris, 1943.

Description: Allied to *Hebrus burmeisteri* but may be separated from it by the deep median furrow of pronotum, the pronounced division of the apex of the scutellum, the different color of clavus, and the slightly larger size. General color fuscous, central portion of pronotum lighter, coarsely punctate; scutellum blackish, broad, with median carina. Hemelytra with clavus gradually becoming white basally; membrane somewhat smoky, with large white spot at apex of each clavus and an ill-defined subapical spot. Rostrum long, yellowish-brown. Head with deep median furrow. Length 2.1 mm.

Distribution: This species has been recorded from New York, Massachusetts, Mississippi, Kansas, Iowa, Colorado, Michigan, and Wisconsin. I have a total of 19 specimens of this species from Virginia. All were collected from the banks of the "Old Reservoir" at the University of Virginia, in Albemarle County.

Habitat: In the above mentioned locality, this species was collected from the debris along the shores of the pond and in moss clumps near the water's edge.

Biology: The life history of *Hebrus buenoi* is not known. I have collected adults in April, May, and August. Since adult males and females have been collected in early April, it is probable that they hibernate as adults instead of in one of the nymphal instars.

Remarks: Within the family Hebridae, this species has been collected in association with *Hebrus burmeisteri* and *H. concinnus.*

* *HEBRUS CONSOLIDUS* **(Uhler), 1894**

I have not collected this species in Virginia, but specimens are in the U. S. National Museum collection from New Jersey, District of Columbia, Florida, Texas, and Kansas, and it probably occurs in Virginia. The species resembles *H. concinnus* but is lighter brown in color and, smaller and more oval in shape.

Genus *MERRAGATA* White, 1877

Description: Antennae 4-segmented, the segments subequal in thickness, or 4 stoutest. Brachypterous and macropterous forms present within the same species.

Distribution: Members of this genus have been recorded from North, Central and South America, and from Mexico, Guatemala, and Hawaii.

Habitat: Hungerford (1919) stated the favorite haunts of this species are secluded coves of lakes, ponds, and swampy pools, where the water is shallow, and where there is an abundant growth of aquatic plants.

Key to Virginia Species of *Merragata*

1. Color blackish or dark brown; membrane of hemelytra with distinct fuscous spots; pronotum with lateral margins moderately constricted, dorsally with a deep broad, median longitudinal furrow -- ---------- *hebroides*, p. 37

   Color pale chestnut-brown; membrane of hemelytra milky-white; pronotum with lateral margins strongly and abruptly constricted, dorsally with a narrow, ill-defined medial longitudinal furrow -- ---------- *brunnea*, p. 38

MERRAGATA HEBROIDES White

Merragata hebroides White, 1877; Blatchley, 1926; Drake & Harris, 1943.

Description: General color fuscous-black. Antennae reddish-brown; short, about ½ again as long as head; fusiform, joints 1 to 3 subequal, 4 longer and stouter. Beak and legs yellowish-

brown. Hemelytra reaching tip of abdomen, with white spots on clavus, corium and membrane. Head as wide across eyes as long; eyes small, prominent, coarsely granulated. Pronotum with lateral margins moderately constricted, dorsally with a deep, broad, median longitudinal furrow. Length 1.6 to 2.0 mm.

Distribution: This species has been recorded in the United States from Massachusetts to Florida and west to California; from the West Indies, Mexico, Central and South America; and from the Hawaiian Islands. It was recorded from Virginia by Drake & Harris (1943), although no specific localities were mentioned.

Habitat: Debris and clumps of grass in marshy areas near water.

Biology: The life history of this species is not known.

MERRAGATA BRUNNEA Drake

Merragata brunnea Drake, 1917; Blatchley, 1926; Drake & Harris, 1943.

Description: Macropterous form oblong, shorter than *hebroides*. General color chestnut-brown; legs and antennae yellow; corium yellow, clavus and membrane milky-white. Pronotum with lateral margins strongly and abruptly constricted at apical third, dorsally with a narrower, ill-defined medial longitudinal furrow. Brachypterous form somewhat darker in general color. Hemelytra represented by small white pads not reaching second dorsal segment. Pronotum smaller, its sides less constricted. Length 1.4 to 1.6 mm.

Distribution: This species has been recorded from New York, Minnesota, Nebraska, Ohio, and Florida.

I have not collected this species in Virginia, but I have seen four specimens in the collection of the Virginia Truck Experiment Station labeled "Norfolk, 7-30-32". Specimens in the Radford College Collection are from Montgomery County: Lucas Ponds, approx. 6 miles southwest of Christiansburg, May 17, 1972 (Coll. & det. R. L. Hoffman).

Habitat: The species will probably be found in haunts as given for the genus.

Biology: Nothing is known concerning the life history of this species.

Family 5. HYDROMETRIDAE Billberg, 1820

Description: Extremely slender insects having a linear, dark colored body. Head as long as entire thorax. Eyes large and placed slightly behind middle of head. Ocelli absent. Antennae filiform, 4-segmented, inserted on sides of enlarged art of head. Rosrtum 3-segmented, very slender, shorter than head. Legs elongate, very slender. Tarsi 3-segmented with two apical claws. Adults dimorphic with respect to wings.

Distribution: The members of the family are cosmopolitan in distribution, having been recorded from North and South America, Africa, China, Japan, Ceylon, India, Madagascar, Australia, New Guinea, New Caledonia, Philippine Islands, Java, and Sumatra.

Habitat: The "marsh-treaders," as these insects are commonly known, live upon the shores and floating vegetation, and among grasses growing in the waters of ponds, ditches, and slow-flowing streams. When disturbed, they leave the shore and run along the surface of the water.

Genus *HYDROMETRA* Lamarck, 1801

Description: The family is represented in North America by a single genus, and the chief characters are those given under the family.

Distribution: Same as that of the family.

Habitat: Same as that of the family. These insects walk upon the water and do not propel themselves by a rowing motion as do the members of the family Gerridae.

Key to Virginia Species of *Hydrometra*

1. Male with sternite of sixth abdominal segment bearing a pair of transversely linear prominences; 2 pits on sides above middle coxae (Fig. 5b & e); chestnut brown in color ---------- 2

   Male with sternite of sixth abdominal segment bearing a pair of spine-like tubercles; 4 pits on sides above middle coxae (Fig. 5, a&c); bluish-black in color ---------- *hungerfordi*, p. 40

2. Hind lobe of pronotum with several large, scattered punctures on disk; second segment of antennae twice as long as the first ---------- *martini*, p. 42

Hind lobe of pronotum smooth or only feebly punctate; second segment of antennae 2½ times as long as first ---------- *australis*, p. 43

HYDROMETRA HUNGERFORDI **Torre-Bueno** (Fig. 5a & c)

Hydrometra australis [nec Say] Hungerford, 1923a; Torre-Bueno, 1926; *H. hungerfordi*, Torre-Bueno, 1926; Drake & Hottes, 1952; Froeschner, 1962.

Description: Apical portion of head dilated toward tip. Four pits on sides above middle coaxe. Male with sternite of sixth abdominal segment bearing a pair of conical tubercles near cephalic margin. Color bluish-black, darker than other species. Length 8 to 11 mm.

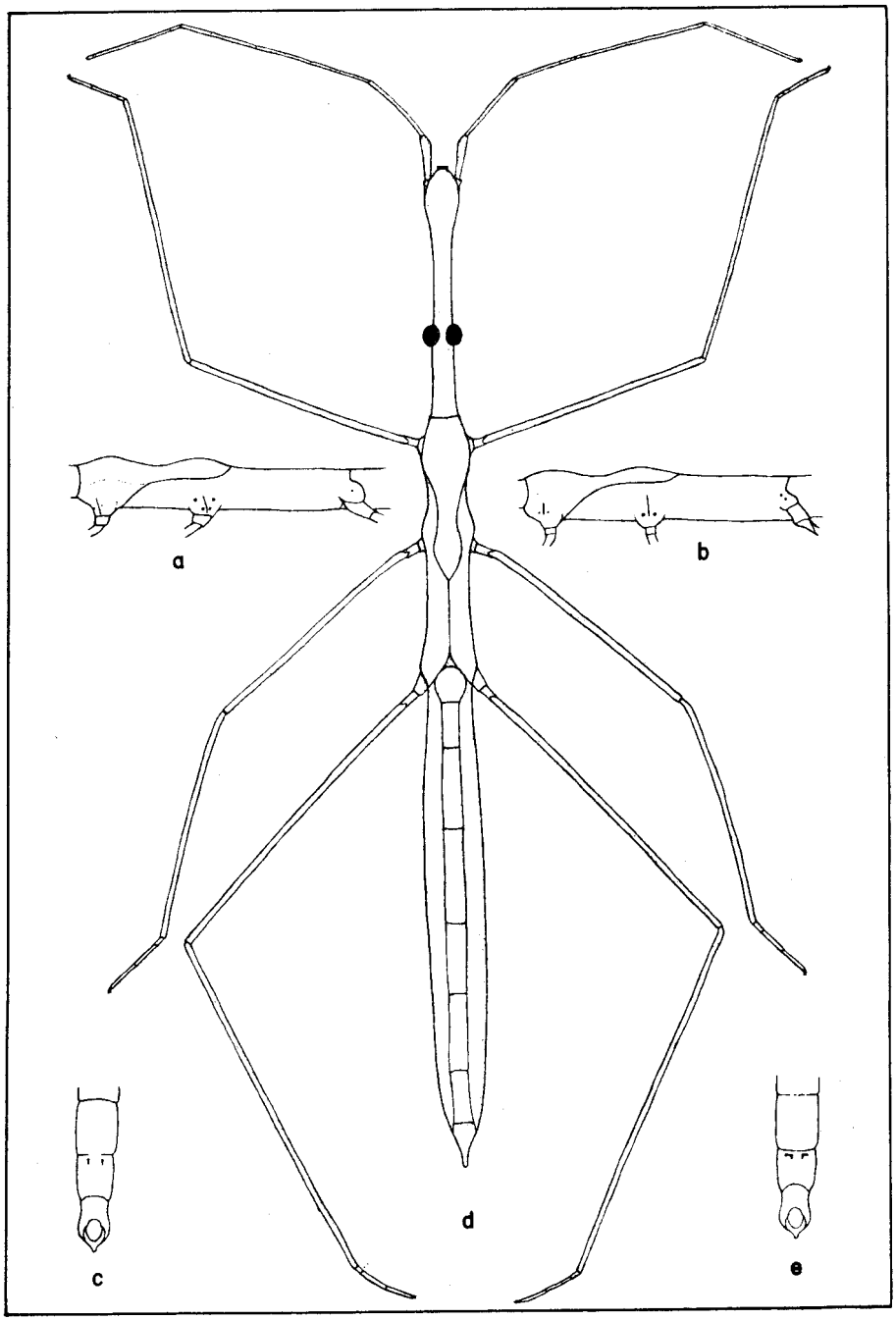
Distribution: This species has been recorded from Kansas, Mississippi, Florida and Georgia. Specimens are in the U. S. National Museum from these additional states: Louisiana, Virginia, District of Columbia, Maryland, New Jersey, New York, and Arkansas.

Hydrometra hungerfordi has not been previously recorded from Virginia. Specimens in the U. S. National Museum from Virginia were collected from the Clinch River near Dungannon, Scott county (7-?-58). I have material from the following localities: Isle of Wight County, 2.8 miles E. of Franklin on U. S. Hwy. 58; Surry County, 11.7 miles N. of Bacon's Castle on St. Hwy. 10; Albemarle County, Charlottesville; City of Chesapeake, 8.5 miles E. of U. S. Hwy. 17 on Co. Hwy. 740; City of Virginia Beach, 4.1 miles W. of Princess Anne Courthouse on St. Hwy. 165. In addition, there are specimens in the Old Dominion University collection from the City of Chesapeake.

Habitat: This species has been collected from among the vegetation along the shores of slow-flowing streams and rivers, and from swamps.

Figure 5.

a. Thorax of *Hydrometra hungerfordi* Bueno
b. Thorax of *Hydrometra martini* Kirkaldy
c. Venter of caudal end of abdomen of *Hydrometra hungerfordi* Bueno
d. Adult of *Hydrometra australis* Say
e. Venter of caudal end of abdomen of *Hydrometra martini* Kirkaldy


a
b
c
d
e

Biology: Nothing is known of the life history of this species. I have collected adults during the months of May through August. The adults probably live through the winter, as do the other species of *Hydrometra*.

Remarks: *Hydrometra hungerfordi* has been taken in association with *H. martini* in eastern Virginia, and Herring (1948) reported collecting it in company with *H. myrae* (= *H. australis*) in Florida.

HYDROMETRA MARTINI **Kirkaldy** (Fig. 5b & e)

Hydrometra lineata Say, 1832; Martin, 1900; *Hydrometra martini*, Kirkaldy, 1900; Torre-Bueno, 1905b, 1926; Hungerford, 1919; Hungerford & Evans, 1934; Drake & Hottes, 1952; Sprague, 1956; Froeshner, 1962.

Description: Pronotum with a vague, median, longitudinal whitish line. Hemelytra, when present, dusky white with dark nervures. Apical third of head narrower than in *Hydrometra hungerfordi* Torre-Bueno. Color dark chestnut or fuscous brown. Antennae reddish-brown, darker toward apex. Rostrum, legs, ventral surface, and middle of dorsum brownish-yellow. Two pits on sides above middle coxae. Male with sternite of sixth abdominal segment bearing a pair of emarginate prominences near cephalic margin. Length 8 to 11 mm. (Fig. 5 e).

Distribution: This species has been recorded from Maine, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, North Carolina, Georgia, Florida, Louisiana, Mississippi, Indiana, Illinois, Kansas, Arkansas, Michigan, Texas, Arizona, Ontario, and Cayman Islands. There are also specimens in the U. S. National Museum from Missouri, South Carolina and Virginia (Great Falls, Fairfax County, and the City of Chesapeake).

H. martini has not previously been recorded from Virginia. Specimens in my collection were taken in the following counties: Albemarle, Alleghany, Appomattox, Bedford, Clarke, Chesterfield, Dinwiddie, Fairfax, Fluvanna, Giles, Montgomery, Nansemond, Rockingham, Southampton, and the cities of Chesapeake and Hampton. In addition, I have seen 12 specimens in the collection of the Virginia Truck Experiment Station from New Church, Accomack County, and there are specimens in the Old Dominion University collection from Fauquier County.

Habitat: *Hydrometra martini* lives upon the vegetation along the shores of ponds, streams, and swamps; and they are frequently found in numbers upon the blankets of algae in quiet pools.

Biology: Torre-Bueno (1905b) and Hungerford (1919) have published life history notes on this species. Soon after mating, the abdomen of the female begins to swell, and it is little wonder, for the abdomen is only 6 mm. long and the mature eggs are from 2.5 to 3.0 mm. long. Egg deposition begins in 2 or 3 days after mating, and the female may lay hundreds from May until August. The female places her eggs upon any support a little above the water. Martin (1900) stated that the female exudes a drop of gummy gelatinous substance from the genital opening, which she presses against the object that has been chosen to support the egg. This sticky mass is the base of the egg stalk and fastens the egg in place before it has left the body. The insect then walks away, thus freeing herself from the egg. The eggs hatch in 4 to 22 days, depending upon the temperature, but Hungerford stated that the average was 7 days in Kansas. There are 5 nymphal instars, and the interval between each instar is approximately 3 days. Hungerford gave the following measurements for the immature stages: egg, 2.07 mm. long and 0.277 mm. in diameter; first instar, 1.3 mm. long and 0.216 mm. wide; second instar, 1.75 mm. long (tip of head to tip of hind femur); third instar, 3.0 mm. long (tip of head to tip of hind femur); fourth instar, 4.0 to 4.5 mm. long (tip of head to tip of hind femur); and 0.406 mm. wide; fifth instar, 6.0 mm. long (tip of head to tip of hind femur) and 0.47 mm. wide. The greenish color of the nymphs blends perfectly with the surroundings in which they live. They feed upon small insects and crustacea, and even upon young nymphs of their own species. I have observed that all stages of the nymphs bend the abdomen up over the back, much in the fashion of a scorpion, when disturbed. The adults live throughout the summer, and Hungerford stated that there may be 3 to 5 generations per year. The adults hibernate during the winter under leaves and trash along the banks of ponds and streams.

HYDROMETRA AUSTRALIS Say (Fig. 5d)

Hydrometra australis Say, 1832; *Hydrometra myrae*, Torre-Bueno, 1926; Hungerford & Evans, 1934; *Hydrometra australis*, Drake & Hottes, 1952.

Description: Color very similar to that of *Hydrometra martini*. Posterior lobe of pronotum impunctate or only nearly so. Second segment of antennae 2½ times as long as first. Pits on middle coxae, and prominences of abdominal sternite of male similar to those of *H. martini*. Length 8 to 11 mm.

Distribution: This is a widely distributed species in the U. S. It is the commonest species in the Gulf States and extends into the West Indies, Mexico, and Central America.

Hydrometra australis has not previously been recorded from Virginia. I have specimens from Albemarle County from the "Old Reservoir" at University of Virginia in Charlottesville and from Miller School reservoir at Batesville; Fluvanna County, from stream crossing U. S. Hwy. 15 about 3 miles S. of Zion Crossroads (U. S. 15 & U. S. 250).

Biology: The life history of *H. australis* has not been published, but that given for *H. martini* may be based upon this species in part. If not, the two species probably have very similar life cycles.

Family 6. MESOVELIIDAE Douglas & Scott, 1867

Description: The family Mesoveliidae comprises a small group of of small, slender, semi-aquatic, greenish insects. Eyes large and prominent. Pronotum feebly constricted in front of middle. Scutellum large, its base with an elevated calloused area. Hemelytra, when present, largely membranous. Antennae slender, 4-segmented, more than half as long as body. Rostrum slender, 3-segmented, reaching to or beyond middle coaxe, joint 2 longer than 1 and 3 united. Legs slender, subequal in length. Tarsi 3-segmented, the basal segment minute, the second longest. Third tarsal segment with two apical claws.

Distribution: Members of the family are represented in all regions of the world.

Habitat: The majority of the Mesoveliidae live upon the floating and emergent vegetation growing in the shallow waters of pools and ponds. They scurry to open water when disturbed, running on the surface rather than rowing as do the members of the family Gerridae.

Genus *MESOVELIA* Mulsant & Rey, 1852

Description: The principal characters of this genus are the same as those given under the family heading. In addition, the head is much prolonged anterior to the eyes. Hemelytra with clavus very large and wholly membranous; membrane without veins.

Distribution: This is a cosmopolitan genus as stated above.

Habitat: All members of the genus inhabit situations as given under the family.

MESOVELIA MULSANTI BISIGNATA Uhler (Fig. 6a)

Mesovelia mulsanti White, 1879; Hungerford, 1917f, 1919; *Mesovelia bisignata*, Uhler, 1884; *Mesovelia mulsanti bisignata*, Jaczewski, 1930; Hoffman, 1932; Usinger, 1942.

Description: Color greenish with a yellowish tinge, fading marginally to brownish-yellow. Under surface pale yellow with a silvery pile. Antennae slender and filiform; segments 1 and 3 sub-equal, 2 shortest. Front and middle femora armed beneath with numerous, rather stout, setae. Apterous and macropterous forms present. Length 3.8 to 4.0 mm. (Fig. 6a).

Distribution: *Mesovelia mulsanti bisignata* has been recorded from New York, Massachusetts, New Jersey, Maryland, Ohio, North Carolina, Georgia, Florida, Texas, Indiana, Kansas, Illinois, Michigan, and Minnesota.

I have collected more than 100 specimens from the Virginia counties of Accomac, Albemarle, Alleghany, Appomattox, Bath, Buckingham, Charlotte, Clarke, Dickenson, Fairfax, Fluvanna, Giles, Greene, Halifax, Lunenburg, Mecklenburg, Northumberland, Page, Patrick, Prince William, Shenandoah, Smyth, Rockingham, Westmoreland, Wise, Wythe, and from the cities of Chesapeake, Newport News, and Virginia Beach.

Habitat: *Mesovelia mulsanti bisignata* lives upon floating and emergent vegetation of the waters of ponds and quiet pools of streams. Their greenish coloration blends with the background of algae, duckweed, cattails, and other vegetation upon, and among which, they live.

Biology: Hungerford (1917 f) and Hoffman (1932) have published notes on the life history of *Mesovelia mulsanti bisignata*. The egg stage lasts from 7 to 9 or more days, and the 5 nymphal stages require about 20 days for development. There are a number of overlapping generations throughout the summer. This subspecies has been thought by most workers to overwinter as adults, but Hoffman observed that eggs in cattail leaves were able to withstand freezing temperatures and hatch the following spring. From numerous early spring collections he concluded that a large percentage of this species overwintered in the egg stage. My seasonal data, while scanty, seems to agree with Hoffman's conclusions, since very few adults have been taken during the winter months. One wingless female was collected in February and another in December. Wingless males and females were only collected from June to Sep-

tember, but wingless forms of both sexes were collected in numbers from March through October. They feed upon a variety of small insects which live along the shores and, by accident or otherwise, get onto the surface of the water. Hungerford states, however, that he has come to believe that they are not dependent upon the uncertain fare of terrestial insects caught upon the surface film, but feed upon organisms that dwell below but come to the surface — such as ostracods and like forms.

Remarks: F. B. White described the first species of the genus, *Mesovelia mulsanti,* in 1879 from specimens collected "in the Amazons." From a group of specimens collected from North America, Uhler (1884) described *Mesovelia bisignata* which Champion (1898) synonymized with *Mesovelia mulsanti* White. In 1930, Jaczewski recognized several subspecies of *Mesovelia mulsanti,* which, in addition to having restricted ranges, show distinct differences in the shape of their gonapophyses. The North American subspecies was designated *Mesovelia mulsanti bisignata.*

Family 7. GERRIDAE Amyot & Serville, 1843

Description: The family Gerridae comprises insects of small to medium size, having the body usually narrow, elongate, widest behind pronotum, covered with dense velvety pile. Head horizontal, shorter than pronotum and mesonotum united. Antennae filiform, 4-segmented, inserted on sides of head in front of eyes. Eyes large, rounded, prominent. Ocelli very small and obscure. Thorax varied in form according to degree of wing development. Rostrum short or long, always 4-segmented. Middle and hind legs very long and slender; front legs comparatively short, raptorial. Front coxae distant from middle pair; middle and hind coxae close together. Tarsal claws ante-apical, inserted in a cleft a short distance proximad of apex of last tarsal segment. Tarsi 2-segmented. Apterous, brachypterous, and macropterous forms may occur within same species.

Distribution: Members of the family are world-wide in distribution, except for the polar regions.

Habitat: The Gerridae live upon the surface of quiet waters of ponds and streams and glide gracefully over the surface film in search of food. When disturbed, they move very rapidly by using their middle pair of legs like oars.

Remarks: The nymphs can be distinguished from the adults by the 1-segmented tarsi.

Hungerford & Matsuda (1960) and Matsuda (1960) have divided this family into 5 subfamilies, 4 of them having species represented in Virginia. Inasmuch as the characters utilized to distinguish these groups are highly technical as well as subtle, it seems best to retain the traditional arrangement followed by Blatchley (1926) and others, which provides adequate generic identification.

KEY TO SUBFAMILIES OF GERRIDAE

1. Inner margins of eyes concave or emarginate; body comparatively long and narrow; abdomen usually longer than thorax ---------- Gerrinae, p. 47
   Inner margins of eyes convexly rounded; body short and broad; abdomen usually very short ---------- Halobatinae, p. 67

Subfamily GERRINAE Amyot & Serville, 1843

Description: Small to large elongate "water-striders" with sides subparallel; abdomen usually elongate. Eyes concavely rounded on inner margins. Apterous, brachypterous, and macropterous forms present. General color brown to black, frequently marked with brilliant silvery pubescence.

Distribution: Members of the subfamily Gerrinae are known from all parts of the world.

Habitat: Same as that of the family.

Key to Virginia Genera of Gerrinae

1. Dorsal surface of head and pronotum sericeous, dull; first and second tarsal segment of front leg subequal in length ---------- *Gerris*, p. 47
   Dorsal surface of head and pronotum glabrous, shiny; first tarsal segment of front leg short, about half as long as second ---------- *Limnogonus*, p. 65

Genus *GERRIS* Fabricius, 1794

Description: Pronotum dull, fused with mesonotum in apterous form. Antennae moderately long, rarely reaching beyond caudal margin of pronotum. Tarsi of front legs subequal in length; femora of middle and hind legs extending slightly beyond tip of abdomen.

Distribution: The genus *Gerris* has been recorded as present on every continent.

Habitat: The members of this genus inhabit the quiet waters of pools, ponds, and streams, where they are to be seen resting in the shade of over-hanging vegetation or "skating" over the water surface.

Remarks: The nymphs of all of the Virginia representatives of this genus are similar to those of *marginatus* and *canaliculatus* (Fig. 8 & 9), except for size and coloration.

Key to Virginia Species of *Gerris*

1.	Body length 12 mm. or more	2
	Body length 8 to 11 mm.	7
2.	Males (fig. 6a-j)	3
	Females (fig. 7a, c)	5
3.	Caudoventral margin of sixth abdominal segment doubly emarginate at apex, the secondary emargination forming a more or less distinct notch at middle; connexival spines short (Fig. 6d)	
		remigis, p. 52
	Caudoventral margin of sixth abdominal segment simply emarginate at apex; connexival spines very long, reaching to or slightly beyond middle of last genital segment	4
4.	Venter of sixth abdominal segment with prominent, deep, broad, depressed median furrow (Fig. 6c; first antennal segment subequal to 2 and 3 united	
		nebularis, p. 54
	Venter of sixth abdominal segment without distinct median depression (Fig. 6b; first antennal segment longer than 2 and 3 united	*conformis*, p. 50
5(2).	Antennal segment 1 subequal to 2 and 3 united	6
	Antennal segment 1 distinctly longer than 2 and 3 united	*conformis*, p. 50
6.	Connexival spines long, slender, curved mesodorsad, and as long as genital segments	*nebularis*, p. 54
	Connexival spines short, only as long as first genital segment	*remigis*, p. 52
7(1).	Males (fig. 6a-j)	8
	Females (fig. 7a, c)	13

8. Caudoventral margin of sixth abdominal segment simply emarginate at apex; connexival spines very long, reaching to or slightly beyond middle of last genital segment (Fig. 6e) ---------- *canaliculatus*, p. 59

Caudoventral margin of sixth abdominal segment doubly emarginate at apex, the secondary emargination forming a more or less distinct notch in middle; connexival spines much shorter ---------- 9

9 Venter of first genital segment with a distinct tuft of long conspicuous hairs on each side of median ridge (Fig. 6f) ---------- *comatus*, p. 58

Venter of first genital segment without a distinct tuft of long hair ---------- 10

0. Anterolateral margins of pronotum with a dusty yellow or silvery stripe ---------- *argenticollis*, p. 57

Anterolateral margins of pronotum without a stripe-- 11

1. Omphalium strongly produced, prominent -- *alacris*, p. 65

Omphalium not prominent (Fig. 6g) ---------- 12

2. Venter of first genital segment strongly impressed on each side of median ridge (Fig. 6i) ---------- ---------- *marginatus*, p. 55

Venter of first genital segment plump, scarcely impressed on each side of median ridge (Fig. 6 j) -- ---------- *insperatus*, p. 56

3(7). Anterolateral margins of pronotum with a dusky yellow or silvery stripe ---------- 14

Anterolateral margins without a stripe ---------- 15

4. Anterolateral stripe reaching basal margin of pronotum ---------- *argenticollis*, p. 57

Anterolateral stripe not reaching basal margin of pronotum ---------- *canaliculatus*, p. 59

5. Connexival spines strongly incurved, their tips clothed with short stiff hairs ---------- *comatus*, p. 58

Connexival spines not strongly incurved ---------- 16

6. Connexival spines moderately thick, reaching to apex of first genital segment ---------- *marginatus* †, p. 55

Connexival spines thick, not reaching to apex of first genital segment ---------- 17

7. Venter of genital segments yellowish -- *insperatus* †, p. 56

Venter of genital segments dark ---------- *alacris* † p. 65

† Females so similar that it is difficult to separate them.

GERRIS CONFORMIS **(Uhler)** (Fig. 6b)

Hygrotrechus conformis Uhler, 1878; *Gerris conformis*, Drake, 1915; Drake & Harris, 1928, 1934; Deay & Gould, 1936b.

Description: Color dark brownish-black with yellowish pubescence along sides of thorax. Antennae dark; segment 1 distinctly longer than 2 and 3 united; 2 and 4 subequal, 3 slightly shorter than 2. Connexiva margined with brown, the terminal spines very long, black. Hemelytra brownish-black, entire, reaching sixth abdominal segment. Caudoventral margin of sixth abdominal segment of male with simple broad emargination (Fig. 6b). Length 15.0 to 16.5 mm.

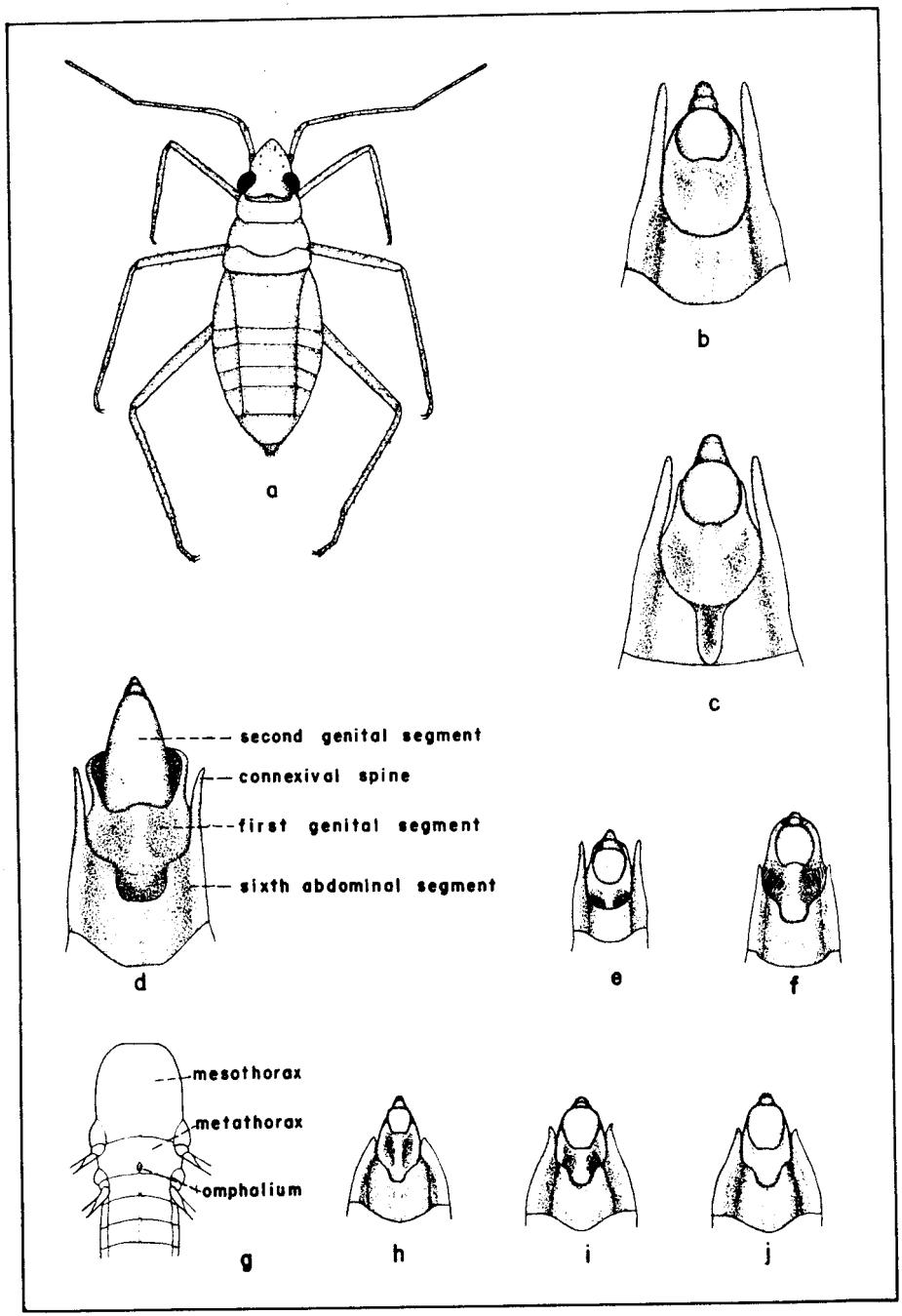
Distribution: This species has been recorded from the following states: Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Wisconsin, Ohio, and Michigan.

Gerris conformis has been recorded from Virginia by Drake & Harris (1934), but no specific locality was mentioned.

I have a large number of adults and nymphs in my collection from counties in each physiographic province of Virginia.

Figure 6.

a. Adult female of *Mesovelia mulsanti bisignata* Uhler
b. Caudoventral abdominal segments of male of *Gerris conformis* (Uhler)
c. Caudoventral abdominal segments of male of *Gerris nebularis* Drake and Hottes
d. Caudoventral abdominal segments of male of *Gerris regimis* Say
e. Caudoventral abdominal segments of male of *Gerris canaliculatus* Say
f. Caudoventral abdominal segments of male of *Gerris comatus* Drake and Hottes
g. Ventral surface of thorax of *Gerris marginatus* Say showing location of omphalium
h. Caudoventral abdominal segments of male of *Gerris argenticollis* Parshley
i. Caudoventral abdominal segments of male of *Gerris marginatus* Say
j. Caudoventral abdominal segments of male of *Gerris insperatus* Say


a
b
c
second genital segment
connexival spine
first genital segment
sixth abdominal segment
d
e
f
mesothorax
metathorax
ompholium
g
h
i
j

Habitat: *Gerris conformis* lives upon the surface of quiet waters of rivers and streams, where they are found resting in the shade near the banks or rowing slowly over the surface in jerky movements.

Biology: Life history notes on this species have been published by Drake (1915). He stated that mating occurs early in the spring, and the eggs are deposited on "material" just beneath the surface of the water. They are fastened there by means of a viscous, waterproof substance. The egg stage lasts 11 days, and one adult developed from egg to adult in 34 days. Drake & Harris (1934) stated that they have never found apterous or brachypterous forms, although they have one specimen from Louisiana. Only macropterous forms have been collected in Virginia. Adult males and females have been collected from April through August, and nymphs during the period May through August. The seasonal collecting data are peculiar in that no adults have been collected from September through March, even though numerous collections have been made during the period. As will be seen later, many specimens of a closely related species, *Gerris remigis*, have been taken during the fall and winter months from under leaves and trash along the shores of streams, and it was expected that *Gerris conformis* would also be encountered, but this was not the case. I can give no explanation why *G. conformis* was not found in hibernation as expected.

Remarks: This species has been taken in association with the following species in the family Gerridae: *Gerris remigis, G. insperatus, G. marginatus, G. argenticollis, G. canaliculatus, Trepobates inermis,* and *Metrobates hesperius.*

GERRIS REMIGIS Say (Fig. 6d)

Gerris remigis Say, 1832; Torre-Bueno, 1917c; Riley, 1912, 1922b; Drake & Harris, 1934; Deay & Gould, 1936b.

Description: Color reddish-brown to brownish-black. Antennae brownish-black; segment 1 subequal in length to 2 and 3 united; 3 subequal to 2 and a little shorter than 4. Connexival spines moderately short, not reaching tip of last genital segment. Caudoventral margin of sixth abdominal segment of male doubly emarginate, the secondary emargination deeply and roundly excavated (Fig. 6d). Both apterous and macropterous forms are present in the same localities. Length 11.5 to 16.0 mm.

Distribution: This is the most widely distributed species of the larger Gerridae in North America, having been recorded from every state in the United States, and from Canada, Mexico, and Guatamala.

It has previously been recorded from Virginia by Drake & Harris (1934), but no specific records were listed.

I have collected more than 500 adults and nymphs from many counties of each physiographic province of Virginia, with the exception of the Coastal Plain. Specimens from this Province are in the collection of Dr. James F. Matta, Old Dominion University, Norfolk.

Habitat: This species is found upon the surface of quiet waters of streams and pools and occasionally upon the water of ponds. On the quiet waters of shaded streams they sometimes occur in groups of 25 or more, but usually, they congregate in smaller numbers.

Biology: Torre-Bueno (1917c) has published the life history of this species. He stated that adults are numerous from the earliest days of spring until the cloudy days of autumn, and may begin breeding as early as February. I have observed mating in early April and copulation is seemingly continuous all summer. The eggs are attached by means of a colorless glue to the edges of grasses and other vegetation growing in the water, and measure 1.6 mm. long and 0.5 mm. wide. Torre-Bueno gave the following account of the life cycle: When the embryo is fully mature, the egg shell slits instead of opening though a cap, as do most hemipterous eggs. The egg stage lasts 1 to 12 days, the first instar 6 days, the second instar 6 days, the third instar 5 days, the fourth instar 7 days, and the fifth instar 10 days. Thus, the complete life cycle is passed in from 41 to 46 days. Nymphs are present from May to October, and there may be three generations per year. In Virginia nymphs have been collected from May to December, and the seasonal data indicate that three generations may be involved. Wingless adults have been collected during each month of the year, and winged females have been collected during June and September. The adults hibernate along the banks of streams under logs, stones, and other debris.

Remarks: The front pair of legs is short and adapted for holding prey. The middle pair of legs is used only for rowing or propelling the insect over the surface of the water, and the tarsi are in contact with the water along their whole length. The hind pair of legs is used only in steering, both tibia and tarsi lying on the surface.

Within the family Gerridae, *Gerris remigis* has been taken in association with *G. conformis, G. marginatus, G. insperatus, G. canaliculatus, G. argenticollis, G. nebularis, Metrobates hesperius, Trepobates inermis,* and *T. pictus.*

GERRIS NEBULARIS **Drake & Hottes** (Fig. 6c)

Gerris nebularis Drake & Hottes, 1925; Drake & Harris, 1928, 1934; Deay & Gould, 1936b.

Description: Color brownish-black, antennae dark; segment 1 equal to 2 and 3 united, shorter than in *conformis.* Hemelytra often abbreviated, not extending beyond middle of third abdominal segment. Connexival spines moderately long, reaching a little beyond first genital segment. Sixth ventral segment with a broad, deep median furrow. Ventral side of first genital segment with broad high keel along its entire length, the areas to each side of keel strongly impressed (Fig. 6c). Length 14.0 to 16.0 mm.

Distribution: This species has been recorded from New York, New Jersey, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, Arkansas, Kansas, Indiana, Illinois, Ohio, Missouri, Iowa, and Nebraska.

Gerris nebularis has not previously been reported from Virginia. I have only two specimens in my collection from Virginia, both of which are males with short wings. They were collected from James City County, side pool of river 6.5 mi. E. of Chickahominy River on St. Hwy. 5; Middlesex County, Dragon Run 15.6 mi. N. of Gloucester Court House. However, there are 44 specimens of this species in the Old Dominion University collection from Henrico, Greenville, and Nansemond counties, and from the cities of Richmond, Hampton, Virginia Beach, and Chesapeake. In addition, I have 1 male with long wings and 3 males and 3 females with abbreviated wings from Murphreesboro, Hertford County, North Carolina, collected August 30, 1949 (H. H. Hobbs, Jr.).

Habitat: This species has been taken from a small stream and the backwaters of a river.

Biology: Nothing is known of the life history of *Gerris nebularis.* My two Virginia specimens were collected during the month of June, and the North Carolina specimens were collected in August.

Remarks: *Gerris nebularis* has been taken in association with the following members of the family Gerridae: *G. remigis* and *G. argenticollis.*

GERRIS MARGINATUS Say (Figs. 6g & i, 7c & d, 9a-e)

Gerris marginatus Say, 1832; Torre-Bueno, 1917b; Hungerford, 1919; Riley, 1922a, 1922b; Drake & Harris, 1934; Deay & Gould, 1936b.

Description: Body moderately robust, black or brownish-black; body and veins of wings with yellowish pubescence. Antennae moderately short, segment 1 subequal in length to 2 and 3 united, scarcely longer than 4. Hemelytra usually present, usually reaching to tip of abdomen, but may be abbreviated. Pronotum without a lateral stripe. Caudoventral margin of sixth abdominal segment of male with a deep, rounded notch in middle. Ventral surface of first genital segment with a distinct median ridge, strongly impressed on each side (Fig. 6i). Length 8 to 11 mm.

Distribution: This is the most widely distributed member of the genus in the Americas, having been recorded from every state in the United States, from Canada, Mexico and Brazil.

It has previously been recorded from "Virginia" (Hungerford 1919; Drake & Harris 1934). I have collected a large number of adults and nymphs from more than half the counties in Virginia, and it occurs in all physiographic provinces.

Habitat: *Gerris marginatus* is primarily a pond species, but has been taken on the surface of slow-flowing streams, muddy pools, swamps, borrow pits, backwaters of rivers, and drainage ditches.

Biology: Torre-Bueno (1917b) has given excellent descriptions of the immature stages of *Gerris marginatus*, but his remarks on the total life history are brief. Drake & Harris (1934) stated that "the literature pertaining to this species is much involved, for until quite recently *incognitus, comatus, incurvatus, alacris, pingreensis, insperatus,* and perhaps one or two other distinct forms have been confused in collections, and included in scientific papers under the name *marginatus.* It is also impossible to accredit the ppaers on ecology and life history entirely to *marginatus* as observations, in most cases, were based on two, three or more species." This is probably true of Torre-Bueno's paper since all of the species listed by Drake and Harris have been described since the publication of his paper on *marginatus.* Life history notes from Torre-Bueno are given, however, since all of these species probably have similar life cycles. Torre-Bueno stated that the adults begin to oviposit early in the spring and attach the cylindrical eggs to floating objects in the water. The eggs were said to measure 3 mm. long and 1 mm.

wide (I find them to be 1.0 mm. long and 0.3 mm. wide) and hatch in 10 days to 2 weeks in the spring, but within 8 or 9 days during the summer. There are 5 nymphal instars, the first lasting 3 to 5 days, the second 3 to 5 days, the third 3 to 6 days, the fourth 3 to 5 days, and the fifth 5 to 7 days. The period from egg to adult lasts 33 or 34 days, which would allow for 3 broods each summer. *Gerris marginatus* hibernates during the winter as an adult under debris along the banks of ponds and other aquatic situations. The adults are strong fliers.

The majority of my females were identified by Dr. Carl J. Drake, Iowa State College, Ames, since I was not able to separate the females from those of *Gerris insperatus*. Neither was I able to distinguish the nymphs of *Gerris marginatus* from *G. insperatus* and *G. argenticollis*, thus the seasonal data for the immature stages include all three species. Micropterous males and females were collected from March through October. Brachypterus females were collected from June through August, and one brachypterus male was collected in June. Large numbers of nymphs were collected from May through August.

Remarks: This species has been taken in association with the following members of the family Gerridae: *Gerris conformis, G. remigis, G. insperatus, G. argenticollis, G. canaliculatus, Trepobates inermis, T. pictus, Limnogonus hesione,* and *Rheumatobates rileyi.*

GERRIS INSPERATUS Drake & Hottes (Fig. 6j)

Gerris insperatus Drake & Hottes, 1925; Drake & Harris, 1934; Deay & Gould, 1936b; Kuitert, 1942.

Description: Size, form, and markings similar to *G. marginatus*. Ventral surface of first genital segment of male very short, plump, very faintly impressed on each side, without a distinct median ridge (Fig. 6j). Length 7.4 to 8.6 mm.

Distribution: Drake & Harris (1934) stated that *G. insperatus* ranges throughout the eastern portion of North America, from Quebec and Ontario, west to Colorado and south into Mexico.

This species has previously been recorded from Warrenton, Fauquier County, (Kuitert, 1942), and Vienna, Fairfax County, Virginia, (Drake & Hottes, 1925). I have collected a large number of adults and nymphs from more than half the counties in Virginia, and this species occurs in all physiographic provinces.

Habitat: This species inhabits the same situations as *G. marginatus*, but in addition, has frequently been taken on the waters of very stagnant pools and swamp puddles where *marginatus* was absent.

Biology: No life history studies have been recorded for this species, but as stated under *G. marginatus* the species was probably included in studies on *marginatus*. Drake & Harris (1934) stated that apterous and brachypterous forms are unknown, but I have collected 5 brachypterous individuals. Two males and 2 females were collected in June, and 1 female in July. The seasonal data show macropterous adults present from March through October.

Remarks: The adults of this species have been taken in association with the following members of the family Gerridae: *Gerris conformis, G. remigis, G. marginatus, G. argenticollis*, and *G. canaliculatus*.

GERRIS ARGENTICOLLIS **Parshley** (Fig. 6h)

Gerris argenticollis Parshley, 1916; Drake & Harris, 1934; Deay & Gould, 1936b.

Description: Elongated, brownish-black forms. Antennal segments 2 and 3 subequal in length, together about as long as 1 and slightly longer than 4. Hemelytra sometimes abbreviated, whitish between the nervures on the inner margin at base. Pronotum with median and anterolateral stripes yellowish, the latter clothed with silvery pubescence. Venter with distinct median carina. Ventral surface of first genital segment longer than broad, feebly depressed on each side of narrow median ridge (Fig. 6h). Length 7.0 to 8.5 mm.

Distribution: This species ranges from Massachusetts west to Michigan, Indiana, and Illinois, and south into North Carolina and Louisiana.

This species has not previously been reported from Virginia. The 73 adults in my collection from Virginia have been taken in the counties of Albemarle, Buckingham, Chesterfield, Charlotte, Dinwiddie, Gloucester, Hanover, Henrico, Isle of Wight, Middlesex, Nansemond, New Kent, Southampton, Wise, and Wythe, and in the cities of Roanoke, City of Chesapeake, and City of Virginia Beach.

Habitat: *Gerris argenticollis* inhabits ponds, slow-flowing streams, swamps, stagnant pools, roadside ditches, and the backwaters of rivers.

Biology: The life history of this species is not known. It probably over-winters as an adult, since adults have been collected in

April. Macropterous adults have been collected from April through July, and a brachypterous male was collected in July.

Remarks: *Gerris argenticollis* has been taken in association with the following members of the family Gerridae: *G. conformis, G. remigis, G. marginatus, G. insperatus, G. nebularis, Trepobates pictus,* and *Rheumatobates rileyi.*

GERRIS COMATUS Drake & Hottes (Fig. 6f)

Gerris comatus Drake & Hottes, 1925; Drake & Harris, 1934; Deay & Gould, 1936b.

Description: Size, color, and general appearance similiar to *G. marginatus.* Antennal segment 1 subequal in length to 2 and 3 united; 4 slightly shorter than 1. Ventral surface of first genital segment of male with tufts of long pale hairs in the depressed area on each side of median ridge (Fig. 6f). Connexival spines of female strongly incurved and clothed at tips with short, stiff hairs. Length 7.35 to 9.2 mm.

Distribution: This species has been recorded from New York, New Jersey, Pennsylvania, Maryland, Ohio, Illinois, Indiana, Michigan, Minnesota, Iowa, South Dakota, Colorado, Nebraska, Kansas, Missouri, and Ontario. I have collected this species from the following Virginia localities: Giles County, bay off New River at Narrows; Page County, stream in Luray; Patrick County, pond on St. Hwy. 8, just south of Woolwine; Smyth County, pond on St. Hwy. 16 north of Marion; Tazewell County, Gose Millpond at Burkes Garden.

Habitat: My specimens were taken from wide, swift streams with sparse over-hanging vegetation, from a lake above a dam, in a river, and from man-made ponds.

Biology: The life cycle of *Gerris comatus* is not known. Drake & Harris (1934) and Deay & Gould (1936b) stated that apterous, macropterous, and brachypterous forms are frequently taken in the same pond or stream. All of my females are macropterous, but several of the males are brachypterous.

Remarks: In Virginia this species has been taken in association with the following members of the family Gerridae: *G. insperatus G. remigis,* and *Rheumatobates palosi.*

GERRIS CANALICULATUS Say (Fig. 6e, 7a & b, 8a-e)

Gerris canaliculatus Say, 1832; Torre-Bueno, 1911; Drake & Harris, 1934; Deay & Gould, 1936b; Penn & Goldsmith, 1950; Bobb 1951a.

Description: Body slender, elongated; color varying from reddish-brown to brownish-black. Pronotum extending over mesonotum in apterous form, with median longitudinally carina in both apterous and macropterous individuals; anterior lobe of pronotum with brownish-red median line; anterolateral stripe not reaching cephalic margin. Antennae brownish, segment 1 shorter than 2 and 3 united, 2 slightly longer than 3, 4 sub-equal to 1 in length. Legs brown, long and slender. Tarsi 2-segmented. Caudoventral margin of sixth abdominal segment of male broadly rounded, without a median notch. Connexival spines long, slender, reaching to tip of first genital segment (Fig. 6e). Length 8.5 to 11.6 mm.

Distribution: This species is widely distributed, having been recorded from most states in Eastern U.S. as far west as Iowa and Texas. It has previously been reported from Virginia (Kuitert 1942), but no specific locality was mentioned. I have approximately 400 adults and nymphs of *Gerris canaliculatus* in my collection from the counties of Albemarle, Alleghany, Appomattox, Charles City, Charlotte, Chesterfield, Dinwiddie, Gloucester, Isle of Wight, Nelson, Northumberland, Scott, Southampton, and from the City of Chesapeake.

Habitat: This species has been collected most frequently from ponds, but has occasionally been collected from swamps, roadside ditches, slow-flowing streams, and stagnant pools. *G. canaliculatus* is found on the surface of the water among the vegetation near the shores, or in the shade of over-hanging branches of trees along the banks. When disturbed it quickly rows out into the deeper parts of the pond, but not being content to remain there, it soon returns to the shallower waters near the banks.

Biology: At the time my studies (Bobb 1951a) of the life history of *Gerris canaliculatus* were made no published data were available for this species. Penn & Goldsmith (1950) published a brief life history of *G. canaliculatus* in Louisiana, but did not mention the number of generations per year. They stated that the life cycle from egg-laying to emergence of the adults average 28.9 days (the same cycle in Virginia averaged 45.1 days), and that the eggs "were considerably smaller than those described for other species." My measure-

ments of eggs of *marginatus*, *insperatus*, and *canaliculatus* were almost identical. The measurements given by Torre-Bueno (1971b) for eggs of *marginatus* were undoubtedly misprinted and should have been 1.0 mm. long and 0.3 mm. wide, which is identical with the measurements given by Penn & Goldsmith for *canaliculatus*. The measurements given for the nymphal stages were generally slightly smaller than those of my specimens, but notes on the life history were very similar to mine.

I reared 11 specimens of this species, from egg to adult, in a large aquarium with considerable difficulty. The adults are difficult to keep in captivity since they get frightened and dash madly against the sides of the aquarium in an effort to escape, and thus become waterlogged and drown. I have not been able to keep adults for more than a week, but the nymphs, especially the younger ones, are not so excitable, and they have been reared in small numbers.

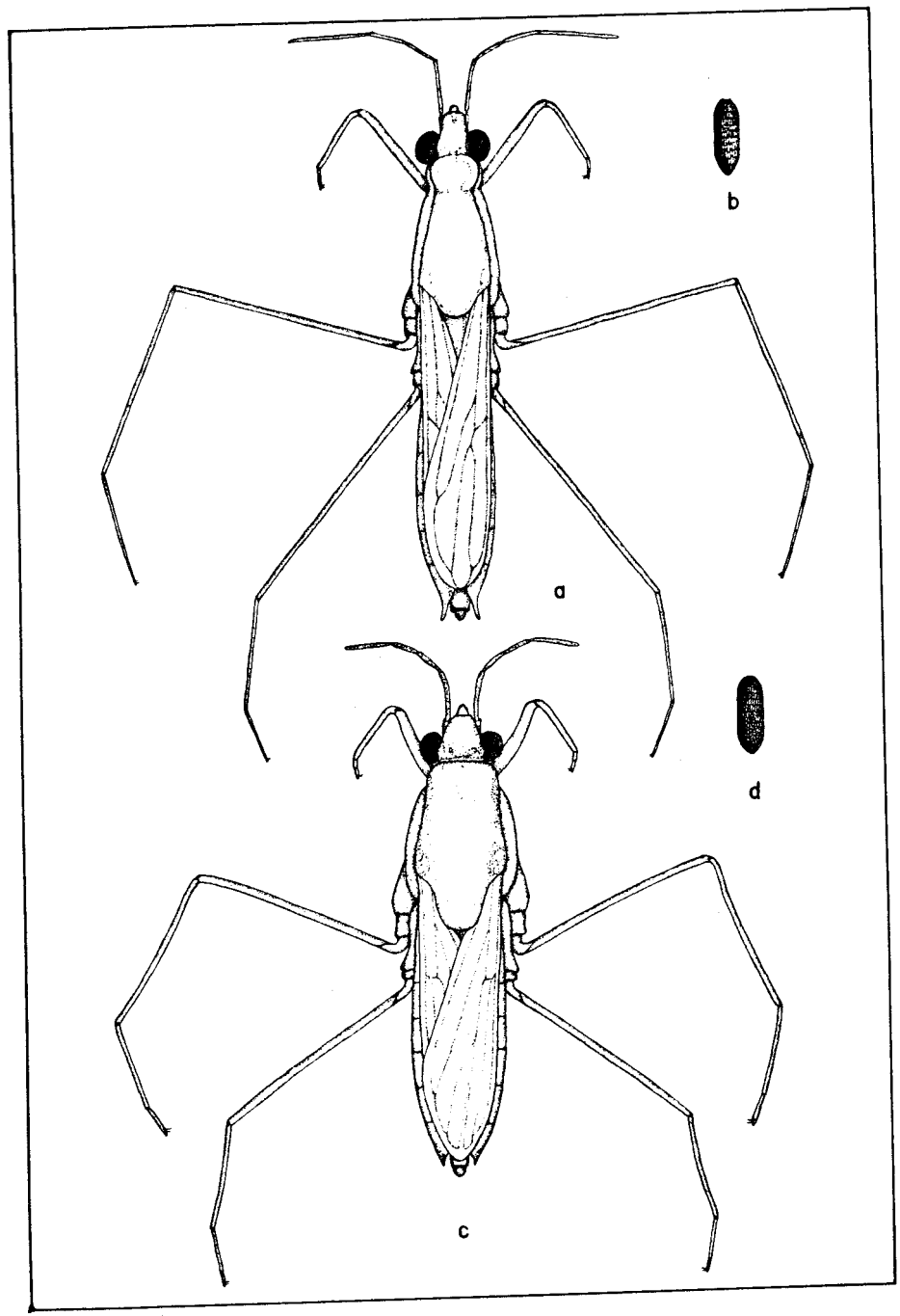
The following time was required for the various life stages: egg 8 to 13 days (avg. 11.1), first instar 5 to 7 days (avg. 6.1), second instar 5 to 7 days (avg. 5.9), third instar 4 to 8 days avg. 6.1), fourth instar 4 to 8 days (avg. 6.7), and fifth instar 7 to 11 days (avg. 9.2). The total life cycle from egg to adult in aquarium studies ranged from 40 to 50 days and averaged 45.1.

Penn & Goldsmith (1950) stated that the life cycle from egg-laying to emergence of adults was completed in an average of 27 to 28 days in aquaria kept outside of buildings in New Orleans. The monthly seasonal data on field-collected specimens in Virginia seem to indicate that breeding is continuous from May through September, with no significant distinct broods. However, when the monthly totals are divided into 10-day intervals and plotted, there is an indication that there are 3 generations per year.

Dissection of numerous adult females of several species of *Gerris* during the spring and summer indicated that *Gerris canaliculatus* was considerably less prolific than *G. marginatus* and *G. insperatus*. The ovaries of the latter species were usually filled with eggs, but this was never true of *G. canaliculatus*. The dissections also showed that the overwintering females of *G. canaliculatus* were spent

Figure 7.

a. Adult female of *Gerris canaliculatus* Say
b. Egg of *Gerris canaliculatus* Say
c. Adult female of *Gerris marginatus* Say
d. Egg of *Gerris marginatus* Say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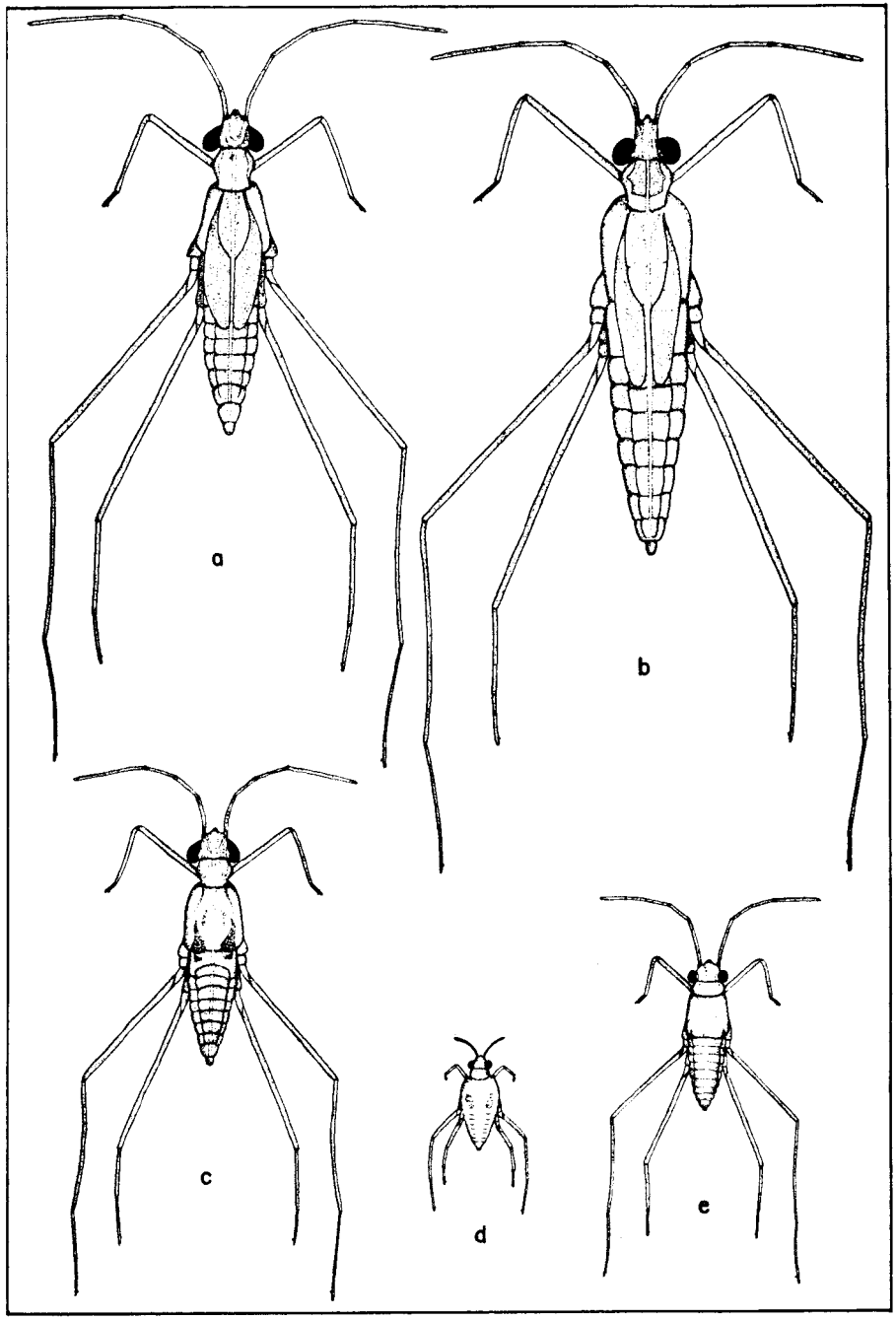
by early June, and they probably died soon thereafter. Both apterous and macropterous forms are present. The seasonal data indicate that very few macropterous individuals are produced during the first generation, but that the ratio to apterous individuals increases greatly during the third generation. The adults hibernate during the winter under logs, rocks, and other debris along the banks of ponds, and occasionally, streams.

Remarks: The nymphs of *G. canaliculatus* may be distinguished from those of all other species by the presence of the dorso-median pale longitudinal line (Fig. 8 a-e). This species has been taken in association with the following members of the family Gerridae: *G. marginatus, G. insperatus, G. remigis, G. conformis, G. argenticollis, Trepobates pictus, T. inermis,* and *Limnogonus hesione.*

Figure 8.

a. Fourth instar nymph of *Gerris canaliculatus* Say
b. Fifth instar nymph of *Gerris canaliculatus* Say
c. Third instar nymph of *Gerris canaliculatus* Say
d. First instar nymph of *Gerris canaliculatus* Say
e. Second instar nymph of *Gerris canaliculatus* Say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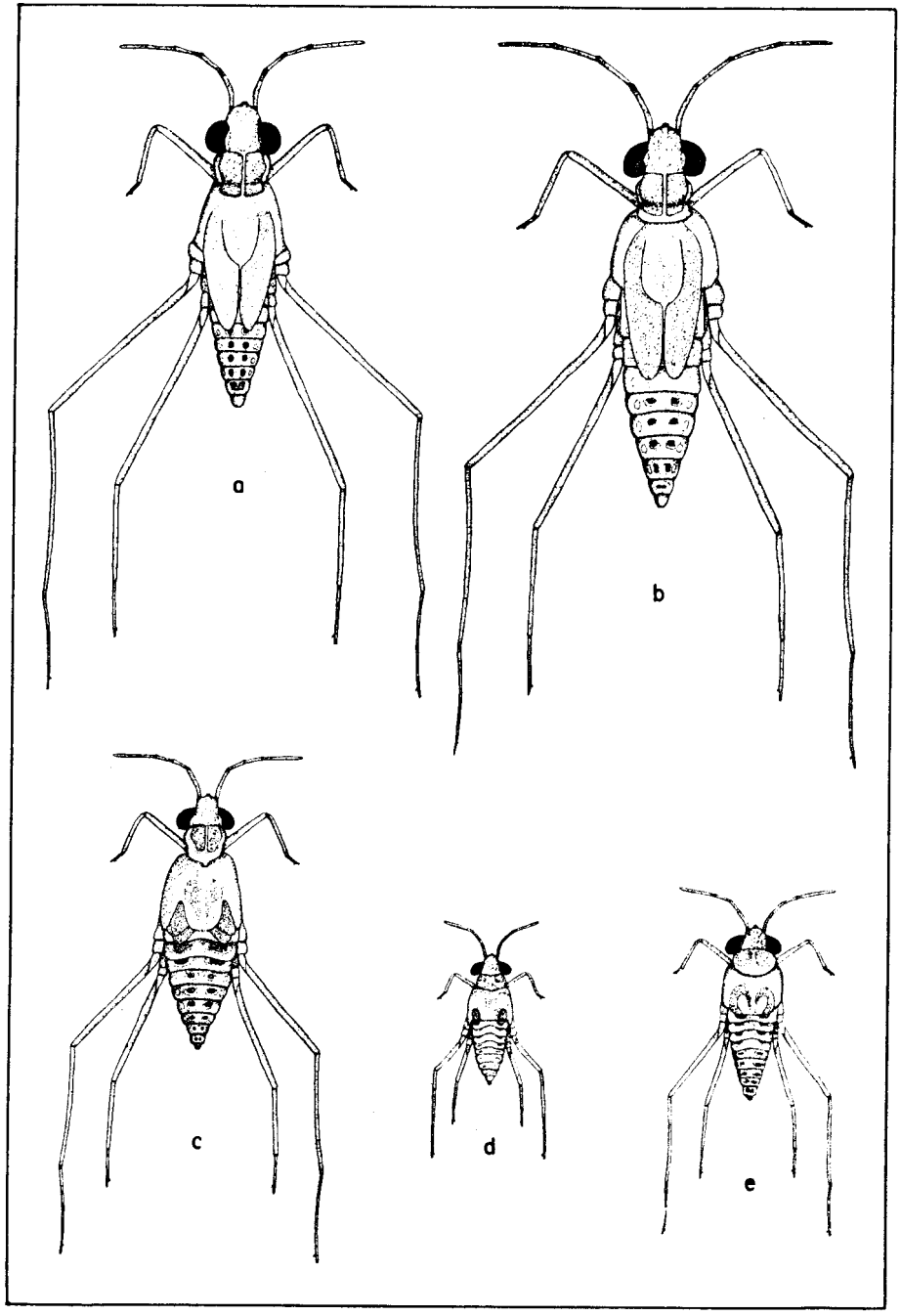
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GERRIS ALACRIS Hussey

Gerris alacris Hussey, 1921; Blatchley, 1926; Drake & Harris, 1934; Deay & Gould, 1936b.

Description: Color, brownish-black; venter usually in part dull yellow. Antennae brown, last two segments darker; segment 1 subsqual in length to 2 and 3 united; 2 and 3 subequal, each one-third shorter than 4. Apterous, brachypterous, and macropterous forms common. Mesosternum of male with extremely large, prominent omphalium. Caudoventral margin of sixth abdominal segment of male with sides of secondary emargination straighter than in *marginatus;* ventral surface of first genital segment short, moderately depressed on each side. Female connexival spines very short, their apices not attaining the middle of first genital segment.

Distribution: This species has been recorded from Maine, New Jersey, District of Columbia, North Carolina, Kansas, Michigan, and Ohio. I have collected the species from Accomac County, roadside creek at intersection of U. S. Hwy. 13 and Co. Hwy. 623; Alleghany County, pond at Griffith (R. L. Hoffman).

Habitat: This species is an inhabitant of quiet waters and has been collected from a pond and a roadside creek.

Genus *LIMNOGONUS* Stal, 1868

Description: Pronotum glabrous, shining, in apterous form, not fused with mesonotum. Antennae very long and slender, only slightly shorter than body. Tarsi of front legs with first segment short,

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Figure 9.

a. Fourth instar nymph of *Gerris marginatus* Say
b. Fifth instar nymph of *Gerris marginatus* Say
c. Third instar nymph of *Gerris marginatus* Say
d. First instar nymph of *Gerris marginatus* Say
e. Second instar nymph of *Gerris marginatus* Say

about half as long as second. Middle and hind legs long, femur extending far beyond tip of abdomen.

Distribution: Species of this genus have been recorded from North, Central, and South America, and from Mexico, and the West Indies. The majority of the species are tropical.

Habitat: The members of this genus inhabit the surface of ponds.

LIMNOGONUS HESIONE (Kirkaldy)

Gerris hesione Kirkaldy, 1902; *Tenagogonus hesione*, Barber, 1914; Hungerford, 1919; Drake & Harris, 1928; *Limnogonus hesione* Osborn & Drake, 1915; Drake & Harris, 1934; Deay & Gould, 1936b; Hrering, 1950.

Description: Black, with a transverse bar on base of head; margin of caudal prolongation of pronotum, and spot on anterior portion of pronotum reddish-yellow. Antennal segment 1 longest, others subequal in length. Apterous form oblong-oval, moderately robust; pronotum short, slightly produced posteriorly in male, strongly so in female, covering anterior portion of mesonotum. Macropterous form with hemelytra brownish-black, reaching considerably beyond tip of abdomen. Length 4.5 mm. to 8 mm.

Distribution: This species has been recorded from most states east of the Rocky Mountains, also from Cuba and Panama.

Limnogonus hesione has previously been recorded from Virginia by Drake & Harris (1934), but no specific localities were mentioned. I have collected males and females of this species in small numbers from the following localities: Albemarle County, pond at Farmington County Club and old quarry in Belmont section of Charlottesville; Appomattox County, pond on U. S. Hwy. 460 at Oxford Furnace Wayside, W. of Appomattox; Alleghany County, pond at Lowmoor (R. L. Hoffman); Lancaster County, pond on St. Hwy. 200, about 15 mi. S. of U. S. Hwy. 360; Lunenburg County, pond on St. Hwy. 40 just S. of Victoria; Russell County, Little Copper Creek, 1.5 mi. N. of Dickerson on U. S. Hwy. 58; Wise County, pond on top of mountain at Rim Rock.

Habitat: This species is an inhabitant of ponds, and prefers sheltered places near shore.

Biology: The life history of *Limnogonus hesione* is little known. I have collected adults during the months of June, August, October, and November, and one nymph in June. All specimens have been taken from the surface of ponds with abundant emergent and over-

hanging vegetation. When approached, they swim very rapidly toward the middle of the pond. Drake (1915) stated that "the winter is probably spent as an egg since no adults could be found in early spring." The life cycle takes about 50 days from hatching of eggs to adults. They feed on small insects that fall onto the water, and do not take food that has been dead for some time.

Remarks: The nymphs of this species can be distinguished from others in the family Gerridae by the shiny, black pronota and mesonota, antennae as long as body, and the very short abdomen from which the middle and hind legs appear to arise. *Limnogonus hesione* has been collected in association with the following members of the family Gerridae: *Gerris canaliculatus* and *Trepobates inermis*.

Subfamily HALOBATINAE Bianchi, 1896

Description: Small "water-striders" with short, broad bodies; abdomen usually very short. Eyes convexly rounded on inner margins. Apterous and macropterous forms present. General color black, frequently marked with yellow.

Distribution: Their distribution is apparently restricted to the Western Hemisphere.

Habitat: The members of this subfamily are found upon the waters of ponds, rivers, and small quiet streams. *Halobates micans* Eschscholtz is known (Blatchley, 1926) to occur in the Atlantic Ocean, along the coast from Florida to North Carolina.

Key to Virginia Genera of Halobatinae

1. Antennal segment 1 subequal in length to other three united, distinctly longer than 2 and 3 ---- *Metrobates*, p. 68
   Antennal segment 1 much shorter than other three united, sometimes shorter than 2 and 3 ---------- 2
2. Abdomen as long as remainder of body, tapering caudally; antennal segment 4 subequal or shorter than 3 ---------- *Rheumatobates*, p 75
   Abdomen much shorter than remainder of body, broadly rounded caudally; antennal segment 4 distinctly longer than 3 ---------- *Trepobates*, p 72

Genus *METROBATES* Uhler, 1871

Description: Body short, robust. Apterous form with head broader across eyes than long, much narrower than mesonotum. Mesonotum very large, not fused with pronotum. Antennal segment 1 subequal in length to other three united, distinctly longer than 2 and 3. Abdomen very short, wider than long.

Distribution: Same as that of family.

Habitat: The species of this genus are found on quiet waters of lakes and in "bayed-out parts" of inland streams (Anderson, 1932).

METROBATES HESPERIUS Uhler (Fig. 10a)

Metrobates hesperius Uhler, 1871; Blatchley, 1926; Anderson, 1932; Deay & Gould, 1936b; Hussey & Herring, 1949.

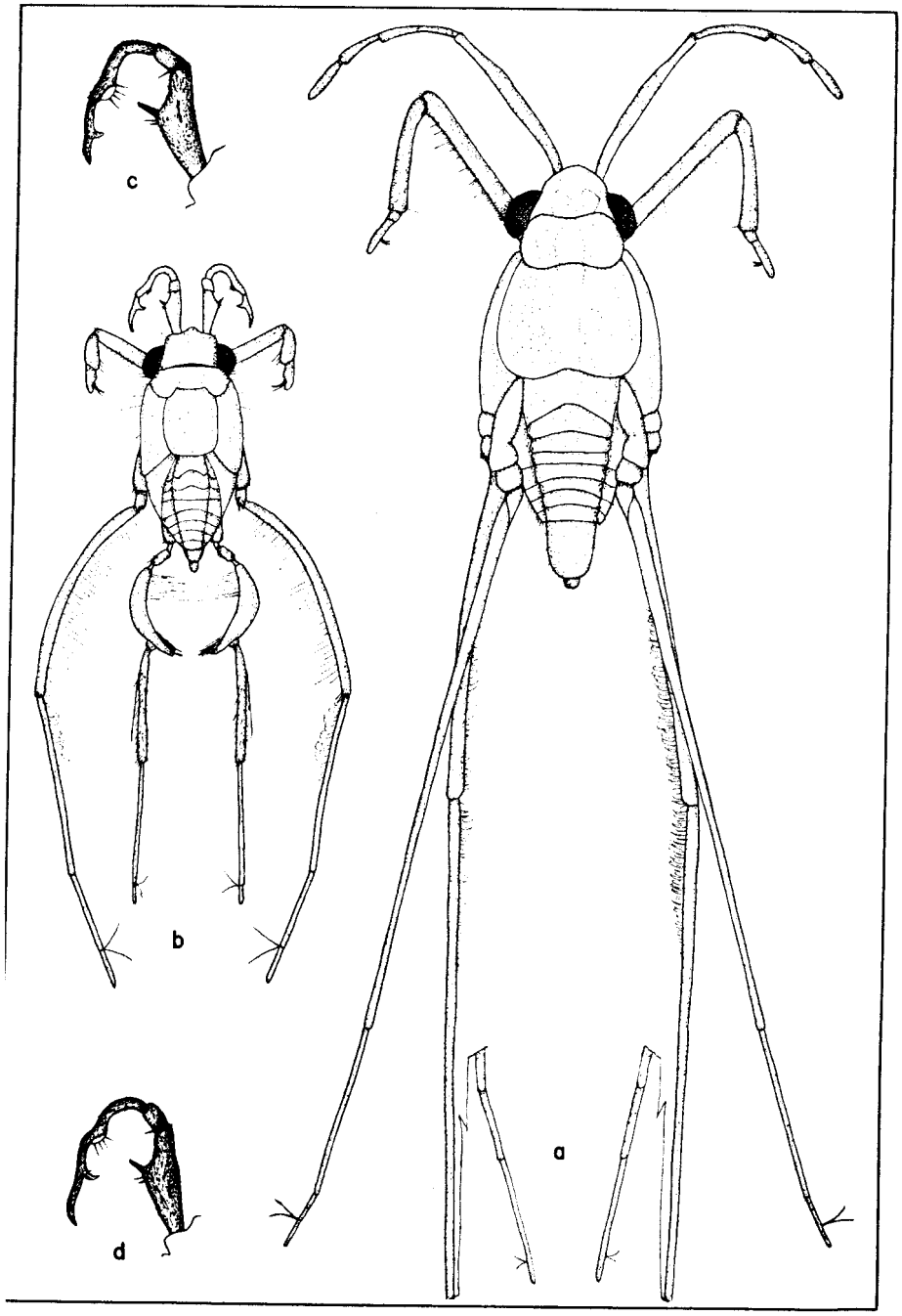
Description: Macropterous form black, clothed with very short velvety pubescence. Base of first antennal segment, 2 spots in interocular space, and median spot in depression on anterior lobe of pronotum reddish-yellow. Pronotum very large. Apterous form black with wide dorsomedian and lateral grayish stripe on pronota and metanota. In both forms, antennae and legs dark brown, coxae yellow. Length of antennae subequal to that of body; segment 1 subequal to other 3 united; segments 1, 2, and 3 enlarged toward apex; 4 fusiform. Abdomen short and blunt in females, narrower with very prominent genital segments in male. Tarsi 2 segmented. Rostrum stout at base, tapering toward apex (Fig. 10a). Length 4 to 5 mm.

Distribution: This species has been recorded from most of the Eastern United States, also from Ontario, but not previously from Virginia. I have collected it in the following counties: Albemarle, Bath, Dickenson, Giles, Goochland, Greene, Halifax, Madison, Nelson, Orange, Patrick, Prince Edward, Scott, and Shenandoah.

Habitat: *Metrobates hesperius* has been collected on the surface of rivers and small streams where they were usually found in schools on the swifter parts.

Figure 10.

a. Adult male of *Metrobates hesperius* Uhler
b. Adult male of *Rheumatobates palosi* Blatchley
c. Antenna of male of *Rheumatobates rileyi* Bergroth
d. Antenna of male of *Rheumatobates palosi* Blatchley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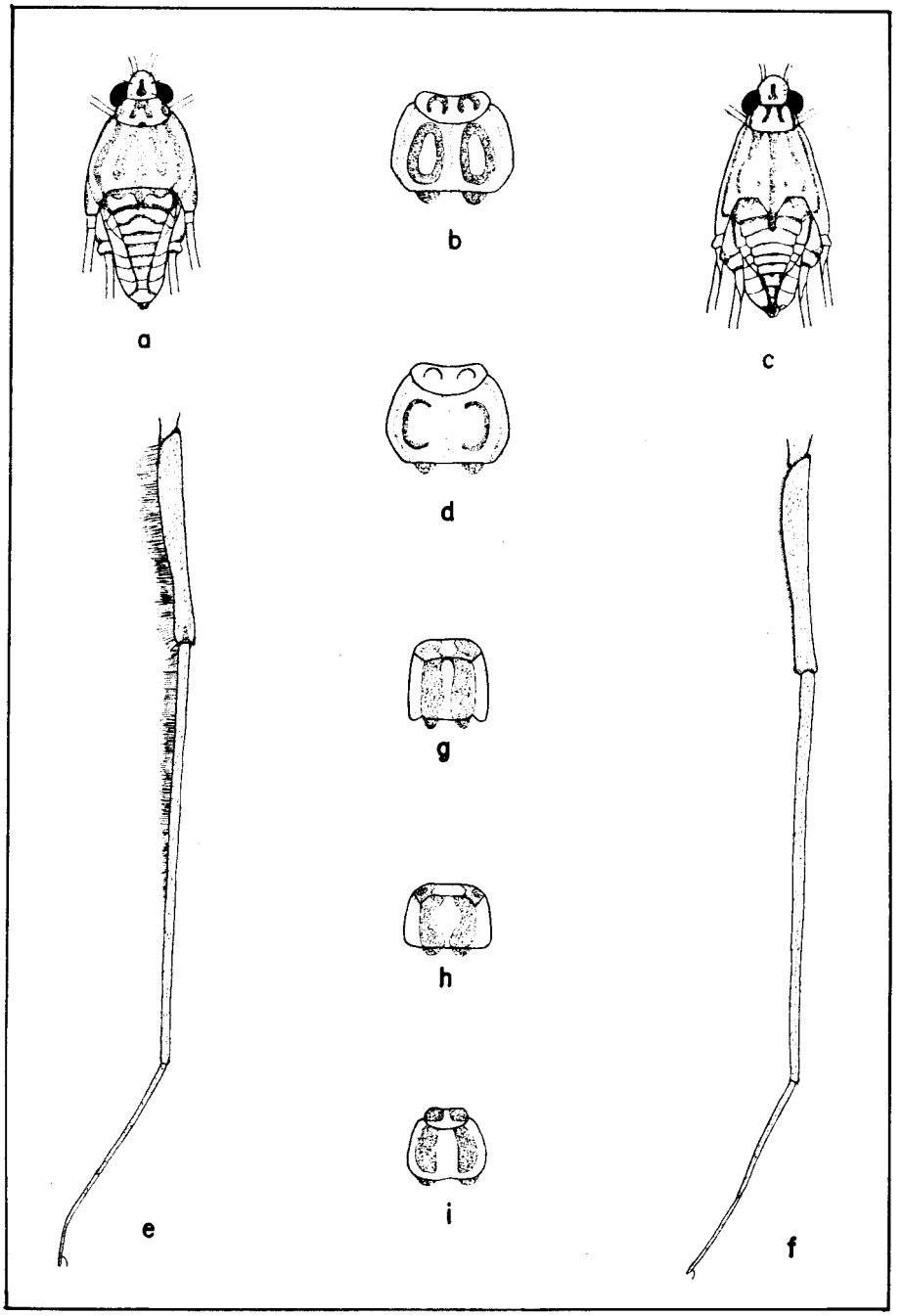
Biology: The life history of this species has not been studied. The adults congregate in groups out in the streams and are extremely swift in their movements. They can leap into the air, and if the collector is not careful, they will jump out of his net before he can catch them. Anderson (1932) stated that members of this species sometimes leap into the air to capture food. I have seen several nymphs in the process of molting; they move onto quiet waters before molting, although the process is very rapid. The old skin splits along the mid-dorsal lines of the head and thorax, the insect emerges by pulling the head back and upwards and then crawling out. All macropterous specimens which have been collected have the hemelytra torn off about midway of the abdomen. The seasonal data indicate that *Metrobates hesperius* spends the winter in the egg or nymphal stages, since nymphs have been collected in June, a month before adults. Apterous adults have been collected from July through October, and macropterous forms during July and August. No nymphs have been collected after late October.

Remarks: The nymphs of *Metrobates hesperius* can be distinguished from all other members of the family Gerridae by the median white spot on the pronotum, a broad median pale longitudinal stripe on mesonotum (lateral of which are oval dark areas) (Fig. 11i), and an oval median white spot on each abdominal segment. This species has been taken in association with the following members of the family Gerridae: *G. conformis, G. remigis, G. marginatus, G. insperatus, G. canaliculatus, Trepobates inermis, T. pictus,* and *Rheumatobates rileyi.*

Figure 11.

a. Adult female of *Trepobates inermis* Esaki
b. Prothorax and mesothorax of third stage nymph of *Trepobates inermis* Esaki
c. Adult female of *Trepobates pictus* (Herrich-Schaeffer)
d. Prothorax and mesothorax of third stage nymph of *Trepobates pictus* (Herrich-Schaeffer)
e. Middle leg of male of *Trepobates inermis* Esaki
f. Middle leg of male of *Trepobates pictus* (Herrich-Schaeffer)
g. Prothorax and mesothorax of fifth stage nymph of *Rheumatobates tenuipes* Meinert
h. Prothorax and mesothorax of fifth stage nymph of *Rheumatobates rileyi* Bergroth
i. Prothorax and mesothorax of second stage nymph of *Metrobates hesperius* Uhler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Genus *TREPOBATES* Uhler, 1894

Description: Stout, robust insects with short head sloping in front. Pronotum in apterous form wider than long, concave at middle, its cephalic and caudal margins truncate. Mesonotum square, about twice as long as pronotum, caudal margin truncate. Antennal segment 4 distinctly longer than 3. Abdomen short and conical, connexiva strongly reflexed.

Distribution: Same as that of subfamily.

Habitat: The species of this genus inhabit ponds, sluggish streams, and the backwaters of rivers. They seem to prefer to remain near the shores.

Key to Virginia Species of *Trepobates*

1. Males (Fig. 11 e, f) ---------- 2
   Females (Fig. 11 a, c) ---------- 3
2. Fringe of hairs on postaxial side of femora and base of tibiae of middle legs as long as diameter of leg at point of origin (Fig. 11e) ---------- *inermis*, p 72
   Fringe of hairs on postaxial side of femora and base of tibiae of middle legs not over half as long as diameter of leg at point of origin (Fig. 11f) ---------- *pictus*, p 74
3. Caudoventral margin of seventh segment of abdomen clothed with long hairs; in apterous forms the caudal margin of mesonotum prolonged caudally into a horn-like process (Fig. 11c) ---------- *pictus*, p. 74
   Caudoventral margin of seventh segment of abdomen without long hairs; mesonotum not prolonged caudally into a horn-like process (Fig. 11a) -- *inermis*, p. 72

TREPOBATES INERMIS Esaki (Fig. 11a, b, e)

Trepobates inermis Esaki, 1926; Drake & Harris, 1932a, 1952; Deay & Gould, 1936b.

Description: Apterous form with highly variable coloration, usually black with yellow markings. Caudal margin of pronotum truncate (Fig. 11a). Basal portion of tibiae and femora of middle legs of male clothed with long hairs, as long as diameter of leg at point

of origin (Fig. 11e) : venter of last genital segment hairy. Caudal margin of last ventral segment of abdomen in female without long hairs; edges of connexiva hairy; base of abdomen with median patch of long hairs. Macropterous form black dorsally. Pronotum produced and broadly triangular; marginal yellow stripe present on caudal margin and often running forward on both sides. Two or 3 yellowish spots on cephalic lobe of pronotum. Hemelytra extend far beyond tip of abdomen. Length 3 to 4 mm.

Distribution: This species has been recorded only from Indiana, but undoubtedly it has been confused with *T. pictus* in most collections, and probably occurs in all the states from which *T. pictus* has been recorded.

I have several hundred specimens of adults and nymphs from the Virginia counties of Albemarle, Appomattox, Augusta, Brunswick, Buchanan, Bland, Dinwiddie, Essex, Frederick, Goochland, Lunenburg, Madison, Mecklenburg, Nelson, Prince Edward, Prince William, Pulaski, Rappahannock, Rockingham, Surry, and from City of Chesapeake and City of Virginia Beach.

Habitat: This species inhabits the surface film of ponds, sluggish streams, and the backwaters of rivers. It is gregarious and usually found in large numbers.

Biology: The life history of *T. inermis* is not known, but since the species is so similar to *T. pictus*, the notes given under the latter might also apply to this species. There are 5 nymphal instars, and my Virginia specimens have the following average measurements: first instar, 0.7mm. long; second instar, 1.2 mm. long; third instar, 1.8 mm. long; fourth instar, 2.5 mm. long; and fifth instar, 3.3 mm. long. The seasonal data indicate that breeding begins in late April or early May, is continuous over a period of several months and might involve two broods. The majority of my individuals were apterous and were collected from May through October. Thirteen macropterous specimens were collected during June. Nymphs were present from May to September.

Remarks: The nymphs of *Trepobates inermis* may be distinguished from those of *T. pictus* by the darker dorsal coloration and by the 2 black oval areas on the mesonotum which have yellow centers (Fig. 11b). This species has been taken in association with the following members of the family Gerridae: *G. remigis, G. conformis, G. marginatus, G. insperatus, G. canaliculatus, Limnogonus hesione, Trepobates pictus, Metrobates hesperius, Rheumatobates rileyi, R. palosi,* and *R. tenuipes.*

TREPOBATES PICTUS **(Herrich-Schaeffer)** (Fig. 11c, d, f)

Halobates pictus Herrich-Schaeffer, 1848; *Trepobates pictus*, Hungerford, 1919; Blatchley, 1926; Deay & Gould, 1936b; Herring, 1950; Drake & Harris, 1952.

Description: Color pattern variable, usually yellow with black markings. Mesonotum of female produced caudally into a horn-like process, very hairy (Fig. 11c). Femur and tibia of middle legs of male clothed with short hairs, never longer than half the diameter of leg at point of origin (Fig. 11f). Genital segments of male without long hairs. Length 3 to 4 mm.

Distribution: This species has been reported from Maine, New Hampshire, Rhode Island, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, Georgia, Florida, Louisiana, Tennessee, Illinois, Kansas, Ohio, Indiana, Michigan, Arizona, Guatemala, and Central America. Formerly, several species were included under this name, and undoubtedly, the distribution records given above are not entirely correct.

This species has been previously recorded from "Virginia" (Hungerford 1919). I have a number of adults and nymphs from Virginia, collected from the counties of Albemarle, Amherst, Appomattox, Augusta, Bath, Charlotte, Dickerson, Fairfax, Fluvanna, Goochland, Loudon, Louisa, Nelson, Page, Prince William, Rappahannock, Rockingham, Scott, Shenandoah, Wise, and from City of Virginia Beach. In addition, I have specimens from Wyoming County, West Virginia.

Habitat: This species is found on the surface of ponds, sluggish streams, and the backwaters of rivers, often in the same "schools" with *T. inermis.*

Biology: Hungerford (1919) stated that the eggs are placed side by side and imbedded in solid masses of yellowish-white, gelatinous material on the underside of leaves and sticks in the water. There are from 3 to 10 eggs in a mass. He stated that eggs laid in the laboratory on June 19 hatched on June 24, an incubation period of 5 days. The egg is elongate oval, with anterior end more pointed; it measures 0.99 mm. long and 0.312 mm. wide. The first instar nymph is 0.676 mm. long and 0.364 mm. wide. Hungerford does not mention the other instars, but my specimens have approximately the same measurements as I have given for *T. inermis.* I have seen the nymphs molt by splitting the old exoskeleton from behind the head, down the dorsomedian line to include the first few abdominal segments. Hungerford stated that, from collection data, apparently the adults hibernate during the winter. All my adults are apterous, but macropterous individuals have been reported (Deay & Gould, 1936b).

Males and females were collected from June to November, and nymphs were observed from June through August.

Remarks: The nymphs of *Trepobates pictus* may be distinguished from those of *T. inermis* by the dominant yellow coloration and by the 2 dark, C-shaped markings on each side of the median line of the mesonotum (Fig. 11d). This species has been collected in association with the following members of the family Gerridae: *G. remigis, G. conformis, G. marginatus, G. insperatus, Trepobates inermis, Metrobates hesperius,* and *Rheumatobates rileyi.*

Genus *RHEUMATOBATES* Bergroth, 1892

Distribution: Small, oblong insects with square heads, large eyes. Apterous forms with pronotum much wider than long; mesonotum subquadrate, 3 or more times longer than pronotum. Macropterous form rare. Antennal segment 4 subequal to 3 in length. Antennae of male curiously modified, the segments curved and armed with stout spines. Tibiae and usually femora of male fringed on inner side with long hairs. Abdomen as long as remainder of body, strongly tapered apically.

Distribution: The species of this genus occur only in the Western Hemisphere.

Habitat: These strange little bugs dwell primarily on the swiftly flowing parts of rivers, backwaters of sluggish streams, standing muddy waters of ponds, and one recently described species (*R. crinitus* Herring, 1949), inhabits only salt waters of coastal marshes.

Remarks: Notwithstanding the revisionary studies of this genus by (Schroeder (1931) and Hungerford (1954), the status of two of the commonest eastern forms remains unsettled. Reference is made to the relationship between the forms *T. rileyi* of Bergroth and its nominal "subspecies" *T. palosi* Blatchley. The latter was originally (1926) proposed as a variety of *T. rileyi,* but accorded subspecific status by Hungerford who noted that the two forms might, following breeding experiments, be regarded as separate species.

The two taxa are largely sympatric in overall distribution but appear to be separated ecologically. Although Drake & Hottes (1951) recorded both from the same localities, Hungerford stated that he had never seen material taken at the same place, nor were the two found associated during my field work in Virginia.

Apparently no one has yet observed intermediates—strong presumptive evidence that interbreeding does not occur under natural conditions. Although *T. rileyi* and *T. palosi* appear to be more closely related to each other than either is to other members of the genus, the males at least can be readily distinguished by a number of characteristics, these characteristics taken along with the sympatric distributions would appear to justify an assumption of specific distinctness. In this paper, *T. palosi* is elevated to specific rank if for no other reason than to compel the attention of other students to a reinvestigation of the matter.

Key to Virginia Species of *Rheumatobates*

1. Hind legs of males normal, femur with very fine short hairs along the entire postaxial surface; mesosternum yellow with the cephalic margin and 2 feebly longitudinal divergent stripes brownish-black; mesonotum black or with a narrow median white line ---------- *tenuipes*, p. 79

   Hind legs of males incrassate, curved, or deformed, femur fringed with long hairs on basal third of postaxial margin; mesosternum wholly yellow; mesonotum with median triangular area of white (Fig. 10b) ---------- 2

2. Spur of terminal antennomere located distad of midlength (Fig. 10c); hind femur of males short and conspicuously arched at its basal third; hind tibia of males very slightly and evenly curved, with a small field of short hairs dorsally near base and a more prominent cluster of setae dorsally near apex; basal tarsal joint only slightly longer than tibia ---------- *rileyi*, p. 77

   Spur of terminal antennomere located proximad to length (Fig. 10d); hind femur of males evenly curved for its entire length; male hind tibia long and slender, bisinuately curved in its basal half, dorsal side with a long fringe of erect hairs but no basal and proximal clusters of setae; basal-tarsal joint much longer than tibia ---------- *palosi*, p. 78

RHEUMATOBATES RILEYI **Bergroth** (Fig. 10c, 11h)

Rheumatobates rileyi Bergroth, 1892; Hungerford, 1919; Blatchley, 1926; Schroeder, 1931; Silvery 1931; Deay & Gould, 1936b; Herring, 1950; Drake & Hottes, 1951; Hungerford, 1954.

Description: Oblong, robust, black insects with venter dusky yellow. Dorsum velvety black; a transverse yellowish-white bar on pronotum at midlength, and similarly colored are a diamond-shaped median spot on mesonotum, a rounded spot above middle coxae, the front femora, and reflexed connexiva. Male with segment 1 of antennae thickened apically, armed beneath at base of apical third with 1 or 2 short spines; segment 2 very short, armed with a slender spine near base; segment 3 strongly curved with shallow spinous fossa at base of apical ⅓; segment 4 with apical part curved, armed beyond middle with a strong tooth (Fig. 10c). Middle femora of male fringed with long straight hairs, middle tibiae with hooked hairs on inner side of basal half; hind femora somewhat swollen, curved to form a circle when held caudad of body, fringed on basal third with row of long hairs, and 2 tufts of hairs at apex. Hind tibiae with a slightly raised spot covered with a dense cluster of hairs. Antennae and legs of female unmodified. Length 2.8 to 3.0 mm.

Distribution: This species has been recorded from New York, New Jersey, District of Columbia, Maryland, North Carolina, Ohio, Illinois, Michigan, Indiana, Iowa, Tennessee, Mississippi, Florida, Vermont, Georgia, and Canada.

Rheumatobates rileyi has not previously been reported from Virginia. I have a total of 37 adults and 41 nymphs in my collection from Virginia. These were collected in the counties of Albemarle, Brunswick, Charlotte, Frederick, Goochland, Madison, Rappahannock, and Shenandoah, and in City of Virginia Beach.

Habitat: This species has been collected from the waters of rivers, small streams, and ponds having submerged and emergent vegetation. They are seldom found in full sun and prefer the shade afforded by the vegetation on the banks.

Biology: Silvery (1931) described the life history of *R. rileyi* in Michigan. He stated that the eggs were deposited in *Potamogeton* leaves floating on the water's surface. The first and second instar nymphs hop along over the water, but the other nymphal stages move smoothly. On damp, cool days the insects congregate near the bank under overhanging branches. Silvery gave the following mea-

surements for the immature stages: egg, 0.68 to 0.74 mm. long and 0.19 to 0.22 mm. wide; first instar, 0.837 to 0.953 mm. long; second instar, 1.023 to 1.113 mm. long; third instar, 1.302 to 1.698 mm. long; fourth instar, 1.581 to 1.907 mm. long; fifth instar, 2.326 to 2.465 mm. long. Each stadium took about 8 days. *Rheumatobates rileyi* feeds on ostracods and immature insects which fall onto the water; cannibalism has not been observed. Silvery also remarked that they feed more actively at night and that mating occurs chiefly at that time. He stated that macropterous forms have not been observed in Michigan. I have found none in Virginia. My seasonal data are too meager to add much to our knowledge of the life history of this species. Adults were collected during July and August; and nymphs, from May through August.

Remarks: Nymphs of this species (and of *R. palosi*) can be distinguished from those of *R. tenuipes* by the transverse median yellowish-white bar on the pronotum and the diamond-shaped white area on the mesonotum (Fig. 11h.) This species has been collected in association with *Gerris conformis, G. remigis, G. argenticollis, Trepobates inermis, T. pictus,* and *Metrobates hesperius.*

RHEUMATOBATES PALOSI **Blatchley, new status** (Fig. 10b & d).

Rheumatobates rileyi var. *palosi* Blatchley, 1926; Schroeder, 1931; Deay & Gould, 1936; Drake & Harris, 1942; Drake & Hottes, 1951; Hungerford, 1954.

Description: This species generally resembles *R. rileyi,* of which it is perhaps a fairly recent derivative, differing in the shape of the ultimate antennal article and the shape and ornamentation of the third pair of legs, as stated in the foregoing key. Females of the 2 species are best identified by association with males. Length about 2.8 mm.

Distribution: Published records for this species indicate that it is common over much of eastern United States, from New York west to Minnesota and Kansas, south to Texas and Florida. Drake & Hottes (1951) stated for the first time that *rileyi* and *palosi* had been found together. *R. palosi* has previously been reported (Hungerford 1954) from Nansemond and Brunswick counties and the present City of Chesapeake. In addition, I have collected it from Northumberland County, pond on U. S. Hwy. 360 about 1.5 mi. E. of Callao; Tazewell County, Gose Millpond at Burkes Garden; City of Virginia Beach, canal on St. Hwy. 165 about 4 mi. W. of Princess Anne Courthouse. With the exception of Tazewell County, all the known Virginia localities are in or near the Coastal Plain.

Habitat: Deay & Gould (1936b) stated that these little insects re found on quiet waters of ponds or backwaters of streams.

Biology: The life cycle of this species remains unknown. My ingle adult male specimen was collected in August.

Remarks: In Virginia, *R. palosi* has been collected only in association with one other gerrid, *Trepobates inermis* (in strong contrast to the numerous gerrid associates of *R. rileyi*).

?*RHEUMATOBATES TENUIPES* Meinert (Fig. 11g)

?*heumatobates tenuipes* Meinert, 1895; Bergroth, 1908; Blatchley, 1926;; chroeder, 1931; Herring, 1950; Drake & Hottes, 1951; Hungerford, 1954.

Description: Form and size of *R. rileyi.* Yellow marking of meso- ıotum narrower than that on pronotum, more nearly a stripe than ı diamond. Mesosternum with cephalic margin and 2 longitudinal tripes blackish-brown. Male with first segment of antennae swollen; hird with basal half strongly curved, the spinose fossa occupying ıbout half the segment and preceded by a slender spine; fourth segnent as long as third, curved at base and apex, armed proximad ›f middle with a strong curved tooth. Hind legs in both sexes ıtraight and hairless. Length 2.8 to 3 mm.

Distribution: This species has been recorded from New York, New Jersey, Maryland, District of Columbia, North Carolina, Georga, Mississippi, Tennessee, Florida and Virginia.

Rheumatobates tenuipes has previously been recorded from Virginia. I have collected the species from the following localities: Richnond County, 4.4 mi. S. of Warsaw on U.S. Hwy. 360; City of Chesapeake, 3.3 mi. E. of Northwest on Co. Hwy. 610; City of Virginia Beach, at Blackwater Bridge on Co. Hwy. 608.

Habitat: This species inhabits swampy areas adjacent to rivers where various swamp reeds and grasses are abundant.

Biology: The life history of *Rheumatobates tenuipes* is not known. All of my specimens were collected in early June, and nymphs were extremely abundant. I did not take any first instar nymphs, but collected 5 second, 16 third, 27 fourth, and 65 fifth instar nymphs. At the time, many thousands were present in the reedy, swamplands along the Rappahannock River in Richmond County.

Remarks: The nymphs of *Rheumatobates tenuipes* may be distinguished from those of *rileyi* by the smaller, roundish, yellowish-white spot on the pronotum and by the yellowish-white dorsomedian strip on the mesonotum. Laterad of the strip is an oval black area ex-

tending onto the metanotum (Fig. 11g). This species has been collected only in association with one species of the family Gerridae, *Trepobates inermis*.

Family 8. VELIIDAE Amyot & Saltville, 1943

Description: Small to medium size insects having short, plump, oblong or oval bodies. Eyes prominent; ocelli absent. Hemelytra present or absent; when present, reaching tip of abdomen. Legs relatively short, the hind femora not or but slightly surpassing tip of abdomen; middle legs equidistant from front and hind legs except in *Rhagovelia*. Antennae 4-segmented. Rostrum 3-segmented. Tarsal segments variable; claws inserted in cleft a short distance proximad of apex of last tarsal segment.

Distribution: The members of this family have been recorded from Africa, Asia, Europe, Australia, North, Central and South America, and the East and West Indies.

Habitat: Some members of the family Veliidae are found wherever there is fresh water: on streams, ponds, springs, marshes — and even on saltwater bays.

Key to Virginia Genera of *Veliidae*

1. Antennal segment 4 longest; front tarsi 2-segmented ---------- *Microvelia*, p. 80
   Antennal segment 1 longest; front tarsi either 1- or 3-segmented ---------- 2
2. Tarsi of middle legs with segment 3 split, the cleft with a tuft of feathery hairs (Fig. 12d); front tarsi 1-segmented—*Rhagovelia*, p. 89
   Tarsi of middle legs not split and without feathery hairs; front tarsi 3-segmented --- *Velia*, p. 92

Genus *MICROVELIA* Westwood, 1834

Description: Very small (less than 3.5 mm.), oblong, rather robust insects, with or without wings. Antennae 4-segmented, apical segment longest. Connexiva elevated. Legs short, apex of femora of hind legs not exceeding tip of abdomen. Macropterous form with pronotum widest near middle; humeral angles prominent; prolonged caudally and obtusely triangular. Hemelytra membranous, reaching tip of abdomen. Front tarsi 1-segmented, middle and hind tarsi-2-segmented.

Distribution: The members of this genus have been recorded rom Canada, United States, Guatemala, Grenada, and Cuba.

Habitat: Species of the genus *Microvelia* are found along the anks of small streams, ponds, rivers, springs, and upon marshes nd swamps.

Remarks: The nymphs are the same general shape as the adults, ut all tarsi are seemingly 1-segmented.

Key to Virginia Species of *Microvelia*

1. Antennae equal to or shorter than head and thorax united; abdomen of apterous from without silvery pubescence; hemelytra of macropterous form with white spots ---------- 2
   Antennae longer than head and thorax united; abdomen of apterous for moften with silvery pubescence; hemelytra of macropterous form concolorous ---------- 4
2. Male elongate, fusiform; female ovate; hind tibiae of male curved ---------- *pulchella*, p. 83
   Male and female ovate in dorsal view; hind tibiae of male straight ---------- 3
3(2) Fourth antennal segment more than twice as long as second segment; hind tibiae slender ---------- *hinei*, p. 86
   Fourth antennal segment only slightly longer than second segment; hind tibiae stout ---------- *austrina*, p. 87
4(1). Segment 4 of antennae slightly longer than 2 and 3 united; abdomen and connexivum of apterous forms with conspicuous tufts of silvery pubescence ---------- *buenoi*, p. 88
   Segment 4 of antennae much shorter than 2 and 3 united; abdomen without conspicuous tufts of silvery pubescence ---------- 5
5. Apterous form with mesonota and metanota concealed by pronotum; body surface reddish-brown and clothed with moderately long hairs; macropterous form unknown ---------- *fontinalis*, p. 88
   Apterous form with mesonota and metanota exposed; body surface dark brown or black and with only short pile; hemelytra of macropterous form uniform brown ---------- *americana*, p. 82

MICROVELIA AMERICANA (Uhler) (Fig. 12a)

Hebrus americana Uhler, 1884; *Microvelia americana* Torre-Bueno, 1910; Hungerford, 1919; Blatchley, 1926; Drake & Hussey, 1955; Froeschner, 1962.

Description: Female elongate oval, robust; male slenderer. Head, pronotum, and ventral surface mostly brownish-black, thickly clothed with minute appressed yellow or silver hairs. Transverse spot on pronotum and large spot on each connexivum brownish-yellow. Antennal segment 4 longest, 2 shortest, 1 and 3 subequal. Macropterous form with pronotum as wide as long, caudally obtusely angular. Hemelytra dark brown, narrower than abdomen, the connexiva exposed. Connexiva of both forms subvertical. Length 2.2 mm. to 2.8 mm. in apterous form, and up to 3.5 mm. in macropterous form.

Distribution: This species has been recorded from Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, Florida, Kansas, Indiana, Illinois, Colorado, New Mexico, California, and Ontario, Canada.

The species has previously been recorded from "Virginia" (Van Duzee 1917 and Hungerford 1919), and specimens are in the U. S. National Museum from Fairfax County. I have collected more than 500 adults and nymphs in Virginia. They have been collected from most counties and from all physiographic provinces of Virginia.

Habitat: I have collected *Microvelia americana* from the shores of ponds, small streams, rivers, and the rocks surrounding springs. They leave the shore only when disturbed, and are able to run quite rapidly upon the surface of the water.

Biology: Torre-Bueno (1910) has published on the life history of this species. He stated that they are present from early spring to "bleak late autumn," and they begin to breed as soon as they leave their winter quarters. About 3 days after mating, the female becomes swollen with eggs which are deposited on stones and sticks just above the water. The eggs rae never deposited on vegetation. Torre-Bueno stated that the ellipsoid, translucent white eggs measure 0.65 mm. long and 0.27 mm. wide, and hatch in 17 days. The first instar nymphs measure 0.75 mm. long and 0.42 mm. wide, and molt in 5 days. The second instar nymphs measure 0.9 mm. long and 0.55 mm. wide, and molt in 4, 5 and 6 days. The third instar nymphs measure 1.32 mm. long 0.8 to 0.72 mm. wide, and molt in 4, 5 and 6 days. The fourth instar nymphs molt in 2 and 4 days. The fifth instar nymphs measure 2.14 mm. long and 1.25 mm. wide and molt

in 7, 8 and 10 days. In moulting, the skin of the head splits longitudinally along the median line of the thorax and down the dorsum to the third or fourth abdominal segment. The life span from egg to adult requires 36 to 46 days; there may be 3 to 5 generations per year. *Microvelia americana* is carnivorous and feeds upon soft-bodied insects such as spring-tails and dipterous larvae. They hibernate during the winter in colonies under overhanging banks of streams and ponds.

Apterous males and females have been obtained during each month of the year, but macropterous forms have been collected only during July. Nymphs were present from April to October.

Remarks: This species has been taken in association with the following members of the family Veliidae: *Microvelia pulchella, M. hinei,* and *Rhagovelia obesa.*

MICROVELIA PULCHELLA Westwood

Microvelia pulchella Westwood, 1834; *M. pulchella incerta,* Kirby, 1890; *M. robusta* Uhler, 1948; *M. marginata* (nec Uhler, 1894) in earlier American literature; *M. borealis,* Torre-Bueno, 1910 (new name for *M. pulchella* sensu American authors, thought by Torre-Bueno to be different from Westwood's species); *M. borealis,* Torre-Bueno, 1916, 1917a; Hungerford, 1919; Blatchley, 1926; *M. pulchella incerta,* Drake & Hussey, 1955.

Description: Head with a median dark impressed line and white line along inner margin of each eye. Antennae slender; segment 2 shortest, 1 and 3 subequal, 4 longest. Body of male fusiform; pronotum long, covering mesonotum, and divided by distinct sutures into three "segments"; genital segment prominent. Tibia of hind legs curved in male, straight in female. Velvety gray-black in color. Length 1.6 to 2.0 mm.

Distribution: This species has an enormous distribution, having been recorded from most of the United States, Canada, and throughout the Neotropical Region. It is apparently statewide in Virginia, and I have a total of 69 specimens of this species in my collection from Virginia. They were collected from the following localities: Albemarle County, "Old Reservoir" at University of Virginia in Charlottesville; Fairfax County, stream 4.1 miles S. of junction of U. S. Hwy. 29 & 50 at Fairfax; Prince Edward County, Bush River 3 mi. S. of Farmville on U. S. Hwy. 460; Scott County, Clinch River crossing U. S. Hwy. 58 E. of Duffield; Northumberland County, pond 3.5 mi. E. Callao on U. S. Hwy. 360; city of Norfolk.

Habitat: My specimens were collected from the margins of a pond where they were living upon the mosses along the water's edge, floating debris near the banks, and along the shady banks of rivers.

Biology: Torre-Bueno (1917a) and Hungerford (1919) have published life history notes on this species, under the old name *M. borealis*. Torre-Bueno stated that the adults leave hibernation in early spring and nymphs appear soon thereafter. He stated that the nymphs "have only four molts, a fact repeatedly tested under varying conditions," but Hungerford claimed that he sometimes found the usual 5 instars. It is possible that both of these workers were correct, the difference being that Hungerford was actually dealing with 2 similar species, *M. pulchella* and *M. hinei*. The latter species was not distinguished and named until later (Drake, 1920). Torre-Bueno gave the following periods for the immature stages: egg, 7 to 23 days, most 8 (Hungerford said 6); first instar, 2 to 11 days, most 6; second instar, 2 to 6 days, most 3 or 4; third instar, 3 to 6 days, most 3; fourth instar, 4 to 10, most 4. The life cycle from egg to adult required 22 to 59 days, with the usual time being 22 to 25 days. The broods overlap during the summer, and there may be 5 or 6 generations from May to September. These bugs feed upon dead insects and waterfleas trapped in the water-surface film. The winter is passed in the adult stage. All my adults are apterous, but macropterous forms have been reported. My adult specimens were collected from April to November; fourth and fifth instar nymphs, during August.

Remarks: This species has been taken in association with the following members of the Veliidae: *Microvelia americana* and *M. hinei*.

The complex nomenclatural history of this species has been treated in detail by Drake & Hussey (1955), who reverted to the earlier usage of *M. pulchella* in opposition to the opinion of Torre-Bueno (1910) who set up the name *M. borealis* for the North American

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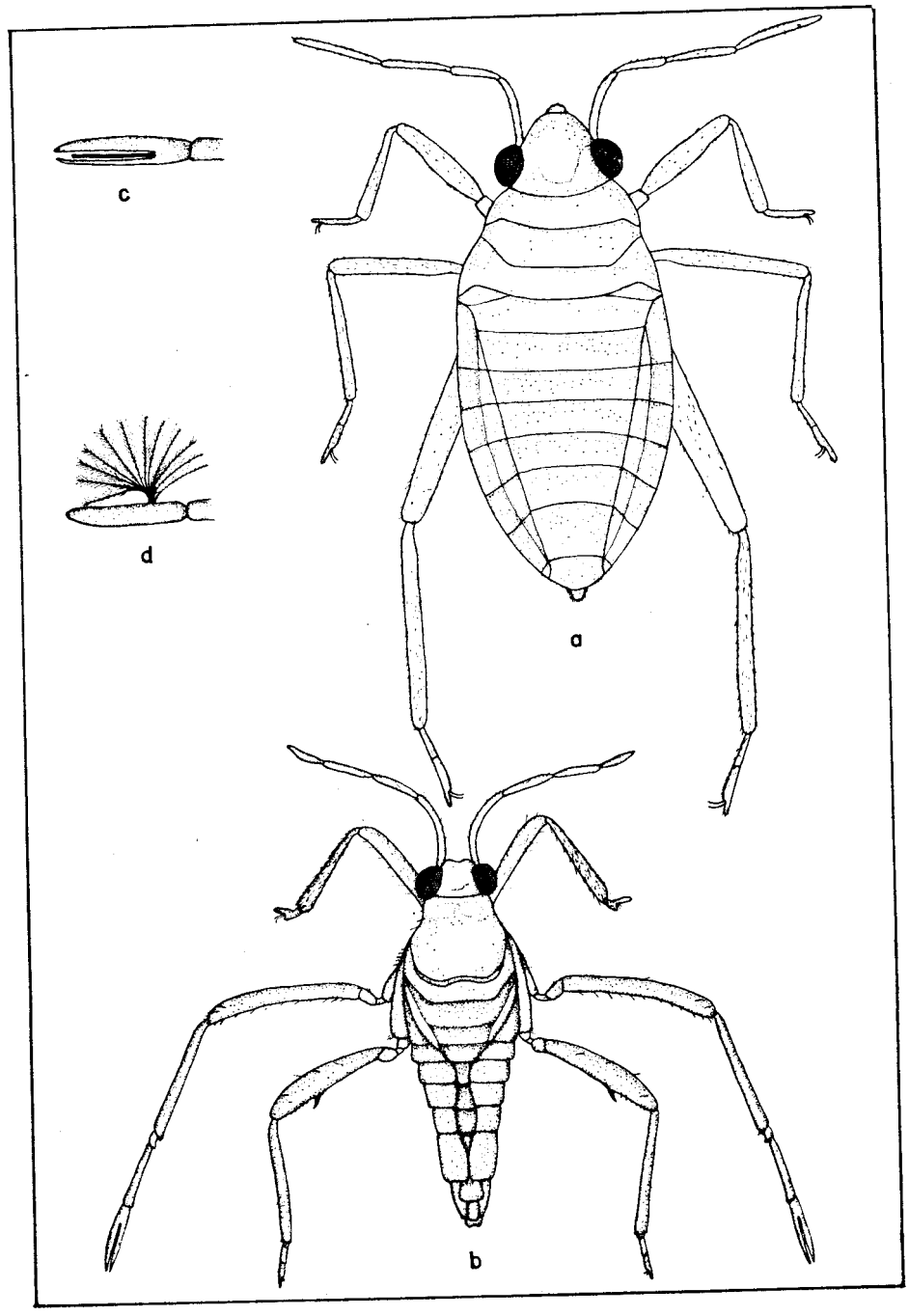
Figure 12.

a. Adult female of *Microvelia americana* (Uhler)
b. Adult female of *Rhagovelia obesa* Uhler
c. Third segment of middle tarsus of *Rhagovelia obesa* Uhler showing cleft.
d. Third segment of middle tarsus of *Rhagovelia obesa* Uhler with tuft of feathery hairs in cleft.


c
d
a
b

populations. *M. pulchella* was described from St. Vincent in the West Indies, and occurs throughout most of the Americas. Drake & Hussey felt that 2 subspecific forms could be recognized, and restricted the nominate race to the Neotropical region generally, although extending north to Arizona, Texas, and Florida. For the Nearctic populations of the species, they revived Kirby's name *M. incerta*, based on specimens from Fernando Noronha, which they distinguished as being slightly smaller in average size than the average *M. pulchella*. Since they also admitted that the ranges of the 2 forms overlapped broadly, and that complete transition in body size could be found in single series, there seems to be no compelling reason to recognize *M. incerta* in the present treatment.

MICROVELIA HINEI Drake

Microvelia hinei Drake, 1920; Hoffmann, 1925a; Blatchley, 1926; Herring, 1951; Drake & Hussey, 1955.

Description: Male elongate oval, female slightly broader. Head and pronotum dark brown, the former with a white line along inner margin of eyes. Legs and pronotum dull brownish-yellow, tibiae and tarsi tinged with fuscous, ventral surface dark brown, thickly clothed with fine bluish-gray pubesence. Segment 2 of antennae shortest, 4 longest, 1 and 3 subequal. Macropterous form with 3 white spots on membrane. Length 1.3 to 1.6 mm.

Distribution: This species has been recorded from Canada to Argentina. Specimens are in the U. S. National Museum from Maryland, Missouri, Florida, Colorado, Texas, Massachusetts, New Jersey, District of Columbia, and Virginia.

Microvelia hinei has not previously been recorded from Virginia, but specimens from Alexandria and Great Falls, Virginia, Fairfax County, are in the U.S. National Museum collections. I have a total of 18 specimens in my collection from Virginia. They were collected from the following localities: Accomac County, pond on Co. Hwy. 658 at junction with Co. Hwy. 722; Albemarle County, "Old Reservoir" at University of Virginia and Rivanna River 6 mi. . of Charlottesville on U.S. Hwy. 29; Lunenburg County, pond on St. Hwy. 40 just S. of Victoria.

Habitat: This species is found on the banks of ponds and streams. Hoffmann (1942a) stated that *Microvelia hinei* is unlike *M. pulchella* and *M. americana* in that this species runs upon the banks when disturbed, whereas the latter two species run out upon the water.

Biology: Hungerford (1919) gave the life history of *M. borealis* (= *pulchella*) but this probably pertains to *M. hinei* since he figures this species on plate XII. If this assumption is true, the life history is very similar to that given for *M. pulchella*. The majority of my specimens were collected in March and April, but I do not know the reason for this, because collections were made at approximately weekly intervals, except during the winter months. As seen above, *M. pulchella* was most abundant during August.

Remarks: This species has been collected in association with the following members of the family Veliidae: *Microvelia americana* and *M. pulchella.*

MICROVELIA AUSTRINA Torre-Bueno

Microvelia austrina Torre-Bueno, 1924a; Blatchley, 1926; Brimley, 1938.

Description: Body elongate-oblong. Color a nearly uniform dark brown, clothed with fine appressed grayish-hairs; front margin of pronotum reddish-brown; antennae fuscous-brown. Antennae relatively stout, segment 3 most slender, 4 fusiform; all of nearly equal length. Pronotum with reddish front margin smooth, remainder distinctly punctate and with a median carina. Hind tibiae straight in both sexes. Abdomen of male with sides subparallel, the connexiva wide, subvertical; female narrowed posteriorly with connexiva strongly reflexed. Length 1.5 to 1.8 mm.

Distribution: Torre-Bueno's types were from Raleigh, North Carolina, and this species has been recorded elsewhere only from Indiana. I have collected a total of only 5 individuals in Virginia: 2 males and 3 females, all wingless. They were collected from the following localities: Chesterfield County, 26.1 mi. S. of Richmond on U.S. Hwy. 1; Greenville County, 9.7 mi. E. of Edgerton on U.S. Hwy. 58; King George County, 13.2 mi. E. of Fredericksburg on St. Hwy. 3.

Habitat: This species has been collected only on banks and the shallow water along the shores of streams. There was little or no vegetation where they were collected.

Biology: The life history of this species is not known. All my specimens were collected in late May and early June. Brimley (1938) stated that all the specimens from the type locality came from a single spring.

Remarks: This species has been collected in association with only one member of the family, *M. americana*. It is an interesting phenomenon that all four of the known eastern localities for *M. austrina* are situated on or near the Fall Line, suggesting some possible ecological correlation.

MICROVELIA BUENOI Drake

Microvelia buenoi Drake, 1920; Blatchley, 1926.

Description: Head, pronotum, and ventral surface dark velvety brown; base of antennae, a transverse line on front margin of pronotum, coxae and femora, mostly yellow; hemelytra brown, cells between veins whitish; hemelytra as long as and covering the abdomen. Head with silvery-gray hairs along inner margin of eyes. Segments 1 and 3 of antennae subequal, 4 slightly longer than 2 and 3 united, 2 shortest. Length 1.7 to 2.0 mm.

Distribution: This species has been recorded from Massachusetts, New York, Michigan, Minnesota, and Indiana, and specimens are in the U.S. National Museum from Colorado, Maryland, Oregon, and Idaho.

The species has not previously been recorded from Virginia, and I have collected only 1 apterous and 3 macropterous females in the Commonwealth. They were collected from the following localities which appear to be the southernmost known for this species: City of Chesapeake, 5.7 miles E. of Northwest on Co. Hwy. 610 at intersection with County Hwy. 609, and 4.4 miles S. of intersection of U.S. Hwys. 13 and 17 on U.S. Hwy. 17.

Habitat: *Microvelia buenoi,* has been collected from the surface of dark-colored water in a sluggish stream, and from a drainage ditch running into Dismal Swamp.

Biology: The life history of *Microvelia buenoi* is not known. My specimens were collected on June 1.

Remarks: This species has not been taken in association with any other member of the family Veliidae.

MICROVELIA FONTINALIS Torre-Bueno

Microvelia fontinalis Torre-Bueno, 1916; Blatchley, 1926; Drake & Hussey, 1955.

Description: Oblong-oval, rather robust; reddish-brown in color and thickly clothed with moderately long hairs. Head with a median

longitudinal bluish stripe; dorsolateral margins of second and third abdominal segments, and the whole of sixth and seventh ones, bluish. Pronotum long, concealing mesonato and metanota, with two transverse rows of coarse punctures. Connexiva strongly reflexed. Antennae with segment 2 shortest, 1 and 3 subequal, 4 longest, 3 most slender. Length about 2.3 mm.

Distribution: *Microvelia fontinalis* has been recorded from New York, New Jersey, Ohio, Michigan, and Indiana; in addition, specimens are in the U.S. National Museum from Pennsylvania, Maryland, Virginia, Illinois, Tennessee, Mississippi, Minnesota and Iowa.

Virginia specimens in the U.S. National Museum collection are from Fairfax County, Vienna; Loudon County, Bluemont, and the city of Arlington. I have seen only 2 males and 1 female from Virginia. These were collected at Blakemore Mill, 4.0 miles southeast of Lively, Lancaester County, by R. L. Hoffman, and were mentioned by him (1969:51) in connection with records of some northern taxa of cold springs in the Coastal Plain.

Habitat: My specimens were collected along the marshy shores of a cold spring. Torre-Bueno (1916) stated that "it was taken in numbers at White Plains in a spring in a marshy woodland, where it clings to the long mosses growing into the water, or walks about leisurely a short distance from the rocky sides of the basin".

Biology: The life history of this species is not known. My specimens were collected on August 10, 1948.

Remarks: This species has not been collected in association with any other members of the family Veliidae.

Genus *RHAGOVELIA* Mayr, 1865

Description: Small (2.5 to 4.0 mm.), robust species with short, blunt head, wider across eyes than cephalic margin of pronotum. Middle and hind coxae close together; front coxae more distant. All tarsi with 3 segments; distal ¾ of third segment of middle legs split, with feathery hairs in cleft; second segment of front tarsi very short, wide. Antennae 4-segmented; basal segment longest, slightly curved; segment 4 shortest. Apterous form with caudal margin of pronotum broadly rounded; macropterous form obtusely triangular. Abdomen narrowing caudally.

Distribution: The members of this genus have been recorded from Africa, Asia, Australia, New Guinea, and Europe; from North, Central, and South America; and from the East and West Indies.

Habitat: With the exception of 3 species which live on salt and brackish waters of bays, these small insects are almost confined to rapid-flowing streams. They are gregarious, and large numbers are often seen in the eddies of streams, or upon the riffles and rapids of rivers where they presumably await the arrival of food which the current brings them.

Remarks: The nymphs are broadest across the mesothorax, and the body gradually tapers caudally to a blunt tip. All tarsi are seemingly 1-segmented.

RHAGOVELIA OBESA Uhler (Fig. 12b, c, d)

Rhagovelia obesa Uhler, 1871; Torre-Bueno, 1907a; Hungerford, 1919, Blatchley, 1926; Gould, 1931; Bacon, 1958; *Rhagovelia flavicincta* Torre-Bueno, 1925b; Blatchley, 1926; Gould, 1931. **New synonymy.**

Description: Body oblong-ovate, strongly tapering caudally, mostly black. Pronotum with orange-red spot each side of median line; minutely very sparsely punctate; caudal margin broadly rounded in male and subtruncate in female. Pronotum of macropterous females with caudal apex prolonged, curved upward, its tip slightly widened, sometimes forked. Mesonota and metanota exposed as concentric rings behind pronotum. Connexiva black or yellow. Middle femora of both sexes distinctly longer than hind ones, the later armed beneath at middle or apical third with a stout spine, sometimes bifid, this followed toward apex by several smaller spines (Fig. 12b). Macropterous form with wings covering abdomen and extending slightly beyond tip, black. Length 3.5 to 4.0 mm.

Taxonomic Notes: It will be noted that I have united 2 formerly recognized species under the older name *R. obesa* Uhler. Torre-Bueno (1924b) described *R. flavicincta* from Raleigh, North Carolina, and on the basis of his description, one would hardly doubt the validity of the name. However, after having studied a large series of *Rhagovelia* from some 60 counties in Virginia, I find that, while a few of my specimens appear to be typical *flavicincta,* many show all grades of intermediacy between the so-called diagnostic characters of *flavicincta* and those of *obesa;* viz., in color, length of pronotum, antennal proportions, number and location of spines on hind femora, etc. Thus it appears that Torre-Bueno has described only an extreme variant in a highly variable species. *Rhagovelia flavicincta* has been recorded only from North Carolina and Virginia. Whereas Torre-Bueno (1924b) and Gould (1931) state that it is common in Bruns-

wick County, Virginia, all my adult specimens collected in that county are closer to *obesa* than to *flavicincta*.

Possible a third described species, *R. knighti*, should be reduced to synonomy with *R. obesa*. Among the specimens of the genus *Rhagovelia* which I sent to Dr. Reece I. Sailer at the U.S. National Museum were four which he stated "might be *R. knighti* Drake and Harris, but I don't believe we can be sure that this species is not just a form of *R. obesa*." Upon comparing these specimens with the rest of my series of *Rhagovelia*, I was unable to find a single character which served to separate them from typical *obesa*. Gould (1931) stated that *R. flavicincta* is related to or identical with *R. obesa* and *R. knighti*.

To avoid additional confusion, I am listing separately the localities from which the "extreme *flavicincta*" have been collected; however, it should be pointed out that "extreme *obesa*" was collected in the same locality with them in Buckingham County. Furthermore, it is perhaps significant that the majority of my specimens are intermediate between the two extremes.

Distribution: *R. obesa* is widely distributed over North America, having been recorded from Ontario to Florida and west to California.

This species has previously been recorded from Virginia by Torre-Bueno (1924b) and Gould (1931) and from Brunswick and Fauquier Counties (Bacon, 1958). I have nearly 1,000 adults and nymphs of this species in my collection from Virginia and an additional 26 adults and nymphs of *flavicincta*. These have been collected from most Virginia counties and from all physiographic provinces. In addition, I have specimens from Hardy and Wyoming counties in West Virginia, (H. H. Hobbs, Jr.) and I have examined specimens from Vermont, New York, Pennsylvania, Maryland, Virginia (Stafford, Gloucester, Rockbridge, Fairfax, and Westmoreland counties), Illinois, Ohio, and Canada (Ontario) which were loaned by Dr. G. E. Gould.

My 26 specimens of *R. flavicincta* were collected from the following localities: Louisa County, 3.0 miles S. of Zion Crossroads (intersection of U. S. Hwys. 15 and 250) on U. S. Hwy. 15, and Buckingham County, 10 miles S. of Sprouses Corner on U. S. Hwy. 15. All these specimens were collected from streams flowing through open, sandy terrain. In addition, I have examined 9 specimens from Brunswick County in Virginia and Northampton County in North Carolina. These specimens were loaned by Dr. G. E. Gould from material which he had compared with Torre-Bueno's types.

Habitat: This species lives upon the riffles and rapids of rivers and small streams. Nymphs have also been collected from springs, and quiet nooks along the banks of streams. In 1972, Dr. W. H. Robinson (VPI&SU) reported to me that he observed *Rhagovelia* in the stream that runs out of Hot Springs, Bath County, Virginia. The temperature of the water was 92° F.

Biology: The life history of this species has not been published, but brief notes occur in the literature on behavior. Torre-Bueno (1907a) stated that in almost any swift stream, *R. obesa* can be found in little congregations, weaving in zigzags where current is most rapid, swimming against it, or else sheltered in the eddy behind projecting rocks. I have noted mating in June and July, when the schools are made up largely of sexes in copula. These bugs swim freely underwater and dive frequently. They look like balls of silver underwater, due to the large amount of air carried in the velvety pile covering the insect. They are predaceous and feed on insects that fall upon the water, but usually, they will not attack another of their kind or the larger Gerridae often found in association. Both winged and wingless forms are found. Torre-Bueno (1907a) stated that the winged forms are rare in New York but common in the tropics. Gould (1931) stated that the winged forms are good fliers as is shown by the fact that "Dr. Beamer in 1927 collected two specimens from a water tank in Arizona forty miles from any running water." From my seasonal data it cannot be determined in what stage the species spends the winter, but since nymphs have been taken before adults, it seems possible that the eggs are laid in the late fall or early winter and that the adults die before spring. Only two nymphs have been collected later than August; this would seem to indicate that they do not overwinter. Apterous males and females have been collected from June to December; and macropterous forms, from June to August. All 5 nymphal stages have been collected as early as May.

Remarks: *R. obesa* has been collected in associated with the following members of the family Veliidae: *Microvelia americana* and *M. pulchella.*

Genus *VELIA* Latreille, 1804

Distribution: Medium size (4 mm. or more), robust, pubescent insects. Antennae longer and slenderer than in the other two genera. Pronota and mesonota united; macropterous form with caudal portion of mesonotum broadly triangular with rounded apex.

Distribution: The members of this genus have been recorded from Europe; North, Central, and South America; and the West Indies.

Habitat: Hungerford (1919) stated that as far as he knows all species dwell on flowing waters. Blatchley (1926) stated that they live amongst the roots of grasses, in bunches of decaying weeds and beneath other cover, more often on the ground near stagnant water than on its surface.

Key to Virginia Species of *Velia*

1. Antennae with segment 2 one-fourth shorter than 3; tubercles on sides of pronotum scarcely evident ---------- * *stagnalis*, p. 93
   Antennae with segments 2, 3, and 4 subequal in length; tubercles on sides of pronotum very distinct ---------- * *watsoni*, p. 93

* *VELIA STAGNALIS* Burmeister, 1835

I have not collected *Velia stagnalis* in Virginia, but no doubt it occurs here, since it has been recorded from Ohio, Pennsylvania, District of Columbia, North Carolina, and Florida. It has also been recorded from the West Indies.

* *VELIA WATSONI* Drake, 1919.

V. watsoni has not been collected in Virginia, but it should occur here also, since it has been recorded from New York, Florida, and Kansas.

Family 9. BELOSTOMATIDAE Leach, 1815

Description: Large, flat, brown, oval or oblong-oval insects, commonly known as "Giant Waterbugs" because of their size. Eyes large, projecting caudally over anterior angles of pronotum; ocelli absent. Rostrum stout, 3-segmented; antennae very short, 4-segmented, hidden in pockets beneath eyes. Scutellum large, flat, triangular, its apex acute; hemelytra large, covering abdomen. Front legs raptorial, femur enlarged; middle and hind legs natatorial, tibiae and tarsi flattened. Tarsi 2-segmented; front tarsi with 1 long claw, middle and hind ones with 2 claws.

Distribution: Belostomatids are cosmopolitan, having been recorded from North, Central, and South America, from Europe, Asia.

Africa, and Australia, and from New Guinea, New Caledonia, Cuba, Puerto Rico, and other islands.

Habitat: Species of this family live in large and small ponds, streams, and swamps. The smaller members prefer the shallow waters of ponds and swamps where *Typha* and other emergent vegetation abound. The larger species prefer deeper waters, with or without aquatic vegetation. As a rule, they rest, clinging to some support, with the tip of the abdomen in contact with the surface film.

Remarks: The nymphs may be distinguished from the adults by the presence of 2 long claws on the front tarsus, and the absence of functional wings.

Key to Virginia Genera of *Belostomatidae*

1. Femora of front leg not grooved anteriorly ---------- *Benacus*, p. 94
   Femora of front leg grooved anteriorly (Fig. 13b) ---------- 2
2. Head conically produced, rostrum long and thin; length 40 mm. or more ---- *Lethocerus*, p. 95
   Head not conically produced, rostrum short and stout; length less than 30 mm. ---------- *Belostoma*, p. 99

Genus *BENACUS* Stal, 1862

Description: Front femora not grooved for reception of tibiae, widely clothed with short velvety pile. Large, elongate, oval, flat species having interocular space narrower than diameter of an eye. Lateral margins of pronotum straight to slightly convex. Length 47 to 64 mm.

Distribution: This genus has been recorded from North America and Cuba.

Habitat: Species of the genus *Benacus* are found in sluggish waters of ponds and streams.

Remarks: Lauck & Menke considered *Benacus* to be a subgenus of *Lethocerus*, a precedent followed by Menke (1963) who provides keys, maps, and illustrations in his revision of *Lethocerus*.

BENACUS GRISEUS (Say)

Belostoma griseus Say, 1832; *Benacus griseus*, Uhler, 1876; Torre-Bueno, 1908, Hungerford, 1919; Blatchley, 1926; Cummings, 1933; Needham, 1907.

Description: The characters of the species are given under the genus.

Distribution: This species has been recorded from Quebec and New England west to Minnesota and Iowa, and south to Florida and Cuba. I have only 5 specimens from Virginia, and all are females. They were collected from the following localities: Albemarle County, Charlottesville (flying), and 6.5 miles N. of Charlottesville on U.S. Hwy. 29 (flying); Bedford County, at Forest, in yard with young chicks; Giles County, Mountain Lake. In addition, I have seen 1 specimen from City of Virginia Beach in the Old Dominion University collection, 2 specimens from Accomac County in the Truck Experiment Station collection and 8 specimens in the VPI&SU collection from the following counties: Appomatox, Augusta, Frederick, and Montgomery.

Habitat: The only specimen I have that was taken from water is that collected from the swimming pool at the Mountain Lake Biological Station, Giles County. These insects fly readily in the early evening during the mating season and are frequently attracted to electric lights.

Biology: The life history of this species is not known, but notes have been published by Needham (1907). He stated that the egg clusters are 2 to 3 inches long and contain from 75 to 100 eggs. The eggs are very large and attached by one end in more or less regular rows which cover, in a single layer, the broader flattened side of stems. The egg clusters are attached above the water line. Needham states that the eggs are 5 mm. long and 2 mm. wide. My specimens were taken from March through August.

Remarks: This species has not been collected in association with any other members of the family.

Genus *LETHOCERUS* Mayr, 1852

Description: Large, elongate oval, flat species having interocular space subequal to diameter of an eye. Lateral margins of pronotum slightly convex. Head not conically produced, rostrum short and stout. Front femora grooved for reception of tibiae. Length 40 to 110 mm.

Distribution: The members of this genus are cosmopolitan.

Habitat: The habitat is the same as that given for the family.

Key to Virginia Species of *Lethocerus*

1. Interocular space equal to width of an eye, costal margins feebly but conspicuously curved, middle and hind legs not banded, or only faintly so ---------- *americanus*, p. 96
   Interocular space not over three-fourths width of an eye, costal margin almost straight and subparallel, middle and hind legs distinctly banded -- * *uhleri*, p. 99

LETHOCERUS AMERICANUS (Leidy) (Fig. 13a & b)

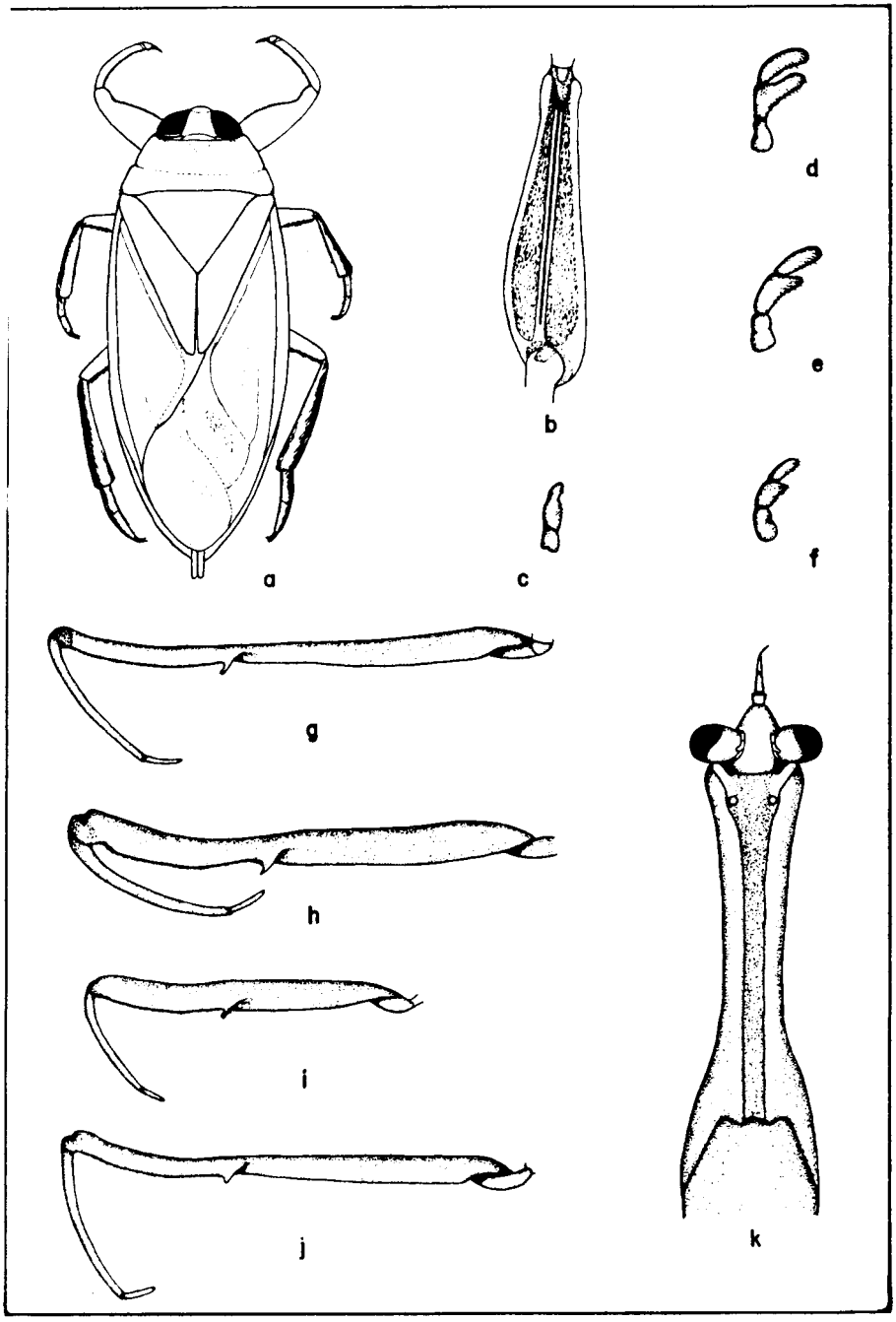
Belostoma americanum Leidy, 1847; Gillette & Baker, 1895; *Amrogius americanus*, Torre-Bueno, 1905c *Lethocerus americanus* Torre-Bueno, 1908; Hoffman, 1924b; Cummings, 1933; Rankin, 1935.

Description: Elongate oval, large species. General color brown; scutellum with large fuscous rectangular area; hemelytra brown with caudal third lighter; middle and hind femora with 3 transverse fuscous stripes. Front of head with indistinct longitudinal medium carina. Interocular space subequal to width of an eye. Front femora broad, the longitudinal grooves bordered by dense dark brown velvety pile, and a narrow row of pile between the two grooves. Length 40.5 to 61.5 mm.

Distribution: This species has been recorded from Quebec and British Columbia, south to Florida and Mexico, and westward to California.

Figure 13.

a. Adult of *Lethocerus americanus* (Leidy)
b. Femur of front leg of *Lethocerus americanus* (Leidy)
c. Antenna of *Ranatra kirkaldyi* Bueno
d. Antenna of *Ranatra fusca* Palisot de Beauvois
e. Antenna of *Ranatra buenoi* Hungerford
f. Antenna of *Ranatra nigra* Herrich-Schaeffer
g. Front leg of *Ranatra buenoi* Hungerford
h. Front leg of *Ranatra fusca* Palisot de Beauvois
i. Front leg of *Ranatra kirkaldyi* Bueno
j. Front leg of *Ranatra nigra* Herrich-Schaeffer
k. Ventral of surface of head and prothorax of *Ranatra buenoi* Hungerford


a
b
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L. americanus has not previously been recorded from Virginia. I have a total of 79 adults and nymphs of this species in my collection from Virginia. They were collected from the following localities: Albemarle County, "Old Reservoir" at University of Virginia; Fluvanna County, pond 2.5 miles west of Columbia on State Hwy. 6. In addition, I have seen 6 specimens in the Truck Experiment Station collection from Painter (Accomac County) which were collected at light traps during May and June, and one specimen in the VPI&SU collection found in sea water at the shore of Virginia Beach by M. Kosztarab.

Habitat: All of my specimens were collected from littoral zones of shallow ponds with an abundance of submerged and emergent vegetation. The nymphs were found among the dead leaves and other debris on the bottom.

Biology: Rankin (1935) has published a brief life history of this species. He collected 2,118 eggs, representing 30 egg masses, in the region of the Douglas Lake Station, Michigan, and stated that "while all but one of my collections were found on dead *Typha* stems from five inches to a foot or more above the water, Doctor Hungerford has collected them on logs and under boards on the shore." The eggs measured 5.0 mm. long and 2.5 mm. wide. They were light-brown in color and had a cap or lid on the anterior end which was much darker. This cap popped open when the egg was ready to hatch. Rankin gave the following lengths for the immature stages: first instar 10 mm.; second instar, 15 mm.; third instar, 22 mm.; fourth instar, 31 mm.; fifth instar, 39 to 43 mm. My immature stages were slightly smaller, measuring from first to fifth instars as follows: 9.5 to 10.0, 14.0 to 14.5, 19.0 to 21.0, 27.0 to 30.0 and 38.0 to 43.0 mm. The nymphs are cannibalistic and the older ones will attack and kill the young nymphs. Rankin stated that in his rearing studies he used tadpoles as food, since nymphs had been captuerd in nature feeding on tadpoles. Hoffmann (1924b) stated that he fed them on 3½-inch trout, since the studies were made at a trout hatchery. It took two of these trout to satisfy a hungry nymph, but adults ate less. Rankin stated that the five nymphal instars required 33.4 days in the field and 58.9 days in the laboratory in Michigan. My seasonal data indicate that the eggs are deposited in April and May, and after hatching and passing through five nymphal instars, the

adult stage is reached in the period from late July to September. There is but one generation per year in Virginia and, from the data collected, it does not seem likely that the adults live and deposit eggs a second year, as observed by Hoffmann. The adults spend the winter in the debris and mud on the bottom of the ponds. Hoffmann stated that he has found them from 3 to 6 inches deep in mud and leaves, and adds that the adults may live over winter and lay eggs the second year.

I have collected adult males and females each month of the year, with the exception of May and June. Nymphs have been collected from May through September.

Remarks: The different instars may be distinguished from each other by size and by degree of development of the wing pads. This species has not been collected in association with other members of the family Belostomatidae.

* *LETHOCERUS UHLERI* (Montandon), 1896

L. uhleri has not been collected in Virginia, but may occur here since it has been recorded from Massachusetts, New Jersey, Pennsylcania, North Carolina, Georgia, Florida, Louisiana, Texas, Kansas, Indiana, Wisconsin, and Mexico. The diagnostic characteristics for this species are indicated in the key above.

Genus *BELOSTOMA* Latreille, 1807

Description: Medium sized, broadly oval, flat species having the interocular space much wider than the diameter of an eye. Lateral margins of pronotum slightly concave. Head conically produced, rostrum long and thin. Front femora grooved. Length 14 to 26 mm.

Distribution: The members of this genus are widely distributed in North and Central America.

Habitat: The members of the genus *Belostoma* are found in ponds, swamps, and roadside ditches. They prefer the shallow, clear or muddy water of such situations where there is abundant emergent vegetation and much debris projecting or floating on the surface.

Key to Virginia Species of *Belostoma*

1. Head short, median length about three-fourths width of vertex and one eye; length less than 20 mm. ---------- *testaceum*, p. 102
   Head long, median length subequal to width of vertex and one ey; length 20. mm. or more ---------- 2
2. Head about two-thirds length of pronotum; tylus less convex; hemelytral commissure distinctly shorter than scutellum ---------- *fluminea*, p. 100
   Head as long as pronotum; tylus more convex; hemelytral commissure equal to or longer than scutellum ---------- *lutarium*, p. 101

BELOSTOMA FLUMINEA Say

Belostoma flumineum Say, 1832; Torre-Bueno, 1906b; Hungerford, 1919; *Zaitha fluminea*, Weed, 1889b; *Belostoma fluminea*, Blatchley, 1926; Froeschner, 1962.

Description: General color varying from a uniform brownish-yellow to fuscous; legs usually with large dark spots. Hemelytra less convergent caudad of middle than in *B. lutarium*, finely and thickly punctate. Length 21 to 24 mm.

Distribution: This species has been recorded from Maine, North Carolina, Florida, Louisiana, Kansas, Indiana, Colorada, Arizona, and Quebec and Manitoba in Canada. In addition, there are specimens from South Carolina in the Clemson University Museum.

This species has not previously been recorded from Virginia. I have collected *B. fluminea* from the counties of Albemarle, Augusta, Charlotte, Giles, Halifax, Lancaster, Lunenburg, and Smyth, and from the cities of Chesapeake, Richmond, and Virginia Beach. I have seen specimens in the Virginia Truck Experiment Station from the City of Chesapeake in addition to those in the Old Dominion University collection from Campbell, Fauquier, and Nansemond counties, and the City of Virginia Beach.

Habitat: All of my specimens were collected in swamps and marshes in eastern Virginia, or in ponds in other parts of the State. They were found among the emergent vegetation in shallow water.

Biology: Torre-Bueno (1906b) and Hungerford (1919) have published the life history of this species. Torre-Bueno stated that oviposition begans early in the spring and continues all summer. The eggs are deposited on the backs of the males in batches of 25 to 125. The female seizes the male and forcibly converts him into a portable

incubator. The eggs are light-brown, imperfectly oval, and measure 2 mm. long and 1 mm. wide. They hatch in 6 to 12 days. The first instar nymphs measure 4.0 to 5.0 mm. long and 2.4 mm. wide and molt in 7 to 13 days. The second instar nymphs are 6 to 7 mm. long and 3.4 to 3.7 mm. wide and molted in 5 to 7 days. The third instar nymphs measure 8.5 to 9.0 mm. long and 3.7 to 4.0 mm. wide and molt in 6 or 7 days. The fourth instar nymphs measure 10 to 12 mm. long and 6.7 mm wide and molt in from 5 to 7 days. The fifth instar nymphs measure 15 to 17 mm. long and 8.4 to 8.8 mm. wide and molt in 11 to 18 days. The total developmental period for three bugs was 45, 53, and 54 days, but Hungerford reared some in a total of 40 days. Torre-Bueno stated that the most noteworthy fact in development is the progressive diminution of the claws on the front tarsi, which finally disappear at the last molt. The adults spend the winter in the mud and trash at the bottom of the pond. My adults were collected in May, June, July, and December; the nymphs, in June. One of the males collected in early June bore 122 eggs on his back.

Remarks: Within the family, this species has been taken in association with *B. testaceum.*

BELOSTOMA LUTARIUM (Stal)

Zaitha lutarium Stal, 1835; *Belostoma lutarium*, Blatchley, 1926; Froeschner, 1962.

Description: General color dull yellowish-brown to fuscous. Legs with fuscous spots sometimes coalescing to form bands. Head longer and tylus more convex than in other species of *Belostoma.* Hemelytra strongly tapering caudad of middle. Length 22 to 26 mm.

Distribution: This species has been recorded from Massachusetts, North Carolina, Florida, Louisiana, Texas, Indiana, and Kansas, and there are specimens from South Carolina in the Clemson University Museum.

Specimens in my collection and that of Old Dominion University are from the counties of Accomac, Chesterfield, Goochland, Henry, James City, and Nansemond, and the City of Chesapeake and the City of Virginia Beach.

Habitat: My specimens were collected from ponds and swamps with abundant growth of emergent grasses.

Biology: Nothing is known of the life history of this species. My specimens were collected in late May and in June and October.

Remarks: This species has been collected in association with other species of the genus *Belostoma.*

BELOSTOMA TESTACEUM (Leidy)

Perthostoma testaceum Leidy, 1847; *Belostoma testaceum*, Van Duzee, 1917; Hungerford, 1919; Blatchley, 1926; Froeschner, 1962.

Description: Color ranging from a nearly uniform pale brownish-yellow to dark fuscous-brown; legs yellowish, irregularly spotted or banded with fuscous; ventral surface fuscous. Head short, obtuse. Length 14 to 18 mm.

Distribution: This species has been recorded from New York, New Jersey, Pennsylvania, District of Columbia, North Carolina, South Carolina, Florida, Alabama, Texas, and Michigan.

This species has not been previously recorded from Virginia. My specimens were collected from Northumberland County, pond on U.S. Hwy. 360 about 3.5 mi. E. of Callao; Richmond County, swamp of Rappahannock river 4.4 mi. S. of Warsaw on U.S. Hwy. 360; City of Chesapeake, swamp pond 5 mi. S. of Great Bridge on St. Hwy. 168. In addition, I have examined specimens in the insect collection at Old Dominion University from Nansemond County, and from the City of Chesapeake and the City of Virginia Beach. I have also seen specimens in the collection of the Virginia Truck Experiment Station from Accomac County and from the City of Chesapeake and the City of Virginia Beach.

Habitat: All my specimens were collected from among the emergent grasses of swamps, ponds, and marshes.

Biology: The life history of this species is not known. My Virginia specimens were all collected in June, and the North Carolina specimen was collected in March.

Remarks: Within the family, this species has been taken in association with *B. fluminea.*

Family 10. NEPIDAE Latreille, 1802

Description: Aquatic insects of diverse form, extremely elongate and slender (*Ranatra*) or relatively short, broad, and suboval (*Nepa*). Head porrect, rostrum short, awl-shaped, with 3 segments. Ocelli absent. Antennae 3-segmented, concealed in concavities beneath eyes. Hemelytra entire, usually covering abdomen; clavus, corium, and membrane distinct. Front legs raptorial; coxae elongate, inserted near cephalic margin of prosternum; tarsi 1-segmented. Middle

and hind legs slender, tarsi 1-segmented, with 2 claws. Abdomen terminating in 2 long, slender, filaments which fit together to form a respiratory tube.

Distribution: Members of this family have been recorded from Europe, and from North and South America.

Habitat: Species of the family Nepidae inhabit streams, ponds, and swamps where they are found in the mud and debris on the bottom, usually in moderately shallow water. They are sluggish swimmers and are occasionally seen slowly paddling through the water.

Key to Virginia genera of *Nepidae*

1. Body broad and robust in outline, about four times as long as the greatest width; pronotum nearly twice as wide as long ---------- *Nepa*, p. 103
   Body very elongate, 10 times as long as wide; pronotum about 4 times as long as broad ---------- *Ranatra*, p. 104

Genus *NEPA* Linnaeus, 1758

Description: Elongate-oval, flattened insects; pronotum broadly quadrate, much broader than head across eyes, flattened; legs of normal proportion and appearance, the anterior pair raptorial, the femora enlarged and grooved beneath.

Distribution: This genus and its single included species is restricted to eastern North America.

Habitat: As stated for the family.

NEPA APICULATA Uhler.

Nepa apiculata Uhler, 1862; Blatchley, 1926.

Description: Generally brownish-gray in color; tarsal claws yellow. Body elongate-oval in outline, about 4 times as long as greatest width of abdomen; head small, narrower than pronotum, latter transversely quadrate its lateral edges convergent anteriorly, anterior edge straight, posterior edge medially concave; scutellum large and triangular, its sides subequal; claval commissure about equal in length to that of scutellum. Legs moderately long and slender except anterior pair which is modified for grasping, the femora in-

crassate and ventrally grooved to accomodate the falciform tibia-tarsus combination. Apical respiratory filaments about one-half of body length. Total length, 18-20 mm.

Distribution: This species has been recorded over a range extending from Quebec and Minnesota south to Georgia. It is, however, not common at most localities and appears to be decidedly rare in the Southeastern States. Maryland specimens in the USNM collection are from Patuxent and Plummer's Island. There are no published recordings from North Carolina, and the only known Virginia specimen was taken in Gloucester County, October 13, 1973, by A. G. Michael (Old Dominion University collection).

Habitat: According to Torre-Bueno (1923) this species is partial to shallow, grassy, slow-moving streams.

Genus *RANATRA* Fabricius, 1790

Description: Body elongate, cylindrical; head small, triangular, wider across eyes than long; eyes very prominent, strongly protruding; pronotum four or more times longer than its greatest width, caudal margin widened and deeply concave. Scutellum almost diamond-shaped. Front legs with femora much longer than tibiae and tarsi united, femur with submedian tooth. Coxae of front legs very long, and widely separated from those of the slender middle and hind legs.

Distribution: Species of this genus have been recorded from Europe and from North and South America.

Habitat: Same as that of family.

Remarks: In view of the fact that the life history of none of the Virginia species belonging to the family Nepidae have been studied, the following account is given to indicate what might be expected from such an investigation. Torre-Bueno (1906a) published the life history of *Ranatra quadridentata;* perhaps most species have a similar cycle. The eggs are deposited on floating dead *Typha* and other debris, and the egg-stage lasts 2 to 3 weeks. There are 5 nymphal instars, with durations as follows: first instar, 8 to 14 days; second instar, 9 days; third instar, 7 days; fourth instar, 8 days; fifth instar, 8 days. Torre-Bueno gives the total life cycle from egg to adult as 61 days.

Key to Virginia Species of *Ranatra*

1. Antennae simple, without lateral projection on pentimate segment (Fig. 13c); front femur broad, stout, not constricted near middle; body length 23 to 32 mm ---------- *kirkaldyi*, p. 105
   Antennae with lateral projection on penultimate segment (Fig. 13d); front femur slender, narrowed in region of median tooth ---------- 2
2. Lateral projection of penultimate antennomere less than half the length of the ultimate segment; front femur without subapical cleft (Fig. 13g) ---------- 3
   Lateral projection of penultimate antennomere more than half the length of the ultimate segment (Fig. 13d); front femur with subapical cleft ---------- 4
3. Longitudinal groove of prosternum as deep as or deeper than wide; respiratory tube longer than abdomen; body length 32 to 38 mm. ---------- *buenoi*, p. 107
   Prosternal groove shallow, more or less convex at middle and with a depressed line on each side; respiratory tube shorter than abdomen; body length 20 to 32 mm ---------- *nigra*, p. 108
4. Juga wider than, and distinctly elevated above, tylus; body length 32 to 37 mm ---------- *australis*, p. 109
   Juga narrower than tylus and not elevated above it ---- 5
5. Front femur stout; eyes little if any wider than interocular space; body length 32 to 42 mm -- *fusca*, p. 106
   Front femur slender; eyes large, wider than interocular space; body length 35 to 45 mm -- *drakei*, p. 110

RANATRA KIRKALDYI Torre-Bueno (Fig. 13c & i)

Ranatra kirkaldyi Torre-Bueno, 1905a; Hungerford, 1922b; Blatchley, 1926: Herring, 1951; Froeschner, 1962.

Description: Color brownish-yellow to fuscous-brown; legs annulated with dark brown. Antennae simple, without lateral prolongations, ultimate and penultimate segments often fused. Front femora shorter and stouter than in other species, not narrowed near submedian tooth. Length of body 23 to 32 mm.

Distribution: This species has been recorded from Massachusetts, New York, North Carolina, Florida, Indiana, Kansas, Ohio, Nebraska, Minnesota, and South Dakota, and specimens from South Carolina

are in the Clemson University Museum. Specimens from New Jersey, Maryland, and Missouri are also in the U.S. National Museum.

R. kirkaldyi has not previously been recorded from Virginia, but I have collected specimens from the following localities: Chesterfield County, 20 mi. S. of University of Richmond on U.S. Hwy. 1; Goochland County, 32 mi. E. of Charlottesville on U.S. Hwy. 250; Hanover County, 4.5 mi. S. of Ashland on U.S. Hwy. 1; Spottsylvania County, 29.5 mi. N. of Ashland on U.S. Hwy. 1.

In addition, I have specimens in my collection from Martin County, North Carolna, and Lexington County, South Carolina.

Habitat: My specimens were collected from mud and debris on the bottom of shallow waters of streams and from sparse aquatic vegetation in very shallow water of a pond.

Biology: The life history of *R. kirkaldyi* is not known. My Virginia specimens (all adults,) were collected in May and June; my North Carolina specimens, in August; and my South Carolina specimens, in September.

Remarks: Within the family, this species has been collected in association with *R. buenoi* in South Carolina, but alone in Virginia.

RANATRA FUSCA **Palisot de Beauvois** (Fig. 13d & h)

Ranatra fusca Palisot de Beauvois, 1805; Torre-Bueno, 1903b, 1905e; Hungerford, 1919, 1922b; Blatchley, 1926; Abbott, 1940; Froeschner, 1962.

Description: Color fuscous-brown. Pronotum with cephalic portion distinctly less than twice the length of the thickened caudal portion. Prosternum with a wide, shallow median groove. Front femora moderately short and broad, with subapical cleft on opposite margin. Length of body 35 to 42 mm.

Distribution: This species has been recorded from New York, New Jersey, North Carolina, Florida, Texas, Kansas, Indiana, Minnesota, Colorado, South Dakota, and Quebec; and there are additional specimens in the U.S. National Museum from Kentucky, Missouri, Pennsylvania, Maryland, Wyoming, Michigan, Iowa, and the District of Columbia.

The species has not previously been recorded from Virginia, but I have collected specimens from the following localities: Charlotte County, pond on St. Hwy. 47 about 1 mi. N. of Cullen; Giles County, roadside ditch with permanent standing water, 6 mi. W. of Narrows; Mecklenburg County, pond 4 mi. W. of Clarksville on U.S. Hwy. 58; Russell County, pond midway between Honaker and Drill; Wise Coun-

ty, pond on top of mountain at Rim Rock; City of Chesapeake, 3.5 mi. E. of U.S. Hwy. 17 on Co. Hwy. 740. In addition there are specimens in the Virginia Truck Experiment Station collection from the City of Chesapeake; and in the Old Dominion University collection, from Caroline County and from Virginia Beach.

Habitat: My specimens and those in the Truck Experiment Station collection were all taken from the debris and black ooze at the bottom of the waters of swamps and ponds.

Biology: The life history is not known. My specimens were collected in June in association with *R. buenoi.* Torre-Bueno (1903b) stated that, for food, *Ranatra fusca* does not depend upon insects that move swiftly by, but rather on the unwary ones that come to rest anywhere within reach of its rapacious claws. The food is approached very slowly. When the tibia are almost touching the victim, the capturing movement is so sudden and quick that it can hardly be observed.

RANATRA BUENOI **Hungerford** (Fig. 13e, g, & k)

Ranatra buenoi Hungerford, 1922b; Blatchley, 1926; Herring, 1951; Froeschner, 1962.

Description: Color dark brown to fuscous. Pronotum with cephalic portion twice the length of the swollen caudal portion. Prosternum with a single deep, broad, median longitudinal groove. Femora of front legs long and slender with submedian tooth nearer apex than base. Length of body 32 to 38 mm.

Distribution: This species has been recorded from North Carolina, Georgia, Florida, Louisiana, Mississippi, Texas, and Missouri, and there are specimens from South Carolina in the Clemson University Museum, and in the U.S. National Museum from Arkansas, Tennessee, and Virginia.

The species has not previously been recorded from Virginia, but I have taken it from the counties of Albemarle, Alleghany, Giles, Greene, King William, and Southampton, and from the City of Chesapeake and the City of Virginia Beach. Also, I have seen specimens in the VPI&SU collection from Montgomery County, in the Virginia Truck Experiment Station collection from Accomac County, and in the Old Dominion University collection from Henrico, Culpeper and Nansemond Counties and from the City of Chesapeake and the City of Virginia Beach.

In addition, I have specimens in my collection from Bertie, Columand Duplin counties, North Carolina, and Lexington County, South Carolina.

Habitat: My Virginia specimens were collected from streams, ponds, and swamps. They were taken from the mud and debris on the bottom and from among submerged aquatic vegetation.

Biology: The life history of this species is not known. Adult specimens from Virginia were collected in May, June, July, and October. One second instar nymph was collected in July, and 7 fifth instar nymphs in August; 15 adults were collected in North and South Carolina in August and September.

Remarks: Within the family, *R. buenoi* has been collected in association with *R. kirkaldyi* and *R. fusca*.

RANATRA NIGRA **Herrich-Schaeffer** (Fig. 13f & j)

Ranatra nigra Herrich-Schaeffer, 1853; Hungerford 1922b; Blatchley, 1926; Herring, 1951; Froeschner, 1962.

Description: Color brownish-yellow to fuscous. Prosternum with very shallow median longitudinal depression. Antennae with lateral prolongation of penultimate segment less than half that of ultimate. Front femora long and slender, narrowed distad of submedian tooth. Respiratory filaments shorter than abdomen. Length of body 29 to 32 mm.

Distribution: This species has been recorded from New York, Pennsylvania, Maryland, Virginia, West Virginia, Florida, Louisiana, Indiana, Kansas, Illinois, Arkansas, Minnesota, and Ontario; and there are specimens from South Carolina in the Clemson University Museum, and from Montana and New Mexico in the U.S. National Museum.

The species has previously been recorded from Virginia by Hungerford (1922b).

I have a total of 22 adults in my collection from Virginia which were collected from the following localities: Albemarle County, 1.5 mi. S. of Charlottesville on U.S. Hwy. 29, 2.5 mi. W. of intersection of U.S. Hwys. 250 and 29 at Charlottesville, and 3.0 mi. S.W. of Charlottesville on U.S. Hwy. 29; Giles County, 6 mi. W. of Narrows on U.S. Hwy. 460; Goochland County, 32 mi. E. of Charlottesville on U.S. Hwy. 250; Patrick County, pond on St. Hwy. 8, S. of Woolwine; Warren County, at Front Royal on St. Hwy. 12. Also, there are speci-

mens in the U.S. National Museum from Scott County, in the VPI&SU collection from the City of Chesapeake.

Habitat: This species has been collected in ponds and in the shallow waters of rivers. The majority of the specimens were found in the debris on the bottom.

Biology: The life history of *Ranatra nigra* is not known. My specimens were collected in May, July, August, September, October, November, and December, which indicates that they pass the winter as adults in the debris on the bottom of ponds or streams.

Remarks: *R. nigra* has not been found in association with any other members of the family.

RANATRA AUSTRALIS Hungerford

Ranatra australis Hungerford, 1923b; Blatchley, 1926; Herring, 1951; Froeschner, 1962; Cross, 1972.

Description: Dark fuscous to grayish-brown, front femora and tibiae with pale annulations. Elongate, rather slender. Diameter of an eye less than width of interocular space. Juga wider than and distinctly elevated above tylus when viewed from side. Anterior part of pronotum twice as long as thickened basal portion, the hind margin of latter broadly and shallowly emarginate. Median groove of prosternum wide and shallow. Front femora rather stout and without preapical cleft. Breathing tube longer than abdomen. Length of body 32 to 37 mm.

Distribution: This species has been recorded from Virginia to Florida and west to Kansas, Louisiana, and Texas.

R. australis has previously been recorded from Virginia, Accomac County (Cross 1972). From the City of Virginia Beach I have collected this species in Blackwater creek 8.3 mi. E. of Northwest on Co. Hwy. 610 during July and August, and there are a number of specimens in the Old Dominion University collection from the City of Virginia Beach and the City of Chesapeake. There is also one specimen in the VPI&SU collection from Brookgreen Gardens, South Carolina.

Habitat: This species has been collected from among water weeds of shallow ditches, along margins of ponds and lakes, and marshy situations of the coastal areas. It has also been collected from a salt marsh impoundment in Virginia.

Biology: The life history of this species is not known. Adult specimens were collected in Virginia during July, August, October, and November.

Remarks: The species was taken in association with *R. buenoi* and *R. drakei.*

RANATRA DRAKEI Hungerford

Ranatra drakei Hungerford, 1923b; Blatchley, 1926; Herring, 1951.

Description: Dull brownish-yellow, legs not annulated. Elongate and extremely slender. Eyes large, the diameter of an eye greater than width of interocular space. Juga more narrow, not elevated above tylus. Pronotum long and slender, apex of anterior portion but little wider than middle. Front femora long and slender with preapical cleft. Breathing tube long. Length of body 35 to 45 mm.

Distribution: This species has been recorded only from Florida and North Carolina. I have one specimen in my collection from Virginia. It was collected 5 mi. N. of Blackwater Bridge on St. Hwy. 190 in the City of Chesapeake. There are 5 specimens in the Old Dominion University collection from the City of Virginia Beach, the City of Chesapeake, and from Nansemond County.

Habitat: The species has been collected from the grassy edges of swamps and roadside ditches.

Biology: The life history of this species is not known. Adults were collected in Virginia during June, July, and November.

Remarks: The species has been collected in association with *R. australis.*

Family 11. PLEIDAE Fieber, 1851

Description: Minute, compact, strongly convex bugs somewhat resembling miniature notonectids and by some authors considered to belong in the Notonectidae. Head relatively large, directed ventrocaudad; rostrum short, 3-jointed. Elytra conjointly forming oval convex carapace closely fitted over abdomen, no trace of membrane. Legs subequal in length and appearance, tibiae and tarsi not flattened and ciliated along margins.

Distribution: Members of the family are represented in North and Central America, also in the West Indies.

Habitat: Pleids appear to prefer freshwater ponds in coastal and other lowland siutations, where they live among submerged aquatic plants and algae.

Remarks: Although traditionally included amongst the notonectids as a subfamily, pleids are now generally accorded separate family status and may, in fact, not be closely related to the Notonectidae. Brues, Melander & Carpenter, (1954) include the group at two places in their classification; first as a famliy in the series Coleorrhyncha of the Homoptera and secondly, as a family among the Cryptocerata of Heteroptera. Only the nominate genus is represented in eastern North America — and there by a single widespread species.

Genus *NEOPLEA* Esaki & China, 1928

Description: With the characters of the family.

Distribution: From New England west to Kansas, south and southwest to Florida, Mississippi, Texas, and southern California; also central and eastern Canada.

Habitat: As given for the family.

Remarks: The type is *Plea striola* Fieber. Elevated to generic rank, Drake & Maldonado-Capriles, 1956.

NEOPLEA STRIOLA (Fieber), 1844

This species has not been recorded from Virginia, but it is known from Pennsylvania. Brimley (1938) records it from Wilmington, North Carolina.

Family 12. NOTONECTIDAE Leach, 1815

Description: Small or medium sized aquatic forms, differing from all others in the persistent habit of swimming on their backs. Much deeper bodied than other aquatic Hemiptera and oval in form with apex of hemelytra conical. Eyes large, reniform, twice sinuated laterally, and project caudally to cover a small portion of cephalic margin of prothorax. Ocelli absent. Pronotum moderately convex, and narrower cephalically. Scutellum visible. Antennae with 3 or 4 segments, shorter than head, and partly concealed in depressions between head and thorax. Rostrum 3- and 4-segmented. Front and middle legs adapted for grasping, hind legs more or less flattened and fringed, thus modified for swimming. Tarsi 2- or 3-segmented. All legs with 2 tarsal claws, but inconspicuous on hind legs of

those species with well-developed swimming fringes. Venter of abdomen equipped with a median longitudinal carina flanked with hairs for closing over the 2 longitudinal troughs (laterad of carina), thus forming air chambers.

Distribution: The Notonectidae are cosmopolitan in distribution, having been recorded from North, Central, and South America, Asia, Europe, Africa, and Australia.

Habitat: The "backswimmers" inhabit ponds, swamps, pools, and quiet niches and backwaters of small streams and rivers. In these habitats they are found hanging from the surface film, head and back downward, resting while submerged in open water, or clinging to aquatic vegetation.

Remarks: Like most of the aquatic and semi-aquatic Hemiptera, the members of the family Notonectidae pass through five nymphal instars. These immature stages may be distinguished on the basis of a number of characters among which are relative size and the degrees of development of the wing pads (see figs. 14 d-h).

Key to Virginia Genera of *Notonectidae*

1. Scutellum almost as long or longer than hemelytral commissure (Fig. 14a) ---------- *Notonecta*, p. 112
   Scutellum about one-half as long as hemelytral commissure, with pit at anterior end of commissure (Fig. 14i) ---------- *Buenoa*, p. 122

Genus *NOTONECTA* Linnaeus, 1758

Description: This genus contains the most common and best known species of the family. Length 8.0 mm. or more. Front margin of pronotum with no cephalomedian projection between eyes. Hemelytra clothed with short, flattened hairs. Hemelytral commissure without pit at anterior end. Lateral margin of pronotum compressed dorso-ventrally into a keel. Sides of thorax densely clothed with rather long hairs. Both antennae and rostrum 4-segmented. Ultimate antennal segment much shorter than penultimate.

Distribution: This genus is well represented in the Western Hemisphere, Europe, North Africa, and Asia, but it appears to be absent from the East Indian Archipelago, New Zealand, Tasmania, Philippine Islands, Hawaii, and other Pacific Island groups.

Habitat: The species of *Notonecta* inhabit pools, swamps, ponds, and quiet niches and backwaters of streams. Some species prefer open water, others the shelter of aquatic vegetation, and still others the dark shadowy places beneath overhanging bushes.

Remarks: The nymphs of the genus *Notonecta* may be distinguished from those of *Buenoa* by the following diagnosis: middle femur stout with spur near distal end in the third to fifth instars. Antennae 3-segmented. Venter of abdomen whitish or spotted with brown, and flanked with hairs on all segments, except in first instar.

Key to Virginia Species of *Notonecta*

1. Mesotrochanter plainly angulate (Fig. 14b) ---------- 2
   Mesotrochanter rounded or nearly so (Fig. 14c) ------ 3

2. Interocular space at posterior margin of vertex very narrow, not more than 1/6 the interocular space at anterior margin; hemelytra brick-red to orange with black blotch on corium; length 10 to 12 mm. ---------- *uhleri*, p. 118
   Interocular space at posterior margin of vertex more than 1/6 that of anterior margin; hemelytra usually pale yellow but sometimes smudged with black; length 8 to 9 mm. ---------- *raleighi*, p. 114

3(1). Large, 13 mm. or more; color dark, with no white markings dorsally; scutellum black, hemelytra irrorated with brown and blue-black ---- *irrorata*, p. 119
   Smaller, less than 13 mm.; color not dark, always with some white markings ---------- 4

4. Male: anterior trochanter with a prominent, stout suberect spine on inner vertical margin; female; last abdominal sternite with median apical notch, when present, distinctly broader than deep; length 10 to 11 mm. ---------- *indica*, p. 121
   Male: anterior trochanter with tooth on inner vertical margin smaller and less erect than in *indica;* female: last abdominal sternite with median apical notch deeper than broad; length 10.5 to 12.6 ---------- *undulata*, p. 116

NOTONECTA RALEIGHI Torre-Bueno

Notonecta raleighi Torre-Bueno, 1907b; Hungerford, 1933; Rice, 1942.

Description: Anterior outline of head somewhat rounded, vertex and eyes in almost an even curve. Vertex slightly longer than its anterior width, anterior margin subequal to frontal margin of eye. Pronotum wider than long and slightly longer than head, lateral margins straight. Mesotrochanter angular. Color pale yellowish throughout or with scutellum black except for pale lateral margins, and hemelytra more or less smudged with black. Our smallest North American species. Length 8 to 9 mm.

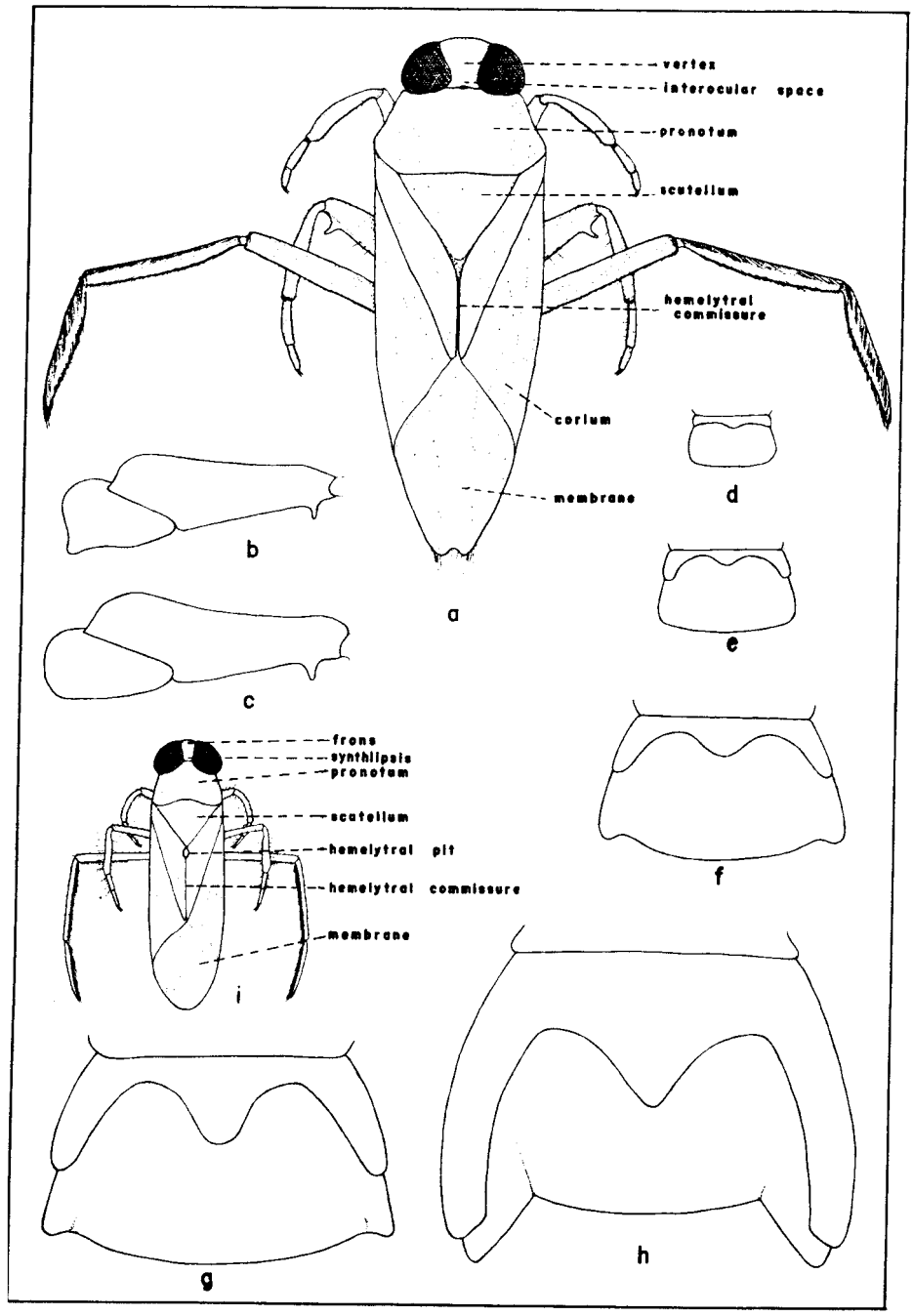
Distribution: This species was described from Raleigh, North Carolina, and has been reported from New York, New Jersey, Maryland, District of Columbia, North Carolina, South Carolina, Indiana. Illinois, and Michigan.

N. raleighi has not been previously reported from Virginia. I have collected this species from the following localities: Accomac County, on St. Hwy. 658 about 4 mi. S. of junction with St. Hwy. 661; Albemarle County, 2 mi. S. of Charlottesville on U.S. Hwy. 29 and old golf course pond (now filled) at University of Virginia; Alleghany County, pond at Griffith (R. L. Hoffman) ; Fluvanna County, 3 mi. S. of Zion Crossroads on U.S. Hwy. 15; Lancaster County, 15 mi. S. of U.S. Hwy. 360 on St. Hwy. 200; City of Chesapeake, 5.7 mi. E. of Northwest at intersection of Co. Hwys. 609 and 610. In addition, I have seen a large number of specimens in the Old Dominion University collection from the counties of Nansemond, Fauquier, Caroline, New Kent, and from the City of Chesapeake.

Habitat: *N. raleighi* has been taken in ponds, quiet reaches of streams, and in still water of a coastal creek where it was found in vegetational zones near the shore, or shallow ponds with abundant aquatic vegetation.

Figure 14.

a. Adult of *Notonecta undulata* Say
b. Mesotrochanter and femur of *Notonecta uhleri* Kirkaldy
c. Mesotrochanter and femur of *Notonecta undulata* Say
d. Wing pads of first instar nymph of *Notonecta undulata* Say
e. Wing pads of second instar nymph of *Notonecta undulata* Say
f. Wing pads of third instar nymph of *Notonecta undulata* Say
g. Wing pads of fourth instar nymph of *Notonecta undulata* Say
h. Wing pads of fifth instar nymph of *Notonecta undulata* Say
i. Adult of *Buenoa margaritacea* Torre-Bueno


vertex
interocular space
pronotum
scutellum
hemelytral commissure
corium
membrane
a
b
c
d
e
f
g
h
i
frons
synthlipsis
pronotum
scutellum
hemelytral pit
hemelytral commissure
membrane

Biology: Rice (1942) published the life history of *N. raleighi* in Tennessee and stated that this species winters as an adult. The eggs are glued to stems and leaf surfaces of plants, and hatch in 8 to 10 days, and the 5 nymphal instars are completed in about 40 days. The greatest number of nymphs are present in June; a few are seen as late as August, so it is probable that there is but one generation per year. Rice gives the following measurements for the immature stages: egg, 1.39 mm. long, 0.45 mm. wide at anterior end, and 0.27 mm. wide at posterior end; first instar, 1.66 mm. long and 0.77 mm. wide; second instar, 2.16 mm. long and 0.96 mm. wide; third instar, 2.16 mm. long and 1.38 mm. wide; fourth instar, 4.21 mm. long and 1.78 mm. wide; fifth instar, 5.6 mm. long and 2.5 mm. wide.

Adults have been collected in Virginia from February to December.

Remarks: The legs of nymphs are conspicuously banded with brown. This species has not been taken in association with any other members of the family Notonectidae.

NOTONECTA UNDULATA **Say** (Fig. 14a, c, d-h)

Notonecta undulata Say, 1832; Hungerford, 1917a; Bare, 1926; Clark, 1928; Hungerford, 1933; Statzman, 1934.

Description: Anterior outline of head as viewed from above somewhat rounded; vertex about as long as its anterior width; anterior margin of vertex slightly less convex and wider than frontal margin of eye. Pronotum less than twice as long as head, lateral margins straight and moderately divergent; anterior angles slightly embracing eyes. Mesotrochanter rounded. Color typically black and white, but dorsal coloration exceedingly variable. Posterior part of pronotum darkened by the underlying black mesonotum. Scutellum black. Hemelytra white with an undulate transverse black band across apex of corium and base of membrane. Length 11 to 12 mm.

Distribution: *N. undulata* is a widely distributed species, having been recorded from a total of 34 states, Mexico, Central America, Chile, and the majority of the provinces of Canada.

In Virginia this species has previously been recorded from Warrenton, Fauquier County, June 7, 1928 (Hungerford 1933).

I have more than 800 specimens of *N. undulata* in my collection from Virginia. In addition, I have examined specimens in the collections of Virginia Truck Experiment Station, Virginia Department of Agriculture, and the U.S. National Museum. The species

appears to be common in Virginia and has been taken in most counties and from all physiographic provinces.

Habitat: This species is primarily an inhabitant of ponds; however, it has been observed in littoral zones of large lakes in other states. Occasionally it has been found in sluggish streams, but since it has never been observed to breed in such situations, it is probable that these have been instances of temporary "stop-overs" in migration. It seems to be able to adapt itself to a wide range of conditions, for it has been found breeding in very small spring-fed pools, stagnant muddy ponds, and clearwater ponds, with or without aquatic vegetation. It rests at the surface more than any other Virginia notonectid.

Biology: Its life history has been discussed in the United States by Hungerford (1917a and 1933), working in Kansas and New York, and Bare (1926) in Kansas, and in Canada by Clark (1928) at Winnipeg. The pearly white eggs are glued to submerged plant stems, sticks, rocks, and other objects. Hungerford stated that the egg stage lasts 5 to 14 days, depending upon the temperature. There are 5 nymphal instars, the first 4 lasting 7 days, and the fifth, 12 days. He gives the following measurements for the immature stages: egg, 1.75 mm. long and 0.55 mm. wide; first instar, 2.13 mm. long and 1.06 mm. wide; second instar, 3.1 mm. long and 1.41 mm. wide; third instar, 4.66 mm. long and 2.0 mm. wide; fourth instar, 6.16 mm. long and 2.75 mm. wide; fifth instar, 8.5 mm. and 3.5 mm. wide.

N. undulata seems to feed on any organisms which it can overpower, such as beetles, grasshoppers, mosquito larvae, ostracods, corixids, and even other members of its own species.

Hungerford (1933) stated that in Kansas there are two main broods each year, and Bare (1926) stated that "several times nymphs in the fourth and fifth instars have been taken in November, and it is quite possible that in Kansas and farther south there are as many as three generations in a season." Adult males and females have been collected during each month of the year in Virginia. When the seasonal data are analyzed they indicate that there are two broods, and perhaps a third, each year. The majority of the first brood eggs hatch in mid-May and the nymphs reach the adult stage in early July. Second brood adults emerge in late August, and it appears that some of these deposit eggs for a third brood, the adults of which emerge in late October. A weak spot exists in the seasonal collecting data, in that only a few collections were made

during September and the numbers of adults and nymphs recorded should be increased approximately five times so that numbers in September would be comparable with those of the other months.

The adults spend the coldest part of the winter in mud and among debris and dead leaves at the bottom of the pond. They do not remain dormant in Virginia throughout the winter, however, and may often be seen slowly swimming under ice. Statzman (1934) stated that he has seen them actively swimming at Reading, Pa., at a temperature of 2 to 5 degrees centigrade. Clark (1928) stated that he found adults hibernating 10 to 13 cm. deep in the mud and debris at the bottom of pools in Canada.

Remarks: The legs of the nymphs of *Notonecta undulata* are concolorous. This species has been taken in association with the following species of the family *Notonectidae*: *Notonecta uhleri, N. irrorata,* and *Buenoa margaritacea.*

NOTONECTA UHLERI **Kirkaldy** (Fig. 14b)

Notonecta uhleri Kirkaldy, 1897; Hungerford, 1919, 1933; Rice, 1942.

Distribution: Anterior outline of head as seen from above slightly convex, vertex longer than its anterior width; anterior margin of vertex narrower than frontal margin of eye. Head shorter than length of pronotum. Pronotum much wider than long. Lateral margins of pronotum strongly divergent and moderately concave. Mesotrochanter angular (Fig. 14b). Color orange to brick-red and black. A dark linear longitudinal band usually present on pronotum behind the dorsal caudolateral margin of eye. Scutellum black. Hemelytra orange to brick-red; corium crossed by broad irregular black band extending from near tip of clavus to costal margin. Hemelytra clothed with silvery hairs. Length 10 to 12 mm.

Distribution: This species has been recorded from Massachusetts, New York, New Jersey, Rhode Island, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Louisiana, Missouri, and Illinois.

In Virginia *N. uhleri* has previously been recorded from Norfolk by Hungerford in 1932. I have only three specimens, two females and one male, in my collection from Virginia. These were collected from the following localities: Albemarle County, "Old Reservoir" at University of Virginia; and City of Chesapeake, 3.5 miles E. of U.S. Hwy. 17 on County Hwy. 740. In the insect collection at Old Dominion University there are 27 specimens of this species from

the following localities: Caroline, Greenville, Nansemond, New Kent counties and the City of Chesapeake and City of Virginia Beach. The majority of the specimens were collected from the Dismal Swamp. In addition, I have specimens from Barnwell, South Carolina, collected by Dr. H. H. Hobbs, Jr., August 16, 1947.

Habitat: The members of this species apparently inhabit ponds and swamps, where at times they rest on roots and vegetation below the surface of the water.

Biology: The life history of this species is not known. Rice (1942) described a fifth instar nymph and stated that the nymphal stages of this species were abundant in shallow pools in the grass and smartweed zones of Reelfoot Lake, Tennessee, but that the adults migrated to the deeper parts of the lake. There is but one generation per year. I have collected adults in June, October, and December, and it is probable that this species overwinters as adults.

Remarks: *N. uhleri* has been collected in associated with the following members of the family Notonectidae: *N. undulata, N. irrorata,* and *Buenoa margaritacea.*

NOTONECTA IRRORATA Uhler

Notonecta irrorata Uhler, 1878; Hungerford, 1919; Rice, 1942.

Description: Anterior outline of head as seen from above somewhat flattened; vertex with anterior width equal to its length; anterior margin of vertex less convex and a little narrower than the frontal margin of an eye. Length of pronotum more than twice that of head; anterior angles not embracing eyes; lateral margins divergent and nearly straight. Mesotrochanter rounded. Color mottled brown and blue-black, the brown usually predominating on the clavus, and the black on the corium; membrane black. A large species; length 13 to 15.5 mm.

Distribution: *N. irrorata* is widespread over the United States, but has not been recorded from the states west of a line extending from Texas to Montana.

In Virginia, this species has previously been recorded from "Chain Bridge," Arlington County, September 3, 1906, Great Falls, Fairfax County, May 22, 1906 (Hungerford 1933), and Amherst, Amherst County, (Rice 1942).

I have collected specimens from the counties of Albemarle, Alleghany, Augusta, Carolina, Fluvanna, Gloucester, Hanover, Isle of

Wight, James City, King William, Mathews, Middlesex, Northumberland, Pittsylvania, and Surry, and from the cities of Chesapeake, Hampton, and Virginia Beach.

In addition, from the collection of the Virginia Truck Experiment Station, I have examined three specimens bearing the label: "Norfolk, 2-6-38, in flight," and there are 32 specimens in the Old Dominion University collection from New Kent, Hanover, Greenville, York, Southampton, and Richmond counties, and the City of Chesapeake and the City of Virginia Beach. There is also one specimen in the VPI&SU collection from Nansemond County.

Habitat: *N. irrorata* breeds in pools, slow-flowing streams, swamps, ponds, and roadside ditches, but after the breeding season the adults migrate to deeper waters of ponds and lakes. In the breeding habitats it prefers the shadows of the bank among the aquatic vegetation to which it clings.

Biology: Hungerford (1919) gave the life history of this species at Ithaca, New York, and Rice (1942) added a few additional notes on the biology in Virginia, Tennessee, and Kentucky. Hungerford stated that this species is the most interesting of all members of the genus in this country with regard to the matter of oviposition. The elongate, oval eggs are inserted in the tissues of plants, instead of being glued to the plant stems as are the eggs of all other species of *Notonecta*. He says that the egg stage is comparatively long—some 2 or 3 weeks, or even longer—but Rice stated that the egg stage probably lasts 8 to 10 days. One female contained 252 ova, according to Hungerford. There are 5 nymphal instars and Hungerford gives the following measurements for the immature stages: egg, 1.51 mm. long and 0.57 mm. wide; first instar, 2.3 mm. long and 0.99 mm. wide; second instar, 3.27 mm. long and 1.5 mm. wide; third instar, 3.51 mm. long and 2.21 mm. wide; fourth instar, 7.0 mm. long and 3.12 mm. wide; fifth instar, 10.6 mm. long and 5.1 mm. wide.

Unlike the adults, the older nymphs spend considerable time at the Surface of the water like N. *undulata*. Rice (1942) stated that, in Virginia and Kentucky, the life cycle from hatching of the eggs to adults requires about 60 days. She found eggs in Virginia on April 14 and these hatched on April 20. Like other members of the genus *Notonecta*, this species is predaceous and feeds on a variety of different insects, and Torre-Bueno (1905a) stated that they can destroy small fish. I put several adults in an aquarium with goldfish and both seemed to fare well together for a few days, but as the

bugs became hungrier they attacked and killed 3 of the goldfish in rapid succession. The fish were 2 to 3 inches long.

I have collected adults throughout the year, but nymphs have only been collected during May and June. The adults pass the winter in deep ponds, lakes, and swamps.

Remarks: The nymphs of this species can be distinguished from all others in Virginia by the dark smoky coloration and the large size. *N. irrorata* has been collected in association with the following members of the family Notonectidae: *N. undulata., N. uhleri,* and *Buenoa margaritacea.*

NOTONECTA INDICA Linnaeus

Notonecta indica Linnaeus, 1771; Torre-Bueno, 1905a; Hungerford, 1933; Rice, 1942.

Description: Head more than one-half the length of pronotum. Lateral margins of pronotum but slightly divergent on anterior two-thirds, then divergent, making the lateral margins appear concave; anterior angles embracing the eyes. Vertex as long or slightly longer than its anterior width; anterior margin of vertex less convex and narrower than frontal margin of eye. Mesotrochanter rounded. Color variable from white to nearly black. Typical color black and white; both scutellum and broad band covering distal end of corium and basal two-thirds of membrane black. Length 10 to 11 mm.

Distribution: Torre-Bueno (1905a) stated that *N. indica* is peculiarly a subtropical form which is found in the warmer portion of the South and West. Hungerford (1933) says that "this is one of the few species common to both North and South America. Its range extends across the southern United States south of 37° latitude. I have seen but one collection north of this line. This is from Maryland, which indicates that east of the Allegheny Mountains it extends northward to include Maryland." As will be seen below, all my specimens are from the extreme southeastern part of Virginia. The species has been recorded from Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Mississippi, Louisiana, Kentucky, Tennessee, Arkansas, Texas, New Mexico, Arizona, California, Mexico, Guatemala, Colombia, Cuba, Jamaica, Puerto Rico, St. Thomas, and St. Croix.

In Virginia, *N. indica* has been reported from Amherst, Amherst County (Rice 1942). Although I have collected in this region, I did not encounter this species; confirmation of the record seems indicated, as it is out of the known or expected range.

I have 10 females, 1 male, and 17 nymphs of this species in my collection from the following localities in Virginia: Nansemond County, 2.4 miles E. of Suffolk on U.S. Hwy. 58; City of Chesapeake, 6.5 miles E. of Suffolk on U.S. Hwy. 58; Surry County, 22 miles N. of Bacon's Castle on St. Hwy. 10. In addition, there are 9 specimens from the City of Virginia Beach in the Old Dominion University collection.

Habitat: This species is at home in swamps, borrow pits, and roadside ditches with abundant emergent vegetation. It seems to prefer the shallow waters of such sites to the deeper water of ponds and lakes.

Biology: Very little is known of the life history of this "backswimmer," since it has been confused with *N. undulata* in most collections and reports (see Hungerford 1933: 113). Rice (1942) stated that the pearly white eggs which measure 1.8 mm. long and 0.495 mm. wide are glued to the surface of weed stems, grass, and sticks. They hatch in 8 to 25 days, depending upon the temperature. Eggs which she collected at Amherst, Virginia, hatched in 8 to 10 days, and it took 40 to 60 days to pass through the five nymphal instars. Of the nymphs which I collected in early June, 1949, 11 were in the fifth, 2 in the fourth, 1 in the third, and 3 in the second instar.

Remarks: The legs of the nymphs *N. indica* have one brownish band. This species has been taken in association with the following species of the family Notonectidae: *Buenoa margaritacea* and *B. confusa*.

Genus *BUENOA* Kirkaldy, 1904

Description: Small (less than 9.0 mm. in length), slender-bodied "backswimmers." Front margin of pronotum with a strong, acute cephalomedian projection between eyes. Hemelytra subhyaline, allowing transmission of hues of underlying parts. An oval depression, the hemelytral pit, at anterior end of the hemelytral commissure. Lateral margins of prothorax not distinctly keeled. Sides of thorax naked. Both antennae and rostrum 3-segmented. Ultimate antennal segment longer than penultimate. Front femur of males usually with a well-defined stridulatory area on inner surface, varying in shape and number of ridges. Tarsi 2-segmented.

Distribution: The genus is limited to the Neotropical region and southern parts of the Nearctic. The geographical range extends from Canada, through the United States, Mexico, Central America, South America and the West Indies.

Habitat: The species of *Buenoa* are found mostly in freshwater pools, lakes, and ponds. A few species inhabit the shores of slow- and fast-moving streams. The majority of species occur in open water, but some may be found with aquatic vegetation.

Remarks: The nymphs may be distinguished from those of the genus *Notonecta* by the following diagnosis: Middle femora slender, without spur near apical end. Antennae 2-segmented. Venter of abdomen solid brown to black, strongly keeled; keel without hairs except for a group on first segment.

Key to Virginia Species of *Buenoa*

1. Synthlipsis wide, about one-half anterior width of vertex; scutellum as long as or longer than pronotum, one-half or more the length of hemelytral commissure ---------- 2
   Synthlipsis narrow, less than one-half anterior width of vertex; scutellum shorter than pronotum, one-third the length of hemelytral commissure ---------- 3
2. Front femur with long, conspicuous, sword-shaped stridulatory area with more than 40 sclerotized ridges; front femur not accuminate at apex ---------- *scimitra*, p. 126
   Front femur with small, subtriangular to oval stridulatory area with less than 25 sclerotized ridges; front femur accuminate at apex --- *margaritacea*, p. 124
3(1). Pronotum strongly inflated with median length equal to humeral width; greatest width of head less than six times the anterior width at vertex; more than 6 mm. in length ---------- *limnocastoris*, p. 126
   Pronotum not strongly inflated, with median length not more than three-fourths the humeral width; greatest width of head six or more times the anterior width at vertex; less than 6 mm. in length ---------- *confusa*, p. 125

BUENOA MARGARITACEA **Torre-Bueno** (Fig. 14i)

Anisops platycnemis Uhler, 1884 (*nec* Fieber, 1851); *Buenoa margaritacea*, Torre-Bueno, 1908; Hungerford, 1971b, 1919; Bare, 1926, 1928.

Description: Pronotum of male as long as scutellum, with an oblong depression on each side of a median carina, and a broader triangular depression laterad of the oblong depression. Pronotum of female slightly shorter than scutellum and with only a vague median carina. Color above, pearly white to pale straw-yellow. Scutellum orange-yellow. Corium and clavus concolorous with rest of dorsum. Length 6.1 to 8.2 mm.

Distribution: This species has been recorded in the United States from Vermont to Minnesota and South Dakota, and south to Florida, New Mexico, and Arizona. It also occurs in Canada and Mexico.

B. margaritacea has previously been recorded in Virginia from "Great Falls, 1-9-06" and "Vienna, 9-19-31," both Fairfax County. I have collected the species from the following counties: Accomac, Albemarle, Charlotte, Clark, Giles, Montgomery, Shenandoah, Smyth, Surry, and Washington. In addition, I have examined specimens from the City of Virginia Beach in the Old Dominion University collection.

Habitat: This species prefers ponds, especially those in live-stock pastures, and roadside pools where algae and other aquatic vegetation are abundant. It is seldom seen at the surface of the water, but suspended several inches below the surface.

Biology: Hungerford (1919) stated that the elongate oval, pearly white eggs are deposited in floating plant steams and measure 1.125 mm. long and 0.406 mm. in diameter. He gives the following measurements for the five nymphal instars: first instar, 1.85 mm. long and 0.625 mm. wide; second instar, 2.25 mm. long and 0.702 mm. wide; third instar, 3.225 mm. long and 0.938 mm. wide; fourth instar, 4.5 mm. long and 1.625 mm. wide; fifth instar, 5.75 mm. long and 2.3 mm. wide. Bare (1926) gave the total period of development for the egg and five instars as 52 to 71 days. The egg stage lasts 10 to 13 days, first instar 4 to 7 days, second instar 5 to 8 days, third instar 7 to 12 days, fourth instar, 12 days, fourth instar, 12 days, and the fifth instar 14 to 17 days. Hungerford (1917b) stated that they feed largely upon Entomostraca, but Bare (1926) has seen both adults and nymphs feeding greedily upon the larvae and pupae of mosquitoes. I have adults collected from ponds in June, July, and August, and fourth and fifth instar nymphs taken in August. The

adults spend the winter in the mud and leaves on the bottom of the ponds, but have been seen in January swimming in a pond beneath one foot of ice (Bare, 1926). Statzman stated that he has seen them simming at Reading, Pa. at a temperature of 3° to 5°C.

Remarks: This species has been taken in association with the following species of the family Notonectidae: *Buenoa confusa*, *Notonecta irrorata*, *N. undulata*, and *N. uhleri*. Superfically this species resembles *B. scimitra*, but there are distinct differences in the male.

BUENOA CONFUSA Truxal

Anisops elegans, Fieber, 1851; Uhler, 1894; *Buenoa elegans*, Torre-Bueno, 1908; Van Duzee, 1917; Hungerford, 1919; Bare, 1926; Blatchley, 1926; *Buenoa confusa* Truxal, 1953.

Description: Pronotum of male one-fourth longer than scutellum, with a narrow central depression divided by a vague median carina. Pronotum of female scarcely longer than scutellum, its disk with a feeble median carina. Color above pale straw- or whitish-yellow. Scutellum orange-yellow. Hemelytra usually with apical fourth of corium shining black, and a vague piceous stripe along outer margin of clavus. Length 5 to 5.5 mm.

Distribution: This species has been recorded from Manitoba, Canada, to Florida, the Cayman Islands, and the West Indies.

In Virginia, *B. confusa* has previously been recorded from Amherst County (Rice 1942) and Great Falls, Fairfax County, (Truxal 1953). The Great Falls specimen was macropterus. I have collected only 25 females in Virginia. These were collected from the following localities: Nansemond County, 2.4 miles E. of Suffolk on U.S. Hwy. 58, and Surry County, 22 miles N. of Bacon's Castle on State Hwy. 10. Confirmation of the Amherst County record would be desirable.

Habitat: This species seems to prefer the clear, shallow waters of ponds and pools.

Biology: Life history notes are given by Bare (1926). He reared three specimens from egg stage through the five nymphal stages to the adult. The total period of development was 42 to 52 days. The females kept laying eggs throughout the summer. Rice (1942) reared individuals which required from 45 to 55 days for total development. The egg stage lasts 10 to 12 days, and she states that the eggs are smaller and more chunky than those of *B. margaritacea*. Adults and

nymphs feed on small living organisms such as mosquito larvae and pupae, and entomostraca. They are very cannibalistic. My specimens were collected from clear water of a pond and pools on June 1, 1949.

Remarks: This species has been taken in association with the following members of the family: *B. margaritacea* and *Notonecta indica.*

BUENOA SCIMITRA Bare

Buenoa scimitra Bare, 1925, 1928; Blatchley, 1926; Truxal, 1953.

Description: Smaller and more slender than *B. margaritacea.* Straw-yellow in color without distinct blackish markings; eyes brown; scutellum orange-yellow; legs and sterna mostly pale, middle of ventrals, sides of dorsals, inner and outer faces of front femora and coxae and tarsal claws, blackish-brown. Head of male across eyes slightly wider than at base or between front of eyes; in female, less narrowed between front of eyes. Pronotum in dried specimens of male with vague depressions and a ridge each side; in females and fresh specimens of male, scarcely impressed. Claval orifice very small, about one-fifth the length of scutellum; commissure hirsute, one-third longer than scutellum. Males with stridular area of front femur as in key, very distinctive. Length 6.5 to 7.5 mm.

Distribution: This species has been recorded from Virginia to California and south to Mexico, Cuba, Jamaica, Puerto Rico, and the West Indies.

I have not collected *B. scimitra* in Virginia, but one male and one female were collected in Accomac County, "New Church — 7-15-34" by L. D. Anderson (Truxal 1953).

Habitat: Not known.

Biology: The life history of this species is not known.

BUENOA LIMNOCASTORIS Hungerford

Buenoa limnocastoris Hungerford, 1923b; Bare, 1925, 1928; Blatchley, 1926; Truxal, 1953.

Description: Interocular area wider than in *confusa;* dark markings more prominent, there being in addition to those on *confusa,* a rather large black or dusty spot on the sides of the pronotum; sides of prosterna and mesosterna and ventrals all dark brown, shining; beak, femora and hind tibiae each with a piceous stripe. Scutellum

horter than in *confusa*, one-half the length of pronotum, male, two-hirds, female. Claval orifice two-thirds the length of scutellum in oth sexes. Length 6.2 to 7.0 mm.

Distribution: This species has been recorded from Minnesota, Michigan, Maine, New Jersey, Virginia, Georgia, Florida, and Canada. In Virginia, *B. limnocastoris* has been collected at Virginia Beach y M. E. Griffith on 8-11-34.

Habitat: In shallow portions along shores of ponds.

Biology: The life history of this species is not known, but is probbly similar to that of *B. confusa*, to which it is closely related.

Family 13. NAUCORIDAE Fallen, 1814

Description: Oval, subdepressed insects having head wider than ong. Outer margin of eye continuous with margin of head, not prouberant. Membrane of hemelytra without veins. Pronotum smooth, hining, much broader than long. Scutellum broadly triangular. Ocelli absent. Antennae short, 4-segmented, concealed beneath eyes. Rostrum very short, acute, 3-segmented. Front legs raptorial, femora greatly enlarged; middle and hind legs slender, fitted for crawlng. Front tarsi 1-segmented, without claws; middle and hind tarsi hree-segmented with two long apical claws.

Distribution: The members of the family are known from Europe nd North Amercia.

Habitat: Species of this family inhabit ponds and quiet waters djacent to streams. They seem to abound where there is an abunance of aquatic plants.

Genus *PELOCORIS* Stal, 1876

Description: Eyes widely separated, their front margins convergng and inner margins sinuate. Front margin of pronotum slightly oncave behind each eye. Front tibia slender, curved, received in groove on underside of stout femora.

Distribution: Species of the genus are recorded from the Western Iemisphere.

Habitat: The members of the genus inhabit the same situations s that given for the family.

Key to Virginia Species of *Pelocoris*

1. Side margins of pronotum broadly flattened, without punctures. Median lobe of sixth ventral segment of female deeply cleft (Fig. 15b) ---------- *carolinensis*, p. 130

   Side margins of pronotum but feebly flattened with scattered shallow punctures. Median lobe of sixth ventral segment of female not cleft (Fig. 15a) ---------- *femoratus*, p. 128

PELOCORIS FEMORATUS **(Palisot de Beauvois)** (Figs. 15, a & c)

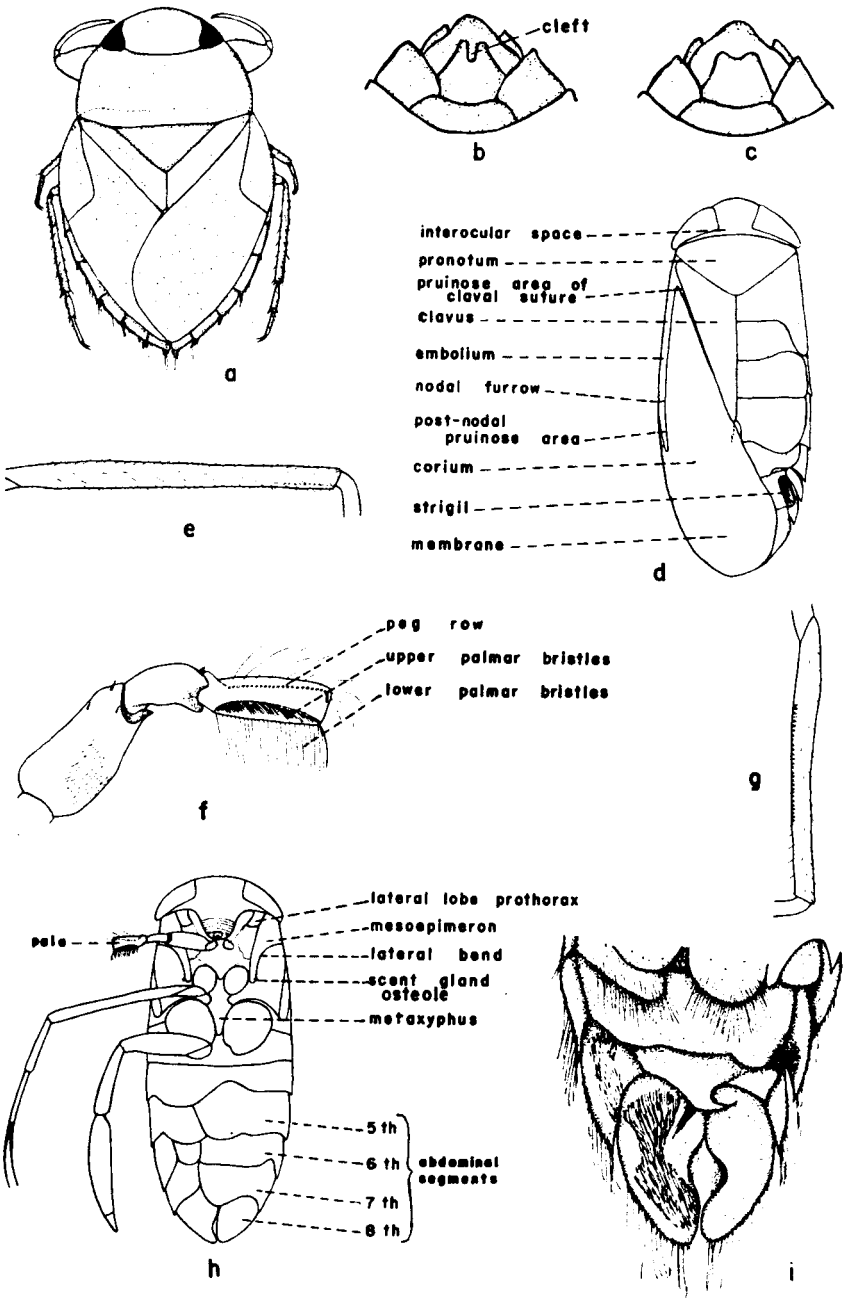
Naucoris femoratus Palisot de Beauvois, 1805; *Pelocoris femoratus*, Torre-Bueno, 1903; Hungerford, 1919; Blatchley, 1926.

Description: Broadly oval, subdepressed. Pronotum more than twice as wide as its median length; transverse impressed line across the basal fourth; middle of cephalic portion with triangular area marked with short, transverse, impressed lines. Scutellum and hemelytra very finely punctate. Head, cephalic portion of pronotum, and sometimes the scutellum dull greenish-yellow. Hemelytra, ventral surface, and usually the scutellum olive brown; clavus pale yellow. Legs and rostrum dull, greenish-yellow. Length 9 to 11.5 mm.

Distribution: This species has been reported from most of Eastern United States as far west as Kansas, also from Canada, Mexico, Guatemala, Panama, Cuba, Venezuela, Uruguay, and Colombia. *P. femoratus* has not previously been recorded from Virginia. In my

Figure 15.

a. Adult of *Pelocoris femoratus* Palisot de Beauvois
b. Sixth ventral segment of female of *Pelocoris carolinensis* Torre-Bueno
c. Sixth ventral segment of female of *Pelocoris femoratus* Palisot de Beauvois
d. Dorsal surface of male of *Hesperocorixa interrupta* Say
e. Femur of middle leg of *Palmacorixa buenoi* Abbott
f. Front leg of male of *Hesperocorixa interrupta* Say
g. Femur of middle leg of *Palmacorixa nana Walley*
h. Ventral surface of male of *Hespercorixa interrupta* Say
i. Caudodorsal segments of abdomen of male of *Palmacorixa buenoi* Abbott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cleft
b
c
interocular space
pronotum
pruinose area of claval suture
clavus
embolium
nodal furrow
post-nodal pruinose area
corium
strigil
membrane
d
e
peg row
upper palmar bristles
lower palmar bristles
f
g
lateral lobe prothorax
mesoepimeron
lateral bend
scent gland osteole
metaxyphus
pale
5 th
6 th
7 th
8 th
abdominal segments
h
i

collection from Virginia I have specimens from the following localities: Accomac County, 4 mi. S. of St. Hwy. 661 on St. Hwy. 658; Albemarle County, 0.4 mi. W. of intersection of U.S. Hwys. 250 and 29 on U.S. Hwy. 250; Dinwiddie County, 14.7 mi. S. of Petersburg on U.S. Hwy. 1; Goochland County, 34.7 mi. E. of Charlottesville on U.S. Hwy. 250; Lancaster County, 15 mi. S. of U.S. Hwy. 360 on St. Hwy. 200; Nansemond County, swamp below reservoir at city limits of Suffolk on U.S. Hwy. 58. In addition, I have examined 19 specimens in the collection of the Norfolk Truck Experiment Station taken in the City of Chesapeake, and 20 specimens in the Old Dominion University collection from Nansemond, New Kent, and Prince William counties and the City of Chesapeake.

Habitat: This species inhabits ponds and swampy pools where there is an abundance of emergent vegetation.

Biology: *P. femoratus* is a vigorous swimmer, and in the spring, may be seen swimming freely among the aquatic vegetation. When alarmed it hides in the soft ooze at the bottom of the pond or pool or among the weeds. The salivary secretion of these "bugs" is highly toxic.

Torre-Bueno (1903a) has published notes on the life history of this species. He gave the following measurements of the immature stages: egg, 1.4 mm. long and 0.6 mm. wide; first instar, 2.5 mm. long and 1.5 mm. wide; second instar, 3.25 mm, long and 2.0 mm. wide; third instar, 4.8 mm. long and 3.0 mm. wide; fourth instar, 6.5 long and 4.2 mm. wide; fifth instar, 8.3 mm. long and 5.5 mm. wide. Torre-Bueno stated that the imperfectly oval eggs are attached to stems of aquatic plants and require from 22 to 27 days to hatch, the average being 24 days. The first instar lasts 7 to 10 days, average 8; the second instar 6 to 9 days, average 8; third instar 8 days; fourth instar, 10 to 12 days, average 11; and fifth instar, 16 days. This gives a total time of development from egg to adult of 75 days. I have found eggs in late May and second- to fifth-instar nymphs in early July. My adults were collected in May, June, July, August, October, and November. The adults spend the winter in the mud and leaves on the bottom of the ponds.

* *PELOCORIS CAROLINENSIS* **Torre-Bueno** (Fig. 15b)

Pelocoris carolinensis Torre-Bueno, 1907b; Blatchley, 1926; Hungerford, 1927b.

Description: Closely resembles *P. femoratus,* but slightly smaller and more narrowed across head and pronotum. General color paler, the flattened margins of pronotum and embolium usually a pale

greenish-yellow. Median lobe of sixth ventral segment of female deeply cleft, male difficult to separate from *P. femoratus*. Length 8.3 to 9.6 mm.

Distribution: I have seen specimens of this species in the U.S. National Museum collection from North Carolina, South Carolina, Georgia, Florida, and Arkansas; in addition, it has been recorded from Kansas.

The species has not been collected in Virginia, although it seems probable that it should be present in the extreme southeast corner of the state, since it was described from Lake Ellis (Craven County), N. C., about 100 miles south of the state line. However, I have seen many specimens of *Pelocoris* in the insect collection at Old Dominion University from this section of Virginia, and all have been *P. femoratus*.

Habitat: This species inhabits ponds and swampy pools which have an abundance of aquatic vegetation.

Biology: The life history has been studied by Hungerford (1927b). The female glued the eggs to leaflets and stems of aquatic plants. The incubation period varied from 32 to 45 days. The nymphal stages required the following average number of days for development: first, 12; second, 11; third, 9; fourth, 11; fifth, 14; total 57. The total period from the deposition of the egg to the appearance of the adult varied from 88 to 102 days.

Family 14. CORIXIDAE Leach, 1815

Description: Small to medium-sized insects (2.8 to 11.4 mm.), somewhat flattened dorsoventrally, the head broad, triangular in front view, concave posteriorly and overlapping the cephalic margin of the prothorax. Rostrum apparently unsegmented and firmly attached to head. Eyes large, triangular in outline. Ocelli absent. Antennae short, 3- or 4- segmented, inserted beneath the eyes and hidden between the head and prothorax. Hemelytra parchment-like with clavus, corium, embolium, and membrane, the latter without veins and of same texture as corium. Front legs short with terminal segment variable in form, but often more or less spoon-shaped and fringed with strong bristles for gathering food; middle legs for anchorage and support, long and slender, the tarsal segment ending in 2 long claws; hind legs fairly stout, with 2-segmented tarsi that are flattened and fringed for swimming.

Distribution: The corixids are cosmopolitan and have been recorded from every continent.

Habitat: These insects are found in pools, ponds, backwaters of streams, and occasionally in slow-flowing streams. The majority live in fresh water but a few inhabit brackish waters. Some species prefer waters with an abundance of aquatic vegetation while others prefer more open waters. Often, extremely large numbers are found in their preferred habitat, and a number of different species may occupy the same pool.

Remarks: The members of the family Corixidae undergo five nymphal instars, as do the majority of the aquatic and semi-aquatic Hemiptera. The wing pads show plainly, beginning with the third instar. The nymphs have 2-segmented antennae, 1-segmented hind tarsi, and the pala and tibia of the front leg is a single segment.

Key to Virginia Genera of *Corixidae*

1. Males with sinistral asymmetry, and strigil on left; pala short, triangular, the tibia produced apically over the base of pala (Fig. 16q); females with apices of clavi not exceeding a line drawn through the coastal margins of hemelytra at the nodal furrows (Fig. 15d) ---------- *Trichocorixa*, p. 133

   Male with dextral asymmetry, and strigil on right; pala elongate, triangular or subparallel-sided, the tibia not produced apically over the base of the pala (Figs. 17d, 18k, 16a); females with apices of clavi exceeding a line drawn through the costal margins of hemelytra at nodal furrows ---------- 2

2. Interocular space much narrower than the width of an eye; hind wings usually rudimentary and nonfunctional; dorsomedian lobe of seventh abdominal segment of male bearing a hook-like projection (Fig. 15i) ---------- *Palmacorixa*, p. 142

   Interocular space as wide as or wider than the width of an eye; hind wings usually present; dorsomedian lobe of seventh abdominal segment of male without a hook-like projection ---------- 3

3. Male pala triangular, with a row of pegs near dorsal margin and another row in or near the upper palmar row of bristles; front tibia of male provided with a fleshy pad (Fig. 16a). -------- *Corisella*, p. 145

Male pala triangular or with subparallel sides, with row of pegs near dorsal margin (*Sigara pectenata* with pegs near upper palmar row of bristles); front tibia of male without a fleshy pad ---------- 4

4. Large, more than 7.0 mm.; pruinose area along claval suture very short, shorter than post-nodal pruinose area; pala of male subparallel-sided (Fig. 17d) ---------- *Hesperocorixa*, p. 146

Small, less than 7.0 mm.; pruinose area along claval suture as long as or longer than post-nodal pruinose area; pala of male triangular (Fig. 18o) ---------- *Sigara*, p. 157

Genus *TRICHOCORIXA* Kirkaldy, 1908

Description: Moderately small, elongate insects, never exceeding 5.7 mm. Hemelytra with scattered short, spinose setae and a varying number of long hair-like setae. Nodal furrow situated near end of embolar groove. Hind wings rudimentary, or fully developed. Front tibia produced apically over base of pala; the latter short, thick, triangular and with an oblique row of pegs on inner surface. Abdominal symmetry of male sinistral. Length 3.0 to 5.7 mm.

Distribution: The members of this genus have been recorded from North, Central and South America, from Bermuda, the Hawaiian Islands, and Shanghai, China. Sailer (*in* Hungerford 1948) stated that the species reported from China is "common in the Hawaiian Islands, and it seems most likely that it found its way from there across the Pacific by ships."

Habitat: Species of *Trichocorixa* inhabit quiet waters of streams backwater niches of rivers, ponds, swamps, and standing water in marshes. The majority remain on the bottom where they rest among the aquatic vegetation and in the mud and silt.

Key to Virginia Species of *Trichocorixa*

1. Length of pronotum about one-fourth its width ---------- *macroceps*, p. 138
   Length of pronotum one-third or more its width ---------- 2
2. Males ---------- 3
   Females ---------- 7
3. Apices of clavi not reaching a line produced through the costal margins of the two hemelytra at the nodal furrows ---------- *naias*, p. 139
   Apices of clavi reaching or exceeding a line produced through the margins of the two hemelytra at the nodal furrows ---------- 4
4. Left posterior lobe of abdomen with the lateral anterior angle produced to form a lobe, causing the lateral margin to appear concave at some region along its length ---------- *v. verticalis*, p. 140
   Left posterior lobe of abdomen with the lateral margin convex, often expanded from anterior lateral angle to apex ---------- 5
5. Strigil appearing as little more than a heavy dark line along lateral margin of left tergal lobe of sixth abdominal segment, and usually curved abruptly upward at the medial apex ---------- *calva*, p. 135
   Strigil normal, showing definite transverse comblike rows of teeth ---------- 6
6. Anterior and posterior margins of strigil parallel or nearly so ---------- *kanza*, p. 141
   Anterior and posterior margins of strigil not parallel, noticeably widened in lateral half ---- *louisianae*, p. 139

7(2). Nodal furrow appearing absent or at apex of embolar groove ---------- *naias*, p. 139
   Nodal furrow dividing the pruinose area of embolar groove into apical and basal portions ---------- 8
8. With a very noticeable tuft of hair at apex of each clavus ---------- *louisianae*, p. 139
   Without a tuft of hair, at most 2 or 3 setae ---------- 9
9. Length of polished area along costal margin of hemelytra anterior to nodal furrow equal to or less than the length of middle tibia -------- *v. verticalis*, p. 140
   Length of polished area along costal margin of hemelytra anterior to nodal furrow greater than the length of the middle tibia ---------- 10

10. Margins of polished prenodal area parallel or nearly so to apex, costal margin abruptly emarginate; venter of seventh abdominal segment with at least two patches of bristle-like setae on right side in region of spiracle ---------- *kanza*, p. 141

Margins of polished prenodal area not parallel, costal margin gradually emarginate anteriorly; venter of venter of seventh abdominal segment with no more than a slightly longer pubescence on the right side around spiracle ---------- *calva*, p. 135

TRICHOCORIXA CALVA (Say) (Fig. 16o & p)

Corixa calva Say, 1832; *Corisa burmeisteri*, Fieber, 1851; *Corixa burmeisteri*, Abbott, 1931b; Blatchley, 1926; *Trichocorixa burmeisteri*, Lundblad, 1931; *Trichorixa calva*, Sailer, in Hungerford 1948.

Description: Vertex of head strongly produced, projecting cephalic to the eyes for a distance equal to one fourth the length of head as seen from above. Pronotum slightly wider than long, smooth, with eight to nine dark transverse lines which are sometimes broken. Lateral lobe of prothorax elongate, rounded apically. Hemelytra smooth, coarsely reticulose; basal portion of clavus with pronounced oblique lines; slightly oblique, irregular lines tending to fuse on corium near apices of clavi and along lateroapical margin; in males the apices of clavi slightly exceeding a line produced through the costal margins of hemelytra at nodal furrows; apices of clavi not reaching such a line in females. Length 3.8 to 4.6 mm.

Distribution: This species has been recorded from 28 states, from New York to Florida and west to Arizona and the Dakotas.

T. calva has previously been recorded from Virginia by Sailer (in Hungerford 1948). Sailer gives the following locality records: Norfolk, and City of Chesapeake, July 4, 1931; Vienna, Fairfax County, September 19, 1931, New Church, Accomac County, July 10, 1934; Lake Drummond, Norfolk County, September 10, 1933.

I have almost 500 adults and nymphs in my collection from Virginia, collected from many counties in each of the physiographic provinces.

Habitat: I have collected this species from both small and large slow-flowing streams and from ponds, swamps, and drainage ditches. The majority of specimens have been collected from streams, with swamps being second in importance as a habitat. Specimens have sometimes been observed in great numbers along the bottom

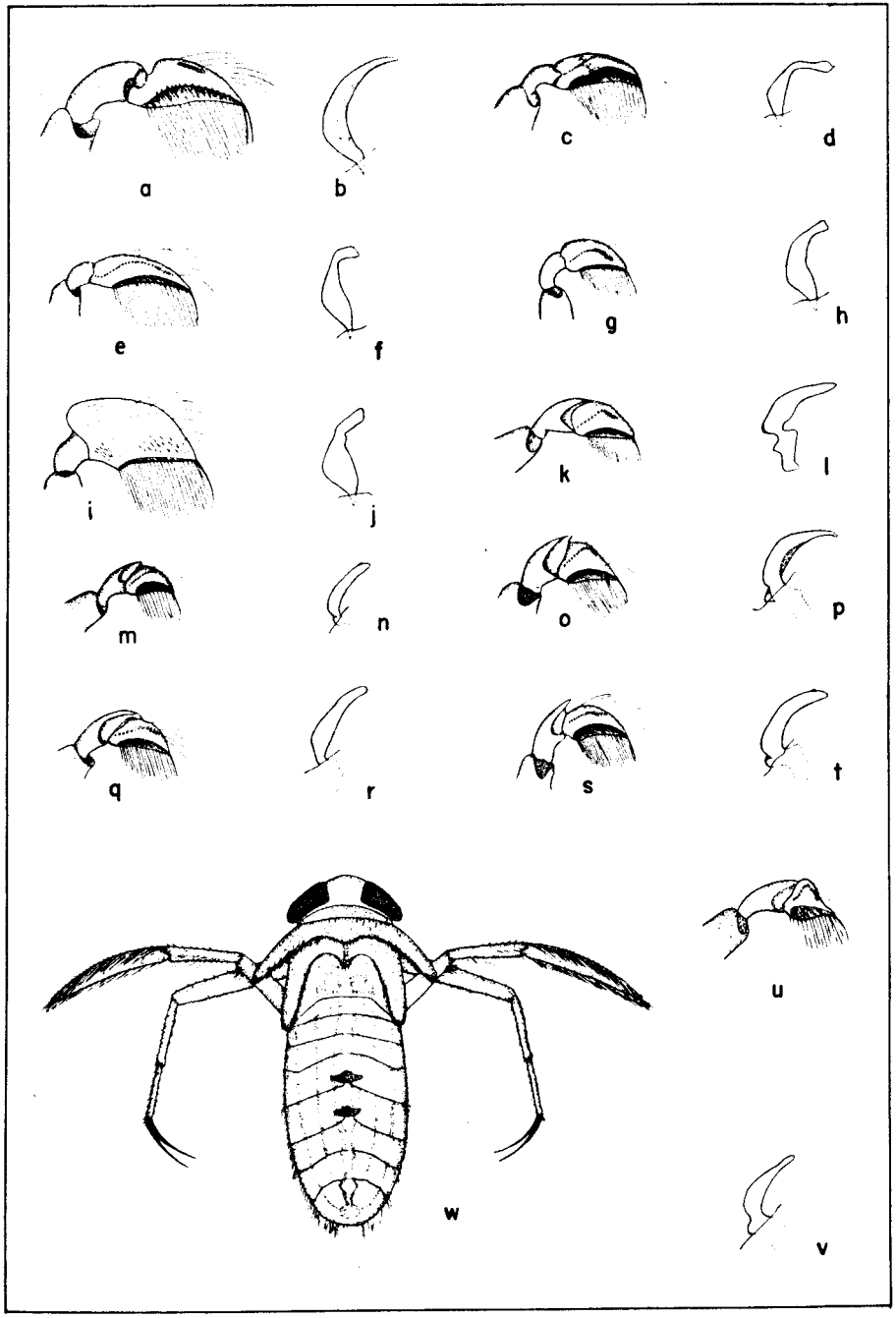
of shallow waters of streams clinging to watercress and other submergent plants.

Biology: The life history of this species has not been studied. It is possible that *T.calva* passes the winter as adults. In collecting, no attempt was made to take hibernating forms in the mud and debris on the bottom of the ponds and streams; this probably accounts for the fact that few winter collections are represented among my specimens. Breeding seems to be continuous from early May through August.

Remarks: Within the family Corixiae, *T. calva* has been collected in association with the following: *T. louisianae, T. macroceps, Sigara modesta, S. signata, S. alternata, S. pectenata, S. compressoidea, S. zimmermanni, S. hydatotrephes, Hesperocorixa interrupta,*

Figure 16.

a. Pala of male of *Corisella edulis* (Champion)
b. Right clasper of male of *Corisella edulis* (Champion)
c. Pala of male of *Sigara zimmermanni* (Fieber)
d. Right clasper of male of *Sigara zimmermanni* (Fieber)
e. Pala of male of *Palmacorixa buenoi* Abbott
f. Right clasper of male of *Palmacorixa buenoi* Abbott
g. Pala of male of *Palmacroixa nana* Walley
h. Right clasper of male of *Palmacorixa nana* Walley
i. Pala of male of *Palmacorixa gillettei* Abbott
j. Right clasper of male of *Palmacorixa gillettei* Abbott
k. Pala of male of *Trichocorixa louisianae* Jaczewski
l. Right clasper of male of *Trichocorixa louisianae* Jaczewski
m. Pala of male of *Trichocorixa macroceps* (Kirkaldy)
n. Right clasper of male of *Trichocorixa macroceps* (Kirkaldy)
o. Pala of male of *Trichocorixa calva* (Say)
p. Right clasper of male of *Trichocorixa calva* (Say)
q. Pala of male of *Trichocorixa naias* (Kirkaldy & Torre-Bueno)
r. Right clasper of male of *Trichocorixa naias* (Kirkaldy & Torre-Bueno)
s. Pala of male of *Trichocorixa verticalis verticalis* (Fieber)
t. Right clasper of male of *Trichocorixa verticalis verticalis* (Fieber)
u. Pala of male of *Trichocorixa kanza* Sailer
v. Right clasper of male of *Trichocorixa kanza* Sailer
w. Fourth instar nymph of *Sigara depressa* Hungerford.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H. nitida, H. minor, and *Palmacorixa buenoi.* With the majority of these species *T. calva* has been taken in association only once or twice, but it has been collected in association with *S. modesta* twenty times. This seems to indicate that either *S. modesta* and *T. calva* inhabit similar situations or the former has a very wide ecological tolerance.

TRICHOCORIXA MACROCEPS **(Kirkaldy)** (Fig. 16m & n)

Arctocorisa macroceps Kirkaldy, 1908; *Corixa macroceps,* Abbott, 1913a; Blatchley, 1926; *Trichocorixa macroceps,* Lundblad, 1931; Sailer, in Hungerford 1948.

Description: Vertex but slightly projected, rounded in front. Pronotum about four times wider than long; minutely rugose, with at most, three transverse dark lines. Lateral lobe of prothorax elongate, moderately narrow, anterior apical angle distinct. Hemelytra with markings tending to fuse into irregular longitudinal lineations, one along inner margin of corium, one along lateral margin of corium, and another along lateral margin of clavus. Hind wings vestigal. Length 2.8 to 3.2 mm.

Distribution: This species has been recorded from New Hampshire, New York, New Jersey, Virginia, North Carolina, South Carolina, Georgia, Mississippi, Texas, Michigan, and Illinois.

The species has previously been recorded from Virginia by Sailer (*in* Hungerford 1948) from Norfolk County (now City of Chesapeake), May 11, 1928.

I have collected a total of 34 adults and nymphs in Virginia from the following localities: Dinwiddie, Goochland, Hanover, Southampton, Westmoreland, and Lancaster counties, and the City of Chesapeake.

Habitat: Most frequently my specimens have been collected in ponds, but collections have also been made in a swamp and in a marsh along a stream.

Biology: The life history of *T. macroceps* is not known. This is primarily a coastal plain species and the seasonal data show nothing more than the collection trips made in eastern Virginia during May, June, and October.

Remarks: Within the family, *T. macroceps* has been collected in association with *T. calva, Palmacorixa buenoi, Sigara modesta, S. alternata,* and nymphs of *Hesperocorixa* sp.

TRICHOCORIXA LOUISIANAE **Jaczewski** (Fig. 16k & l)

Trichocorixa louisianae Jaczewski, 1931a; Sailer, in Hungerford 1948.

Description: Vertex rounded in front. Pronotum slightly wider than long, with 7 to 9 dark transverse lines which are usually complete and wider than intervening yellow lines. Lobe of prothorax moderately broad, slightly narrowed apically. Hemelytra smooth, reticulose, markings usually showing a definite tendency toward an undulant transverse arrangement. Length 3.6 to 4.6 mm.

Distribution: This species has been recorded from New Hampshire, New York, Massachusetts, Virginia, North Carolina, Georgia, Florida, Louisiana, Mississippi, Alabama, Texas, Cuba, Mexico, Puerto Rico, and Haiti.

T. louisianae has previously been recorded from Virginia by Sailer (*in* Hungerford 1948) from Norfolk, City of Chesapeake, July 4, 1931, and Lorton, Fairfax County, August 4, 1946, "marsh pools along Potomac".

I have collected specimens of this species from the following localities: Brunswick, Middlesex, Spottsylvania, Mathews, Lancaster, and Accomac counties, and the City of Chesapeake and the City of Virginia Beach.

Habitat: Individuals of this species have been collected from ponds, backwaters of a swift river, and swamp and marsh pools. The latter was the most usual habitat, and here they were found in the black ooze on the bottom.

Biology: The life history of this species is not known. Sailer (*in* Hungerford 1948) stated that they seem to live by preference in saline or salt water, but none of my specimens were collected in such water.

Remarks: Within the family, *Trichocorixa louisianae* has been collected in association with *T. calva, Sigara compressoidea, S. zimmermanni, S. modesta, S. hydatotrephes, Palmacorixa buenoi,* and *Hesperocorixa nitida.*

TRICHOCORIXA NAIAS **(Kirkaldy & Torre-Bueno)** (Fig. 16q & r)

Arctocorisa naias Kirkaldy & Torre-Bueno, 1908; *Trichocorixa naias*, Hungerford, 1928b; Jaczewski, 1939; Sailer, in Hungerford 1948.

Description: Pronotum nearly twice as wide as long in male, slightly longer than wide in female; 6 to 7 dark transverse lines, usually twice the width of the intervening yellow lines. Hemelytra

with lineations tending toward transverse, frequently anastomosing, dark lines wider than intervening pale areas. Length 3.3 to 4.4 mm.

Distribution: This species has been recorded from Massachusetts, New York, Pennsylvania, District of Columbia, Virginia, Georgia, Florida, Louisiana, Texas, Mississippi, Kansas, Iowa, Illinois, Michigan, Indiana, Wisconsin, Minnesota, South Dakota, Colorado, Mexico, Canada, and Cuba.

T. naias has previously been recorded from Virginia by Sailer (*in* Hungerford 1948), from New Church, Accomac County, July 14, 1935, and Norfolk, City of Chesapeake, July 4, 1931.

I have collected only 23 male and 5 female specimens in Virginia. These were collected in the city of Hampton about 5 miles northwest of Phoebus on U.S. Hwy. 258, and in Accomac County, on Rt. 658 at junction with Rt. 722.

Habitat: My specimens were collected from a pool in very marshy land where they were found in the entangled aquatic vegetation several feet below the water surface, and from a pond with much vegetation.

Biology: Nothing is known of the life history of this species. My specimens were all collected in late June, and only 2 nymphs were found.

Remarks: Within the family, *T. naias* has been collected in association with *T. v. verticalis.*

TRICHOCORIXA VERTICALIS VERTICALIS (Fieber)

(Fig. 16s & t)

Corisa verticalis Fieber, 1851; *Corixa verticalis*, Abbott, 1913b; Blatchley, 1926; *Trichocorixa verticalis*, Lundblad, 1929; *Trichocorixa verticalis verticalis*, Sailer, *in* Hungerford 1948.

Description: Pronotum rugose, with a variable number of transverse lines which are broken or not complete, and only slightly wider than long. Hemelytra with lineations tending toward transverse, sometimes reticulose, dark lines seldom wider than intervening pale areas. Vertex thickly covered with minute dark punctures. Length 2.9 to 5.0 mm.

Distribution: The distribution of typical *T. verticalis* has been given as New York, Pennsylvania, Virginia, North Carolina, Florida, Louisiana, Alabama, Mississippi, Texas, New Mexico, Cuba, Puerto Rico, Haiti, Virgin Islands, Grenada, Guadeloupe, Bermuda, Cayman

Islands, Jamaica, British Honduras, and Mexico.

T. verticalis verticalis has previously been recorded from Virginia by Sailer (*in* Hungerford 1948) from Norfolk, City of Chesapeake, July 14, 1931, Onley, Accomac County, and Chincoteague Island, Accomac County, May 4, 1912.

I have 12 adults which were collected in the City of Hampton, about 5 miles north of Phoebus on U.S. Hwy. 528.

Habitat: All of my specimens were collected from a pool in very marshy land. The water may have been slightly brackish.

Biology: The life history of this species is not known, but Sailer (*in* Hungerford 1948) stated that the species is primarily an inhabitant of coastal areas, and the members live, by preference, in more or less saline water. My specimens were likewise collected near the coast, and the water probably contained a small amount of salt. My only collection of this species was made in late June, and no nymphs were observed.

Remarks: Within the family, *T. v. verticalis* has been collected in association with *T. naias.*

Dr. Sailer recognizes several subspecies of *T. verticalis,* but only the typical form has been recorded from Virginia. However, *T. verticalis sellaris* may also occur in the state, since it has been recorded from Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, North Carolina, and Georgia.

* *TRICHOCORIXA KANZA* **Sailer** (Fig. 16u & v)

Trichocorixa verticalis Rau, 1943; *Trichocorixa kanza,* Sailer, *in* Hungerford 1948.

Description: Hemelytra smooth and polished, coarsely reticulose, tending toward a transverse arrangement of markings; pronotal disk with 8 to 9 transverse lines, usually narrower than intervening areas. Other characters as given in key to species.

Distribution: The species has been recorded from Kansas, Missouri, Arkansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Gerogia, Florida, Tennessee, District of Columbia, Pennsylvania, Illinois, Wisconsin, Iowa, Nebraska, and Mexico.

T. kanza has not been recorded from Virginia but may occur here.

Habitat: In ponds with much aquatic vegetation.

Biology: This is the only species of *Trichocorixa* for which there is any published life history data. Sailer (1948) collected specimens

of this species in mid-April in Kansas and put them in an aquarium. Eggs were laid on eel grass and stems, and attached by a suckerlike disk. The eggs were pearly white when first laid, and in general, ovoid in shape, measuring 0.357 mm. in diameter and 0.503 mm. long. This species, and as far as known all species of *Trichocorixa*, feed on the flocculent bottom ooze, diatoms and algae. Sailer stated that one female was observed to withdraw in ten seconds the contents of a strand of *Spirogyra* equal to her own length.

Remarks: Females of *T. kanza* and *T. calva* can easily be confused with each other since they are approximately the same size and color.

Genus *PALMACORIXA* Abbott, 1912

Description: Elongate, slender species of small size. Interocular space much narrower than the width of an eye. Surface of pronotum and hemelytra rugulose. Caudal margin of head strongly curved, embracing a very short pronotum which is sharply angulate laterally. Lateral lobe of prothorax linear, longer than broad. Hemelytra narrow, elongate, tapering caudally, only slightly overlapping at apex; membrane very small, not distinctly defined from corium; pruninose area caudal to nodal furrow very long. Hind wings usually rudimentary and non-functional. Dorsomedian lobe of seventh abdominal segment of male bearing a hooklike projection. Pale of male thin, its palm narrow. Metaxyphus short, subtriangular. Abdominal asymmetry of male dextral. Length 4.0 to 6.0 mm.

Habitat: The members of this genus seem to be associated with ponds and streams of a permanent nature and have not been collected from temporary waters. They have been collected among blades of grasses hanging in the water and masses of filamentous green algae near the shore.

Key to Species of *Palmacorixa*

1. Pala of male a very broad, flattened plate with a cluster of poorly defined pegs near its base (Fig. 16i); pronotum with well-marked anterolateral depressions in both sexes ---------- *gillettei*, p. 145

   Pala of male not a broad, flattened plate, and with pegs in an arching row (Fig. 16e and 16g); pronotum without anterolateral depressions ---------- 2

2. Middle femur of male with a longitudinal row of pegs on its ventral surface (Fig. 15g) ___ *nana*, p. 144

Middle femur of male without a longitudinal row of pegs on its ventral surface (Fig. 15e) ____ *buenoi*, p. 143

PALMACORIXA BUENOI **Abbott** (Fig. 15, e & i and 16, e & f)

Palmacorixa buenoi Abbott, 1913a, 1913b; Hungerford, 1919; Blatchley, 1926; Walley, 1930a, Hungerford, 1948.

Description: Pronotum with 4 to 9 brown transverse lines which may be entire or broken. Hemelytral pattern reticulate; pattern of membrane continuos with that of corium; embolium pale. Hemelytra rugulose with sparse hairs. Middle femur of male without a longitudinal row of pegs on ventral surface. Pala of male elongate with pegs usually in a single row although occasionally they are scattered distally. Length 4.3 to 6.0 mm.

Distribution: This species has been recorded from Massachusetts, New York, New Jersey, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Texas, Kansas, Indiana, Michigan, Minnesota, South Dakota, Iowa, and from Quebec and Ontario, Canada.

P. buenoi has previously been reported from Virginia by Hungerford (1948) from Vienna, Fairfax County, September 19, 1931 and April 30, 1932; Norfolk, City of Chesapeake, April 9, 1932 and May 11, 1938.

I have a total of 107 adults of this species in my collection from Virginia. These were collected from the following counties: Accomac, Albemarle, Augusta, Brunswick, Charlotte, Essex, Hanover, Lancaster, Northumberland, Rappahannock, Spotsylvania, and Tazewell.

Habitat: This species inhabits ponds and sluggish streams where it sometimes occurs in considerable numbers among filamentous green algae near the shores.

Biology: The life history of this species was studied by Hungerford (1919) at Ithaca, New York, but he has since (1948) stated that the work done at Ithaca "many years ago indicated that *P. buenoi* and *P. nana* wintered there in the fourth nymphal instar whereas most corixids winter as adults." He further stated that since that time (1919) he has seen adult specimens of *P. buenoi* taken in January, February, and March from South Carolina, Texas, Kansas, and Alabama, indicating that, in the southern range at least, the winter can be passed as adults. My seasonal data show that adults

also pass the winter in Virginia. Adults were collected during most months of the year.

Remarks: Within the family, *P. buenoi* has been taken in association with *P. gillettei, Trichocorixa calva, T. louisianae, Sigara modesta, S. compressoidea,* and *Hesperocorixa interrupta.*

PALMACORIXA NANA **Walley** (Fig. 15g and 16g & h)

Palmacorixa nana Walley, 1930a; Hungerford, 1948.

Description: Pronotum with about 7 slightly interrupted transverse black lines which are slightly narrower than pale interspaces; twice as wide as long. Pala of male shorter and stouter than in *P. buenoi* with slenderer pegs in an irregular row. Middle femur of male with a longitudinal row of 20 to 35 pegs on the ventral surface. Length 4.0 to 5.0 mm.

Distribution: This species has been recorded from New York, North Carolina, Michigan, Minnesota, and Quebec.

P. nana has not previously been recorded from Virginia. I have only one specimen in my collection from Virginia, which was collected from the "Old Reservoir," Albemarle County, at the University of Virginia. In addition, I have seen one specimen in the Old Dominion University collection labeled, "Henrico Co., 10-13-72."

Habitat: My specimen was collected from a shallow pond containing much submerged aquatic vegetation. The bottom was covered with decaying detritus and soft mud.

Biology: Hungerford (1919) published an account of the life history of this species, under the name of *P. buenoi,* at Ithaca, New York. He stated that the species winters as fourth instar nymphs, reaches the adult stage about the first of June, and after a maturation period of 8 days, oviposition begins. The egg stage also lasts about 8 days. He gives the following measurements for the immature stages: egg, 0.546 to 0.572 mm. long and 0.325 and 0.39 mm. in diameter; first instar, 1.09 mm. long; second instar, 1.638 mm. long; third instar, 2.21 mm. long; fourth instar, 3.072 mm. long; fifth instar, 3.9 mm. long. Hungerford does not give the time required for completion of the immature stages but states that the first generation becomes adult during August and starts the generation that overwinters as nymphs. This would mean that this species requires more than 2 months to complete a generation. My specimen was a male and was collected in April.

Remarks: Within the family, *P. nana* has been taken only in association with *Hesperocorixa interrupta.*

PALMACORIXA GILLETTEI **Abott** (Fig. 16i & j)

Palmacorixa gillettei Abbott, 1912, 1913b; Hungerford, 1919; Blatchley, 1926; Walley, 1930a; Hungerford, 1948.

Description: Pronotum twice as wide as long, faintly rastrate; crossed by 6 or more broken transverse brown lines. Pattern of hemelytra reticulate, the dark lines more or less dispersed, frequently entirely absent on the inner basal angle of clavus. Pattern of membrane continuous with that of corium. Pala of male much dilated and and flattened, covered with appressed white, spine-like hairs. Length 4.6 to 6.0 mm.

Distribution: *P. gillettei* has been recorded from Colorado, Michigan, Iowa, Minnesota, and Quebec.

The species has not previously been recorded from Virginia. I have taken only four specimens, from the following localities: Albemarle County, old golf course pond at University of Virginia (now filled); Appomattox County, 4.5 miles E. of Appomattox on U.S. Hwy. 460 at Oxford Furnace Wayside.

Habitat: My specimens were collected from a pond and from deep pools of a sluggish stream. In the water near the shore of the pond was a submerged mass of filamentous green algae, and *P. gillettei* was found in this mass of algae.

Biology: The life history of this species is not known. My specimens were collected in April, August, and November. Since collections were made at frequent intervals from the same pond over a period of 3 years, this species is considered to be rare in the Charottesville area.

Remarks: Within the family, *P. gillettei* has been collected in association with *P. buenoi* and *Hesperocorixa interrupta.*

Genus *CORISELLA* **Lundblad, 1928**

Description: Dorsal surface smooth, shining, never more than faintly rugulose except on pronotum. Lateral lobe of prothorax elongate, tonguelike. Hemelytra clothed with fine hairs. Hind wings well-developed. Front tibia of male rather long and provided with a fleshy pad. Male pala triangular and provided with two rows of pegs. Abdominal asymmetry of male dextral. Length 4.0 to 8.0 mm.

Distribution: The members of this genus have been recorded from the western United States and Mexico with one species extending eastward to Pennsylvania, and another to Georgia and the District of Columbia.

Habitat: My representatives of the genus were collected from a pond with an abundance of submerged and emergent vegetation.

CORISELLA EDULIS (Champion) (Fig. 16 a & b)

Corixa edulis Champion, 1901; *Arctocorisa edulis*, Kirkaldy & Torre-Bueno, 1908; *Arctocorixa edulis*, Van Duzee, 1917; Blatchley, 1926; Hungerford, 1928d; *Corisella edulis*, Lundblad, 1928; Griffith, 1945; Hungerford, 1948.

Description: Vertex produced in front. Interocular space wider than eye. Pronotum smooth, shining, crossed by ten or twelve slender transverse dark lines which may be effaced laterally. Hemelytra shining; corial pattern effaced at inner base; remainder of hemelytron closely marked with short, transverse, undulate, irregular, dark lines, the markings so arranged as to form four irregular longitudinal series. Length 6.3 to 7.9 mm.

Distribution: This species has been recorded from the District of Columbia, Georgia, Mississippi, Texas, Kansas, Arizona, Nevada, Utah, Nebraska, Oklahoma, Iowa, Oregon, Minnesota, New Mexico, Tennessee, and Mexico.

Corisella edulis has not previously been recorded from Virginia. I have 5 males, 13 females and 1 third-instar nymph in my collection from Virginia. All were collected in Shenandoah County, 11.7 miles S. of Woodstock on U.S. Hwy. 11. In addition, I have seen a male and a female of this species in the Old Dominion University collection which were collected in the City of Virginia Beach on November 10, 1970.

Habitat: In Virginia, this species was collected from a pond with an abundance of submerged and emergent vegetation.

Biology: The life history is not known. My specimens were all collected on August 22, 1948.

Remarks: *Corisella edulis* was not taken in association with any other members of the family.

Genus *HESPEROCORIXA* Kirkaldy, 1908

Description: Fairly large species (6.3 to 11.4 mm.) having the pronotum more or less rastrate, and clavus and corium always with

some striations. Lateral lobe of prothorax trapezoidal, often oblique truncate at apex. Hemelytra with pruninose area along claval suture shorter than pruninose area caudad of nodal furrow. Metaxyphus usually long. Pala of male with subparallel sides; a row of pegs along upper margin which follows contour around apical angle. Abdominal asymmetry of males dextral.

Distribution: The genus is holarctic in distribution.

Habitat: Species of this genus inhabit ponds, swamps, and streams where they are found swimming or resting on vegetation near the bottom.

Key to Virginia Species of *Hesperocorixa*

1. Mesoepimeron at level of scent gland osteole as broad or broader than the lateral lobe of prothorax (Fig. 15h) ---------- 2
   Mesoepimeron at level of scent gland osteole distinctly narrower than the lateral lobe of the prothorax --- 4
2. Corial pattern in longitudinal series -- * *semilucida*, p. 156
   Corial pattern not in longitudinal series ---------- 3
3. Hemelytra but slightly rastrate; orange to red, with large black spot on base of clavus and on distal portion of corium; male pala not longitudinally carinate on outer surface, appearing thin in dorsal view ---------- *brimleyi*, p. 155
   Hemelytra rather strongly rastrate; clavus and corium either solid black or else with pale crossbands, never with spots; male pala longitudinally carinate on outer surface, appearing thickened in dorsal view ---------- *kennicottii*, p. 155
4. Lateral lobe of prothorax narrow, plainly longer than wide; insects less than 8 mm. long --- *minor*, p. 152
   Lateral lobe of prothorax broader; insects more than 8 mm. long ---------- 5
5. Color pattern in part effaced, at least on corium ---------- *lucida*, p. 154
   Color pattern normal ---------- 6
6. Pattern of hemelytra reticulate; surface of pronotum non-rastrate ---------- *laevigata*, p. 156
   Pattern of hemelytra not reticulate; surface of pronotum from faintly to strongly rastrate ---------- 7

7. Pale bands of corium beyond hemelytral suture forming slender transverse series; corium and membrane not plainly separated ---------- *vulgaris*, p. 153
Pale bands of corium beyond hemelytral suture not forming slender transverse series; or if so, then corium and membrane plainly separated ---------- 8

8. Hind femur with a row of about 10 spines on distal portion of rear margin ---------- *nitida*, p. 149
Hind femur with a row of about 6 spines on distal portion of rear margin ---------- 9

9. Corium and membrane plainly separated, often by a pale line; upper distal angle of male pala not produced ---------- *interrupta*, p. 148
Corium and membrance not plainly separated; upper distal angle of male pala produced ------ *obliqua*, p. 153

HESPEROCORIXA INTERRUPTA (Say)

(Fig. 15 d, f & h, 17 d & e; 20 a-h)

Corixa interrupta Say, 1825; *Arctocorisa interrupta*, Kirkaldy & Torre-Bueno, 1908; *Arctocorixa interrupta*, Van Duzee, 1917; Hungerford, 1925a; Blatchley, 1926; Brimley, 1938; *Hesperocorixa interrupta*, Hungerford, 1948.

Description: Head about one third the length of pronotum. Pronotum with 8 to 10 dark transverse lines, somewhat irregular caudally. Hemelytra with broad dark bands on clavus in fairly regular series; dark bands of corium narrower and less regular. Lateral lobe of prothorax quadrate, almost straight across apex, broader than long. Pala of male with 28 to 30 pegs in a row along margin. Caudal margin of hind femur with about 6 stout spines on distal portion. Length 9.0 to 11.0 mm.

Distribution: This species has been recorded from Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Ohio, Indiana, Michigan, Wisconsin, Illinois, Arkansas, Nebraska, Missouri, and Quebec and Ontario.

H. interrupta has previously been recorded from Virginia by Hungerford (1948) from "Church Bridge," Great Falls, Fairfax County, May 16, 1920, Dogue Creek July 6, 1927, Nelson County July 27, 1928, and "Virginia." I have in my collection from Virginia a large number of adults and nymphs of this species, collected in the following localities: Accomac, Albemarle, Alleghany, Charlotte, Dinwiddie, Henrico, Isle of Wight, King William, Loudon, Middlesex, Mont-

gomery, Nansemond, Rockingham, Smyth, Surry, the City of Chesapeake, and City of Virginia Beach.

Biology: Observations on the life history of this species have been made in Virginia by Bobb (1953). After mating in late summer the males die, and considerable numbers have been seen floating on the surface of a pond in October and November. The adult females, and a few males, pass the winter on the bottom of the pond, but remain more or less active. In 1947 the first nymphs were found on May 15, but hatching had begun earlier, as both first- and second-instar nymphs were found on that date. Probably the majority of the eggs are deposited during April, because dissection of females in early to mid-April contained many fully developed eggs, while in late April, some of the females contained no eggs and their ovaries apparently were spent. The overwintering adults began dying in early May, and by the latter part of that month very few were alive. During three years of observations, I have seen but one overwintering adult later than June 1, this one being collected on June 11. Nymphs were first observed to transform into the adult stage between July 4 and July 11. Males and females occur in about equal numbers in July, but some males begin to die after mid-August. There are five nymphal stages which require about 2 months for their total development. There is but one generation per year in Virginia.

Remarks: Within the family, *H. interrupta* has been collected in association with the following species: *H. nitida, Palmacorixa buenoi, P. gillettei, P. nana, Trichocorixa calva, T. macroceps, Sigara signata, S. modesta,* and *S. alternata.* The most common associations were with *S. modesta, S. signata,* and *H. nitida.*

HESPEROCORIXA NITIDA (Fieber) (Fig. 17, g & h)

Corisa nitida Fieber, 1851; *Arctocorisa nitida,* Kirkaldy & Torre-Bueno, 1908; *Arctocorixa nitida,* Parshley, 1914; Van Duzee, 1917; Blatchley, 1926; *Hesperocorixa nitida,* Hungerford, 1948.

Description: Pronotum with about nine broad, regular, dark transverse lines. Hemelytra with claval pattern in more or less regular transverse series; dark banks of corium irregular and broken, though still in more or less transverse series; pattern of membrane not separated from that of corium. Lateral lobe of prothorax a little longer than broad, apex slightly rounded. Pala of male with about 22 pegs in a row along margin. Caudal margin of hind femur with about 10 stout spines on distal portion. Length 8.0 to 9.0 mm.

Distribution: This species has been recorded from Maine, Massachusetts, Rhode Island, New York, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Kentucky, Tennessee, Ohio, Indiana, Michigan, Illinois, Minnesota, Iowa, Missouri, Kansas, Texas, and Louisiana.

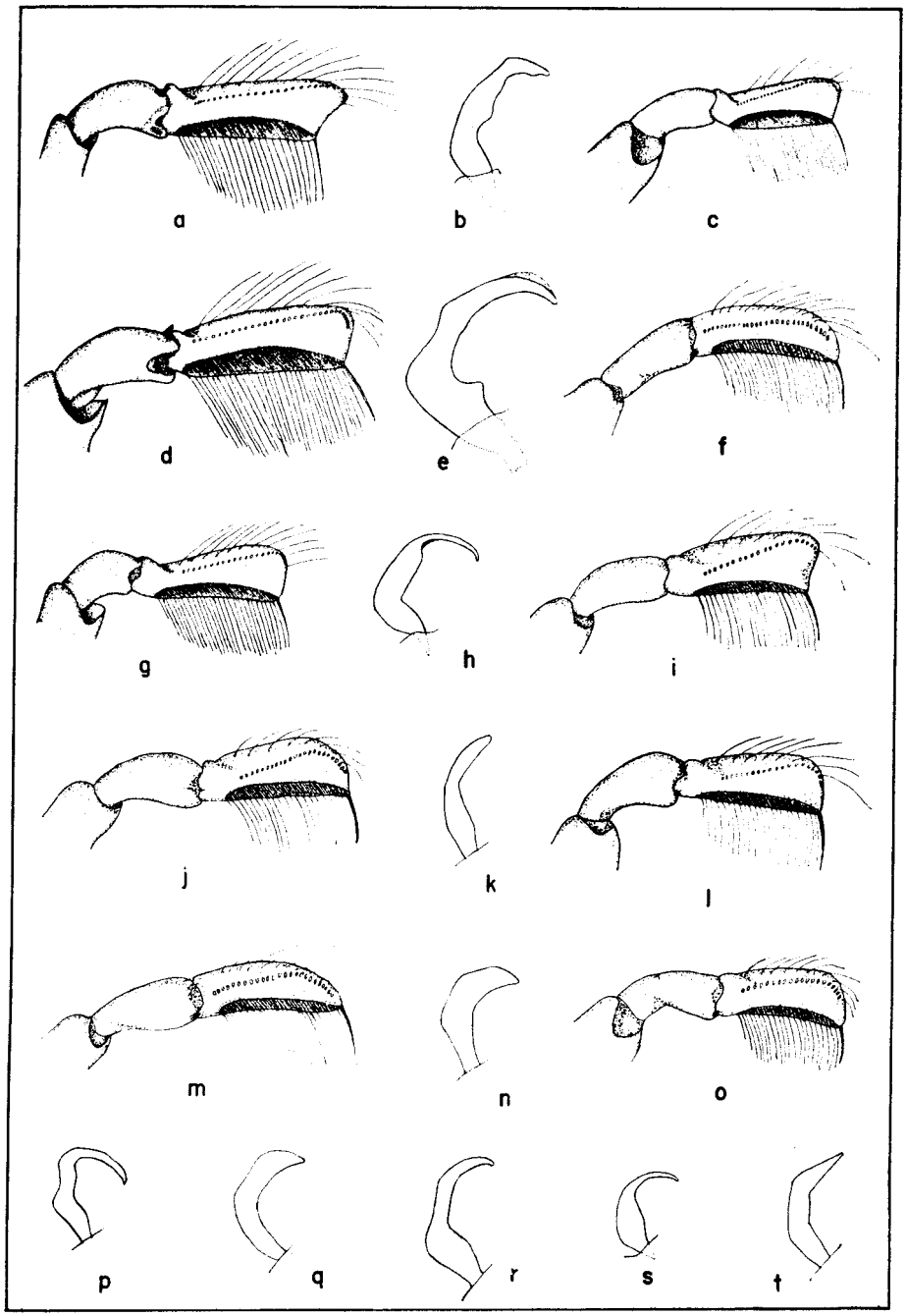
H. nitida has previously been recorded from Virginia by Hungerford (1948) from Great Falls, Fairfax Co., May 16, 1920. I have many adults in my collection which were collected in the following Virginia localities: Accomac, Albemarle, Chesterfield, Henrico, Nansemond, New Kent, Northampton, and the Cities of Chesapeake and Virginia Virginia Beach.

Habitat: This species has been collected from ponds, stagnant water in a roadside ditch, and from a swampy canal.

Biology: The life history of this species is not known. Collections were made throughout the year but no specimens were found during the winter months. The only explanation seems to be that perhaps this species hibernates in the mud and debris on the bottom of the pond instead of being more or less active, as is true of *H. interrupta.*

Figure 17.

a. Pala of male of *Hesperocorixa obliqua* (Hungerford)
b. Right clasper of male of *Hesperocorixa obliqua* (Hungerford)
c. Pala of male of *Hesperocorixa minor* (Abott)
d. Pala of male of *Hesperocorixa interrupta* (Say)
e. Right clasper of male of *Hesperocorixa interrupta* (Say)
f. Pala of male of *Hesperocorixa brimleyi* (Kirkaldy)
g. Pala of male of *Hesperocorixa nitida* (Fieber)
h. Right clasper of male of *Hesperocorixa nitida* (Fieber)
i. Pala of male of *Hesperocorixa vulgaris* (Hungerford)
j. Pala of male of *Hesperocorixa laevigata* (Uhler)
k. Right clasper of male of *Hesperocorixa laevigata* (Phler)
l. Pala of male of *Hesperocorixa lucida* (Abbott)
m. Pala of male of *Hesperocorixa kennicottii* (Uhler)
n. Right clasper of male of *Hesperocorixa kennicottii* (Uhler)
o. Pala of male of *Hesperocorixa semilucida* (Walley)
p. Right clasper of male of *Hesperocorixa vulgaris* (Hungerford)
q. Right clasper of male of *Hesperocorixa brimleyi* (Kirkaldy)
r. Right clasper of male of *Hesperocorixa lucida* (Abbott)
s. Right clasper of male of *Hesperocorixa minor* (Abbott)
t. Right clasper of male of *Hesperocorixa semilucida* (Walley)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The summer brood of adults and the few nymphs observed seem to fit into a life cycle similar to that for *H. interrupta*. Adult males were collected from June to October and females, from May to December.

Remarks: Within the family, *H. nitida* has been collected in association with the following species: *H. interrupta, Trichocorixa calva, T. louisianae, Sigara modesta, S. alternata, S. signata, S. zimmermanni, S. compressoidea*, and *S. hydatotrephes*. The greatest number of associations were with *H. interrupta* and *Sigara alternata*.

HESPEROCORIXA MINOR (Abbott) (Fig. 17, c & s)

Arctocorisa nitida var. *minor* Abbott, 1931b; Blatchley, 1926; *Hesperocorixa minor*, Hungerford, 1948.

Description: Pronotum with 7 to 9 fairly regular dark transverse lines which tend to coalesce medially; pale lines very narrow. Hemelytra with dark and pale subtransverse lines on corium in fairly regular series cephalically; dark pattern tending to coalesce along mesal margin caudal to claval suture. Lateral lobe of prothorax quadrate, a little longer than wide. Pala of male with 20 to 22 pegs. Mesepimeron narrow, the osteole near the tip. Length 7.0 to 7.4 mm.

Distribution: This species has been recorded from Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Texas.

The species has previously been reported from Virginia by Hungerford (1948) from Church Creek, September 9, 1906, and Great Falls, Fairfax County, May 22, 1906. I have a small number of specimens from Virginia. These were collected from the following localities: Albemarle County, "Old Reservoir" at University of Virginia; Chesterfield County, 20.0 miles S. of University of Richmond on U.S. Hwy. 1; Surry County, 4.7 miles N. of Bacon's Castle on St. Hwy. 10; Mathews County, 3 miles west of Mathews on St. Hwy. 198; Hanover County, (in Old Dominion University collection).

Habitat: My specimens were collected from pools of sluggish streams and from a pond with abundant aquatic vegetation.

Biology: The life history of this species is not known. My specimens were collected in January (1 male), February (1 female), May (1 male and 1 female), and June (5 females and 1 male.)

Remarks: I have collected *H. minor* in association with the following members of the family: *H. interrupta, Trichocorixa calva, Sigara signata, S. modesta,* and *S. alternata.*

HESPEROCORIXA OBLIQUA **(Hungerford)** (Fig. 17, a & b)

Arctocorixa obliqua Hungerford, 1925a, 1928d; Walley, 1936; *Hesperocorixa obliqua,* Hungerford, 1928.

Description: Pronotum rastrate with about 12 dark transverse lines. Hemelytra with dark bands of clavus narrow at base but broader distally; pattern of corium wavy and broken, continuous with that of membrane. Lateral lobe of prothorax no longer than broad. Pala of male elongate, sides almost parallel, distal end obliquely produced, 24 to 25 pegs in row along margin. Mesoepimeron narrow, the osteole near tip. Length 10.1 to 11.0 mm.

Distribution: This species has been recorded from Massachusetts, New York, New Jersey, Pennsylvania, West Virginia, Tennessee, Ohio, Indiana, Illinois, Michigan, Minnesota, Iowa, Colorado, Oklahoma, Kansas, Arkansas, Missouri, Texas, Mississippi, California, and Alaska.

H. obliqua has not previously been recorded from Virginia. I have a total of 70 specimens in my collection from Virginia. All were collected at the Blandy Experimental Farm near Boyce, Clark County, and in Giles County, about 6 miles west of Narrows. I have also seen several specimens of this species in the VPI&SU collections from Montgomery County.

Habitat: These specimens were collected from a pond with *Typha* and water lilies growing abundantly in the water, and from a roadside ditch with permanent standing water and abundant vegetation.

Biology: The life history is not known. All of my specimens were collected in July and August.

Remarks: Within the family Corixidae, this species was collected only in association with *Sigara alternata.*

HESPEROCORIXA VULGARIS **(Hungerford)** (Fig. 17, i & p)

Arctocorixa vulgaris Hungerford, 1925a; Blatchley, 1926; *Sigara vulgaris,* Jaczewski, 1936; *Hesperocorixa vulgaris,* Hungerford, 1948.

Description: Pronotum heavily rastrate, crossed by about 10 broad dark bands. Head slightly more than one-third the length of pronotal disk, vertex not produced, interocular space broad. Clavus with broad, dark bands in somewhat zigzag transverse series. Corium

and membrane not clearly separated, pattern on membrane more broken than that on corium. Mesoepimeron slender with osteole near tip. Metaxyphus arrow-shaped, no longer than broad. Pala of male with sides nearly parallel, about 18 to 20 pegs in peg row. Length 9.2 to 10.1 mm.

Distribution: This species has been recorded from Main, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, District of Columbia, Virginia, North Carolina, Georgia, Mississippi, Texas, Kansas, Illinois, Indiana, Ohio, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Montana, Oregon, Washington, California, and Canada.

H. vulgaris has previously been reported from Virginia by Hungerford (1948) from Virginia Beach and Norfolk, August 11, 1934. I have not collected this species.

Habitat: Not known.

Biology: Not known.

HESPEROCORIXA LUCIDA **(Abbott)** (Fig. 17, l & r)

Arctocorisa lucida Abbott, 1916; Van Duzee, 1917; Blatchley, 1926; Hungerford, 1926d; *Sigara lucida*, Jaczewski, 1936; *Hesperocorixa lucida*, Hungerford, 1948.

Description: Pronotum usually unicolorous, but sometimes with 7 or 8 faint-brown lines. Clavus usually solid brown, suture between claws and corium marked with yellow. Membrane smoky with faint pattern or none. Head not quite half as long as pronotal disk. Mesoepimeron narrow, osteole near tip. Metaxyphus arrow-shaped, slightly broader than long. Pala of male with sides nearly parallel, distal end almost truncate, with about 20 pegs in peg row. Length 8.5 to 9.4 mm.

Distribution: This species has been recorded from New York, Massachusetts, Connecticut, Rhode Island, Pennsylvania, New Jersey, Maryland, District of Columbia, Virginia, Georgia, Florida, Texas, Arkansas, Illinois, Michigan, and Canada.

The species has previously been recorded from Norfolk, August 11, 1925 and April 9, 1932. I have collected 5 specimens from Lancaster County, on St. Hwy. 200 about 15 miles S. of U.S. Hwy. 360.

Habitat: My specimens were collected from a pond with much vegetation.

Biology: The life history of this species is not known. My specimens were collected in late June.

Remarks: This species may be distinguished from other *Hesperocorixa* by the incomplete corial pattern. With the family Corixidae the species was collected in association with *H. brimleyi, H. kennicottii,* and *Trichocorixa macroceps.*

HESPEROCORIXA KENNICOTTII **(Uhler)** (Fig. 17, m & n)

Corixa kennicottii Uhler, 1897; Hutchinson, 1940; *Arctocorixa kennicottii* Kirkaldy, 1908; Van Duzee, 1917; Abbott, 1923; Blatchley, 1926; *Sigara kennicottii,* Jaczewski, 1936; *Hesperocorixa kennicottii,* Walton, 1943; Hungerford, 1948.

Description: Color pattern variable. Pronotum with or without 7 or 8 brown bands. Embolium and membrane pale yellow. Corium with more or less regular transverse series or the pattern fused into a solid black field. Head as long as pronotal disk, disk about half as long as wide. Mextaxyphus as broad as long, apex pointed. Pala of male subparallel-sided, rounded apically, with about 28 pegs in row. Length 8.0 to 8.8 mm.

Distribution: This species has been recorded from Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Maryland, District of Columbia, Virginia, Ohio, Illinois, Michigan, Wisconsin, and Minnesota.

The species has previously been recorded from Norfolk, Virginia, by Hungerford (1948) May 11, 1928. I have collected 3 specimens from Lancaster County, on St. Hwy. 200 about 15 miles S. of U.S. Hwy. 360.

Habitat: My specimens were collected from a pond with much aquatic vegetation.

Biology. The life history of this species is not known. My specimens were collected in late June.

HESPEROCORIXA BRIMLEYI **(Kirkaldy)** (Fig. 17, f & q)

Arctocorisa brimleyi Kirkaldy, 1908; Van Duzee, 1917; *Hesperocorixa brimleyi,* Blatchley, 1926; Hungerford, 1928d; Brimley, 1938; Hungerford, 1948.

Description: Pronotum without cross bands. Basal third of clavus black, other reddish-orange. Corium reddish-orange with diagonal black band beyond claval tip. Distal angle of corium and membrane reddish-orange. Embolium smoky. Head equal to or slightly longer than pronotal disk, disk about half as long as wide. Mesoepimeron

broad with osteole remote from tip. Metaxyphus pointed, no longer than broad. Pala of male subparallel-sided, long, with about 28 pegs. Length 8.2 to 8.8 mm.

Distribution: This species has been recorded from New Jersey, North Carolina, Georgia, and Alabama.

H. brimleyi has not previously been recorded from Virginia. I have 8 specimens in my collection from Lancaster County, on St. Hwy. 200 about 15 miles S. of U.S. Hwy. 360.

Habitat: My specimens were collected from a pond have an abundance of aquatic vegetation.

Biology: The life history is not known for this species.

* *HESPEROCORIXA SEMILUCIDA* **(Walley)** (Fig. 17, o & t)

Arctocorixa semilucida Walley, 1930a; *Sigara semilucida*, Jaczewski, 1936; *Hesperocirixa semilucida*, Hungerford, 1948.

Description: Background color varying from yellow to red. Pronotum with 7 to 9 brown bands. Clavus and corium with brown pattern arranged in longitudinal series. Head slightly shorter than pronotal disk, disk about twice as wide as long. Mesoepimeron broad with osteole remote from tip. Metaxyphus slender and pointed, considerably longer than wide. Pala of male subparallel-sided, apex blunt, about 20 to 22 pegs in row. Length 7.0 to 7.5 mm.

Distribution: This species has been recorded from Massachusetts, New York, New Jersey, Delaware, North Carolina, Florida, Louisiana, Tennessee, Illinois, Michigan, and Canada.

H. semilucida has not been recorded from Virginia, and I have not collected the species. However, from the recorded distribution, it should occur in our Coastal Plain Province.

Remarks: Hungerford (1948) stated that this species differs from *H. brimleyi* and *H. Kennicottii* in having a long, slender metaxyphus.

* *HESPERICORIXA LAEVIGATA* **(Uhler)** (Fig. 17, j & k)

Corisa laevigata Uhler, 1893; *Arctocorisa laevigata*, Van Duzee, 1917; Hungerford, 1925a; Blatchley, 1926; *Sigara laevigata*, Jaczewski, 1936; *Hesperocorixa laevigata*, Hungerford, 1948.

Description: Pronotum with about 12 irregular dark bands. Clavus with wavy, zigzag lines, coral pattern less irregular. Pattern of membrance much interrupted, suture distinct. Head one third as long as pronotal disk. Mesoepimeron narrow, with scent gland

osteole near tip. Metaxyphus arrow-shaped, pointed at apex, longer than broad. Pala of male with sides subparallel, broad, bluntly rounded at distal end, about 24 to 26 pegs. Length 9.9 to 11.0 mm.

Distribution: This species has been recorded from Canada southward to North Carolina, Texas, and New Mexico, and westward to California and Washington.

This species has not been recorded from Virginia, and I have not collected it. However, it has been collected in Maryland and North Carolina, and probably occurs in our Coastal Plain Province.

Remarks: Hungerford (1948) stated that the reticulate pattern of the hemelytra will distinguish this species from all other *Hesperocorixa*.

Genus *SIGARA* Fabricius, 1775

Description: The genus is extremely variable and it is difficult to characterize. A number of subgenera have been described. Hungerford (1948:610) gives the following diagnosis of the genus: "Lateral lobes of the prothorax elongate, linguiform [except *S. ornata* (Abbott)]; anterior tibiae with a few small apical spines, those of males carinate dorsally, often with an apical pad; metaxyphus rather small, usually triangular or arrow-shaped. Venter of hind femur pubescent on at least the basal third, often more; the glabrous portion with scattered spines; upper surface with from 2 or 3 spines to 2 or 3 longitudinal rows of spines." The length of Virginia specimens range from 2.9 to 9.2 mm.

Distribution: This genus is cosmopolitan, and representatives of it have been recorded from every continent.

Key to Virginia Species of *Sigara*

1. Pronotum with a median longitudinal pale line 2
   Pronotum without a median longitudinal pale line ... 5
2. Mesal margin of the mesoepimeron extending beyond the distolateral angle of the mesosternum for a distance equal to or greater than the distance between the tip of the mesoepimeron and the scent gland osteole ..... *variabilis*, p. 172
   Mesal margin of the mesoepimeron extending beyond the distolateral angle of the mesosternum for a distance shorter than the distance between the tip of the mesoepimeron and the scent gland osteole 3

3. Mesal margin of the mesoepimeron extending beyond the distolateral angle of the mesosternum for a distance equal to only one third the distance between the tip of the mesoepimeron and the scent gland osteole ---------- *depressa*, p. 162

Mesal margin of the mesoepimeron extending beyond the distolateral angle of the mesosternum for a distance equal to at least one half the distance between tip of mesoepimeron and the scent gland osteole ---------- 4

4. Strongly rastrate; pale figures on distal half of clavus and usually those of corium transverse; pattern of membrane indistinct or effaced ----------
---------- *compressoidea*, p. 173

Moderately rastrate; pale figures on distal half of clavus and on corium arranged longitudinally in more or less connected series; pattern of membrane distinct ---------- *mississippiensis*, p. 173

5(1). Corial pattern in definite longitudinal series or solid black ---------- 6

Corial pattern not in definite longitudinal series nor solid black ---------- 7

6. Claval and corial fields solid black; pronotum black, crossed by three or four pale lines-*hydatotrephes*, p. 159

Dorsum not black; pala of male with two rows of pegs ---------- *mullettensis*, p. 170

7(5). Metaxyphus longer than broad ---------- *signata*, p. 174

Metaxyphus not longer than broad ---------- 8

8. Scent gland osteole nearer the lateral bend of the mesoepimeron than to its tip—(two similar species) ---------- *modesta*, p. 168
and ---------- *stigmatica*, p. 167

Scent gland osteole nearer the tip than to lateral bend of mesoepimeron ---------- 9

9. Claval lineations broken into many fragments
---------- *zimmermanni*, p. 171

Claval lineations more or less entire or slightly forked-- 10

10. Corial pattern in more or less definite longitudinal series ---------- 11

Corial pattern not as above ---------- 12

11. Pronotum laterally reduced; only 4 to 6 pegs on dorsal surface of hind femur --------- *hubbelli*, p. 175

Pronotum not reduced laterally; a row of at least 12 pegs on dorsal surface of hind femur--*defecta*, p. 170

12(10). Pala of male with a row of pegs nearer to palm than to dorsal margin, and with a dorsal hump (Fig. 18e) ---------- *pectenata*, p. 171

Pala of male with a row of pegs nearer to dorsal margin than to palm, and without a dorsal hump (Fig. 18a) ---------- 12

13. Pala of male with from 20 to 26 pegs --- *macropala*, p. 174

Pala of male with more than 30 pegs ---------- 14

14. Mesoepimeron broader at the lateral bend than at the level of the scent gland osteole; osteole on a level with the distolateral angle of the mesosternum ---------- *virginiensis*, p. 169

Mesoepimeron of equal width from osteole to lateral bend; osteole posterior to the distolateral angle of the mesosternum ---------- *alternata*, p. 166

SIGARA HYDATOTREPHES **(Kirkaldy)** (Fig. 18, k & l)

Arctocorisa hydatotrephes Kirkaldy, 1908; *Arctocorixa hydatotrephes*, Van Duee, 1917; Blatchley, 1926; *Sigara hydatotrephes*, Hungerford, 1948.

Description: Pronotum black except for 3 or 4 narrow, pale, transverse lines; much wider than long. Hemelytra with clavus, and membrane black, but with sutures and margins yellow. Pala of male with about 20 pegs, those in middle smaller than those at either end. Mesoepimeron broad with scent gland osteole remote from tip, almost in lateral band. Length 5.3 to 6.0 mm.

Distribution: This species has been recorded from North Carolina, Georgia, and Alabama.

I have 1 male, 3 females and 4 nymphs in my collection from Virginia. They were collected in June from the following localities: City of Chesapeake, 3.5 miles E. of U.S. Hwy. 17 on Co. Hwy. 740, and 5.7 miles E. of Northwest on Co. Hwy. 610 at intersection with Co. Hwy. 609. I have also seen 1 specimen in the Old Dominion University collection from Henrico County, collected October 13, 1972.

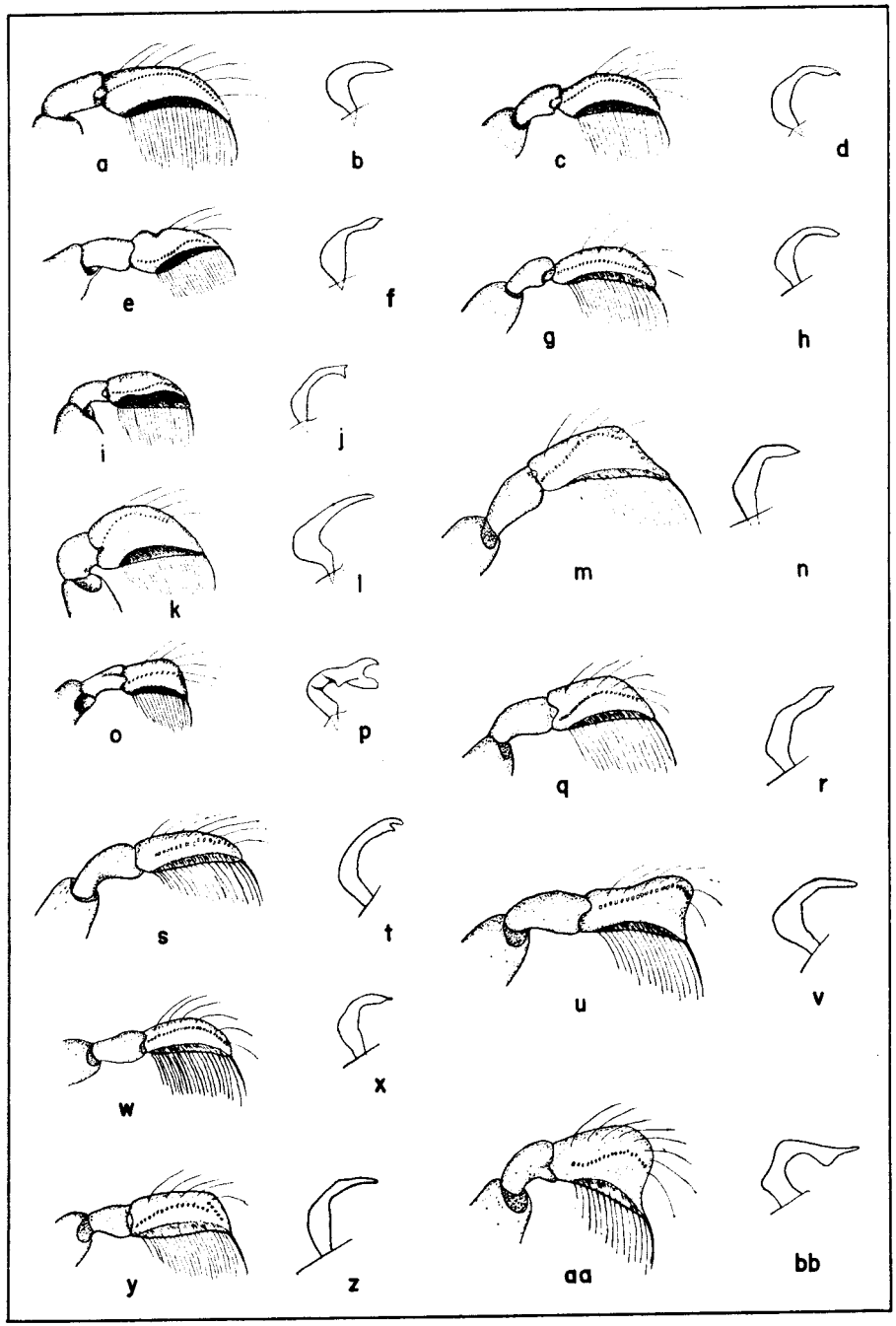
Habitat: They were collected from shallow, sluggish black waters of streams in a swamp. Here they were resting on the bottom, which was covered with a black flocculent organic material.

Biology: The life history is not known. I collected 1 fourth-instar and 3 fifth-instar nymphs in early June.

Remarks: Other Corixidae found in association with *S. hydatotrephes* were *S. modesta, S. zimmermanni, Trichocorixa calva, T. louisianae,* and *Hesperocorixa nitida.*

Figure 18.

a. Pala of male of *Sigara alternata* (Say)
b. Right clasper of male of *Sigara alternata* (Say)
c. Pala of male of *Sigara modesta* (Abbott)
d. Right clasper of male of *Sigara modesta* (Abbott)
e. Pala of male of *Sigara pectanata* (Abbott)
f. Right clasper of male of *Sigara pectanata* (Abbott)
g. Pala of male of *Sigara stigmatica* (Fieber)
h. Right clasper of male of *Sigara stigmatica* (Fieber)
i. Pala of male of *Sigara compressoidea* (Hungerford)
j. Right clasper of male of *Sigara compressoidea* (Hungerford)
k. Pala of male of *Sigara hydatotrephes* (Kirkaldy)
l. Right clasper of male of *Sigara hydatotrephes* (Kirkaldy)
m. Pala of male of *Sigara defecta* Hungerford
n. Right clasper of male of *Sigara defecta* Hungerford
o. Pala of male of *Sigara signata* (Fieber)
p. Right clasper of male of *Sigara signata* (Fieber)
q. Pala of male of *Sigara hubbelli* (Hungerford)
r. Right clasper of male of *Sigara hubbelli* (Hungerford)
s. Pala of male of *Sigara mississippiensis* Hungerford
t. Right clasper of male of *Sigara mississippiensis* Hungerford
u. Pala of male of *Sigara variabilis* (Hungerfrod)
v. Right clasper of male of *Sigara variabilis* (Hungerford)
w. Pala of male of *Sigara virginiensis* Hungerford
x. Right clasper of male of *Sigara virginiensis* Hungerford
y. Pala of male of *Sigara mullettensis* (Hungerford)
z. Right clasper of male of *Sigara mullettensis* (Hungerford)
aa. Pala of male of *Sigara macropala* (Hungerford)
bb. Right clasper of male of *Sigara macropala* (Hungerford)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SIGARA DEPRESSA **Hungerford** (Fig. 19 a-d, 16w)

Sigara depressa Hungerford, 1948.

Description: Pronotal disk with median longitudinal pale stripe, the dark bands on either side numbering about 7 and tending to coalesce distally, lateral margins of disk pale. Clavus with margins pale, some traces of cross bands basally but solid black distally. Corium solid black with pale margins, plainly separated from membrane by a broad, pale band. Head about half as long as pronotal disk, disk nearly twice as broad as long. Mesoepimeron at level of scent gland osteole more than twice as broad as lateral lobe, osteole near lateral bend. Metaxyphus broader than long, apex pointed. Pala of male elongate, the dorsal margin bent inward distally, peg row divided with 13 pegs distally along the dorsal margin and 12 pegs basally. Length 5.88 to 6.40 mm.

Distribution: This species has been recorded only from Virginia, from specimens collected by the writer. I have a total of 85 adults and 3 nymphs in my collection from the following localities: Fluvanna County, (type locality) 3 miles S. of Zion Crossroads (intersection of U.S. Hwys. 15 and 250) on U.S. Hwy. 15; Caroline County, 20.1 miles N. of Ashland on U.S. Hwy. 1.

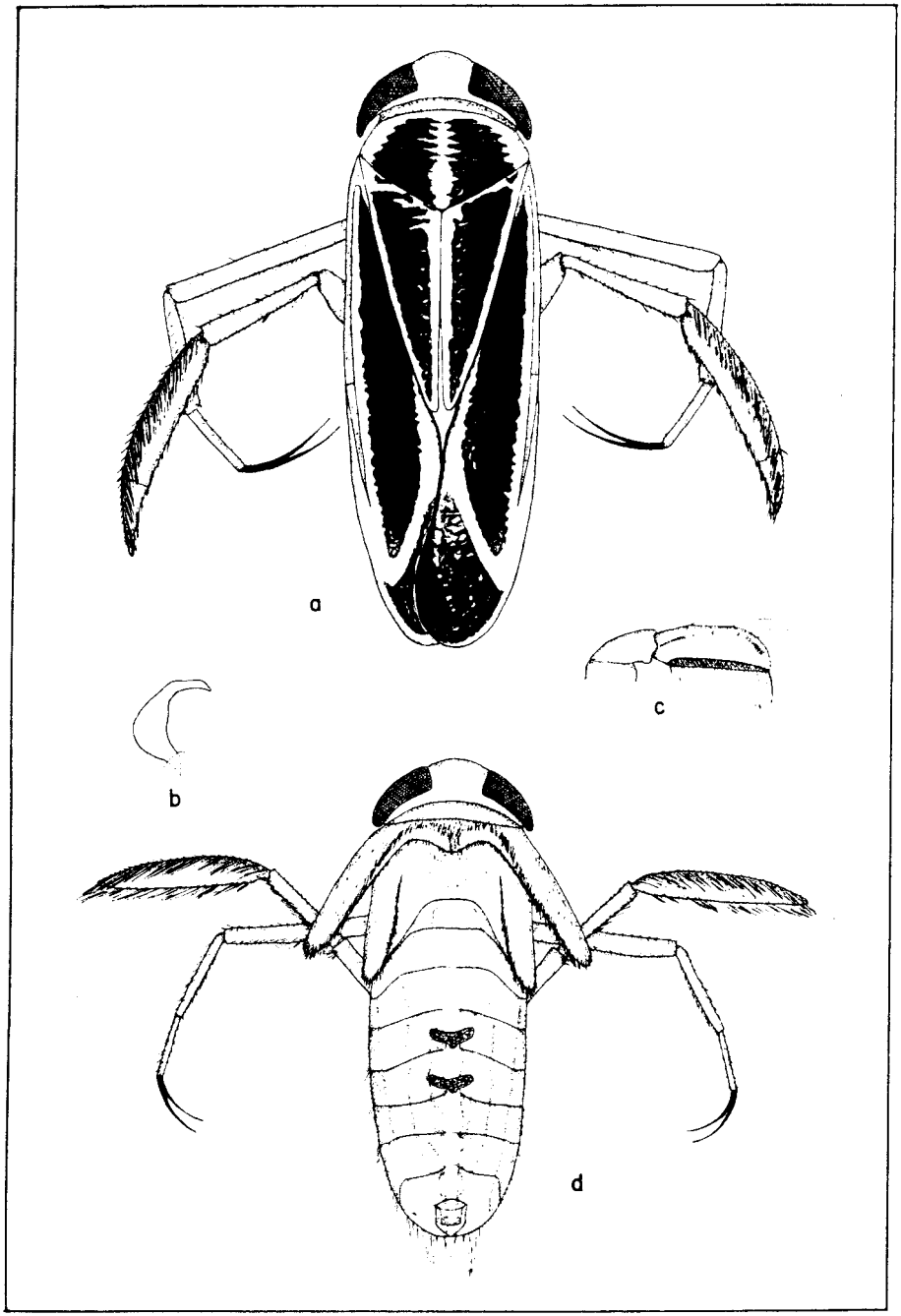
Habitat: In the type locality this species was collected from a large quiet pool in a fairly swiftly flowing stream. There was no aquatic vegetation in the water, although blades of the grass along the banks were hanging into the pool. The Caroline County specimen was collected from a backwater pool of Campbell's Creek, and the habitat was similar to that of the type locality.

Biology: The life history of this species is not known. I have made numerous attempts to rear members of it in large aquaria, but the adults died within 3 or 4 days without depositing eggs. Two nymphal instars have been collected from the type locality, and descriptions of these are given below. Nymphs and adults were scarce during the summer of 1948, and since that time, neither adults nor

Figure 19.

Sigara depressa Hungerford

a. Adult
b. Right clasper of male
c. Pala of male
d. Fifth instar nymph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d

nymphs have been found in the stream south of Zion Crossroads. My collections indicate that the adults overwinter, since large numbers of adult males and females have been collected during March. Nymphs were only collected during July.

Fourth instar: General color yellow. Dorsum of abdomen with six longitudinal brown stripes, and thorax marked with brown. Wing pads extend slightly beyond caudal margin of metathorax and are fringed along caudal and median margins with black hairs; prothoracic pair covered with short dark hairs, some of which extend across cephalic margin of thorax. Two dorsomedian spots (glands) dark brownish-black. Middle legs long and slender, tibiae and tarsi subequal in length, the latter terminating in two long claws. Hind legs with tarsi broad and flat with numerous long hairs, claws inconspicuous. All tarsi 1-segmented. Length 4.6 mm. (Fig. 16w).

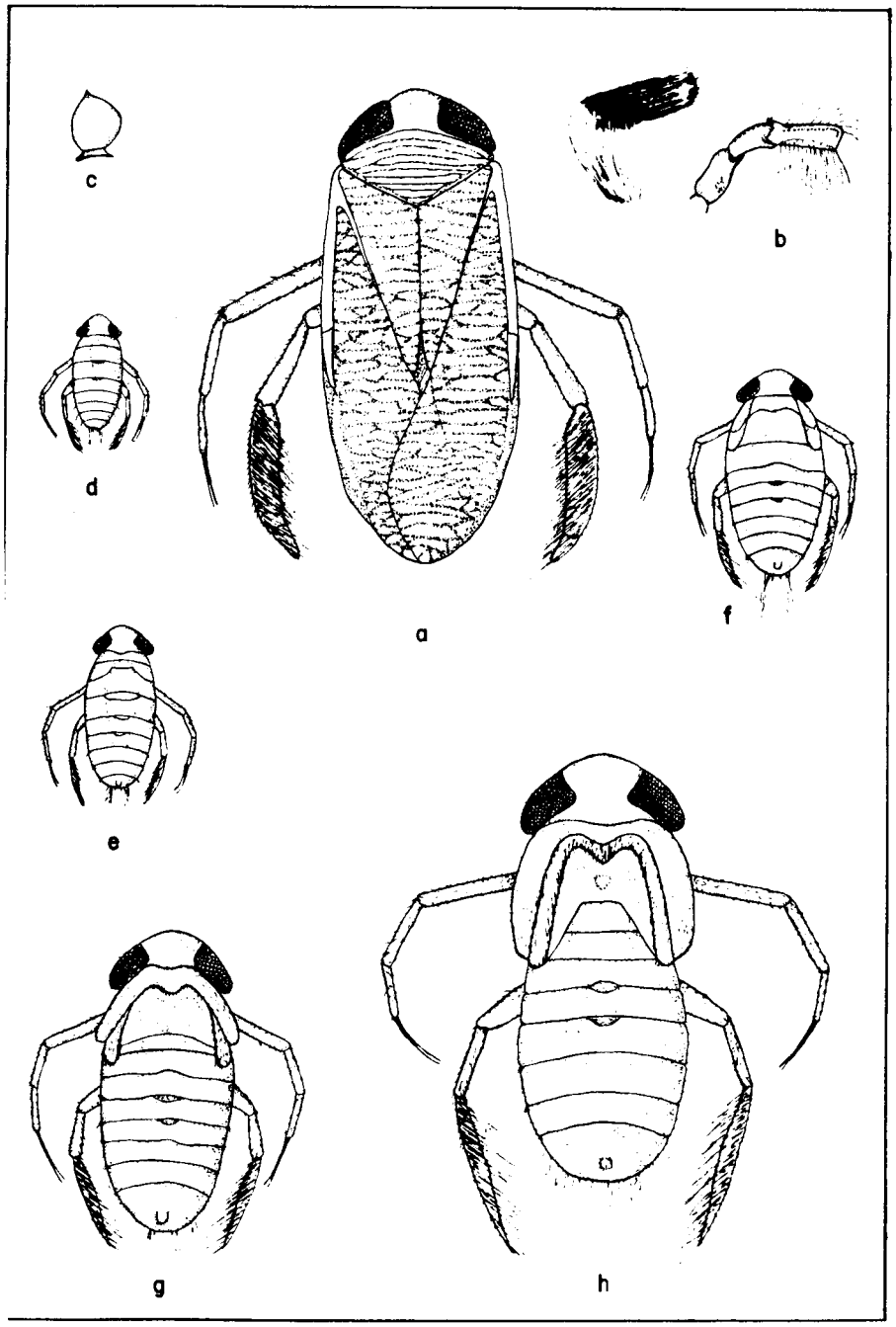
Fifth instar: Color and pattern as in preceding instar. Wing pads long,, both pair reaching onto second abdominal segment and fringed with long black hairs along median margin and across cephalic margin of thorax; prothoracic pair thickly clothed with short black hairs. Two dorsomedian spots larger than in preceding instar. Legs similar to those of fourth nymphal stage, except for proportionate increase in size and longer swimming hairs on hind tarsi. Length 5.8 mm. (Fig. 19d).

Remarks: Within the family, *S. depressa* has been collected in association with *S. alternata* and *S. modesta*. Although this species is closely allied to *S. hydatotrephes,* the palae and claspers of the males are different.

Figure 20

Hesperocorixa interrupta (Say)

a. Adult female
b. Pala of male
c. Egg
d. First instar nymph
e. Second instar nymph
f. Third instar nymph
g. Fourth instar nymph
h. Fifth instar nymph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SIGARA ALTERNATA (Say) (Fig. 18a & b)

Corixa alternata Say, 1825; *Arctocorixa alternata*, Kirkaldy & Torre Bueno, 1908; Hungerford, 1917c; Blatchley, 1926; *Sigara alternata*, Hungerford, 1948.

Description: Pronotum heavily rastrate; angulate laterally, rounded caudally; crossed by 8 or 9 narrow, transverse, brown bands, some complete and some across median region only. Hemelytra with clavus banded with alternate light and dark stripes of equal width; corial pattern much broken, dark area tending to coalesce on inner distal angle; pattern of membrane similar to that of corium but separated from it by a pale line. Scent gland of osteole near tip of mesoepimeron. Pala of male with about 42 pegs along dorsal margin. Length 5.5 to 6.9 mm.

Distribution: This species has been recorded from Nova Scotia to Northwest Territory, Canada, and south and west from North Carolina to California. In addition, specimens from South Carolina are in the Clemson University Museum.

S. alternata has previously been recorded from Virginia by Hungerford (1948) from New Church, Accomac County, July 15, 1934, and "Church Bridge," August 30, 1906. I have collected more than 100 adults and nymphs in Virginia from the following localities: Albemarle, Clark, Chesterfield, Fluvanna, Giles, Hanover, King William, Accomac, Pulaski, Smyth, Middlesex counties and the City of Chesapeake.

Habitat: This species inhabits principally ponds and deep pools of streams, but has been collected from marshy streams and from a swampy borrow pit.

Biology: The life history of *S. alternata* has been published by Hungerford (1917c) from studies made in Kansas and at Ithaca, New York. In the Kansas studies Hungerford stated that the eggs are top-shaped and are laid on dead leaves and stems of plants lodged in the water, or boards and sticks, tin cans, and even on the shells of living snails. He gives the following measurements for the immature stages: egg, 0.581 mm. long and 0.520 mm. in diameter; first instar, 1.17 mm. long; second instar, 1.63 to 1.78 mm. long; third instar, 2.13 mm. long; fourth instar, 3.5 mm. long; fifth instar, 4.375 mm. long. Hungerford stated that there were several generations per year, and in the laboratory the total length of the life cycle from egg to adult varied from 43 to 53 days. The adults pass the winter in a more or less active state. In his summary of the data collected at Ithaca, Hungerford stated that this species has

the widest "range of waters" of any the boatmen studied. The species winters as an adult and begins mating about the middle of April while the waters are still very cold. The eggs hatch in 1 to 2 weeks, and the instars require about 1 week for each stage, the last occupying a few days longer. The first generation emerges about the middle of June. The life cycle in Virginia is probably similar to the above, since fifth instar nymphs have been collected in early June. Adults were collected during each month from May to October.

Remarks: Within the family, *Sigara alternata* has been taken in association with the following species: *S. modesta, S. signata, S. depressa, S. compressoidea, Hesperocorixa interrupta, H. nitida, H. obliqua, H. minor, Palmacorixa buenoi, Trichocorixa calva, T. macroceps,* and *T. louisianae.* Of these the most frequent associations were with *H. interrupta, H. nitida, S. modesta,* and *T. calva.*

SIGARA STIGMATICA **(Fieber)** (Fig. 18g & h)

Corisa stigmatica Fieber, 1851; *Arctocorixa stigmatica,* Kirkaldy & Torre-Bueno, 1908; *Sigara stigmatica,* Hungerford, 1948.

Description: Pronotum with 6 dark transverse bands, slightly narrower than pale interspaces, not reaching lateral margins. Hemelytra moderately rastrate, without hairs; clavus irregularly crossbanded; corial pattern broken and irregular; pattern of membrane reticulate, separated from that of corium by a pale line. Mesoepimeron broad, scent gland osteole almost in lateral bend. Pala of male long and slender with 36 pegs in a single row. Length 4.6 to 5.7 mm.

Distribution: Hungerford (1948) stated, "So far we have been unable to discover where in North America this form was taken." He set up as lectotype a male specimen belonging to the Vienna Museum, labeled "Nord Amer." I have two specimens from Virginia which were identified by Dr. Hungerford as this species. Both were collected from the "Old Reservoir" at the University of Virginia, Albemarle County.

Habitat: My specimens were collected from a pond with an abundance of submerged and emergent vegetation. The bottom was covered with decaying leaves and silt.

Biology: The life history is not known. My two specimens were collected in October.

Remarks: *S. stigmatica* is identical with or extremly similar to *S. modesta,* and Hungerford (1948) keys the two species together Within the family, *S. stigmatica* has been taken in association with

S. modesta, S. signata, Trichocorixa calva, Hesperocorixa interrupta, and *H. nitida.*

SIGARA MODESTA **(Abbott)** (Fig. 18c & d)

Arctocorisa modesta Abbott, 1916; *Arctocorixa modesta*, Van Duzee, 1917; Blatchley, 1926; *Sigara modesta*, Hungerford, 1948.

Description: Pronotum with 6 or 8 dark transverse bands, equal in width to pale ones. Hemelytra moderately rastrate, without hairs; clavus with dark color frequently etched away on inner basal angles, dark banks of central portion darker than those on basal and distal portions; corium irregularly cross-banded; pattern of membrane reticulate, separated from corium by a pale line. Mesoepimeron broad, scent gland osteole almost in lateral bend. Pala of male with about 35 pegs in a single row. Length 4.6 to 5.7 mm.

Distribution: This species has been recorded from New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland District of Columbia, Virginia, West Virginia, Tennessee, Ohio, Michigan, Indiana, Minnesota, Missouri, Arkansas, Oklahoma, Colorado, Texas, Mississippi, Louisiana, and Puerto Rico.

S. modesta has previously been recorded from Virginia by Hungerford (1948) from Natural Bridge, Rockbridge County, August 22, 1918, Warrenton, Fauquier County, May 15, 1923, Page County, April 14, 1940, Bluemont, Loudon County, August 31, 1913, Paris, Fauquier County, July (?) 1898, Springvale, 1897, and "Virginia." I have more than 500 adults and many nymphs in my collection from Virginia. They were collected from about three-fourths of the counties in the state, representing all physiographic provinces.

Habitat: This species has been collected from streams, stagnant pools, a wet-weather spring, a swampy borrow pit, a canal through a swamp, ponds, and very small temporary pools. The preferred habitat seems to be pools and quiet regions of streams, where more than eighty per cent of my specimens have been collected. Only three collections have been made from ponds, the favorite habitat of many species. This species is often found in large numbers in and among watercress in the shallow niches of streams.

Biology: The life history of this species is not known. Nymphs have been collected in late May, but these were in the fourth and fifth instars at the time, and one fifth-instar nymph was collected as late as early October. There are probably 2 or 3 generations per year. Adults have been collected during each month of the year, and pass the winter on the bottom of pools, but remain more or less

active, becoming markedly so on moderately warm days. On February 19, 1948, a female of this species was taken in a puddle formed by melting snow. The maximum temperature for the day was 68°F., and the nearest permanent water was ¼ mile away. These insects fly quite readily during the summer, which probably accounts for the long list of habitats from which they have been collected as well as for the numerous associations with other species of the family.

Remarks: Within the family, *S. modesta* has been found most often in association with *Hesperocorixa interrupta* and *Trichocorixa calva,* but also with *S. signata, S. pectenata, S. alternata, S. depressa, S. compressoidea, S. zimmermanni, S. hydatotrephes, Trichocorixa macroceps, T. louisianae, Hesperocorixa nitida, H. minor,* and *Palmacorixa buenoi.*

SIGARA VIRGINIENSIS **Hungerford** (Fig. 18w & x)

Sigara virginiensis Hungerford, 1948.

Description: Pronotum crossed by 7 to 8 rather narrow, irregular dark bands. Pattern of clavus and corium irregularly transverse. Head about half the length of pronotal disk. Mesoepimeron at level of scent gland; osteole broader than lateral lobe of prothorax; osteole nearer tip than lateral bend. Metaxyphus broader than long, the apex blunt. Pala of male with about 30 pegs in peg row. Length 4.2 to 5.7 mm.

Distribution: This species has been recorded from New Hampshire, New Jersey, Pennsylvania, Ohio, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Tennessee, and Texas.

S. virginiensis was described from specimens collected by L. D. Anderson from New Church, Accomac County, Virginia. Hungerford (1948) also records the species from Warrenton, Fauquier County, May 15, 1928. I have not collected it.

Biology: The life history of this species is not known.

Remarks: This species closely resembles *S. modesta* in color pattern and in structural characteristics, but may be distinguished from the latter by having the mesoepimeron narrow with osteole nearer tip. It also has a large strigil.

SIGARA MULLETTENSIS **(Hungerford)** (Fig. 18y & z)

Arctocorixa mullettensis Hungerford, 1928c; Walley, 1936; *A. impersonata*, Walley, 1930c; *Sigara mullettensis*, Hungerford, 1948.

Description: Pronotum crossed by 6 or 7 broad bands. Pale figures of corium very small and arranged into three longitudinal rows, separated from membrane by pale line. Head about two thirds as long as pronotal disk; disk with lateral margins rounded. Mesoepimeron moderately broad, osteole about one third of the way between tip and lateral bend. Metaxyphus small, broader than long, apex bluntly pointed. Pala of male fairly broad with peg row interrupted apically with 15 to 17 pegs in basal portion and 5 to 6 in apical portion. Length 5.3 to 5.9 mm.

Distribution: This species has been recorded from Maine, New Hampshire, Rhode Island, Connecticut, New York, Michigan, District of Columbia, Virginia, Wisconsin, Minnesota, and Canada.

S. mullettensis has previously been recorded from Vienna, Fairfax County, Virginia, August 19,1931, by Hungerford (1948). I have several specimens of the species in my collection from Alleghany County, (an oxbow pond of the Cowpasture River, near Griffith) which were collected by R. L. Hoffman, July 23, 1950. This is apparently the southernmost locality known for this uncommon corixid.

Biology: The life history of this species is not known.

SIGARA DEFECTA **Hungerford** (Fig. 18m & n)

Arctocorixa bicoloripennis, Walley, 1936; *Sigara defecta*, Hungerford, 1948.

Description: Pronotum with 7 to 8 fairly regular brown bands. Clavus cross-banded. Corium with irregular dark lines arranged in longitudinal series. Pattern of membrane much broken, separated from corium by pale line. Head about two-thirds as long as pronotal disk, disk not reduced. Mesoepimeron narrow with osteole near tip. Metaxyphus plainly broader than long. Pala of male with about 26 pegs in a curved row with apical 2 or 3 set wide apart. Length 5.5 to 6.3 mm.

Distribution: This species has been recorded from New York, Pennsylvania, Maryland, Virginia, North Carolina, Michigan, Illinois, Wisconsin, Minnesota, and Canada.

I have not collected *S. defecta*, but Hungerford (1948) has recorded it from Vienna, Fairfax County, Virginia, September 19, 1931.

Biology: The life history of this species is not known.

SIGARA PECTENATA **(Abbott)** (Fig. 18e & f)

Arctocorisa pectenata Abbott, 1913b; *Arctocorixa pectenata*, Van Duzee, 1917; *Sigara pectenata*, Hungerford, 1948.

Description: Pronotum not as wide as distance between outer basal angles of clavi; crossed by 7 or 8 narrow, rgeular, brown, transverse lines. Hemelytra with clavus banded with narrow, irregular lines, almost effaced on inner basal angle; corium with short, irregular markings arranged in subtransverse series; pattern of membrane reticulate, separated from corium by pale line. Mesoepimeron about as wide as prothoracic lobe, scent globe osteole at about one-third of length from apex to lateral bend. Pala of male with dorsal hump at about midlength; 24 or 25 pegs in row near upper row of palmar bristles. Length 4.4 to 5.0 mm.

Distribution: This species has been recorded from New Jersey, Maryland, District of Columbia, Virginia, North Carolina, Georgia, Alabama, Tennessee, Indiana, Mississippi, Missouri, Oklahoma, and Texas; and there are specimens of it from South Carolina in the Clemson University Museum.

S. pectenata has proviously been recorded from Virginia by Hungerford (1948) from Bluemont, Loudon County, August 21, 1913, Vienna, Fairfax County, July 17, 1913, Warrenton, Fauquier County, June 7, 1928. I have collected only 5 specimens of this species in Virginia from the following localities: Buckingham County, 10.0 miles S. of Sprouses Corner on U.S. Hwy. 15, and 5.5 miles N. of Sprouses Corner on St. Hwy. 20; Southampton County, 32.6 miles E. of Edgerton on U.S. Hwy. 58.

Habit: My specimens were collected from a swamp, a creek, and a stagnant pool with masses of algae. All habitats from which *S. pectenata* was collected had considerable submergent vegetation.

Biology: The life history of this species is not known. I have collected males and females in May and June.

Remarks: Within the family, *Sigara pectenata* has been taken in association with *S. modesta, S. signata,* and *Trichocorixa calva.*

SIGARA ZIMMERMANNI **(Fieber)** (Fig. 16c & d)

Corisa zimmermanni Fieber, 1851; *Arctocorisa zimmermanni*, Kirkaldy & Torre-Bueno, 1908; *Arctocorisa compressa*, Abbott, 1913b; Van Duzee, 1917; Blatchley, 1926; Brimley, 1938; *Arctocorixa zimmermanni*, Van Duzee, 1917; Walley 1936; *Sigara zimmermanni*, Lundblad, 1929; Hungerford, 1948.

Description: Pronotum with 7 to 9 dark transverse lines. Hemelytra with markings irregularly arranged, more or less in longitudinal

series, often almost obscure because of dark background. Mesoepimeron narrow with scent gland osteole near apex. Pala of male sinuous as seen on edge; about 20 pegs in a row curving from base toward dorsal margin and following it to apex. Hind femur lacking row of short spines on caudal margin. Length 4.5 to 5.0 mm.

Distribution: This species has been reported from Maine, Massachusetts, Connecticut, New York, Pennsylvania, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Texas, Michigan, and Ohio.

The species has previously been reported from Virginia by Hungerford (1948) from Norfolk County, May 11, 1911. I have a total of 7 specimens of this species in my collection from Virginia, all from the City of Chesapeake, 3.5 miles E. of U.S. Hwy. 17 on County Hwy. 740, and 5.7 miles east of Northwest on County Hwy. 610 at intersection with County Hwy. 609.

Habitat: My specimens were collected from dark, brownish-black water of swamp streams and were present in the black ooze on the bottom.

Biology: The life history of *S. zimmermanni* is not known. All of my specimens were collected in early July.

Remarks: *S. zimmermanni* was collected in association with the following members of the family: *S. modesta, S. hydatotrephes, Trichocorixa calva, T. louisianae, and Hesperocorixa nitida.*

SIGARA VARIABILIS (Hungerford) (Fig. 18u & v)

Arctocorixa variabilis Hungerford, 1926; Walley, 1930; *Sigara variabilis*, Hungerford, 1948.

Description: Pronotum with broad, dark bands with very narrow spaces between. Clavus and corium with few pale, transverse mottlings. Membrane dark, separated from corium by a pale line. Head three-fourths as long as pronotal disk; disk angulate laterally and broader than long, tip blunt. Pala of male thick and short with 22 to 24 pegs curving apically. Length 5.3 to 5.9 mm.

Distribution: This species has been recorded from Connecticut, New Jersey, District of Columbia, Virginia, Illinois, Michigan, and Canada.

I have not collected *S. variabilis* but Hungerford (1948) recorded it from Vienna, Fairfax Co., Virginia, September 19, 1931.

Biology: The life history of this species is not known.

Remarks: The greatly thickened male pala is a distinctive character.

SIGARA COMPRESSOIDEA **(Hungerford)** (Fig. 18i & j)

Arctocorixa compressoidea Hungerford, 1928c; Walley, 1936; *Sigara compressoidea*, Hungerford, 1948.

Description: Pronotum with lateral margins obliquely truncate; crossed by about 7 dark, transverse lines, interrupted by median longitudinal pale line. Hemelytra with corial pattern much broken, arranged in more or less longitudinal series; pattern of membrane almost obliterated. Metaxyphus broader than long. Male pala with 20 to 22 pegs in a row midway between dorsal margin and upper palmar row of bristles, distal pegs long. Length 5.2 to 5.6 mm.

Distribution: This species has been recorded from Maine, Massachusetts, Connecticut, New York, New Jersey, Maryland, District of Columbia, North Carolina, South Carolina, Michigan, Wisconsin, Minnesota, South Dakota, and Ontario.

The species has not previously been reported from Virginia. I have collected specimens of *S. compressoidea* in Virginia from the following localities: Brunswick County, 1.3 miles N. of Edgerton on St. Hwy. 140; Chesterfield County, 4.1 miles S. of University of Richmond on James River Road; Henrico County, 7.8 miles E. of Byrd Airport, Richmond, on U.S. Hwy. 60;; Alleghany County, pond at Griffith, 7 miles east of Clifton Forge, (R. L. Hoffman).

Habitat: All my specimens were collected from ponds having very little vegetation, except for shoreline grasses, the blades of which hung in the water.

Biology: The life history of this species is not known. My specimens were collected in late May and early June, and no nymphs were observed.

Remarks: Within the family, *S. compressoidea* has been collected in association with *S. alternata, Hesperocorixa nitida, Palmacorixa buenoi, Trichocorixa calva,* and *T. louisianae.*

* *SIGARA MISSISSIPPIENSIS* **(Hungerford)** (Fig. 18s & t)

Sigara mississippiensis Hungerford, 1942, 1948.

Description: Pronotum with 8 dark bands, usually interrupted by median longitudinal pale line. Claval suture pale with wavy dark band paralleling it. Corium with dark areas arranged in irregularly longitudinal series. Pattern of membrane fairly distinct,

reticulate, distal margin dark. Head two-thirds as long as pronotal disk, which is rounded laterally and distally. Mesoepimeron moderately broad, osteole about half way to lateral bend. Metaxyphus broader than long. Pala of male parallelsided with 15 to 18 pegs in single row, the apical 13 or 14 large and blunt, basal ones smaller. Length 3.9 to 4.8.

Distribution: This species has been recorded from Mississippi, Alabama, Georgia, South Carolina, and District of Columbia.

I have not collected *S. mississippiensis* and it has not been recorded from Virginia, but it may occur in the state.

Biology: The life history is not known.

* *SIGARA MACROPALA* **(Hungerford)** (fig. 18aa & bb)

Arctocorixa macropala Hungerford, 1926; *Sigara macropala*, Hungerford, 1948.

Description: Pronotum with 5 or 6 broad brown bands, not interrupted down center. Pale figures of hemelytra small, wavy, somewhat transverse. Membrane and corium separated by pale line. Head about three-fourths as long as pronotal disk; disk about half as long as wide, rounded laterally and distally. Mesoepimeron narrow, osteole near tip. Metaxyphus short, broader than long, triangular. Pale of male short and broad with 19 small pegs in curving row. Length 5.3 to 5.5 mm.

Distribution: This species has been recorded from Minnesota, Michigan, Maine, New York, Massachusetts, Rhode Island, New Jersey, Maryland, and Florida.

S. macropala has not been found in Virginia, but it may occur here.

Biology: The life history of this species is not known.

SIGARA SIGNATA (Fieber) (Fig. 18o & p)

Corisa signata Fieber, 1851; *Arctocorisa signata*, Kirkaldy & Torre-Bueno, 1908; *Arctocorixa scriata*, Abbott, 1916; Van Duzee, 1917; Blatchley, 1926; *Arctocorixa signata*, Van Duzee, 1917; Blatchley, 1926; *Sigara signata*, Hungerford, 1948.

Description: Pronotum with 6 or 7 dark, transverse lines, about as wide as paler interspaces. Hemelytra with pattern consisting of wavy, irregular splotches of intermingled dark and pale areas in indistinct longitudinal series. Corium and membrane separated by a pale line. Metaxyphus longer than broad. Mesoepimeron broad with scent gland osteole about midway between lateral bend and apex.

Pala of male rather short and broad; about 16 large pegs in a sinuate row. Length 4.6 to 5.2 mm.

Distribution: This species has been recorded from Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, North Carolina, South Carolina, Georgia, Ohio, Michigan, Illinois, Wisconsin, Minnesota, Ontario, and Newfoundland.

The species has not previously been recorded from Virginia. I have collected 24 specimens of *S. signata* from the following Virginia localities: Albemarle County, "Old Reservoir" at University of Virginia, and stream 7.0 miles E. of Afton on U.S. Hwy. 250; Buckingham County, 5.5 miles N. of Sprouses Corner on St. Hwy. 20.

Habitat: The majority of my specimens have been collected from a pond, but a few have been taken in pools along streams.

Biology: The life history of this species is not known. I have collected specimens in every month of the year except January; the adults probably pass the winter among the debris on the bottom of the pools or ponds.

Remarks: Within the family, *S. signata* has been collected in association with *S. modesta, S. pectenata, S. alternata, Hesperocorixa interrupta, H. nitida, H. minor*, and *Trichocorixa calva.*

SIGARA HUBBELLI **(Hungerford)** (Fig. 18q & r)

Arctocorixa hubbelli Hungerford, 1928c; Walley, 1936; *Sigara hubbelli* Hungerford, 1948.

Description: Pronotum with 6 to 8 narrow brown bands, about half as wide as interspaces. Clavus cross-barred, effaced at inner basal angle. Corium with irregular dark lines arranged in longitudinal series. Pattern of membrane almost effaced, separated from corium by broad, pale line. Head about half as long as pronotal disk. Mesoepimeron narrow with osteole near tip. Metaxyphus about as broad as long, pointed apically. Pala of male with 24 pegs in a slightly curving row, distal ones longer and more pointed than basal pegs. Length 4.6 to 5.6 mm.

Distribution: This species has been recorded from Florida, Georgia, North Carolina, Virginia, West Virginia, District of Columbia, Maryland, Pennsylvania, New Hampshire, Indiana, Illinois, Iowa, Tennessee, Mississippi, Alabama, Louisiana, Arkansas, Missouri, Minnesota, Kansas, and Canada.

S. hubbelli is not represented in my collection, but the species has been recorded from Virginia by Hungerford (1948) from Vienna, Fairfax County, May 30, 1932.

Biology: The life history of this species is not known.

ACKNOWLEDGMENTS

I wish to express my sincere appreciation to Dr. Horton H. Hobbs r., former Professor of Biology at the University of Virginia, under vhose direction much of the data in this publication were assembled s a dissertation presented to the Graduate Faculty of the University f Virginia in partial fulfillment of the requirements for the degree f Doctor of Philosophy. For several years he gave freely of his ime and provided suggestions and encouragement which were invalu- ble. Drs. Richard L. Hoffman and Reece I. Sailer reviewed the ıanuscript before publication. I am grateful to Dr. Michael Kosz- arab for his constant encouragement in getting the final draft of he manuscript completed and for his labors, and those of Dr. Richard . Hoffman and Dr. James McD. Grayson, spent in preliminary edit- ng of the manuscript.

I am especially indebted to the following persons for providing nformation, identification, or loan of specimens: the late Dr. H. 3. Hungerford, former Head, Department of Entomology, Univer- ity of Kansas; the late Dr. C. J. Drake, Zoology and Entomology)epartment, Iowa State University; Dr. G. E. Gould, formerly with)epartment of Entomology, Purdue University; Dr. R. I. Sailer, ormerly with USDA, ARS, Systematic Entomology Laboratory; Dr. . L. Herring, USDA, ARS, SEL; Dr. O. L. Cartwright, formerly vith Department of Zoology and Entomology, Clemson University;)r. L. D. Anderson, former entomologist of the Virginia Truck Experiment Station; Mr. C. R. Wiley, former state entomologist, 'irginia Department of Agriculture; and Dr. J. F. Matta, Depart- ıent of Biology, Old Dominion University.

Finally, I wish to acknowledge Grant-in-Aid assistance by the Research Council of the Virginia Academy of Science, for which I m grateful. Without these funds it would have been difficult to omplete collections in eastern and southwestern counties of Virginia uring 1972. Mr. R. J. Klare did the final editing of this publica- ion.

LITERATURE CITED

Abbott, C. E. 1940. Some reflex responses of *Ranatra fusca* to contract stimuli. Bull. Brook. Entomol. Soc. 35(4):133-134.

Abbott, J. F. 1912. A new genus of Corixidae. Entomol. News 23:337-339.

_____. 1913a. A new species of Corixidae. Can. Entomol. 45:113-115.

_____. 1913b. Corixidae of Georgia. Bull. Brook. Entomol. Soc. 8:51-93.

_____. 1916. New species of Corixidae (Heteroptera). Entomol. News 27:340-343.

_____. 1923. Corixidae, *in* Guide to the insects of Connecticut, Pt. IV, the Hemiptera or sucking insects of Connecticut. Conn. St. Geol. and Nat. Hist. Surv. Bull. 34:386-390.

Amyot, C. J. B. & J. G. A. Serville. 1843. Histoire Naturelle des Insectes—Hemipteres. 657p. Paris.

Anderson, L. D. 1932. A monograph of the genus *Metrobates* (Hemip., Gerridae). Univ. Kan. Sci. Bull. 20(16):297-311.

Bacon, J. A. 1958. A taxonomic study of the genus *Rhagovelia* (Hemiptera: Veliidae) of the western hemisphere. Kan. Univ. Sci. Bull. 38(10):695-913.

Barber, H. G. 1913. Description of two new species of *Ochterus* Latr. (Hemiptera) with an arrangement of the North American species. Can. Entomol. 45:213-215.

_____. 1914. Insects of Florida. II Hemiptera. Bull. Amer. Mus. Nat. Hist. 33:495-535.

Bare, C. O. 1925. A new species of *Buenoa*. Entomol. News 36:226-228.

_____. 1926. Life histories of some Kansas "backswimmers." Ann. Entomol. Soc. Amer. 19:93-101.

_____. 1928. A monograph of the genus *Buenoa*. Kan. Univ. Sci. Bull. 18(3):265-349.

Battle, F. V. & E. C. Turner, Jr. 1971. A systematic review of the genus *Culicoides* (Diptera: Ceratopogonidae) of Virginia. VPI&SU Res. Div. Bull. 44:1-129.

Bergroth, E. 1892. Notes on the water-bug found by Rev. J. L. Zabriskie. Insect Life 4:321.

_____. 1908. Family Gerridae—Subfamily Halobatinae. Ohio Nat. 8: 371-382.

Bianchi, V. 1896. On two new forms of the heteropterous family Gerridae. Ann. Mus. Zool. St. Petersburg for the year 1896. p. 69-76.

Billberg, G. J. 1820. Enumeratio Insectorum in Museo Billberg. 138 p. Stockholm.

Blatchley, W. S. 1926. Heteroptera or True Bugs of Eastern North America with especial reference to the faunas of Indiana and Florida. Nature Publishing Company, Indianapolis, 116 p.

_____. 1928. Notes on Heteroptera of Eastern North America with descriptions of new species. J. N. Y. Entomol. Soc. 36:1-23.

Bobb, M. L. 1950. A contribution to our knowledge of the acquatic and semi-aquatic Hemiptera of Virginia. Ph.D. Dissertation, Univ. of Va. 372 p.

_____. 1951a. The life history of *Gerris canaliculatus Say* (Hemiptera: Gerridae). Va. J. Sci. 2(2):102-108.

_____. 1951b. Life history of *Ochterus banksi* Barber (Hemiptera: Ochteridae). Bull. Brook. Entomol. Soc. 46(4):140-145.

---------- 1953. Observations on the life history of *Hesperocorixa interrupta* Say) (Hemiptera: Corixidae). Va. J. Sci. 4(3):111-115.
Brimley, C. S. 1938. The insects of North Carolina. North Carolina Department of Agriculture, Division of Entomology, Raleigh. 560 p.
Britton, W. E. 1923. Guide to the insects of Connecticut. Conn. St. Geol. and Nat. Hist. Surv. Bull. 34:675 p.
Burmeister, H. C. 1835. Handbuch der Entomologie—Rhyngota. Vol. 2, 404 p., Berlin.
Champion, G. C. 1897-1901. Rhynchota Heteroptera II. Biologia Centrali-Americana, 416 p., London.
Chapman, H .C. 1962. The Saldidae of Nevada. Pan-Pacific Entomol. 38(3): 147-159.
Clark, A. H. & L. F. Clark. 1951. The butterflies of Virginia. Smiths. Misc. Coll. 116(7):1-239.
Clark, L. B. 1928. Seasonal distribution and life history of *Notonecta undulata* in the Winnipeg region, Canada. Ecology 9(4):383-401.
Cross, J. L. 1972. New state records of aquatic insects from Virginia. Proc. Entomol. Soc. Wash. 74(4):476.
Cummings, C. 1933. The giant water bugs (Belostomatidae, Hemiptera). Univ. Kan. Sci. Bull. 21(9):197-219.
Curtis, J. 1833. Characters of some undescribed genera and species indicated in the "Guide to an arrangement of British insects." Entomol. Mag. 1: 186-189.
Deay, H. O. & G. E. Gould 1936b. The Hemiptera of Indiana, I. Family Gerridae. Amer. Midl. Nat. 17(4):753-769.
Douglas, J. W. & J. Scott. 1867. British Hemiptera: Additions and corrections. Entomol. Mo. Mag. 4:1-6, 45-52, 93-100.
Drake, C. J. 1915. Life history notes on *Gerris conformis* and *Limnognus hesione*. Ohio Nat. 15:503.
---------- 1919. A new species of *Velia* from Florida. Fla. Buggist. 3:1-2.
---------- 1920. Water striders new to the fauna of Ohio, including a description of a new species. Ohio J. Sci. 20:205-208.
---------- 1950. Concerning North American Saldidae (Hemiptera). Bull. Brook. Entomol. Soc. 45(1):1-7.
Drake, C. J. & H. C. Chapman. 1952. A new species of *Micracanthia* from Florida (Hemiptera: Saldidae), Fla., Entomol 35(4):147-150.
---------- 1958. The subfamily Saldoidinae (Hemiptera: Saldidae). Ann. Ent. Soc. Amer. 51: 480-485, figs. 1-5.
Drake, C. J. & H. M. Harris. 1928. Concerning some North American water-striders with description of three new species. Ohio J. Sci. 28(5):269-275.
---------- 1932a. A survey of the species of *Trepobates* Uhler (Hemiptera, Gerridae). Bull. Brook. Entomol. Soc. 27(2): 113-122.
---------- 1934. The Gerrinae of the western hemisphere (Hemiptera). Ann. Carnegie Mus. 23:179-240.
---------- 1942. List of *Rheumatobates* in the western hemisphere. Rev. Brasil Biol. 2(4):399-402.
---------- 1943. Notas sobre Hebridae del hemisferio occidental (Hemiptera). Notas Mus. La Plata 8(64):41-58.
---------- 1952. Genus *Trepobates* Herrich-Schaeffer (Hemiptera: Gerridae). Great Basin Nat. 12:35-38.

Drake, C. J. & F. C. Hottes. 1925. Five new species and a new variety of water-striders from North America (Hemiptera-Gerridae). Proc. Biol. Soc. Wash. 38:69-73.

_____. 1950. Saldidae of the Americas (Hemiptera). Great Basin Nat. 10(1 & 4):51-61.

_____. 1951. Notes on the species of *Rheumatobates*. Proc. Biol. Soc. Wash. 64:155.

_____. 1952. Distributional and synonymical data and descriptions of two *Hydrometra*. J. Kan. Entomol. Soc. 25(3): 106-110.

_____. 1955. Concerning Saldidae (Hemiptera) of the western hemisphere. Biol. de Entomol. Venez. 11(1&2):1-12.

Drake, C. J. & R. F. Hussey. 1955. Concerning the genus *Microvelia* Westwood, with descriptions of two new species and a checklist of American forms. Fla. Entomol. 38(3):95-115.

Drake, C. J., & J. Maldonado-Capriles. 1956. Some pleids and water-striders from the Dominican Republic (Hemiptera). Bull. Brooklyn Ent. Soc., vol. 51 (2), pp. 53-56.

Ellis, L. L. 1955. The aquatic Hemiptera of southeastern Louisiana, exclusive of Corixidae. Amer. Midl. Nat. 48(2):302-329.

Esaki, T. 1926. The water-striders of the subfamily Halobatinae in the Hungarian National Museum. Ann. Hist. Mus. Nat. Hungarici 23:117-164.

Esaki, T., & W. E. China. 1928. A monograph of the Helotrephidae, subfamily Helotrephinae (Hem., Heteroptera). Eos (Madrid) vol. 4, pp. 129-172, 14 figs.

Fabricius, J. C. 1775. Systema Entomologiae Sistens Insectorium, Synonymis, etc. Flensburgi et Lipsiae. 832 p.

_____. 1790. Nova Insecta Genera. Skrift Nat. Selsk. Kjobenhaven 1:227.

_____. 1794. Entomologia Systematica. 4 vols. Hafniae.

_____. 1798. Supplementum Entomologia Systematica. Hafniae 527 p.

Fallen, C. F. 1814. Specimen novam Hemiptera Disponendi Methodum Exhibens. Lund, 26 p.

Fieber, F. X. 1851. Species generis *Corisa* monographice dispositae. Abh. Bohm. Ges. Wiss. Prag. 7:213-260.

_____. 1859. Die Europaischen Arten de Gattung *Salda* Fab. Wien. Entomol. Monnat. 3:256.

Froeschner, R. C. 1962. Contributions to a synopsis of the Hemiptera of Missouri, Part V. Amer. Midland Nat. 67(1):208-240.

Gillette, C. P. & C. F. Baker. 1895. A preliminary list of the Hemiptera of Colorado. Col. Agric. Expt. Sta. Tech. Bull. 31:1-137.

Gould, G. E. 1931. The *Rhagovelia* of the western hemisphere with notes on world distribution (Hemiptera, Veliidae). Univ. Kan. Sci. Bull. 20(1):5-59.

Griffith, M. E. 1945. The environment, life history and structure of the water boatman, *Rhamphocorixa acuminata* (Uhler) (Hemiptera, Corixidae). Univ. Kan. Sci. Bull. 30(14):241-365.

Guerin-Meneville, F. E. 1875. Animaux Articules a Pieds Articules. Sagra's Hist. Cuba. Pt. 2, 7:174.

Herrick-Schaeffer, G. A. W. 1848. Die Wanzenartigen Insecten. Vol. 8, Nurnberg.

_____. 1853. Die Wanzenartigen Insecten. Vol. 9. Nurnberg.

Herring, J. L. 1948. Taxonomic and distributional notes on the Hydrometridae of Florida (Hemiptera). Fla. Entomol. 31(4):112-116.

---------- 1949. A new species of *Rheumatobates* from Florida (Hemiptera, Gerridae). Fla. Entomol. 32(4):160-165.

---------- 1950. The aquatic and semi-acquatic Hemiptera of northern Florida. Part I: Gerridae. Fla. Entomol. 33(1):23-32.

---------- 1951. The aquatic and semi-aquatic Hemiptera of northern Florida. 4. Classification of habits and keys to the species. Fla. Entomol. 34(4):146-161.

Hoffman, C. H. 1932. The biology of three North American species of *Mesovelia* (Hemiptera-Mesovelidae). Can. Entomol. 64:90-115.

Hoffman, R. L. 1969. The biotic regions of Virginia. VPI&SU Res. Bull. 48: 23-62.

---------- 1971. Shield bugs, Hemiptera; Scutelleroidea:Scutelleridae, Corimelaenidae, Cydnidae, Pentatomidae). Va. Polytech. Inst. & St. Univ. Res. Div. Bull. 67:1-61.

Hoffmann, W. E. 1924a. Handy collecting apparatus. Entomol. News 35: 253-255.

---------- 1924b. Biological notes on *Lethocerus americanus* (Leidy). Psyche 31(5):175-183.

Hungerford, H. B. 1917a. The life history of the backswimmer, *Notonecta undulata* Say (Hem., Het.), Entomol. News 28:175-182, 267-268.

---------- 1917b. The egg laying habits of a backswimmer (Hem.), *Buenoa margaritacea* Bueno, and other biological notes concerning it. Entomol. News 28:174-183.

---------- 1917c. Life history of a boatman. J. N. Y. Entomol. Soc. 25:112-122.

---------- 1917f. The life history of *Mesovelia mulsanti* White. Psyche 24(3):73-84.

---------- 1919. The biology and ecology of aquatic and semi-aquatic Hemiptera. Univ. Kan. Sci. Bull. 11:1-341.

---------- 1922a. The life history of the toad bug, *Gelastocoris oculatus* Fab. Univ. Kan. Sci. Bull. 14:145-171.

---------- 1922b. The Nepidae in North America north of Mexico. Univ. Kan. Sci. Bull. 14(18):425-469.

---------- 1923a. Some studies on the genus *Hydrometra* in America north of Mexico, with description of a new species. Can. Entomol. 55:54-58.

---------- 1923b. Expedition of the California Academy of Sciences to the Gulf of California in 1921. The Hemiptera. Proc. Calif. Acad. Sci. 12:123-200.

---------- 1925a. A study of the *interrupta-harrisii* group of the genus *Arctocorixa* with descriptions of new species (Hemiptera Corixidae). Bull. Brook. Entomol. Soc. 20(3):141-145.

---------- 1925b. Report of collections of aquatic Hemiptera taken in Cherokee County, Kansas, and other new records from the state. Entomol. News 36:262-299.

---------- 1926. Some new records of aquatic Hemiptera from northern Michigan with the description of seven new Corixidae. Bull. Brook. Entomol. Soc. 21:198-199.

---------- 1927b. The life history of the creeping water bug, *Pelocoris carolinensis* Bueno (Naucoridae). Bull. Brook. Entomol. Soc. 22(2):77-83.

_____. 1928b. Some South American Corixidae. Bull. Brook, Entomol. Soc. 23(4):174.
_____. 1928c. Some Corixidae from northern states and Canada. Can. Entomol. 60:226-230.
_____. 1928d. Some recent studies on aquatic Hemiptera (including a new subgenus and a new species). Ann. Entomol. Soc. Amer. 21:139-146.
_____. 1933. The genus *Notonecta* of the world. Univ. Kan. Sci. Bull. 21(9):1-195.
_____. 1942. Three new Corixidae from the southern states. Bull. Brook. Entomol. Soc. 37(4):127-131.
_____. 1948. The Corixidae of the western hemisphere (Hemiptera). Univ. Kan. Sci. Bull. 32:1-827.
_____. 1954. The genus *Rheumatobates* Bergroth (Hemiptera: Gerridae). Kan. Univ. Sci. Bull. 36(7):529-588.
Hungerford, H. B. & N. E. Evans. 1934. The Hydrometridae of the Hungarian National Museum and other studies in the family (Hemiptera). Ann. Mus. Nat. Hungarici 28-31-112.
Hungerford, H. B. & R. Matsuda. 1960. Keys to subfamilies, tribes, genera and subgenera of the Gerridae of the world. Univ. Kan. Sci. Bull. 41(1/2): 1-23.
Hussey, R. F. 1919. The waterbugs of the Douglas Lake Region, Michigan. Occas. Papers, Mus. Zool. Univ. Mich. 75:1-23.
_____. 1921. Distributional notes on Hemiptera, with the description of a new *Gerris*. Psyche 28:11-12.
Hussey, R. F. & J. L. Herring. 1949. Notes on the varitation of the *Metrobates* of Florida (Hemiptera: Gerridae). Fla. Entomol. 32(4):166-170.
Hutchinson, G. E. 1940. A revision of the Corixidae of India and of adjacent regions. Trans. Conn. Acad. Arts & Sci. 33:413.
Jaczewski, T. 1930. Notes on the American species of the genus *Mesovelia* Muls. (Heteroptera, Mesovelidae). Ann. Mus. Zool. Polonici. 9(1):3-12.
_____. 1931a. Die Corixiden (Corixidae, Heteroptera) des Zoologischen Staatsinstituts und Zoologischen Museums in Hamburg II. Archiv. fur Hydrobiologie und Planktonkunde. 23:516-519.
_____. 1936. Notes on Corixidae (Hem.). Proc. Royal Entomol. Soc. London, B, V(2):42.
_____. 1939. Notes on Corixidae, XV-XXII. Ann. Mus. Zool. Polonici, 13(23):263-302.
Kirby, W. F. 1890. Insecta, excepting Coleoptera, in H. N. Ridley's "Notes on the Zoology of Fernando Noronha." J. Linn. Soc. London 20:530-548.
Kirkaldy, G. W. 1897. Aquatic Rhynchota: Descriptions and notes. No. I. Ann. & Mag. Nat. Hist. ser. 6, (20):58.
_____. 1900. Recent notes on *Hydrometra martini* Kirk. = *lineata* Say. Entomol. 33:175.
_____. 1902. Miscellanea Rhynchotalia—No. 3. Entomol. 35: 136-138.
_____. 1904. Ueber Notonectiden. Wien. Entomol. Zeit, 23:93-135.
_____. 1906. List of the Genera of the Pagiopodous Hemiptera-Heteroptera, with their type species, from 1758-1904. Trans. Amer. Entomol. Soc. 32:117-156.
_____. 1908. Notes on Corixidae, I. Can. Entomol. 40(4):117-120.
Kirkaldy, G. W. & J. R. de la Torre-Bueno. 1908. A catalogue of American aquatic and semi-aquatic Hemiptera. Proc. Entomol. Soc. Wash. 10:173-215.

Kuitert, L. C. 1942. Gerrinae in the University of Kansas collections. Univ. Kan. Sci. Bull. 28(7):113-143.
Lamarck, J. B. 1801. Systeme des animaux sans vertebres, etc. Paris.
Latreille, P. A. 1802-1804. Histoire Naturelle, Generale et Particuliere des Crustacea et des Insectes. Vols. 3-12. Paris.
---------- 1807. Genera Crustaceorum et Insectorum Secundum. Vol. 3. Paris.
Lauck, D. R. & A. S. Menke. 1961. The higher classification of the Belostomatidae. Ann. Entomol. Soc. Amer. 54:644-657.
LeConte, J. L. 1859. The complete writings of Thomas Say. 2 vols.
Leach, W. E. 1815. Hemiptera in Brewster's Edinburgh Encyclopedia, vol. 9.
Leidy, J. 1847. History and anatomy of the Hemipterous genus *Belostoma*. J. Acad. Nat. Sci. Phil. 1:57-66.
Lethierry, J. & G. Severin. 1896. Catalogue General des Hemipteres, Vol. 3, 275 p.
Linnaeus, C. 1758. Systema Naturae, Tenth edition.
---------- 1771. Mantissa Plantarum, II, p. 534.
Lundblad, O. 1928. Drei neue Corixiden Gattungen. Zool. Anz. 79:148-163.
---------- 1929. Uber einigen Corixiden des Berliner Zoologischen Museums. Archiv. fur Hydrobiologie und Planktonkunde. 20:296-231.
---------- 1931. Uber die Corixiden des Zoologischen Museums in Halle, nebst einer Ubersicht der Gattung *Trichocorixa*. Zool. Anz. 96 (3/4):85-95.
Matsuda, R. 1960. Morphology, evolution and a classification of the Gerridae (Hemiptera-Heteroptera). Univ. Kan. Sci. Bull. 41(1/2):25-632.
Martin, J. O. 1900. A study of *Hydrometra lineata*. Can. Entomol. 32:70-76.
Mayr, G. L. 1852. Zwei neue Wanzen aus Kordofan. Verh. zool-bot. Ges. Wien. 2:14-18.
---------- 1865. Diagnosen neuer Hemipteren—II. Verh. bool.-bot. Ges. Wien. 15:429-446.
Meinert, E. R. 1895. *Rheumatobates tenuipes* n. sp. Entomol. Med. 5:1-9.
Menke, A. S. 1963. A review of the genus *Lethocerus* in North and Central America, including the West Indies (Hemiptera: Belostomatidae). Ann. Entomol. Soc. Amer. 56:261-267.
Montandon, A. L. 1896. Hemipteres-Heteropteres Exotiques. Notes et Descriptions. II. Fam. Belostomatidae. Ann. Soc. Entomol. Belgique. 40:508-620.
Mulsant, E. & C. Rey. 1852. Description de quelques Hemipteres Heteropteres nouveaux ou peu connus. Ann. Soc. Linn. Lyon. 1850-1852:76-141.
Needham, J. C. 1907. The eggs of *Benacus* and their hatching. Entomol. News 18(4):113-116.
Osborn, H. 1901. New genus including two new species of Saldidae. Can. Entomol. 33:181-182.
Osborn, H. & C. J. Drake. 1915. Additions and notes on the Hemiptera-Heteroptera of Ohio. Ohio Nat. 15:501-508.
Palisot de Beauvois, A.M.F.J. 1805. Insectes Recueillis en Afrique et en Amerique. Paris. 267 p.
Parshley, H. M. 1914. List of the Hemiptera-Heteroptera of Maine. Psyche 21(5):139-149.

---------- 1916. New and noteworthy Hemiptera from New England. Entomol. News 27:103-104.
Pechuman, L. L. 1973. Horse flies and deer flies of Virginia (Diptera: Tabanidae). Va. Polytech. Inst. & St. Univ. Res. Div. Bull. 81:1-92.
Penn, G. H. & R. M. Goldsmith. 1950. The life history of the southern water-strider, *Gerris canaliculatus* (Hemiptera, Gerridae). J. Tenn. Acad. Sci. 25(1):76-79.
Provancher, A. L. 1872. Descriptions de plusieurs Hemipteres nouveaux. Nat. Nat. Can. 4:103-1108.
Rankin, K. 1935. Life history of *Lethocerus americanus* Leidy (Belostomatidae, Hemiptera). Univ. Kan. Sci. Bull. 22(15):479-491.
Rau, P. 1943. The neon-sign dance of the water-boatman, *Trichocorixa verticalis* Fieb. (Hemiptera). Entomol. News 54(10):258-259.
Reuter, O. M. 1912. Zur Generischen Teilung der Palaearktischen und Nearktischen Acanthiaden. Ofv. Finska Vet-Soc. Forsk. 54(12):1-24.
Rice, L. A. 1942. Notes on the biology and species of the three genera of Notonectidae found at Reelfoot Lake, Tennessee, J. Tenn. Acad. Sci. 17(1):55-67.
Riley, C. F. C. 1921. Responses of the larger water-strider, *Gerris remigis* Say, to contact and light. Ann. Entomol. Soc. Amer. 14(4)):231-289.
---------- 1922a. Droughts and cannibalistic responses of the waterstrider, *Gerris marginatus* Say. Bull. Brook. Entomol. Soc. 17:79-87.
----------.1922b. Food during captivity of the water-striders, *Gerris remigis* Say and *Gerris marginatus* Say. Entomol. News 33:86-88.
Sailer, R. I. 1948. (in Hungerford). The Genus *Trichocorixa* (Corixidae, Hemiptera). Univ. Kan. Sci. Bull. 32:289-407.
Say, T. 1825. Descriptions of new Heteropterous insects collected in the expedition to the Rocky Mountains, under command of Major Long. J. Acad. Nat. Sci. Phil. 4:307-345.
---------- 1832. Descriptions of new species of Heteropterous Hemiptera of North America. New Harmony, Ind. 39 p.
Schell, D. V. 1943. The Ochteridae (Hemiptera) of the western hemisphere. J. Kan. Entomol. Soc. 16:29-46.
Schroeder, H. O. 1931. The genus *Rheumatobates* and notes on the male genitalia of Gerridae (Hemiptera, Gerridae). Univ. Kan. Sci. Bull. 20(2):63-99.
Schuh, T. 1967. The shore bugs (Hemiptera: Saldidae) of the Great Lakes region. Amer. Entomol. Inst. Contrib. 2(2):2-35.
Silvery, J. K. G. 1931. Observations on the life history of *Rheumatobates rileyi* (Berg.) (Hemiptera-Gerridae). Mich. Acad. Sci. Arts and Letters 13:433-466.
Slosson, A. T. 1908. A hunt for *Saldoida* Osborn. Entomol. News 18:424-428.
Sprague, I. B. 1956. The biology and morphology of *Hydrometra martini* Kirkaldy. Univ. Kan. Sci. Bull. 38:579-691.
Stal, C. 1855. Nya Hemiptera. Ofv. sv. Vet-Ak. Forsk. 12:181-192.
---------- 1862. Hemiptera Mexicana enumeravit speciesque novas descripsit. Stettiner Entomol. 23:81-118, 273-281, 289-325, 437-462.
---------- 1876. Enumeratio Hemipterorum. Konglika Svenska Vetenskaps-Akad. Handlingar. 14(4):137-140.
Statzman, J. W. 1934. Some observations on *Notonecta undulata* Say (Hemiptera: Notonectidae) and other aquatic insects in winter. Entomol. News 45(10:278-280.

Todd, E. L. 1955. A taxonomic revision of the family Gelastocoridae. Univ. Kan. Sci. Bull. 37(11):277-475.

---------- 1961. A check-list of the Gelastocoridae (Hemiptera). Proc. Hawaiian Entomol. Soc. 17(3):461-476.

Torre-Bueno, J. R. de la. 1903a. Notes toward the life history of *Pelocoris femoratus* Pal. B. with a few remarks on habits. J. N. Y. Entomol. Soc. 11:166-173.

---------- 1903b. Notes on the stridulation and habits of *Ranatra fusca* Pal. B. Can. Entomol. 35:235-237.

---------- 1905a. The genus *Notonecta* in America north of Mexico. J. N. Y. Entomol. Soc. 14:46, 159.

---------- 1905b. Notes on *Hydrometra martini* (= *lineata Say*). Can. Entomol. 37:12-15.

---------- 1905c. A list of certain families of Hemiptera occurring within seven miles of New York. J. N. Y. Entomol. Soc. 13:29-47.

---------- 1905d. *Nerthra stygica* Say and some notes on the family Gelastocoridae. Ohio Nat. 5:287-290.

---------- 1905e. The three Ranatras of the northeastern United States. Can. Entomol. 37:187-188.

---------- 1906a. Life history of *Ranatra quadridentata* Stal. Can. Entomol. 38:242-252.

---------- 1960b. Life histories of North American water-bugs. II *Belotoma fluminea* Say. Can. Entomol. 38.189-197.

---------- 1907a. On *Rhagovelia obesa* Uhler. Can. Entomol. 39: 61-64.

---------- 1907b. Two undescribed water bugs from the United States. Can. Entomol. 39:225-227.

---------- 1908. Hemiptera-Heteroptera of Westchester County, N. Y. J. N. Y. Entomol. Soc. 16:223-238.

---------- 1910. Life histories of north American water bugs—III. Can. Entomol. 42:176-186.

---------- 1911. The Gerrids of the Atlantic States (Sub-family Gerrinae). Trans. Amer. Entomol. Soc. 37:243-252.

---------- 1916. The Veliidae of the Atlantic States. Bull. Brook. Entomol. Soc. 11:52-61.

---------- 1917a. Life history of the northern *Microvelia—Microvelia borealis* (Hem., Het.). Entomol. News 28:354-359.

---------- 1917b. Life history and habits of the marginated water-strider, *Gerris marginatus* Say, (Hem., Het.). Entomol. News 28:295-301.

----------.1917c. Life history and habits of the larger water-strider, *Gerris remigis* Say (Hem.). Entomol. News 28:201-208.

---------- 1923a. A saldid genus new to the United States and a new species. Bull. Brook. Entomol. Soc. 18:149-154.

----------.1923b. Aquatic and Semiaquatic families, except Corixidae in Guide to insects to Connecticut IV. The Hemiptera or sucking insects of Connecticut. Conn. St. Geol. and Nat. Hist. Sur. Bull. 34, p. 391-421.

---------- 1924a. A preliminary survey of the species of *Microvelia* of the western world, with description of a new species. Bull. Brook. Entomol. Soc. 19:186-194.

---------- 1924b. The nearctic *Rhagovelia*. Trans. Amer. Entomol. Soc. 50:243-252.

---------- 1926. The family Hydrometridae in the western hemisphere. Entomol. Amer. 7(2):83-128.

Truxal, F. S. 1953. A revision of the genus *Buenoa* (Hemiptera: Notonectidae). Univ. Kan. Sci. Bull. 35(2):1351-1523.

Uhler, P. R. 1862. Notes on the Hemiptera in Harris' "Insects Injurious to Vegetation."

---------- 1871. Notices of some Heteroptera in the collection of Dr. T. W. Harris. Proc. Bost. Soc. Nat. Hist. 14:93-109.

---------- 1876. List of Hemiptera of the region west of the Mississippi River, including those collected during the Hayden Explorations of 1873. Bull. U. S. Geol. Geog. Sur. 1:269-361.

---------- 1877. Report upon the insects collected by P. R. Uhler during the explorations of 1875, including monographs of the families Cydnidae and Saldidae. Bull. U.S. Geol. Geog. Sur. 3:355-475, 765-801.

---------- 1878. Notices of Hemiptera-Heteroptera in the collection of the late T. W. Harris, M. D. Proc. Bost. Soc. Nat. Hist. 19:365-446.

---------- 1884. Order VI. Hemiptera: suborder III. Heteroptera. Kingsley's Standard Nat. Hist. 2:249-296.

---------- 1886. Check list of the Hemiptera-Heteroptera of North America. Brook. Entomol. Soc. 34 p.

---------- 1893. Summary of the collection of Hemiptera secured by Mr. E. A. Schwarz in Utah. Proc. Entomol. Soc. Wash. 2:384-385.

---------- 1894. On the Hemiptera-Heteroptera of the island of Grenada, West Indies . Proc. Zool. Soc. London. 167-224.

----------.1897. Contributions towards a knowledge of the Hemiptera-Heteroptera of North America, No. 1. Trans. Maryland Acad. Sci. 1:383-384,

Usinger, R. L. 1942. Notes on the variation and distribution of *Mesovelia mulsanti* White (Mesovelidae, Hemiptera). Bull. Brook. Entomol. Soc. 37(5):177-178.

---------- 1945. Review of the genus *Saldoida* with new records for Georgia and Virginia. Bull. Brooklyn Ent. Soc., 40: 116-118.

Van Duzee, E. P. 1914. A preliminary list of the Hemiptera of San Diego Co., California. Trans. San Diego Soc. Nat. Hist. 2:1-57.

---------- 1917. Catalogue of the Hemiptera of America north of Mexico excepting the Aphididae, Coccidae, and Aleurodidae. Univ. Cal. Pubs. Entomol., Vol. 2, 902 p.

Walley, G. S. 1930a. A review of the genus *Palmacorixa* Abbott (Hemip., Corixidae). Can. Entomol. 62-99-106.

---------- 1930b. Heteroptera from the north shore of the Gulf of St. Lawrence. Can. Entomol. 62: 75-81.

---------- 1930c. A new *Arctocorixa* with a note on synonymy (Hemiptera: Corixidae). Bull. Brook. Entomol. Soc. 25(4);204-205.

---------- 1936. New North American Corixidae with notes (Hemiptera). Can. Entomol. 68(3):55-63.

Walton, G. A. 1934. The natural classification of the British Corixidae (Hemiptera). Trans. Soc. Brit. Entomol. 8(5):161.

Weed, C. M. 1889. On the feeding habits of the lesser water bug (*Zaitha fluminea* Say). Ohio Agric. Expt. Sta. Tech. Bull. 1(1):11.

Westwood, J. O. 1834. Memoir sur les genres *Xylocoris, Hylophia, Microphysa, Leptopus, Velia, Microvelia, Hebrus,* etc. Ann. Soc. Entomol. France 3:636-653.

White, F. F. 1877. Descriptions of new species of Heteropterous Hemiptera collected in the Hawaiian Islands by the Rev. T. Blackburn, No. 1. Ann. Mag. Nat. Hist. 20:110-114.

----------. 1879. List of the Heteroptera collected in the Amazons by Prof. J. W. Trail in the years 1873-1875, with descriptions of the new species. Trans. and Proc. Entomol. Soc. London. 268-269.

Wiley, G. O. 1922. Life history notes on two species of Saldidae (Heteroptera). Univ. Kan. Sci. Bull. 14(9):301-311.

Williams, M. L. & M. Kosztarab. 1972. Morphology and systematics of the Coccidae of Virginia with notes on their biology (Homoptera: Coccoidea). Va. Polytech. Inst. & St. Univ. Res. Div. Bull. 74:1-215.

Zetterstedt, J. W. 1838. Insecta Lapponica Descripta. 1140 p.

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