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A Taxonomic Survey of the Family Gyrinidae (Coleoptera) of the State of Virginia

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A TAXONOMIC SURVEY OF THE FAMILY GYRINIDAE (COLEOPTERA) OF THE STATE OF VIRGINIA

by

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ABSTRACT

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OF THE STATE OF VIRGINIA

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The aquatic insect fanua of Virginia is not very well known. This is especially true of the order Coleoptera. There are few taxonomic studies on the families of Coleoptera found within the state, and one of the least known is the family Gyrinidae. It is the intent of this study to determine what species of Gyrinidae are found within the state and where they are found. Collections of the beetles were made throughout the state from March to December.

Twenty-one species of Gyrinidae were identified in Virginia, nine species of Dineutus and 12 species of Gyrinus. The family is distributed throughout the state with little regard to the physiographic provinces. The major factor in the beetles' distribution is the availability of water. Two habitat preferences were recognized; lotic habitats and lentic habitats. All species demonstrated some type of preference for one or both of these habitats during the study. Only three species of the genus Dineutus exhibited specific recognizable patterns of distribution. The remaining species of both genera were either distributed throughout the state or were so sparsely collected that no distributions were identifiable.

All species exhibited the aggregation identified in the family known as "rafting." Depending on the species and habitat type these rafts were either very tightly or very loosely formed, and in many cases were multispecific or multigeneric in composition. There was no evidence to suggest that specific species tended to form multigeneric aggregations more than any other species. Simplified keys to the species are presented with this study.

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INTRODUCTION

The family Gyrinidae is a small family of aquatic Coleoptera found throughout the world. The common name "Whirligig Beetle" is given to this group because of their erratic circling pattern when alarmed. These beetles are among the few insects to inhabit the area called the supraneuston, the surface of the water. This habitat offers an opportunity for highly specialized structures and habits to evolve, as is the case with the family Gyrinidae.

While there is literature available on the Gyrinidae of some states and areas of the United States, there has not been any study on the Gyrinidae of Virginia. Matta (1973, 1979) reported that three species of Gyrinus and two species of Dineutus were found in the Dismal Swamp. However there are no other published works on the Gyrinidae of Virginia.

The gyrinid records for the state are very limited and this is best illustrated by the fact that in a collecting trip to the northeast and southcentral parts of the state by Dr. James Matta of Old Dominion University (ODU) and myself, 27 new county records were recorded in one day. This large number of new county records within an easily accessable area of the state demonstrates the incompleteness of the study of this family in Virginia.

The purpose of this study is to increase the ecological and systematic knowledge of the family Gyrinidae as it occurs in the State

of Virginia. The goals of this study are: (1) to identify the genera and species found in Virginia; (2) to determine the ranges of the species found in the state; (3) to compare the morphology, habits and habitats of the species to aid in identification; (4) to produce simpler keys to the species of the family within the state.

LITERATURE REVIEW

There has been a generous amount of primary literature produced on the family Gyrinidae when compared with other families of aquatic coleoptera of similar size, such as the Haliplidae. In addition, there are several publications which cover the entire order Coleoptera or the aquatic Coleoptera and contain general information on the Gyrinidae, such as Dillon & Dillon (1961), Gordon and Post (1965), Leech (1948), Leech & Chandler (1971), Brigham (1982), and Young (1954).

Brigham (1982) contains well written keys to the species of the genera Dineutus, Gyrinus and, Gyretes. While there are a few unclear areas within the key to the Gyrinus, it serves as a good identification manual for the species in the east central United States. Leech (1948) covers the Gyrinids found in lower California. He describes two species each of the genera Gyrinus and Dineutus. Leech and Chandler (1971) describes the Coleoptera throughout California. Seven species of adult Gyrinus, a single species each of adult Dineutus and Gyretes are described. Also included, is a key to some larval Dineutus. Dillon and Dillon (1961) contains a brief chapter with keys and short descriptions to four species of Dineutus and three species of Gyrinus. Young (1954) covers the Gyrinidae found throughout Florida with keys and descriptions to nine species of Dineutus, eight species of Gyrinus, and one species of Gyretes. Gordon and Post (1965) contains a short section on the gyrinids of North Dakota with a description on one

species of Dineutus and a key and descriptions to eight species of Gyrinus.

There has been a fair amount of work published dealing with the taxonomy of the family alone, and many of these works contain descriptions, and keys to the species for certain regions. The most useful of these studies are Fall (1922), Ferkinhoff and Gundersen (1983), Hatch (1951), Malcolm (1971), Roberts (1895), Wood (1962). There are other studies of taxonomic interest in the available literature, mostly dealing with single species descriptions and notes, such as Fall (1931) and Leng (1911), but one important exception to this is Hatch (1925b) who discusses the phylogeny of the family.

Fall's work of 1922 contains very good descriptions and a comprehensive key to 33 of the species in the genus Gyrinus. Ferkinhoff and Gundersen (1983) examines gyrinids of the north central region of the United States and Canada. Their publication contains good taxonomic information on six species of Dineutus and 27 species of Gyrinus, most of which are found in the eastern United States. Roberts (1895) produced a short but useful study on the Dineutus of North America. There are descriptions and a key to eight species. Wood (1962) gives a synopsis of the genus Dineutus and includes keys to the majority of the species and some of the subspecies within the genus.

The morphology of the family has been covered in several papers, but Hatch (1927a) is probably the best detailed presentation of the overall adult morphology. Wickham (1893, 1894) gives a short description of the larvae of the genera, but these two papers are of

only marginal use.

A large proportion of the available literature on the family Gyrinidae concerns the behavior of the species. These works include studies on the general ecology of the family (Hatch, 1925a), the aggregation, foraging, defense, intraspecific competition, and interspecific competition (Benfield, 1972; Brown & Hatch, 1929; Butcher, 1930; Freilich, 1986; Hatch , 1925a, 1927b; Heinrich & Vogt, 1980; Istock, 1966, 1967; Kolmes, 1983, 1985; Leech, 1970; Smith, 1926; Tucker, 1962; Weiss, 1913; Wilde, 1941).

PREVIOUS INVESTIGATIONS

General morphology

In general, the adult Gyrinidae are dark colored beetles, ranging from 2mm to 16mm in length. The Gyrinid body is dorso-ventrally flattened and has a general oval shape. The coloration of the body consists of a dark brown to black dorsum and a venter ranging from yellowish-brown to black. The head overlaps the pronotum, while the posterior end of the pronotum overlaps the elytra to give the beetle a rigid and streamlined body form. The head also possesses one large pair of eyes separated on the margin of the head at the insertion of the antennae. This gives the impression of having four distinct eyes, one pair located dorsally, the second and larger pair located ventrally. The apparent two pairs of eyes is the distinctive characteristic of the Gyrinidae. The antennae are short, eight segmented, and are flattened anteriorly into a scoop-like shape. When not in use, the antennae can be folded back into a groove on the head which enhances the streamlined body form.

The thorax contains three highly specialized legs, each performing different functions. The front legs are non-flattened appendages which function as ambulatory appendages on the land, prehensile appendages for the capturing and holding of prey, clasping appendages for the male

during mating, and steering organs in swimming. The middle and hind legs are adapted for swimming by being extremely flattened into an oar-like shape, possessing tufts of hairs on the outer fringes which increase surface area, and lastly, have the coxa solidly and deeply set within the venter (Hatch 1925a). The middle legs and hind legs are similar in structure but they perform slightly different functions. According to Wood (1962), the middle legs are used for slow swimming and postion holding, while the hind legs are usually only brought into play during times of rapid swimming or diving.

The elytra of the Gyrinidae varies from being nearly rounded to emarginate or angled at the apex. It can be marked with striations, or rows of punctures, usually nine to eleven, which may be very distinct to almost non-existent. The lateral edges of the elytra are curved outwards to form the hypomera. The hypomera articulates with the lateral portions of the thorax and the basal segments of the abdomen, thus contributing to the streamlined form of the body.

The abdomen consists of 10 segments, with the last two being the genitalia. The eighth abdominal segment is flattened, fringed with hairs and extends out from under the elytra. The last segment along with the sexual apparatus forms a rudder for the beetles.

Special Modifications for Supraneuston

The Gyrinidae are modified for their life on the surface of water in two major ways; their bodies are modified into streamline and rigid forms, and their last two pair of legs are highly modified into very

efficient swimming appendages. The streamline body form is brought about by the fact that the head, pronotum, and elytra form a continuous outline of the body, thus, causing no irregular shapes or angles which increase resistance to the water when swimming. Further modifications which streamline the body are, eyes depressed into the head, legs which fold into groves within the venter, and usually an absence of pubescence and a reduction in sculpture.

The increased rigidity of the Gyrinidae body form is brought about by the overlapping and anterio-posterior compression of the body sections. The head is set well back into the prothorax which serves to strengthen the body, while the prothorax overlaps the mesothorax except at the midventral region, here the anterior lobe of the mesosternum protrudes between the procoxae (Hatch, 1925a). The middle and hind legs are adapted for efficient swimming by being modified into extremely flattened paddle-like appendages. Hatch (1925a) states that the Gyrinid legs represent a much higher degree of aquatic adaptation than do the legs of any other aquatic coleoptera. The mesocoxa and metacoxa are deeply set within the venter, with the mesosternum and metasternum being very well developed, thus, allowing for the attachment of the powerful muscles needed for continuous swimming.

Another Gyrinid adaptation for life on the water's surface is the fact that they float in the water much like a boat, and do not rest upon it as do some Hemiptera. Hatch (1925a) suggests that the water tension is also an aid in keeping the Gyrinidae afloat, when he states, "...As the beetle rests upon the water's surface, the surface appears

to be depressed slightly on all sides, thus, offering a measure of support to the body. The importance of this support was demonstrated by the difficulty that the animal experienced in keeping afloat when the surface tension of the water was reduced by the introduction of soap." Because of the air stored within the body and under the elytra, the Gyrinidae are lighter than the water. The disadvantages to this is that when they wish to submerge, they must continue swimming in a head downward position in order to stay submerged; this action requires a great deal of energy expenditure.

The sexes of the Gyrinidae are very similar, with the only visible differences being the genitalia, tarsal segments of the propods, and in some cases the presence of a tooth on the males' forefemur. The tarsal segments of the male possesses a short pubescence on the ventral side which resembles a small scrub-brush. The females' tarsus does not possess this pubescence, only a few scattered and produced hairs. The aedeagus or sexual appendage of the males is usually very characteristic for each species and is an important taxonomic character. The male genitalia consists of a median lobe called the aedeagus and a pair of flattened lateral lobes called the parameres. The length, lateral, and apical shapes are the principle features used to distinguish the different aedeaga.

The sexual apparatus of the females consists of two flattened lobes bearing a fringe of hairs along the distal margins (Hatch, 1927a). The female genitalia are very similar between the species and, therefore, do not have much taxonomic significance.

Larval Morphology

The larvae of the Gyrinidae are unlike other Coleoptera larvae. Mature larvae are pale, elongated, and dorso-ventrally flattened, with an average length of 10mm to 15mm for the genus Gyrinus, and 20mm to 30mm for the genus Dineutus. All larvae possess a single pair of long, lateral respiratory filaments on each of the first eight abdominal segments and two pairs on the ninth segment and they are independant of the water's surface. The last segment also possess two pairs of short hook-like appendages which are used to hold the larvae in place. The differences in the larvae of the genera Dineutus, Gyrinus, and Gyretes have been summarized by Pennak, 1978, "...Dineutus larvae have a subcircular head with a distinct and narrow neck. Gyretes and Gyrinus larvae have an elongated head, and the neck is about as wide as the head and not distinct. The Gyrinus have two to four teeth in a transverse row on the anterior median projections of the frons, but there are no such teeth in the Gyretes...." The larvae of the other North American genus, Spanglerogyrus has not been described.

Habitat

Gyrinidae inhabit most freshwater habitats throughout North America. They can be found in small to large ponds, lakes, and slow flowing streams and rivers of all sizes. It is for this reason that the Gyrinidae can be divided into two major categories, lentic species and lotic species. The genus Gyrinus seems to be more ubiquitous than Dineutus. A larger percentage of the Gyrinus species are able to

survive in any one of the above areas. Dineutus, however seem to be more restricted in the types of habitats in which they live, and therefore less abundant.

Although Gyrinidae show distinct preferences in habitat selection, there does not seem to be a distinct morphological reason for their choice. There is no special adaptation in either group which would lead one to expect to find a particular species in a certain habitat. Upon close examination there seems to be no significant difference in either body shape, or leg shape and size to lead one to expect a preference. The larvae may exhibit variations corresponding to habitat preference, but with most of the larvae unassociated, these variations are impossible to investigate.

Lentic, or quiet water inhabiting Gyrinids are usually found close to the banks near emergent vegetation, although some species of Dineutus have been found one hundred or more yards from the shore at times. Lentic Gyrinidae have a tendency to form very large aggregations, or "rafts" (Heinrich and Vogt, 1980) of individuals of one or more species, or they can be found clinging to the emergent vegetation.

The lotic, or stream-dwelling Gyrinids usually inhabit areas of slower moving waters, whether it is near the bank or out in the main flow of the stream, as long as they avoid areas of riffles, or torrential waters (Folkerts and Donavan, 1974). As with the lentic Gyrinids, the lotic Gyrinids form large aggregations in the slower water flows, or in small protected coves away from the water flow.

Members of the genus Dineutus are usually found in areas where the water is slowed by obstructions, such as, emergent logs, rocks, vegetation, or in the areas of slow waters within pools or wide meanders. Most Gyrinus are usually found in areas of slow current near the stream banks. Gyretes and certain species of Gyrinus prefer areas where the bank, roots of stream edge trees, or bank vegetation overhang the water, thus, creating a protective cove-like area with relativity slow current (Folkerts & Donavan, 1974).

Living in the stream habitat presents the problem of being swept down the stream. To counteract this problem, the Gyrinids either constantly swim against the current, or rest on the emergent vegetation. When swimming against the current, Gyrinids move in a series of jerks, only fast enough to maintain a position that is fixed relative to the shoreline. When disturbed, Gyrinids quickly swim down the stream a few meters, or in the case of pond species, scatter in all directions. After some time they reassemble in a group in the original spot (Hatch, 1925a). Sometimes, in order to rest from the constant swimming, an individual Gyrinid will swim towards the shore and swim slowly in the quiet waters there. A second method of getting out of the current in order to conserve energy is to find resting sites out of the water.

In order to conserve the vast amounts of energy needed to maintain their position on flowing water, Gyrinids climb out of the water onto emergent twigs, roots, or leaves. All species can be found resting in this manner at sometime, although the distance which they are found above the water surface varies with the species. The smaller Gyrinus

are usually found higher above the water on emergent objects than Dineutus, which are usually found resting on a part of a leaf, with their body seldom completely out of the water (Folkerts & Donavan, 1974). This could be because the Dineutus, with larger bodies, are not very good climbers, while Gyrinus, with smaller bodies, are better climbers and are able to climb higher. When Folkerts and Donavan examined resting individuals they found that many species rested together on the same object. They then go on to say that, "...frequently species of the same genera are found together, and some species of Gyrinus and Gyretes are also found together."

According to Folkerts and Donavan (1974), the reasons for resting on emergent objects are manyfold. First, less energy is expended, second, thermal regulation could be utilized in order to gain the heat necessary for activity in the higher temperatures which occur a few centimeters above the water, third, to reduce the predation from fish, and fourth, to escape flood waters.

Larval habitat

The larvae of the Gyrinidae are gill-breathers and are only found submerged in the water. Usually the larvae are found clinging to completely submerged plants, or the submerged portions of emergent plants. In areas where the larvae are found on completely submerged vegetation, they are usually found where there is three to four feet of water above the vegetation. The larvae on the emergent vegetation are usually found near the bank within shallow areas with a depth of 12 to

18 inches. The larvae on emergent vegetation tends to be younger instar, thus, showing a possibility of migration of the growing larvae from shallow to deeper water (Hatch, 1925a). Occasionally, the larvae may be seen swimming underwater in an undulating fashion by using their abdominal gills to aid in propulsion (Brigham and Brigham, 1982), this type of swimming is the probable method for larval migration.

Predation and defense

Adult Gyrinidae have few natural predators, some fish, birds, and mammals feed upon the beetles, but Gyrinids secrete a chemical substance which is repulsive to most predators. This secretion is highly effective in repulsing predacious fish, and other predators, but the behavior to avoid the secretion is learned in most predators, therefore, there is a loss of beetles due to predator training. In support of this, Heinrich and Vogt (1980) stated that a captured rock bass instantly grabbed a live beetle when it was dropped into its tank. A second was eaten within a minute, but was then regurgitated, and the third was not eaten at all. Fitzgerald (1986) observed that little brown bats would capture and taste Dineutus nigrior but would not eat them. Therefore, it would seem that this chemical protection is very effective on predators once the behavior is learned.

When not disturbed, most standing water and some stream Gyrinids usually aggregate into small to very large groups numbering from two to the thousands. These groups are called rafts by Heinrich and Vogt (1980). These rafts can be either single or multi-specific, or multi-

generic in nature. Although genera usually stay within the groups while foraging, the species composition can change greatly. The rafts are relatively permanent groups, but they usually break up at night, and reform in the mornings. The only other time at which the rafts are dispersed is when there is some type of disturbance in the area. It is believed that when a disturbance occurs, such as an approaching boat or predator, the individuals at the periphery of the groups detect the disturbance and start to swim in a very erratic manner. These beetles collide with others, causing other beetles to swim erratically until the entire raft is totally dispersed, and the supposed predator is confused. Once the water settles down and the predator leaves, the beetles reform the rafts and continue activities. Freilich (1986) supports this when he suggests that "...individuals use physical contacts to mediate their rafting behavior."

The beetles stay within the rafts mainly for protection. Heinrich and Vogt points out that fish living near rafting sites usually avoid the beetles within the groups, while the beetles apart from the groups were fed upon more often. Possible reasons why beetles within the groups are usually safe from predation are; 1) the natural secretions are combined, and therefore, stronger, 2) a predator being confronted by thousands of randomly moving beetles of similar appearance decreases the chance of any one individual being captured in the confusion, 3) beetles that join aggregations are moving into areas where there are no hungry predators, or where the available predators have already had ample opportunity to catch beetles, and thus learned to avoid catching

any more (Heinrich and Vogt 1980).

The third reason, migration into areas with no hungry predators, is believed to be the more plausible of the three reasons for rafting. Heinrich and Vogt (1980) point out that it would be easier to randomly capture beetles in large groups than if they were chasing a single individual. Also, fish are usually repelled by the secretions of one individual, therefore the need for combining the strength of the secretion would not be an advantage. They go on to point out that incidental localized availability of food, or increased availability of mating adults could be secondary reasons for the rafting behavior, but this has not been shown experimentally thus far.

Reproduction

Copulation in Gyrinids occurs on the surface of the water with the males mounting the females. This copulation may last as little as 30 minutes or as long as all day in some Gyrinus (Hatch, 1925a). During this time, the female continues to swim about with the male attached to her back by his propods. Dineutus ciliatus was observed during this study to copulate for approximately one hour with the beetles frequently separating and mounting regularly.

After copulation, the eggs are laid end to end in several rows on submerged vegetation, or portions of emergent vegetation a few inches below the water line. Hatch describes what was seen to occur when the beetles laid eggs in captivity, "...eggs of both Dineutus and Gyrinus where laid on aquarium plants and on the sides of the container, both

above and below the water line, those laid in the air desiccated. When the females were brought from the field and placed in aquaria, most laid eggs within the first 12-18 hours. From 20-50 eggs were usually laid by a single Dineutus. The incubation period for Dineutus ranges from 5-17 days and 10-14 days for Gyrinus."

Once hatched, the larvae go through three instars which lasts most of the Spring and Summer. Once maximum growth is achieved around the middle to late summer, the larvae crawl out of the water and build pupal cases of dirt or sand. The pupal cases are constructed either on vertical plants stems, rocks, or on shore several inches above the water line. The activity of case building usually occurs at night. Gyrinus seems to prefer pupating in the vegetation, while Dineutus prefers the shore (Bulcher 1930). Pupation lasts up to approximately one month, after which time, the adults emerge. There is usually only one generation per year.

There is some confusion concerning the length of the breeding season within the family Gyrinidae. The season can begin as early as April or May, while the eggs have been found as late as July. In light of information stated about pupation time and larval growth, adults will emerge in late August or early September. This does agree with Pennak, 1978, who states that the adults are most abundant in the late summer, but the confusion comes about when attempting to work out the exact schedules of the breeding season of different species. The breeding season of Dineutus at latitudes of 40 degrees to 50 degrees north begins in May when the water temperatures reach about 18 degrees

C, (Istock, 1965). It is possible that water temperature stimulates breeding, thus, in the lower latitudes, breeding may begin earlier, but much is not known about the area of Gyrinidae reproduction. Few life histories have been developed, and much work still needs to be done.

Feeding

Adult Gyrinidae have an unusual manner of searching out and capturing prey. They seek out live insects that fall upon the surface of the water and use their prehensal foreleg to grab them. Although, this type of prey forms the majority of the Gyrinid's food, they have been observed to feed upon dead animal matter and vegetation. Therefore, Gyrinids can be considered to be opportunistic feeders. Although Gyrinids feed on most things, they have never been seen to obtain food under the water's surface.

The Gyrinidae larvae are highly predacious, and will attack all types of mature and immature insects, and sometimes young fish. The larvae feed by sucking out the body fluids of their prey with its mandibles, as in Dytiscidae larvae. These mandibles are very large and have a canal running their length in which the preys body fluids are passed. The larvae are such voracious feeders, that they will attack and eat other Gyrinid larvae. It is this fact which makes the larvae difficult to rear in captivity.

METHODS AND MATERIALS

Sampling and Sampling Techniques

Samples for taxonomic study were obtained in two manners, first by an examination of preserved collections from other sources, and second, by a series of field collections. Preserved specimens of Gyrinidae for study were obtained from the Coleoptera collection of Dr. Michael Kosztarab, Virginia Polytechnic Institute and State University, Department of Entomology, (VPI&SU), Dr. James F. Matta, Department of Biological Sciences, Old Dominion University, (ODU) and Dr. Paul Spangler, National Museum of Natural History, (NMNH). In each case, the specimens were examined, identified, and the location data recorded.

Field collections were conducted for approximatly nine months of the year, starting in March and continuing through early December. This was done in order to obtain as many stages of Gyrinids as possible, and to sample populations throughout any seasonal cycles or variations which they may possess. Efforts were made to sample as many different habitats, in as many counties as possible throughout the state of Virginia. Areas sampled included small streams, rivers, ponds and lakes.

The sites to be sampled were selected by one of two methods. The

first was to locate areas of standing or running water by examining counties on Virginia county maps printed by the Virginia Department of Highways. The second method was to pick a traveling route through an area, stopping at all streams or ponds which the roads crossed. Every effort was made to include all state parks or natural refuges near the route of travel in order to sample in as many undisturbed or undeveloped areas as possible. This second method usually resulted in a diverse set of collecting sites being sampled while allowing a large area to be sampled in a short time.

Adult collections

All adult sampling was carried out with the use of a longhandled aquatic dip net. In areas where beetles were observed to be swimming on the surface, either singly or in aggregations, a quick sweep through the aggregation was usually sufficient enough to capture a good number of individuals. There are two techniques which seem to work well in capturing adult Gyrinids. Matta (1973) suggests that the best method for their capture is, "...a quick leap into the water and an energetic swing of the net..." While I agree with the fact that this usually does get good results, as he states, "...this is very disquieting when the water covers three or four feet of mud...", I would suggest that caution be used when using this method.

The second collection technique is to slowly walk up to the bank of the water and wait for the aggregations of beetles to resume their normal activity, and then quickly sweep the net back and forth through

the water. This technique, while taking longer than the first one, usually resulted in the same collection success with less distress to the collector. Either method has its advantages in different situations.

Once the beetles were captured, they were either taken directly from the net and placed in screw-top glass vials containing 70%-80% isopropyl alcohol, or the contents of the net were placed in a white enamel lined pan, and sorted. The white enamel is a good contrast to the beetles and makes sorting easier. Once the collecting at a site was finished, the vials were labeled with the county name and location, along with the date and collectors' names. A data sheet was also filled out with all available information such as time of day, date, type of aquatic habitat and other descriptive data.

Some samples of adults were not preserved upon capture, these beetles were kept alive for breeding in the laboratory for larval study. This decision was made randomly, or where beetles were seen copulating before capture. Beetles to be observed were transported in brown paper lunch bags which had been wetted in the available water. The tops of the bags were slightly twisted to prevent escape, and then placed in a plastic bag with a small amount of water in the bottom to prevent the paper bag from drying out. The plastic bag was not closed, permitting some air to diffuse into the bag. The beetles usually survived in the bag for one to three days. One advantage to using this technique was the fact that the females usually laid eggs while in the bags. The reason for this is unknown, but approximately 70 percent of

the females did produce eggs while being transported.

Larval collections

In attempting to collect larval Gyrinidae, again two methods were used. The first consisted of, slowly dipping an enamel lined pan in the water, edge-first along the margins of the banks, thus letting water rush into the pan carrying organisms with it. The material in the pan was then removed and organisms were removed with the use of forceps or plastic eye-droppers. Although, the technique was very successful in collecting larvae of many types of aquatic beetles, no Gyrinid larvae were collected with this method.

The second method of collecting larvae was to pass a longhandled dip net through the submerged vegetation several times, collecting organisms and vegetation at the same time. The material was then placed in a enamel pan and sorted. This method was also very successful in collecting larval forms of many organisms, however, it also did not lead to the collection of any Gyrinid larvae.

Rearing

Once the beetles were transported to the laboratory, 5-10 beetles from a collection site were placed in a five gallon aquarium. The aquariums contained two to three inches of water and some type of structure such as, rocks, twigs or paper strips attached to the glass for the beetles to rest upon, or to lay eggs on. While in the tanks, the beetles were fed on curlywinged Drosophila melanogaster. The curly-winged Drosophila were chosen because they are unable to fly and, therefore, would not pose a problem if any escaped while feeding.

Although other types of food were tried, such as, dried fish food, turtle food and a variety of meats, the Gyrinids preferred the Drosophila to any of the others types of food. This may have been because the flies are closest to their natural foods. The beetles were then kept for two to three weeks to allow them time to breed. At the end of that time if they had not produced any eggs, they were removed and preserved for the Coleoptera collection.

In cases where eggs were laid, the adults were removed and preserved within five days after the first eggs were seen. This was done to eliminate any possiblity of the adults disturbing the eggs in such a small enclosed area, or feeding upon the larvae when they hatched. The eggs were left where they were laid and allowed to develop with a minimum of disturbance. After hatching, each larvae was placed into a small finger bowl to eliminate cannibalism (Tonapi, 1958). The larvae were then allowed to mature in the bowls. The water was changed or added to every few days to help eliminate the build up of wastes. The larvae were fed on a diet of small arthropods, such as, Collembola, Cladocera, small Drosophila, and many other small organisms. Any larvae which died were removed and preserved in 70% isopropyl alcohol and labeled. Once the larvae reached the third instar, they were collected and preserved in alcohol along with the adults for identification.

Identification and Preservation

All specimens were identified in the laboratory using a Wild M8

Zoom Stereomicroscope Microscope. Identification was carried out to the species level when possible, using a combination of keys from Brigham and Brigham (1982), Fall (1922), Ferkinhoff and Gundersen (1983), Hatch (1927b), and Roberts (1895). Once identified, specimens of each species were placed in separate small screw-top glass vials with 70%-80% isopropyl alcohol for storage. Labels were added to each vial to identify collection location and species. Each series of specimens was assigned a catalog number for later reference.

In cases of uncertainty, the genitalia of the available males were extracted for positive identification. The extraction of the genitalia was carried out with a microdissection needle bent at the tip to form a hook and placed in the end of a small wooden applicator stick. The hooked end was inserted between the tergum and sternum of the last abdominal segment above the genitalia, the base of the genitalia was then hooked and pulled out of the abdomen just enough to see the needed features. If further investigation of the genitalia was needed, they were fully extracted and placed in glycerine. After examination the genitalia were placed in glycerine filled plastic micro-vials, stoppered and returned to the specimen vial.

In many of the specimens, the identifying characteristics were obscured by dirt or some type of debris, thus, necessitating cleaning. In most cases, the specimen was placed in 70% isopropyl alcohol and allowed to stand for 30 minutes to one hour to soak off any debris. However, in cases where the beetles were extremely dirty or the alcohol would not remove enough of the material, the specimens were sonicated.

Sonication was done by placing a single beetle in a 25 milliliter beaker filled with alcohol or acetone in a Branson Bransonic 2 Sonicator for 15-30 seconds . Only one beetle was placed in a beaker at a time to reduce the possiblity of it being damaged. This usually removed the majority of unwanted material with no harm to the specimens. Acetone was usually used when a dried specimen needed to be cleaned but could not be softened for some reason. Acetone was used because of its high rate of evaporation; as quick evaporation tends to soften the specimen less.

Measurements

A random sampling of the collection of each species was measured for size comparison. Measurements were made on the Wild M8 Zoom Stereomicroscope Microscope using an attached Wild MMS 225 Digital Length-Measuring Set. Each specimen was measured for length and width. The measurement for length was made from the anterior end of the clypeus to the most posterior end of the elytra. The width was measured across the widest area of the elytra. All measurements were recorded for later species comparison.

Distribution Mapping Procedures

In order to produce distribution maps for each species the SAS Graphic package was used on the IBM computer system. The presence or absence of each species in each county was recorded, then distribution maps of the state was produced for each species.

FAMILY TAXONOMY

The family Gyrinidae is a small group of aquatic beetles consisting of approximately 700 species within four subfamilies, approximately 59 species are known from North America, north of Mexico (See appendix A). Subfamily divisions are Enhydrinae, Gyrininae, Orectochilinae, and Spanglerogyrinae, all which are represented in North America. Folkerts (1979) suggests that this classification be changed to include only two subfamilies, Gyrininae and Spanglerogyrinae, while the remaining three subfamilies be reduced to the tribes Enhydrini, Gyrinini, and Orectochilini, and the tribes be reduced to the subtribe level. The reason for this is that the Spanglerogyrinae are so remotely different from the other three subfamilies that he feels that to place all four groups at the subfamily level would be inconsistent. This point may seem valid, but this new classification is not accepted at this time. The older, accepted form of classification is used in this work, but Folkerts' suggestion is included for completeness.

The subfamily Enhydrinae includes the tribes Enhydrini and Dineutini. Of these, Dineutini is the only tribe found in North America, and is represented by the genus Dineutus MacLeay. This genus contains some 14 species divided into the two subgenera Dineutus s. str. and Cyclinus Kirby. Nine of the 14 species found in North America are known from the State of Virginia.

The spelling of the genus Dineutus was changed to Dineutes (auctt.), and the first publication of this spelling was by Aube in 1838. This incorrect spelling persisted throughout most of the literature until about 1958 even though the original spelling was advocated by Article 19 of the International Code of Zoological Nomenclature in Ochs, 1924 (Woods, 1962). Thus, the correct spelling of the genus is Dineutus.

The subfamily Gyrininae contains the tribe Gyrinini, which contains the two genera, Aulonogyrus and Gyrinus Geoffroy. The only genus found in North America is the genus Gyrinus, and it contains some 69 species worldwide with 40 North American species and with 12 species reported from the State of Virginia.

The subfamily Orectochilinae is represented in North America by a single genus Gyretes Brulle', with two North American species. Both species are confined the the southern parts of the United States.

The fourth subfamily represented in North America is the Subfamily Spanglerogyrinae. This subfamily contains the single species, Spanglerogyrus albiventris Folkerts, which is recorded only from Alabama (Folkerts, 1979).

Key to the Genera of North American Gyrinidae.

1a. Scutellum visible; body length less than 8.0mm.....2

1b. Scutellum not visible; body length variable.....3

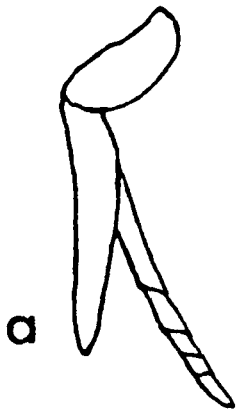
2a. Mesotibia and metatibia flattened and paddle-like in appearance (Figure 1a).....Gyrinus

2b. Mesotibia and metatibia not flattened nor paddle-like in appearance, found only in Alabama (Figure 1b).....Spanglerogyrus

3a. Body length less than 7.0mm; terminal abdominal segment elongated and conical in shape (Figure 1c).....Gyretes

3b. Body length greater than 8.0mm; terminal abdominal segment not elongated nor conical in shape (Figure 1d).....Dineutus

Figure 1: Midleg shape of adult Gyrinidae: a) Spanglergyrus[1], b) Dineutus and Gyrinus. Terminal abdominal shape of adult Gyrinidae: c) Gyretes, d) Dineutus and Gyrinus. ([1] redrawn from Folkerts, 1979)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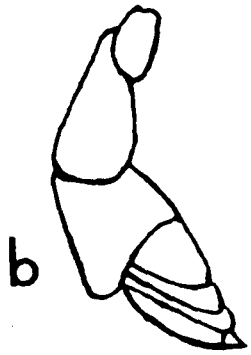
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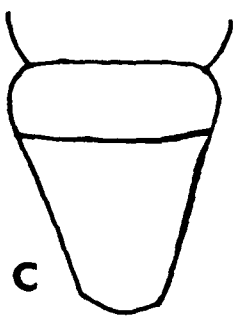
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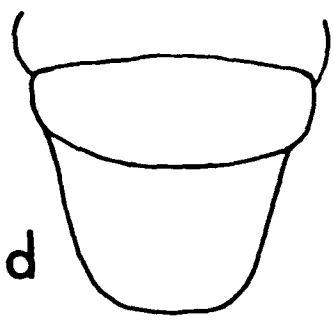
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Genus Dineutus MacLeay

The genus Dineutus contains the largest members of the family Gyrinidae found in North America with lengths of 10mm to 16mm. Dineutus are easier to identify than the Gyrinus. The species of Dineutus are usually distinguished by the following characters; male genitalia, shape of apices of the elytra, the structure and shape of the anterior tibiae and femora, and the color and striations of the elytra. As with the Gyrinus, the Dineutus male genitalia is the best character for the identification of the species, but the other characters used in their identification are of greater reliablity than those used in the identification of the Gyrinus except for the color and striations. These characters are usually variable or the differences so slight as to be more confusing than helpful.

The second character for the species level identification is the shape of the elytra apices. Like Gyrinus, the apices of Dineutus can be rounded or emarginate, but unlike Gyrinus this character applies to the males and the females of most species.

The third important character in separating different species of Dineutus is the presence or absence, and the shape of a femoral tooth. On the inside margin of the forefemur near the anterioral apex is either a strong tooth or a rounded marginal area. This character is fairly obvious, and can be used to separate certain species. The only problem with this character is that there is some variability which can lead to some confusion on the pronouncement of the tooth.

The fourth taxonomic character used to separate species is the

shape of the anterior tibiae. Roberts (1895) claims that there are four types of tibiae represented: (1) The truly sinuate, (2) subsinuate-cylindrical at basal third suddenly broadening and continuing nearly parallel to the apex, (3) wedgeshaped flattened and gradually broadened from base to apex, (4) club-shaped, cylindrical at the base, not flat and, thus, gradually broadened to the apex. These are fairly good characters for identification as far as characters can be in the family Gyrinidae, but they still leave much room for interpretation, and thus, can sometimes lead to more confusion in the identification. This character will be used in this work only when the lack of adequate characters makes it necessary.

The above characters, when used together, give reliable information as to species identification. Unlike the Gyrinus, many of the characters used, such as femoral and tibial shapes, apply to the females as well as the males and make identification of females possible.

The genus Dineutus is characterized by species which are large in size, usually greater than 9.0mm in length, and have an oval and convex body shape. The dorsum is usually shiny and possesses a more or less bronze sheen and the scutellum is not visible. Each elytron is marked with nine striae. The terminal abdominal segment is dorso-ventrally flattened and rounded at the apex.

Key to the species of adult male *Dineutus*[1]

1a. Forefemur toothed or angulate on inner margin near apex (Figure 2a).....2

1b. Forefemur rounded, not toothed or angulate on inner margin near apex (Figure 2b).....5

2a. Venter pale to brownish-yellow; body distinctly pointed.....3

2b. Venter very dark brown to black; body not distinctly pointed.....4

3a. Apex of elytra serrulate; median lobe of male genitalia sharply pointed (Figure 3a).....*serrulatus*

3b. Apex of elytra not serrulate; median lobe of genitalia blunt; (Figure 3b).....*discolor*

4a. Femoral tooth strong; apex of elytra not serrulate; median lobe of genitalia constricted near middle then expanded and strongly narrowed (Figure 3c).....*emarginatus*

4b. Femoral tooth weak, apex of elytra serrulate; median lobe of genitalia gradually narrowed from base to apex (Figure 3d).....*carolinus*

5a. Length of body from head to apex of elytra greater than 12mm.....6

5b. Length of body from head to apex of elytra less than 12mm.....7

6a. Elytra distinctly punctured with bluish-purple reflections; median lobe of genitalia sharply pointed at apex and narrowed towards base, apex flattened in lateral aspect (Figure 3e).....*ciliatus*

6b. Elytra obscurely punctured, without bluish-purple reflections; median lobe of genitalia blunt at apex, nearly parallel sided,

apex blunt in lateral aspect (Figure 3f).....*robertsi*

7a. Venter dark reddish-brown to nearly black, elytral hypomeron in part light red to brownish-yellow; length 10mm to 11mm; median lobe of genitalia slender, nearly evenly narrower from base to pointed apex, about 7 times longer than greatest width (Figure 3g).....*horni*

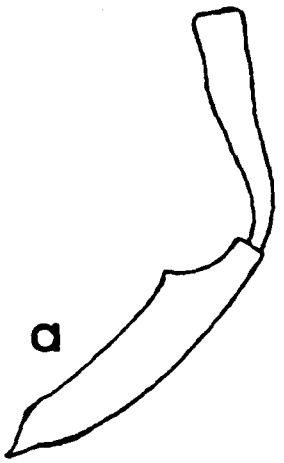
7b. Venter dark brown to black; elytral hypomeron not in part light red, but completely very dark brown to black; median lobe of genitalia not as above.....8

8a. Elytral apex horizontal or nearly so, suture separated towards apex (dehiscent); median lobe of genitalia strongly constricted before apex (Figures 2c and 3h).....*assimilis*

8b. Elytral apex strongly produced; median lobe of genitalia much less constricted before apex (Figures 2d and 3i).....*nigrior*

[1]Revised from Brigham, 1982.

Figure 2: Forefemur of *Dineutus*: a) toothed, b) rounded.
Elytral apex: c) *D. assimilis*, d) *D. nigrior*.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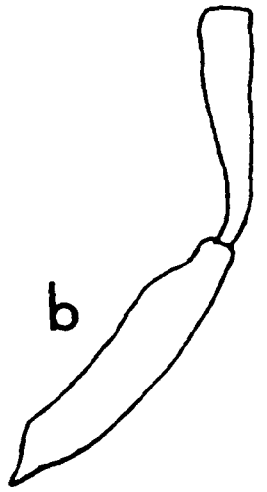
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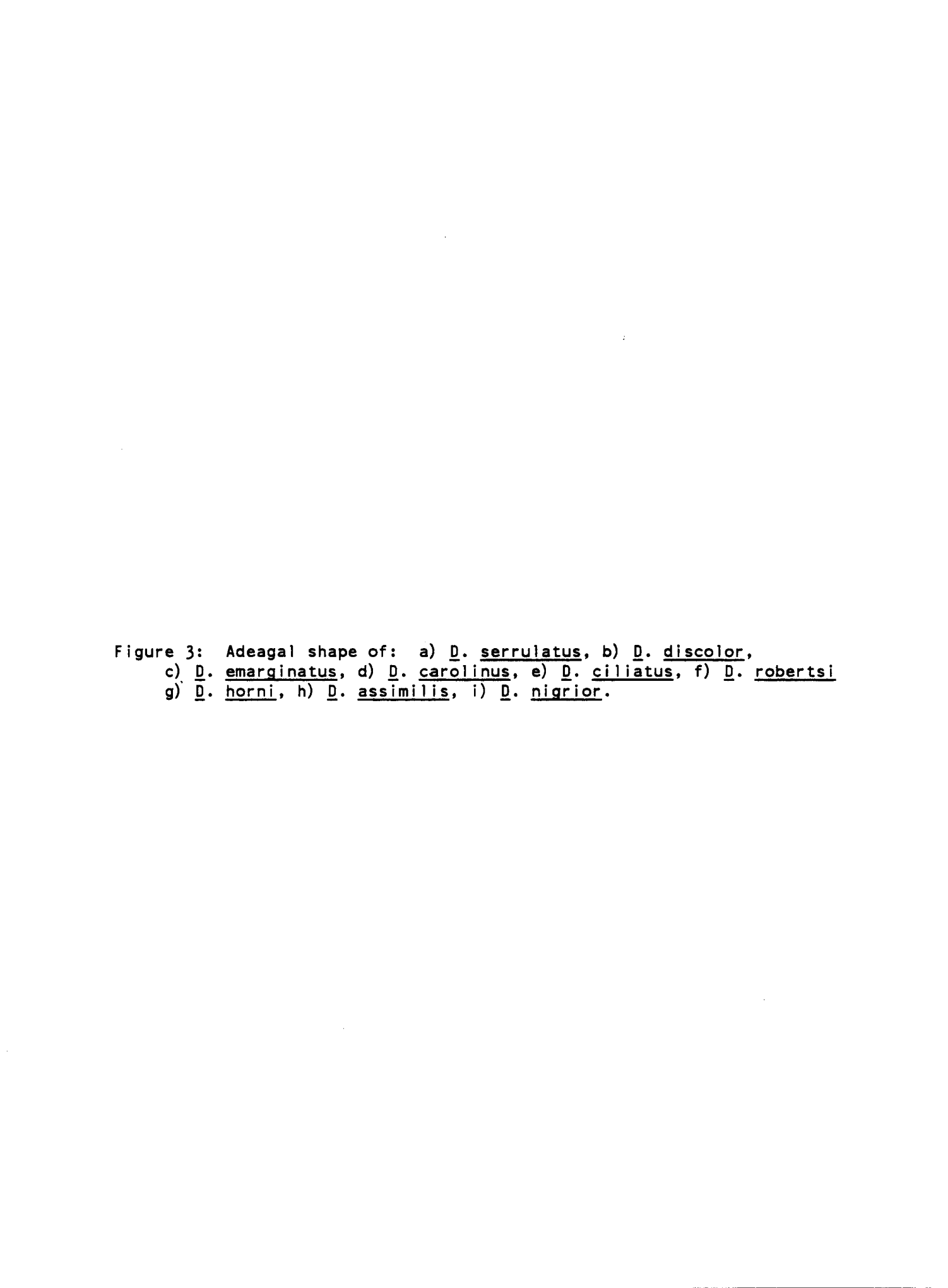
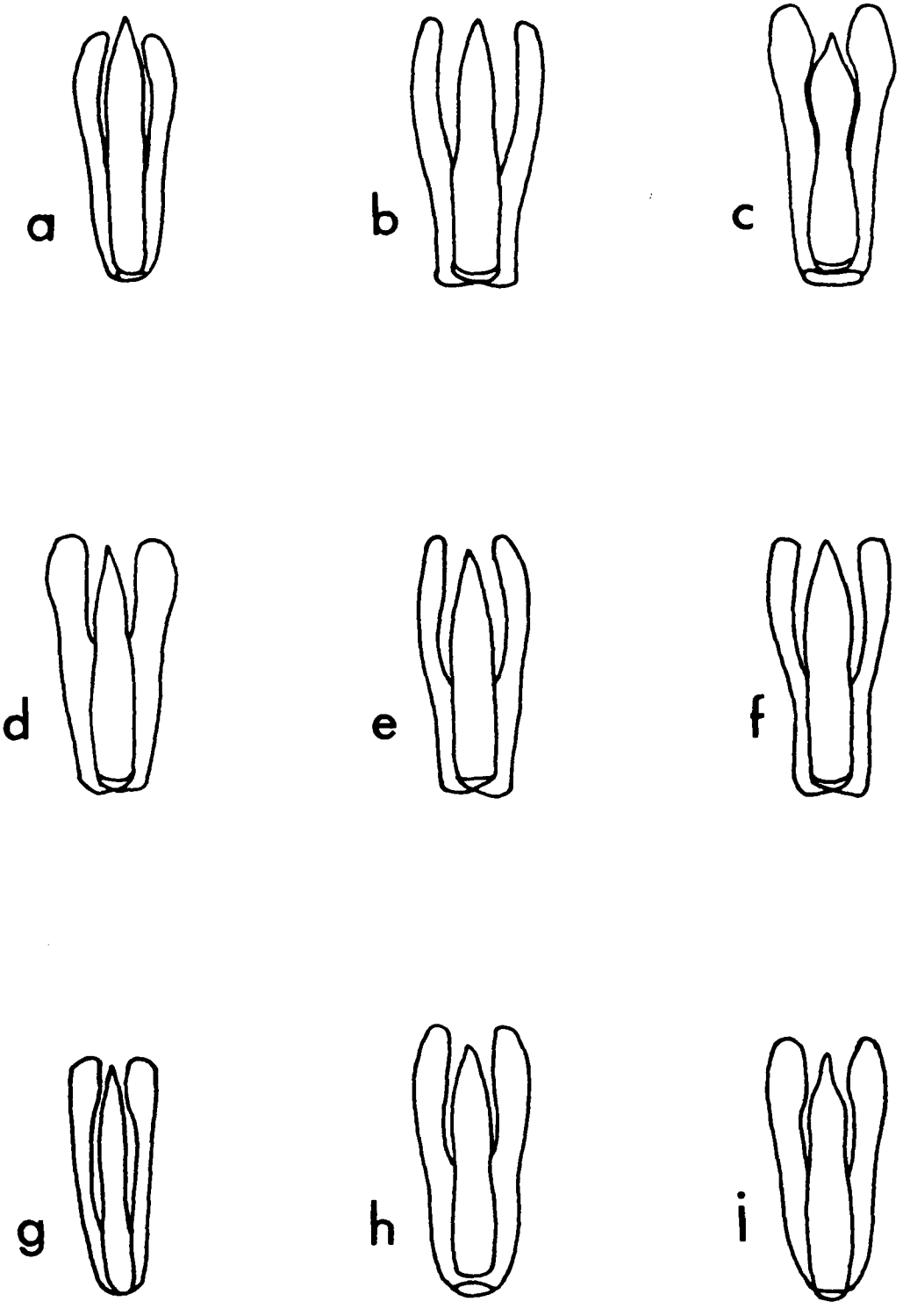


Figure 3: Adeagal shape of: a) D. serrulatus, b) D. discolor, c) D. emarginatus, d) D. carolinus, e) D. ciliatus, f) D. robertsi g) D. horni, h) D. assimilis, i) D. nigrior.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Key to the species of adult female *Dineutus*[1]

1a. Apex of elytron rounded.....2

1b. Sutural angle of elytron produced, angled, or quadrate.....5

2a. Length, including abdomen, not more than 11mm.....3

2b. Length 12mm to 16mm.....4

3a. Apex of elytron near suture serrulate.....*carolinus*

3b. Apex of elytron may be slightly uneven, but not serrulate.....
.....*emarginatus*

4a. Elytron distinctly punctured, with bluish-purple reflections.....
.....*ciliatus*

4b. Elytron obscurely punctuate, without bluish-purple reflections....
.....*robertsi*

5a. Venter usually black or pitchy black, elytral hypomeron in part brownish-yellow; apex of foretibia oblique; elytral apex strongly produced .....*horni*

5b. Entire venter, including hypomeron, uniformly black to brownish-yellow.....6

6a. Venter black to very dark brown or pitchy black, about as dark as dorsum.....7

6b. Venter light brown to brownish-yellow, strongly contrasting with dark dorsum.....8

7a. Elytra distinctly separated at suture (dehiscent).....*assimilis*

7b. Elytra scarcely dehiscent at suture.....*nigrior*

8a. Elytral apex serrulate; outer apical angle of foretibia rounded .....*serrulatus*

8b. Elytral apex smooth, not serrulate; outer apical angle of foretibia distinct.....*discolor*

[1]From Brigham, 1982.

Dineutus angustus LeConte

Diagnosis: Length 9.0-10.5mm. Width 4.5-5.5mm. The body form is narrowly ovate and strongly convex. The elytral color is black, and highly polished with the striae obliterated, but the elytral punctures are present. The elytral apices are produced in both sexes, but more so in the female. The venter is rufotestaceous while the legs are rufous in color. The femoral tooth is present and distinct.

Dineutus angustus is very similar to D. discolor except that the body form of D. angustus is more elongate, narrower and more convex than that of D. discolor. The striae of the elytra are mostly obliterated in angustus, whereas, the striae of discolor are more distinct.

Range: Florida west to Texas, north to Virginia (Young, 1954).

Virginia records: This species is reported to be found in Virginia (Young, 1954), but there is no exact record as to where in the State that it was found. From the statement by Young, "...angustus is restricted to certain highly calcareous streams...", it would seem that this species would tend to be found in the streams in the western mountainous areas of the State.

Habitat: This species is reported to be found in highly calcareous streams (Young, 1954).

Dineutus assimilis (Kirby)

Diagnosis: Length 10.3-11.2mm. Width 5.2-6.1mm. The body form is

oblong-ovate and very convex with the elytral apices slightly produced and dehiscent. The elytra are black with a bronze sheen, and the striae are very faint, but become more distinct towards the apex. The venter is dark brown to black in color with the anal sternite and lateral margins of the 5th and 6th sternite sometimes yellowish-brown. The forefemur is darkened medially and lacks the femoral tooth.

D. assimilis is similar to D. nigrior in Virginia. These two species are easily confused when individuals of each species are not seen together. D. assimilis is smaller in size, being at most 11.2mm in length, whereas, D. nigrior is as long as 12.0mm. This size difference is sometimes difficult to use in identification because there is much overlap between the species. The elytral apices of the males are both somewhat produced, but the apices are more dehiscent in assimilis than in nigrior. The females are somewhat easier to tell apart, the elytral apices of assimilis are only slightly produced, whereas, the apices of nigrior are more strongly produced. The elytral striae are more distinct overall in nigrior than in assimilis, with the striae in both species becoming more evident towards the apex.

Range: Maine to Florida and west to New Mexico and Utah.

Virginia records: This species has been reported in 35 counties and 5 cities (Figure 4a). There seems to be no specific range for it across the state, it was collected by the author in many of the counties surveyed during this study. From the data collected, D. assimilis seems to be found throughout the State.

Recorded from Accomack, Albemarle, Amelia, Amherst, Arlington,

Augusta, Bath, Bland, Charlotte, Chesterfield, Culpepper, Cumberland, Dickenson, Fauquier, Giles, Hanover, Henrico, Highland, Isle of Wight, James City, Louisa, Montgomery, Nelson, New Kent, Northumberland, Pittsylvania, Powhatan, Pulaski, Richmond, Russell, Southampton, Surry, Sussex, Washington, and York counties; and the cities of Chesapeake, Newport News, Norfolk, Virginia Beach, and Suffolk.

Habitat: This species is usually a lentic species, but the author has collected it in small, slow moving streams and rivers within Virginia. In cases where it has been found in standing waters, these waters have been small to large woodland ponds. In one case it was collected at a large reservoir, but even in this case the species was found in a quiet backwater area of the reservoir, which simulated the type of environment one would find in woodland ponds. In the cases where it was collected in streams, these too, were very slow moving, and usually ran through a wooded area.

Dineutus carolinus LeConte

Diagnosis: Length 9.0mm to 10.0mm. Width of 5.5mm to 6.0mm. The body form is narrowly ovate, and moderately convex in shape. The elytral color is black, with hints of bronzing at times, the elytral striae and punctures are very faint. The ventral color is black and somewhat bronzed, while the legs are black without the bronzing. The forefemoral tooth is present, but small and weak.

D. carolinus is very similar only to D. emarginatus in Virginia; the major differences being that the femoral tooth is not as strong in

carolinus as it is in emarginatus, and the apices of the elytra in carolinus are finely serrulate, whereas, the elytral apices of emarginatus are not. Carolinus is the distinctly the smaller of the two with the largest specimen just reaching the length of the smallest emarginatus. Differences should be looked at very carefully since these two species are frequently collected together.

Range: Virginia to Florida and west to Texas.

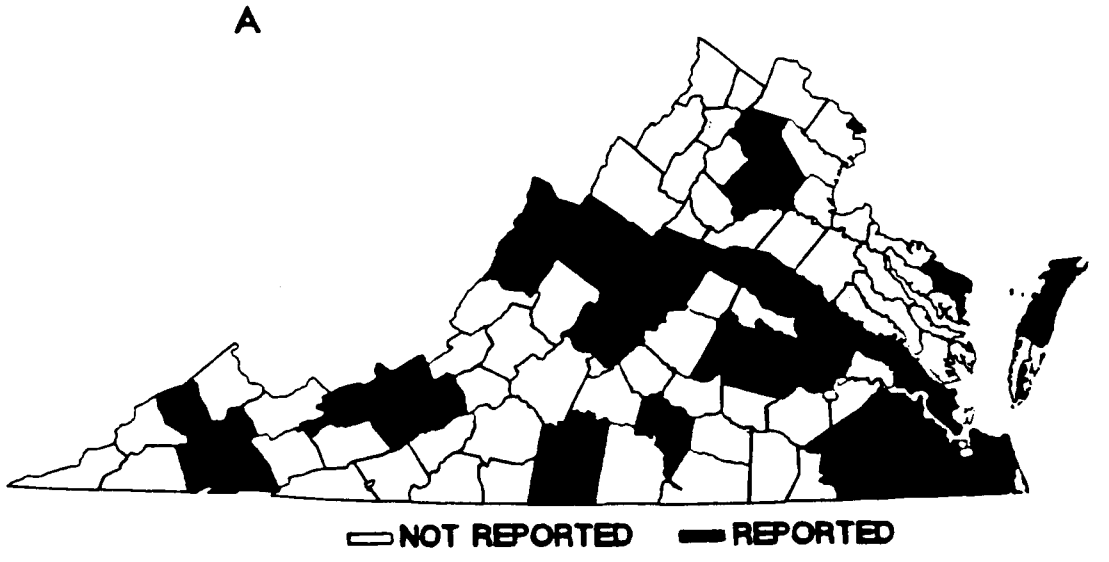
Virginia records: This species has been reported in 15 counties and 4 cities (Figure 4b). D. carolinus has been collected primarily on the coastal plain in Virginia. In cases where carolinus was reported from a county which is not considered to be in the coastal plain, the county was on the boundary of the coastal plain and the piedmont and the specimens were collected in areas near the boundary. One would expect to find this type of "fuzzy" distribution near the boundaries of the physiographical provinces because this is a transition zone, and the area can show charactistics of both provinces.

Recorded from Accomack, Amelia, Chesterfield, Fauquier, Henrico, Isle of Wight, James City, New Kent, Richmond, Southampton, Spotsylvania, Stafford, Surry, Sussex, and York counties; and the cities of Chesapeake, Norfolk, Suffolk, and Virginia Beach.

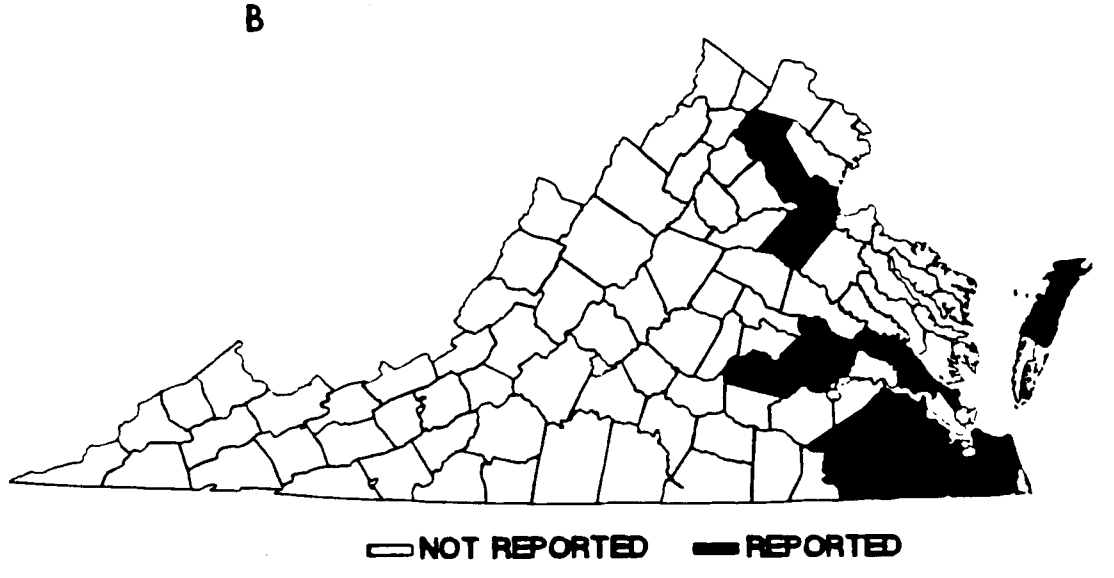
Habitat: This species is usually lentic in nature, but it has been found occasionally in streams with very slow moving waters with large amounts of vegetation, or in the backwaters of larger streams. In Virginia carolinus can be found in either of the above areas.

Figure 4: Distribution map of: a) D. assimilis, b) D. carolinus.

Distribution by County and Selected Cities
Dineutes assimilis



Distribution by County and Selected Cities
Dineutes carolinus



Dineutus ciliatus (Forsberg)

Diagnosis: Length 12.0-15.5mm. Width 8.0-10.0mm. The body form is regularly oval and feebly convex with the elytral apices rounded. The elytra are black and very shining, with a bronze sheen across the thorax, extending almost to the apex. There is a bluish sheen laterally on the elytra, with the elytral striae and punctures faint towards the middle and becoming more evident at the sides. The venter is dark brown or pitchy in color. The forefemoral tooth is absent.

D. ciliatus is similar to only one other species in Virginia, D. robertsi. Both of these species are large in size and are found in similar habitats. In ciliatus the elytra are marked with faint punctures and a bluish sheen on the lateral margins, whereas, in robertsi the punctures are very obscure to non-existant and the bluish sheen is lacking. It is best to compare the more lateral punctures of ciliatus to those of robertsi. This is the area where the punctures should show the most difference. The punctures are indistinct in both species towards the elytral suture. The venteral color is a good secondary characteristic to differentiate the two species. D. ciliatus has a dark brown venter, whereas, D. robertsi has a more testaceous venter. These characteristics are usually distinct enough to discern the two species, but there are cases where the differences are very slight and an identification is very difficult. The use of the shape of the terminal segments of the antennae is often useful to discern extremely similar specimens of the two species, but the characteristic is sometimes difficult to see. The antennal club of D. robertsi is

narrower and more parallel sided and the terminal segment is longer and more pointed than that of D. ciliatus (Leech, 1938).

Range: Maine to Florida and west to Oklahoma. Virginia records: This species has been reported from 25 counties and one city (Figure 5a). As reported, ciliatus is mainly found to inhabit peidmont type streams, and this is evident in the distribution of the species. There are cases where ciliatus was reported from a county not considered to be in the peidmont. There are streams in the coastal plain, especially near the city of Richmond, that have the characteristic steep cut banks and rocky outcroping of peidmont streams. These are the streams in which ciliatus were collected. The record in Northumberland county is questionable for two reasons. First, there are no peidmont type streams found in this county as far as the author has been able to find. Secondly, the specimen has been lost. The sighting is doubtful, but for completeness, this sighting is included in the record.

Reported from Albemarle, Amelia, Amherst, Arlington, Buckingham, Chesterfield, Culpepper, Essex, Fairfax, Fauquier, Gloucester, Goochland, Greene, Greensville, Halifax, Isle of Wight, Loudoun, Mecklenburg, Northumberland, Powhatan, Prince George, Spotsylvania, Stafford, Surry, and Sussex counties; and the city of Richmond.

Habitat: This species is entirely lotic in nature, being found only in small shaded sandy-bottomed streams throughout the Piedmont province of the state, or in Piedmont-like streams in other areas. In most cases, ciliatus was collected very near the banks in some type of shaded and protected area, usually in small groups of less than twenty

individuals. Ciliatus is never found in bright sunlit areas unless frightened in some manner. In many cases this species may be found under bridges close to walls or piling, or under large logs crossing streams which cast large shadows over the water.

Dineutus discolor Aube

Diagnosis: Length 11.3-13.3mm. Width 6.2-7.1mm. The body form is narrowed anteriorly and slightly convex in shape, with the head being somewhat pointed anteriorly. The elytra are black and highly bronzed with the elytral striae and punctures very faint. The venter is reddish-brown to yellowish-brown in color. The forefemoral tooth is present but weak.

D. discolor is very similar to D. serrulatus and D. angustus, which may be found in similar types of habitats throughout Virginia. Both are narrowed anteriorly, but the elytral apex of D. serrulatus is serrulate, whereas, the elytral apex of discolor may be irregular, but not serrulate. The striae of discolor are present but faint, whereas, the striae of serrulatus are absent. Although, a fairly good characteristic, the pronouncement of the striae is a fine distinction, and should be used carefully. The best characteristic is the serrated elytral apex which easily distinguishes the two species.

There are two distinct variations in the elytral striae and punctures in D. discolor within Virginia. The more common variants have the elytra covered with faint striations and punctures. While the less common variants have deep and distinct elytral striations and

punctures. The two morphological variants have not been found within the same immediate area, but were collected within the same counties. Even though the two variants seem to express an allopatric distribution, there is no evidence to suggest that they are anything other than a variation within the general population. See the diagnosis of Dineutus angustus for major differences between D. discolor and D. angustus.

Range: Maine to Florida and west to Texas, with scattered records as far west as Arizona.

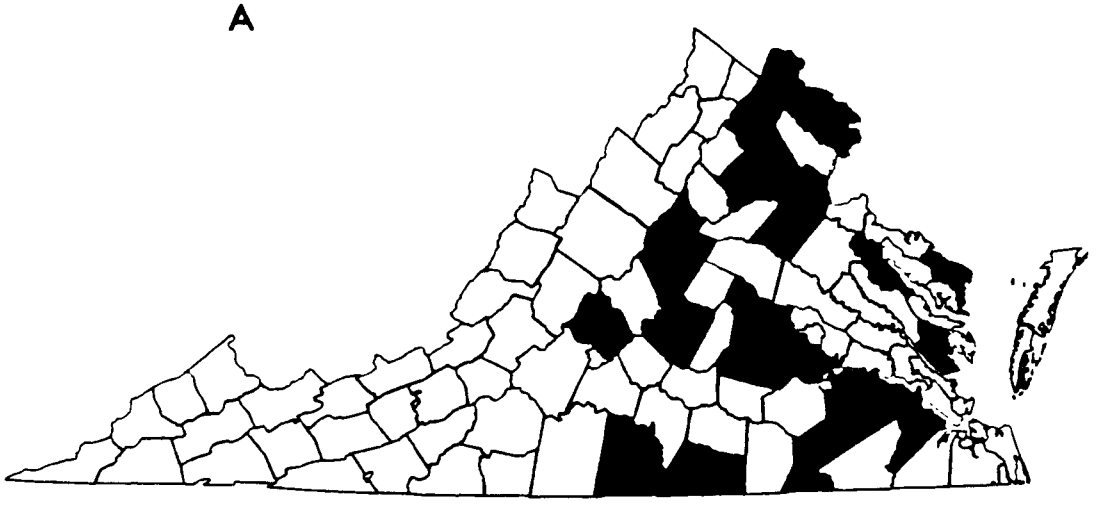
Virginia records: This species has been reported from 41 counties and 3 cities, making it the most widely distributed species of Dineutus found in the State (Figure 5b). D. discolor can be found in fast flowing waters throughout the State. limiting its distribution is the location of fast flowing waters.

Reported from Albemarle, Amelia, Amherst, Bath, Bland, Carroll, Chesterfield, Culpepper, Fauquier, Frederick, Giles, Goochland, Greensville, Halifax, Hanover, Henrico, Henry, Isle of Wight, King and Queen, Louisa, Lunenberg, Montgomery, Nelson, Orange, Page, Pittsylvania, Powhatan, Prince George, Prince William, Pulaski, Richmond, Roanoke, Rockingham, Russell, Shenandoah, Southampton, Spotsylvania, Stafford, Surry, Sussex, and Warren counties; and the cities of Newport News, Suffolk, and Virginia Beach.

Figure 5: Distribution map of: a) D. ciliatus, b) D. discolor.

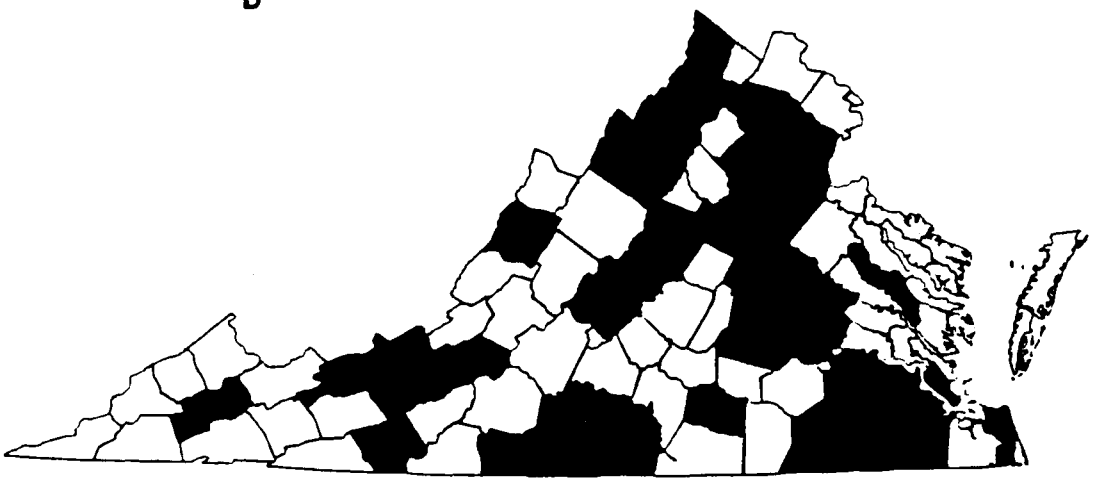
Distribution by County and Selected Cities
Dineutes ciliatus

A



Distribution by County and Selected Cities
Dineutes discolor

B



Habitat: This species is entirely lotic in nature, never being found in any type of standing water. D. Discolor is found in small upland streams to large fast moving flatland rivers. In all cases the species is found in the current usually not the protected areas of the flow. The only case when discolor is not found out in the current, is when the current is too swift for the beetle to hold its position. Here, the beetle is usually found in the eddies behind emergent structures such as, rocks and piling of bridges. When in these protected areas, the beetles are usually found in large groups, as opposed to small groups when out in the current.

Dineutus emarginatus (Say)

Diagnosis: Length 10.0mm to 11.0mm. Width of 6.0mm to 7.0mm. The body form is broadly oval and moderately convex. The elytra are dull black in color, with hints of bronzing throughout the length; the elytral striae and punctures are very faint. The entire venter is shiny black. The femoral tooth on the foreleg is very strong.

D. emarginatus is very similar to D. carolinus except that the femoral tooth is very strong in emarginatus when compared to carolinus. The apex of the elytra of emarginatus is not serrate, whereas, the elytral apex is serrate in carolinus. D. emarginatus is distinctly larger in size than D. carolinus with the smallest specimen of D. emarginatus being somewhat larger than the largest specimen of D. carolinus. See the diagnosis of Dineutus carolinus for additional comparisons.

Range: Maine to South Carolina and west to Michigan.

Virginia records: This species has been reported from 17 counties and four cities (Figure 6a). D. emarginatus has been collected mainly in the eastern and central areas of the State, extending only as far west as Albemarle County. This distribution is expected since this species is found in slow moving streams and the backwaters of rivers. This is the type of habitat which is found in coastal plain areas and along the larger rivers extending into the central areas of the State.

Reported from Albemarle, Amelia, Caroline, Chesterfield, Cumberland, Dinwiddie, Essex, Fauquier, Gloucester, Isle of Wight, James City, Louisa, Prince Edward, Southampton, Stafford, Surry, and Sussex counties; and the cities of Chesapeake, Norfolk, Suffolk, and Virginia Beach.

Habitat: This species is usually lentic in nature, but it has been found occasionally in streams with very slow moving waters with large amounts of vegetation, or in the backwaters of larger streams. Dineutus carolinus is frequently found with Dineutus emarginatus in Virginia.

Dineutus horni Roberts

Diagnosis: Length 10.3-12.0. Width 5.7-6.6mm. The body form is slightly convex, with the elytral apices rounded and slightly dehiscent in males. The apices are distinctly produced and dehiscent in females. The elytra are black with the striae very faint to obliterated. The venter is black, with the epipleura, anal segment, and lateral margins

of the abdominal segments ruffous testaceous in color. The forefemoral tooth is absent.

This species is not easily confused with any other species found in Virginia. The ruffo-testaceous coloring of the epipleura, anal segment, and lateral margins of the abdominal segments make D. horni very distinct from the similar species, D. nigrior, D. emarginatus, D. assimilis, and D. carolinus.

Range: Maine to North Carolina and west to Texas.

Virginia records: This species has been reported from one county and five cities (Figure 6b). Ferkinhoff and Gundersen, 1983 and Istock, 1965 state that horni is found throughout the eastern United States, including the entire State of Virginia. There is no evidence to dispute or confirm this statement since there are suitable habitats throughout the State which would support a population of horni. During the course of this study, there were few suitable habitats for horni were sampled in the western portion of the state.

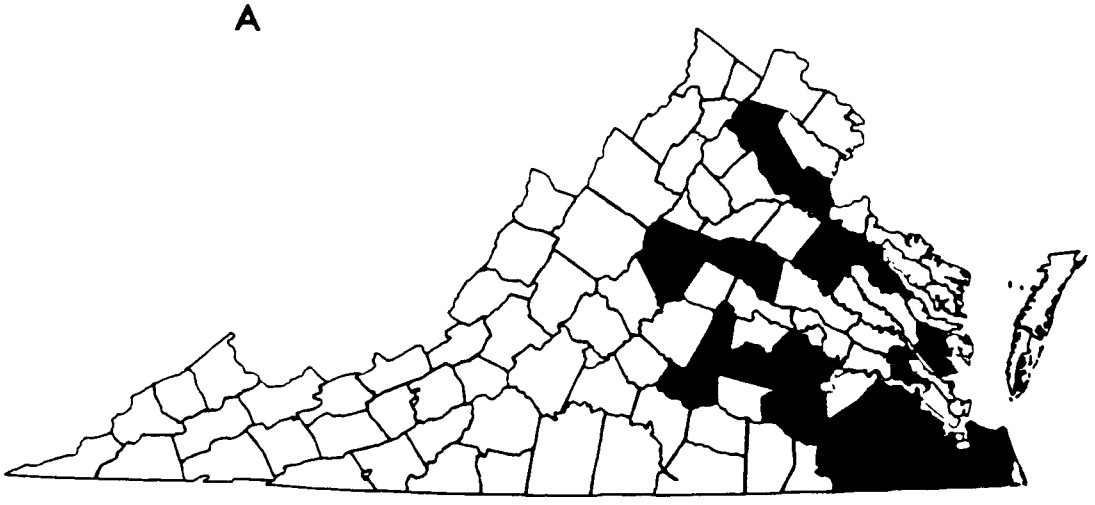
Sussex county; and the cities Chesapeake, Norfolk, Portsmouth, Suffolk, Virginia Beach.

Habitat: This species is found in in woodland ponds. These ponds are usually shallow and may have a large amount of marginal vegetation. Hilsenhoff, 1972 reports that horni is found in the shady areas of the slow moving waters of rivers. The author did not collect horni during this study and habitat information was missing on the collection reported, therefore no first-hand habitat information is available for the state.

Figure 6: Distribution map of: a) D. emarginatus, b) D. horni.

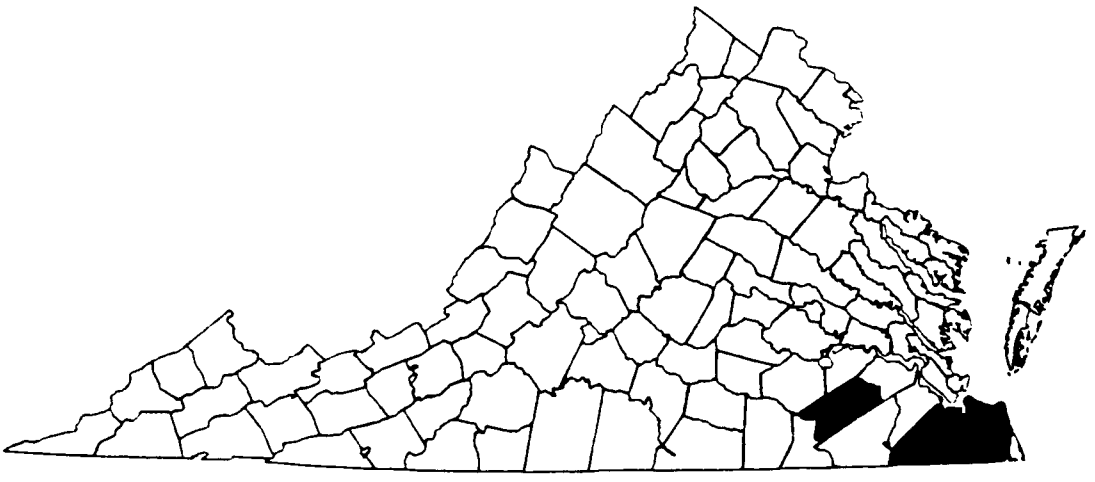
Distribution by County and Selected Cities
Dineutes emarginatus

A



Distribution by County and Selected Cities
Dineutes horni

B



Dineutus nigrior Roberts

Diagnosis: 10.0mm-12.0mm. Width 6.0mm-7.0mm. The body form is regularly oval and convex. The elytral apices of the male are slightly produced, but not dehiscent at suture; the apices of the female are strongly produced and sinuate. The elytra are black in color and somewhat bronzed throughout, with the striae and punctures more evident posteriorly. The venter is black with the tip of the anal segment sometimes yellowish-brown. The forefemoral tooth is absent.

D. nigrior is similar to D. assimilis in Virginia, see the above diagnosis of D. assimilis for additional diagnostic characters.

Range: Maine to Georgia and west to North Dakota.

Virginia records: This species has been reported in 19 counties and four cities (Figure 7a). It has been reported as far north as Fairfax County and as far west as Montgomery County. There is no specific distribution pattern through the State and nigrior was found in most of the suitable habitats sampled.

Reported from Amherst, Augusta, Bath, Culpepper, Fairfax, Fauquier, Halifax, Highland, James City, Loudoun, Madison, Montgomery, Nelson, Pulaski, Rockingham, Spotsylvania, Stafford, Sussex, and York counties; and the cities of Chesapeake, Portsmouth, Suffolk, Virginia Beach.

Habitat: This species is mostly lentic in nature, but it has been found occasionally in streams with very slow moving waters, or in the backwaters of larger streams.

Dineutus robertsi Leng

Diagnosis: Length 10mm-15.0mm. Width 7.5mm-10mm. The body form is very large and oval with rounded elytral apices in both sexes. The elytra are black in color, entirely bronzed with obscure punctures, and not vittate. The venter is entirely testaceous in color. D. robertsi is very similar to only one other species in North America, D. ciliatus. See the diagnosis of Dineutus ciliatus for major differences between the two species.

Range: Virginia to Georgia, west to Alabama

Virginia records: This species has been reported in 13 counties (Figure 7b). D. robertsi is found in peidmont streams, and has a distribution similar to D. ciliatus in the State. The species is found in many of the same areas as D. ciliatus but seldom if ever are they found together. D. robertsi is less abundant than ciliatus (Folkerts and Donavan 1974).

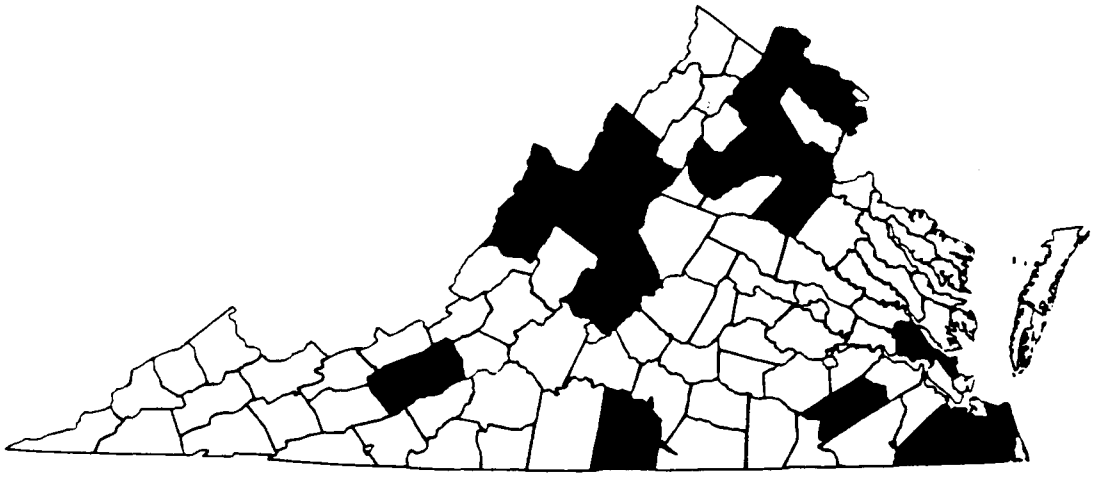
Reported from Accomack, Amherst, Buckingham, Chesterfield, Culpepper, Fairfax, Franklin, Greene, Hanover, Henrico, Mecklenburg, Southampton, and Stafford counties.

Habitat: This species is usually found in protected areas of small shaded streams above the fall line (Folkerts and Donavan 1974). This is typical of the streams found in the Peidmont areas of the state. These streams are characterized by have steep cut sides, slow to moderate moving water, and numerous outcroping. The majority of the individuals are collected behind behind these outcropings.

Figure 7: Distribution map of: a) D. nigrior, b) D. robertsi.

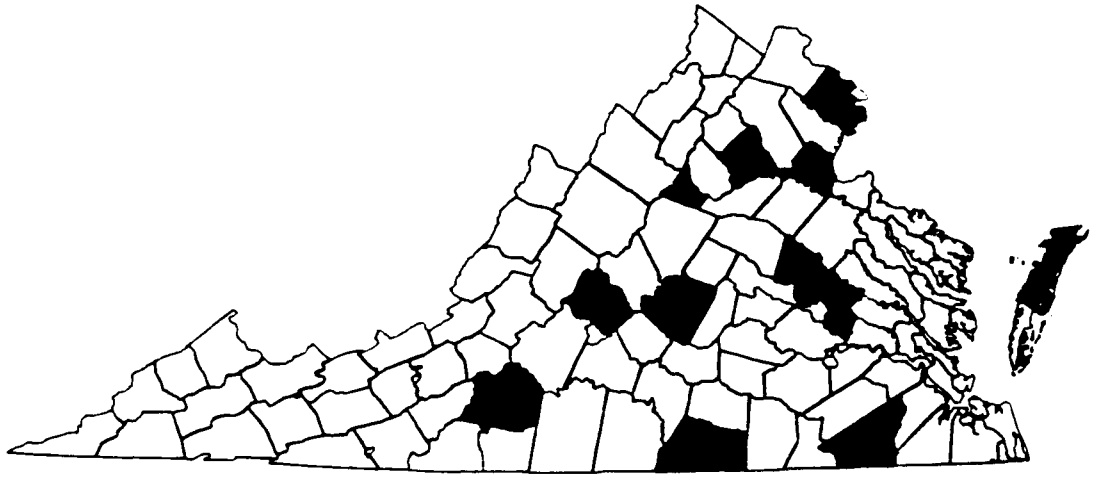
Distribution by County and Selected Cities
Dineutus nigrior

A



Distribution by County and Selected Cities
Dineutes robertsi

B



Dineutus serrulatus LeConte

Diagnosis: Length 9.0-12.0mm. Width 5.0-7.0mm. The body form is narrowed anteriorly, and very convex in shape; the head is also strongly narrowed anteriorly. The elytra are black and shining with purplish reflections but not bronzed. The venter is chestnut-brown to yellowish-brown in color. The forefemoral tooth is very strong.

D. serrulatus is very similar to D. discolor and is found in the same types of habitats. See the diagnosis of Dineutus discolor for major differences between the two species.

Range: Virginia to Florida and west to Oklahoma.

Virginia records: This species has been reported in 15 counties and one city (Figure 8). The collection site are scattered throughout the State with no definite pattern although D. serrulatus does seem to be distributed along the major rivers or large streams of the eastern parts of the State.

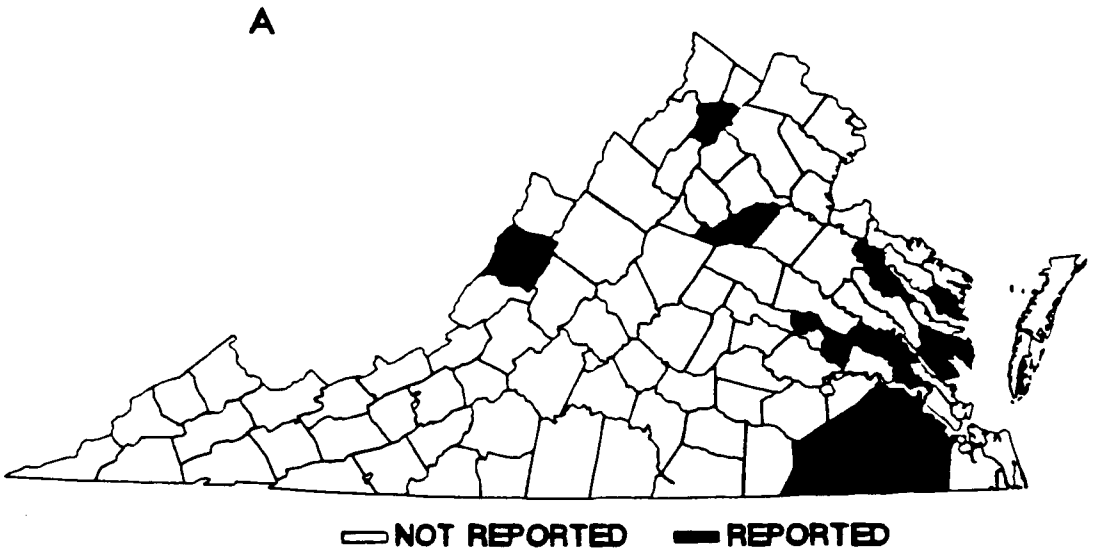
Reported from Bath, Essex, Gloucester, Greensville, Henrico, Isle of Wight, James City, Lancaster, Mathews, New Kent, Orange, Southampton, Surry, Sussex, and Warren counties; and the city of Suffolk.

Habitat: This species is always found in lotic habitats usually in small sandy-bottomed upland streams, flatland streams, and sometimes in large rivers. This species is highly rheostatic and is usually found in the current to a greater extent than D. discolor. But in cases where the current is too swift to maintain position serrulatus can be found in the eddies behind emergent structures. It is for this reason

that it is sometimes very difficult to collect specimens. They are usually well out of reach of a collector on the bank.

Distribution by County and Selected Cities

Dineutes serrulatus



Genus Gyrinus Geoffrey

The genus Gyrinus contains most of the smaller individuals of the family Gyrinidae in North America, their size is generally less than 8.0mm. Gyrinus have the general oval Gyrinidae body shape, and the color is usually black to dark brown. All species of this genus are very similar, and distinct specific characters are few. Thus, the genus Gyrinus is easy to distinguish from other genera, but the distinction between the species is difficult.

The characteristics used to separate the species of the genus Gyrinus are the male genitalia, color of the venter, elytral sculpture, size, the presence or absence of scutellar carina, the proximity of the lateral, or eleventh elytral stria to the submarginal groove, and the shape of the elytral apices. Of these characters, the male genitalia is the most reliable, the other characters are of a limited aid to those not familiar with family because individuals contain variable degrees of these characters, thus, using characters other than the males genitalia can lead to confusion when identifying individuals to the species level. Once one becomes very familiar with the genus the characters can be distinguished with more certainty, but there is almost always some doubt in the identifications when males are not available, therefore, females often can only be assigned to a species by association with males.

The genus Gyrinus is characterized by species which are small in size, usually less than 8.0mm in length, and having varying degrees of oval and convex body shapes. The dorsum is shiny to dull and may have

a bronze sheen to it, the scutellum is visible. Each elytron is marked with eleven punctuate striae. The terminal abdominal segment is dorso-ventrally flattened and rounded at the apex.

Key to the genus *Gyrinus* of North America east of the Mississippi River

1a. Scutellum with short fine basal carina; body beneath nearly uniform testaceous (brownish yellow) or rufo testaceous (reddish-yellow); mesosternum feebly sulcate.....*rockinghamensis*

1b. Scutellum without short fine basal carina; body variable.....2

2a. Body beneath including hypomera and epipleura testaceous or ferruginous.....3

2b. Body beneath black, hypomera and epipleura testaceous or rufous.....15

2c. Body beneath entirely metallic black or virtually so; sides of ventral segments rarely dull rufous; epipleura normally showing no more than obscure rufous tint.....16

3a. 11th elytral stria relatively remote from margin; body beneath of nearly uniform tint.....4

3b. 11th elytral stria close to the margin, almost to the point of not being seen on the posterior third of elytral margin; body beneath variable in color.....8

4a. Species with average length of 5.5mm rarely less than 5mm; reflexed lateral margins wide.....5

4b. Species with average length of 4.5mm rarly greater than 5mm; reflexed lateral margins very narrow.....6

5a. Apex of middle lobe of aedeagus truncate with a slight projecting angle at middle; lateral angles distinct (Figure 9a).....*ventralis*

5b. Apex of middle lobe of aedeagus broadly angulate at middle; lateral angles rounded (Figure 9b).....*fraternus*

6a. Surface of dorsum not bronzed (iridescent), female not detectablly alutaceous; median lobe of aedeagus distinctly wider apically than lateral lobes (Figure 9c).....*marginellus*

6b. Surface not or only feebly bronzed, aedeagus not distinctly wider apically than lateral lobes.....7

7a. Surface feebly bronzed, female extremely finely alutaceous, median lobe of male aedeagus about 1/2 as wide apically as lateral lobes (Figure 9d).....*woodruffi*

7b. Surface distinctly and nearly uniformly bronzed; body form moderately convex. Middle lobe of aedeagus narrowed, sides parallel in apical 1/5, this portion of median lobe about 1/3 width of paramere. Female dorsum extremely finely alutaceous (Figure 9e).....*aeneolus*

8a. Size small, average length less than 4.5mm.....9

8b. Size large, average length greater than 5mm; except in *elevatus* where length is 4.6mm-5.15mm.....10

9a. Transverse pronotal impressed line of punctures parallel with and close to the front margin; venter brownish or piceous except at apex (Figure 9f).....*dichrous*

9b. Transverse pronotal line of punctures more accurate laterally and, therefore, more distinct from the front margin; color beneath nearly uniform (Figure 9g).....*latilimbus*

10a. Surface finely alutaceous and minutely punctuate, more noticeably

in females.....11

10b. Surface highly polished and either not at all alutaceous nor punctuate, or only visibly so under high power.....12

11a. Upper surface, except margins, scarcely bronzed; average length slightly less than 6mm; middle lobe of aedeagus constricted at apical third (Figure 9h).....bifarius

11b. Upper surface more bronzed; average length greater than 6mm; middle lobe of aedeagus not constricted at apical third (Figure 9i).....confinis

12a. Color beneath nearly uniform; surface without distinct trace of micro-sculpture in either sex.....13

12b. Color beneath normally darker medially than along the margins; may have traces of micro-sculpture.....14

13a. Form broad and strongly convex; length nearly 6mm; apex of median lobe of genitalia broad, almost as broad as base of paramere, also median lobe slightly longer than paramere (Figure 10a)..pachysomus

13b. Form narrow; longitudinal profile strongly convex and distinctly hump-backed; size small, average length less than 5mm; apex of median lobe of male genitalia very slender, much narrower than the base of the paramere (Figure 10b).....elevatus

14a. Form narrower and rather small; aedeagus rufo-testaceous (Figure 10c).....aquiris

14b. Form broad; aedeagus dark brown or piceous (Figure 10d)...lecontei

15a. Sides of ventral segments rufo-maculate (Figure 10e).maculiventris

15b. Sides of ventral segments not rufo-maculate; surface of both sexes thickly covered with very fine short oblique striolae (Figure 10f) .....affinis

16a. Basal joint of front tarsi of male narrower than the two following joints, size rarely if ever as great as 7mm; fifth ventral segment normal.....17

16b. Basal joint of front tarsi of male as wide as the two following joints; size large, 7mm or greater; sides of thorax and elytra less continuous than usual; the fifth ventral segment longer than in other species (Figure 10g).....impressicollis

17a. Anterior margin of mesosternum emarginate and impressed on each side, giving a tri-lobed outline (Figure 10h).....pectoralis

17b. Anterior margin of mesosternum not impressed and emarginate.....18

18a. Strial punctures of elytra much larger at the sides than near the suture; lateral striae canaliculate.....19

18b. Strial punctures of elytra less evidently larger laterally, frequently scarcely at all so, lateral striae not or scarcely impressed.....21

19a. Eleventh elytral stria so nearly margined as to be scarcely visible when viewed from the side; size small, less than 5.5mm (Figure 10i).....parcus

19b. Eleventh elytral stria not so marginal, distinctly visible when viewed from the side; size greater than 5.5mm.....20

20a. Sides of ventral segments obscurely and diffusely rufous (Figure 11a).....pugionis

20b. Sides of ventral segments not paler, the anal segment alone sometimes in part rufous; lateral stria very distinctly impressed and canaliculate (Figure 11b).....*borealis*

21a. Upper surface polished and without or, with scarcely detectable micro-sculpture in male.....22

21b. Upper surface less shining or rather dull, and with more or less evident micro-sculpture in the male.....24

22a. Form strongly convex; surface without trace of alutaceous sculpture in either sex; median lobe of male genitalia dilated apically, apex 3/4 width of paramere; length 4.9mm to 5.2mm (Figure 11c).....*pernitidus*

22b. Form moderately convex; females alutaceous, but often just perceptibly so; median lobe of male genitalia narrow, not dilated apically.....23

23a. Form rather broad, surface luster, especially of the female, less strongly shining with fine alutaceous sculpture; anal segment black or pale red; median lobe of male genitalia narrower near apex, about 1/5 width of paramere, but appreciably wider when viewed laterally; length 5.1mm to 6.7mm.....*lugens*

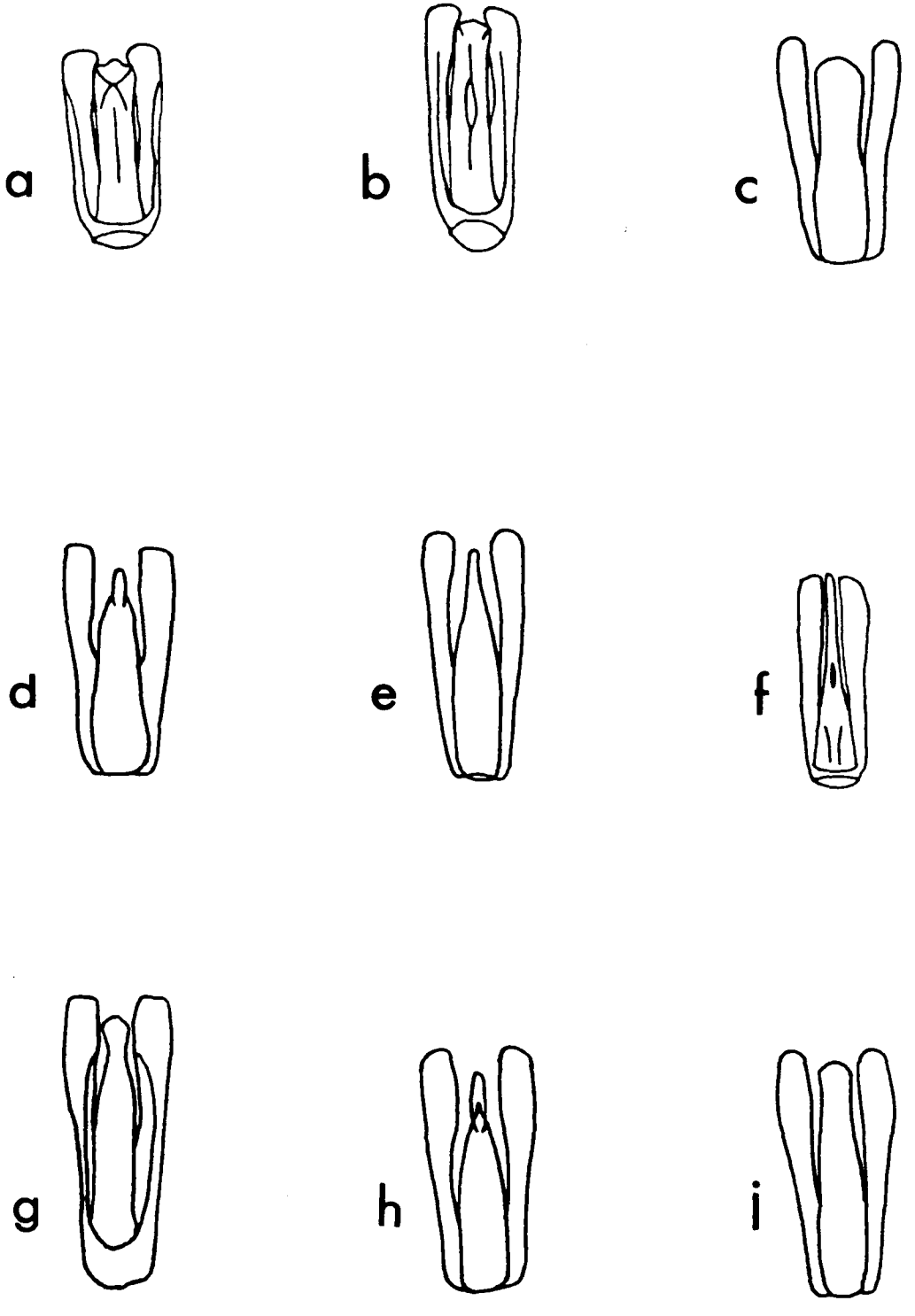
23b. Upper surface distinctly aeneous, anal segment conspicuously rufous; form rather narrow and of a smaller size; length 4.5mm to 5.5mm; median lobe of male genitalia broader near apex, about 1/4 width of paramere (Figure 11d).....*analis*

24a. Form moderately hump-backed in profile; median lobe of aedeagus broad, spatulate; width at apex approximately equal to that of

parameres (Figure 11e).....*frosti*

24b. Form very thick, strongly hump-backed.....*gibber*

Figure 9: Adeagal shape of: a) G. ventralis[1], b) G. fraternus[1], c) G. marginellus, d) G. woodruffi, e) G. aeneolus, f) G. dichrous[1], g) G. latilimbus[1], h) G. bifarius, i) G. confinis. ([1] redrawn from Ferkinhoff and Gundersen, 1983)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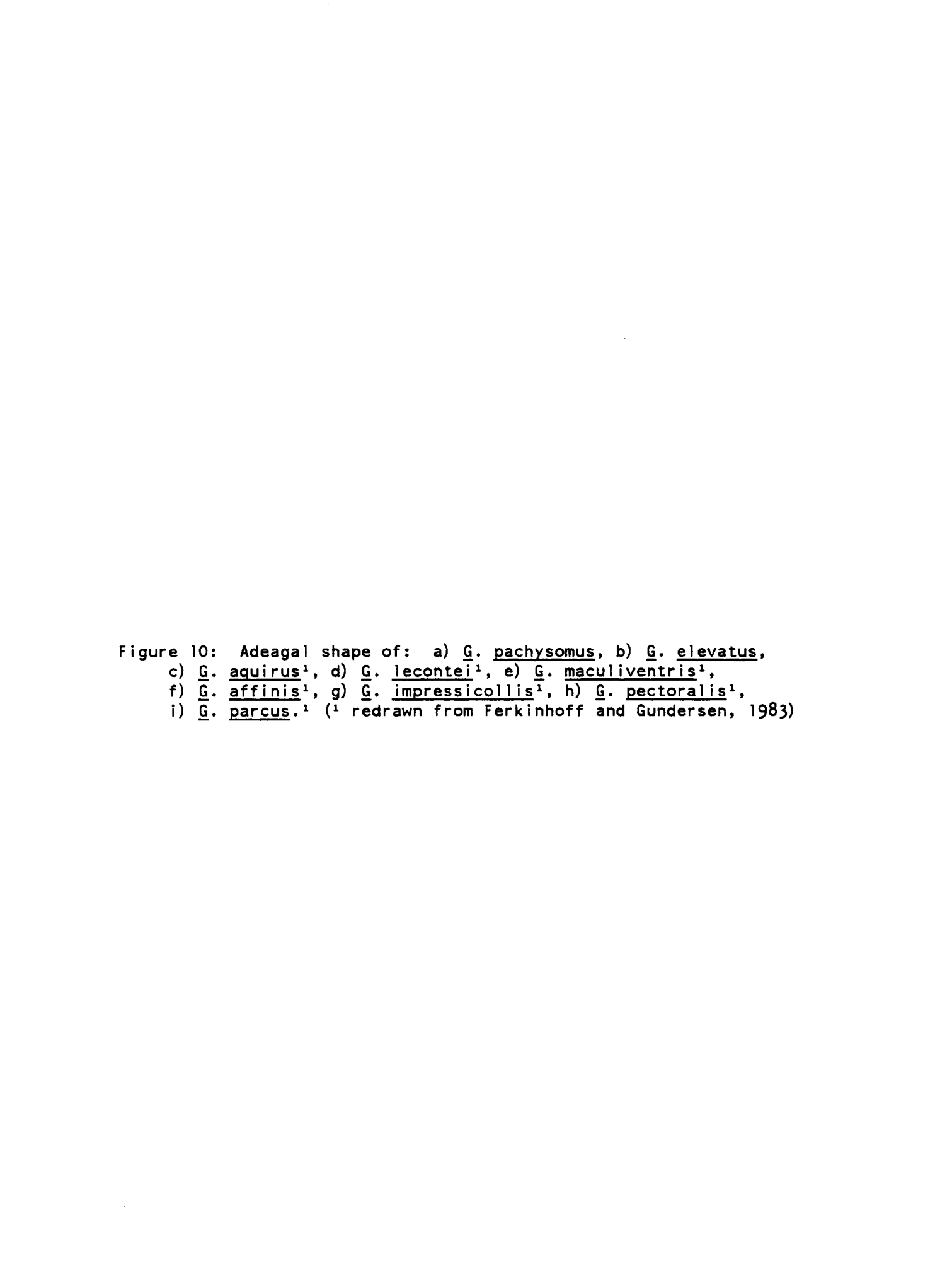

Figure 10: Adeagal shape of: a) G. pachysomus, b) G. elevatus, c) G. aquirus[1], d) G. lecontei[1], e) G. maculiventris[1], f) G. affinis[1], g) G. impressicollis[1], h) G. pectoralis[1], i) G. parcus.[1] ([1] redrawn from Ferkinhoff and Gundersen, 1983)

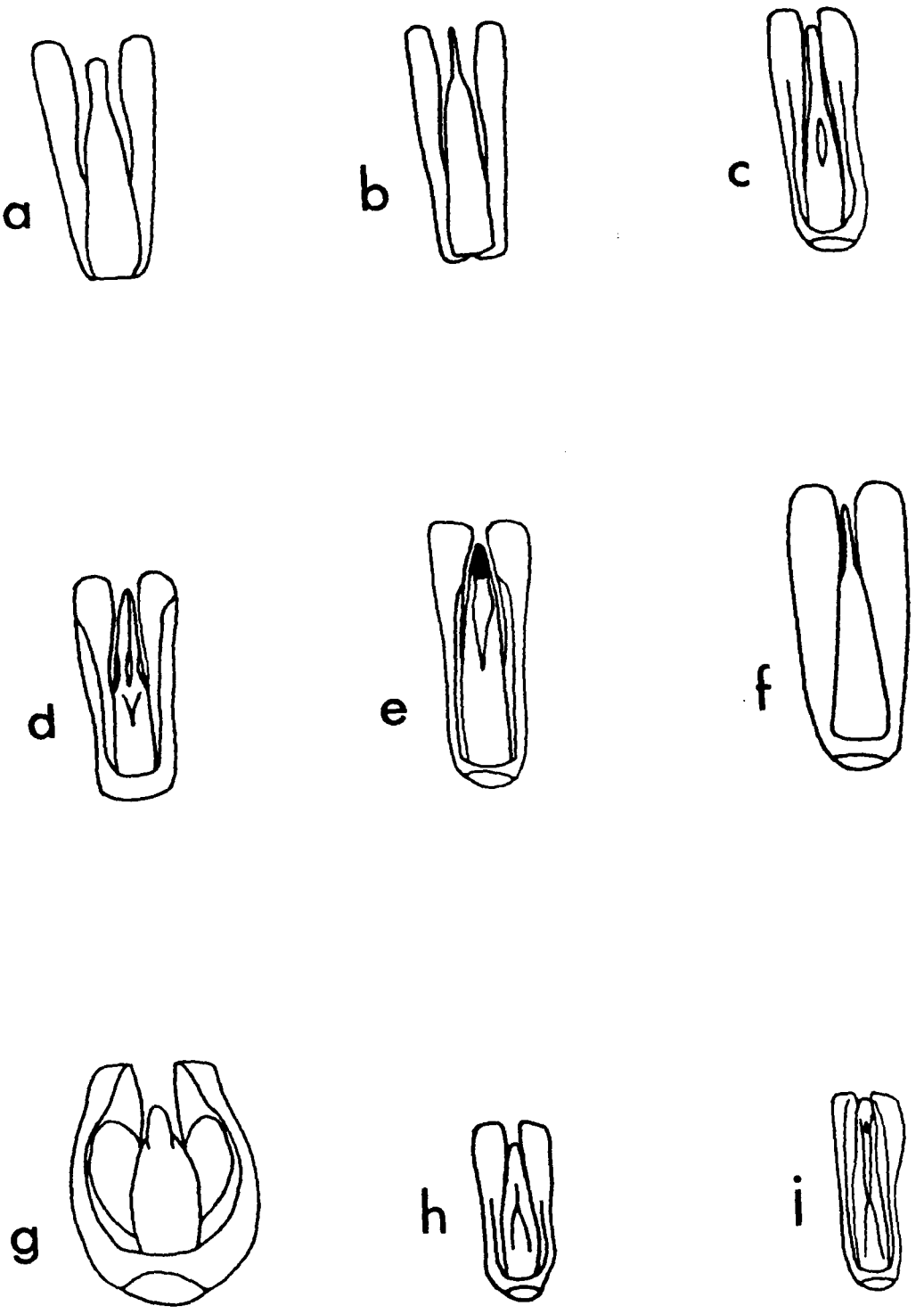
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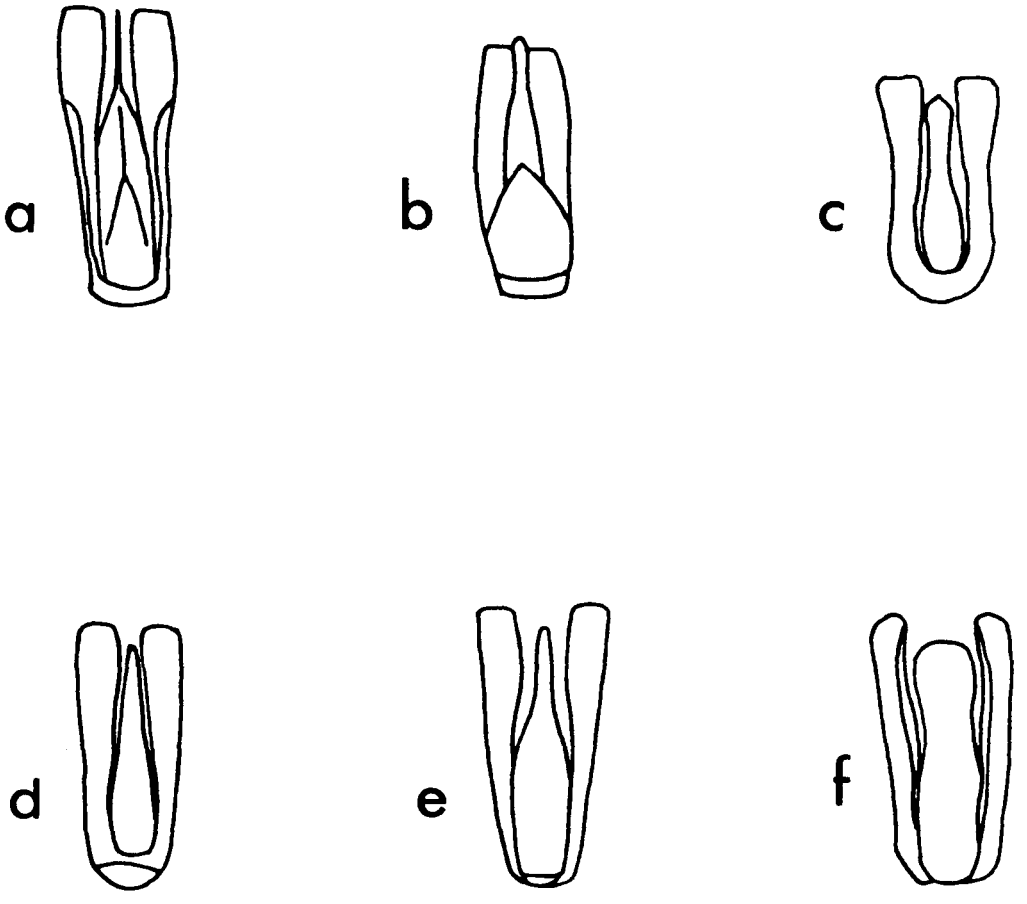
Figure 11: Adgagal shape of: a) G. pugionis[1], b) G. borealis[1], c) G. pernitidus[1], d) G. lugens, e) G. analis, f) G. frosti. ([1] redrawn from Ferkinhoff and Gundersen, 1983)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Gyrinus aeneolus LeConte

Diagnosis: Length 4.0-5.1mm. Width 2.2-2.7mm. The body form is narrow and rather convex. The elytra are black, distinctly bronzed, and highly polished, but without noticeable sculpturing or non-strial punctures; the strial punctures are slightly larger laterally than medially. The lateral margins are narrow with the 11th elytral striae removed from the margin. The entire venter is reddish-brown in color.

Gyrinus aeneolus is only similar to Gyrinus woodruffi in Virginia. Gyrinus aeneolus is less convex in body form, and is more distinctly bronzed throughout the elytra than is G. woodruffi. The bronzing in these two species can be a difficult character to use for identification in Virginia, because G. aeneolus tends not to be as bronzed in the eastern part of North America as in the western parts (Fall, 1922). Therefore, this character may only be useful to one which is very familiar with these two species within a geographic area.

Range: Maine to Virginia and west to Kansas.

Virginia records: This species has been reported in four counties (Figure 12a). There is not enough information available to make any definite conclusions on the specific range for aeneolus in the State.

Reported from Accomack, Carroll, Richmond, and Sussex counties.

Habitat: Fall, 1922 reports that aeneolus is found in creeks and small streams. Hilsenhoff, 1972 also reports this with the addition that specimens are collected on the downstream side of logs, snags and rocks in rivers. This species was not collected by the author during this study.

Gyrinus affinis Aube

Diagnosis: Length 6.0-7.0mm. Width 3.4-4.1mm. The body form is rounded and large in size. The elytra are black, and shining, but distinctly and densely sculptured with fine short oblique scratches; the strial punctures are slightly larger laterally than medially; the 11th elytral striae is very close to the lateral margin. The venter is black with the hypomera, epipleura, mesosternum, and 7th abdominal segment reddish-brown in color.

Range: Maine to Virginia and west to Kansas.

Virginia records: This species has been collected only once in Virginia (Figure 12b). One specimen of affinis was collected from a drainage ditch in the Dismal Swamp in Chesapeake.

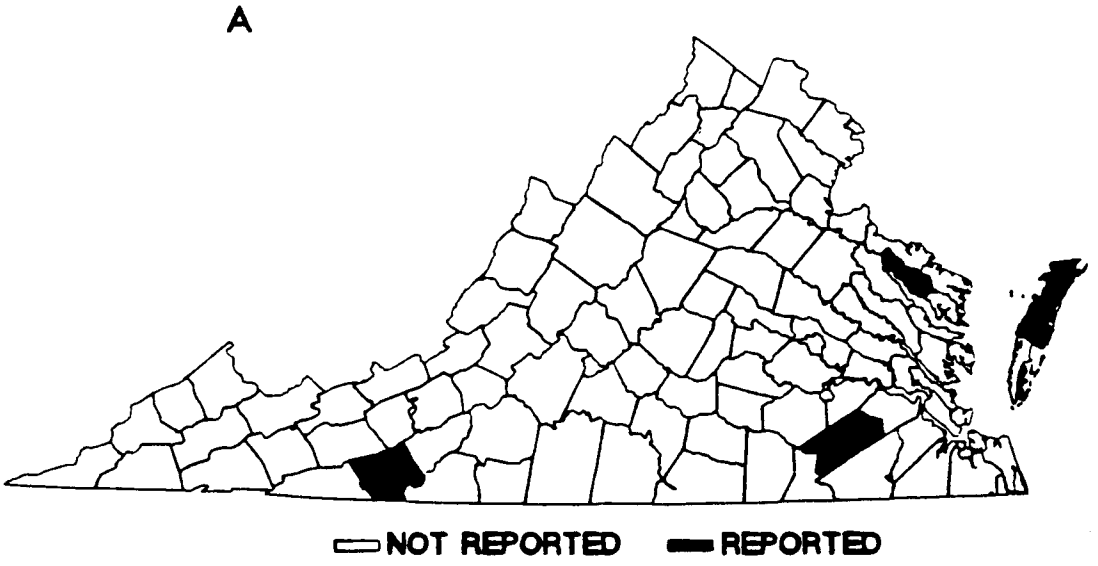
Habitat: Hilsenhoff, 1972 reports that affinis is found to inhabit downstream areas of logs and snags in streams and rivers. This species was not collected by the author during this study.

Gyrinus analis Say

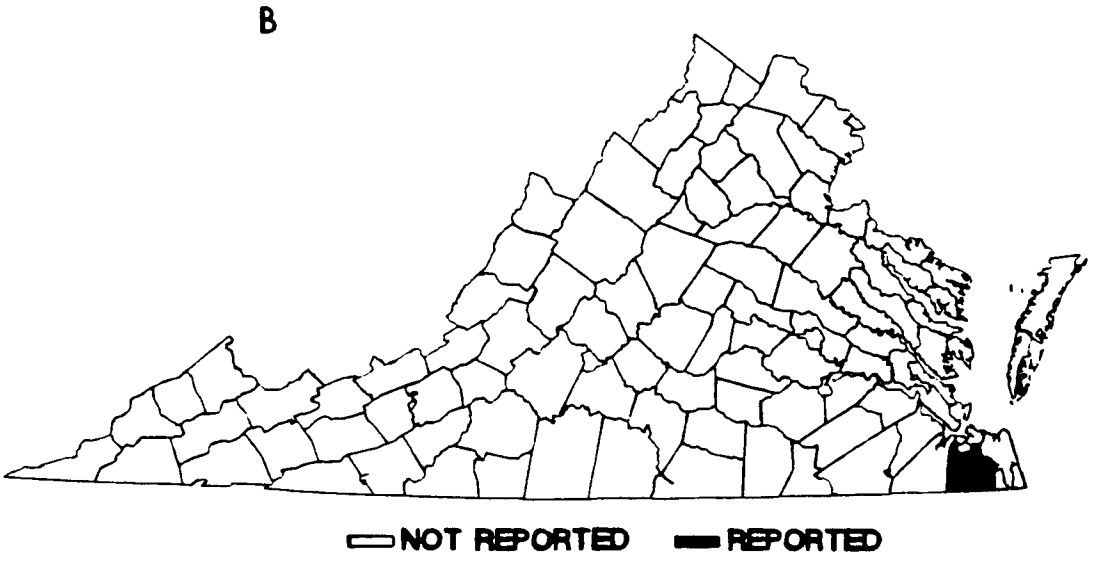
Diagnosis: Length 4.2-5.5mm. Width 2.4-2.9mm. The body form is rather narrow and convex. The elytra are black, extremely shiny, somewhat bronzed in color, and finely sculptured in male. The female elytra are moderately shiny and densely sculptured; the non-strial punctures are present in both sexes, but more noticeable near suture of the female than the male. The lateral punctures are approximately the same size as those near the suture in both sexes. The venter is black

Figure 12: Distribution map of: a) G. aeneolus, b) G. affinis.

Distribution by County and Selected Cities
Gyrinus aeneolus



Distribution by County and Selected Cities
Gyrinus affinis



with the anal segment distinctly reddish-brown.

Range: Maine to Florida and west to Kansas and the Gulf.

Virginia records: This species has been reported in 11 counties and four cities (Figure 13a). G. analis is very abundant in the eastern part of the state, where it is usually the most frequently collected species. It seems to be less frequently encounted towards the western areas of the State.

Reported from Augusta, Isle of Wight, Louisa, Mecklenburg, Montgomery, New Kent, Powhatan, Prince George, Russell, Southampton, and Surry counties; and the cities of Chesapeake, Newport News, Suffolk, and Virginia Beach.

Habitat: This species is commonly found in the backwaters of rivers and in small streams. In all cases it seeks out the slowest moving areas of water and does not venture out into the current unless forced to do so. G. analis can also be found in the eddies of the faster moving smaller streams, but usually near the banks. This beetle usually congregates in large groups in each case.

Gyrinus bifarius Fall

Diagnosis: Length 5.2-6.3mm. Width 2.6-3.5mm. The body form is moderately elongate and somewhat convex. The elytra are black and shining in the male, dull, especially posteriorly, in the female. The lateral margins of the elytra are bronzed and densely covered with fine non-strial punctures. The elytra of the male is moderately sculptured, with the female elytra being very heavily sculptured posteriorly. The

11th elytral striae is removed from lateral margin. The venter is uniformly reddish-brown.

Gyrinus bifarius is similar to Gyrinus confinis in Virginia. Both species have the fine non-strial punctures and sculpturing, but G. confinis is the slightly larger of the two, and has the 11th elytral stria somewhat closer to the lateral margin than does G. bifarius. Also, G. bifarius is slightly less bronzed than G. confinis. Even these characters are not completely reliable, bifarius is very variable throughout its range and some overlapping of characters can be expected. The best character for identification is the form of the male genitalia.

Range: Maine to California with records in New York and Virginia.

Virginia records: This species has been reported from two counties (Figure 13a). No definite range is definable on the information gathered.

Reported from Chesterfield and Highland counties.

Habitat: Hilsenhoff, 1972 reports that affinis is found to inhabit areas downstream of logs and snags in streams and rivers. Habitat information was not available for the collections in the state.

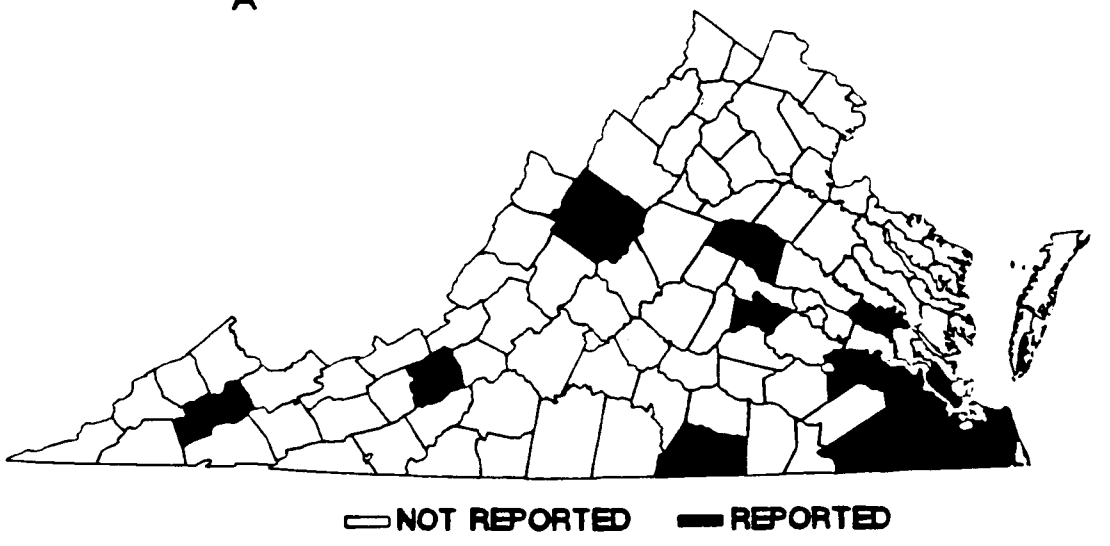
Gyrinus borealis Aube

Diagnosis: Length 5.7-5.9mm. Width 3.1-3.3mm. The body form is broad and distinctly convex. The elytra are black, somewhat shiny, and finely sculptured. The sculpture in the female is noticablly coarser and denser than in the male. The non-strial elytral punctures are rare

Figure 13: Distribution map of: a) G. analis, b) G. bifarius.

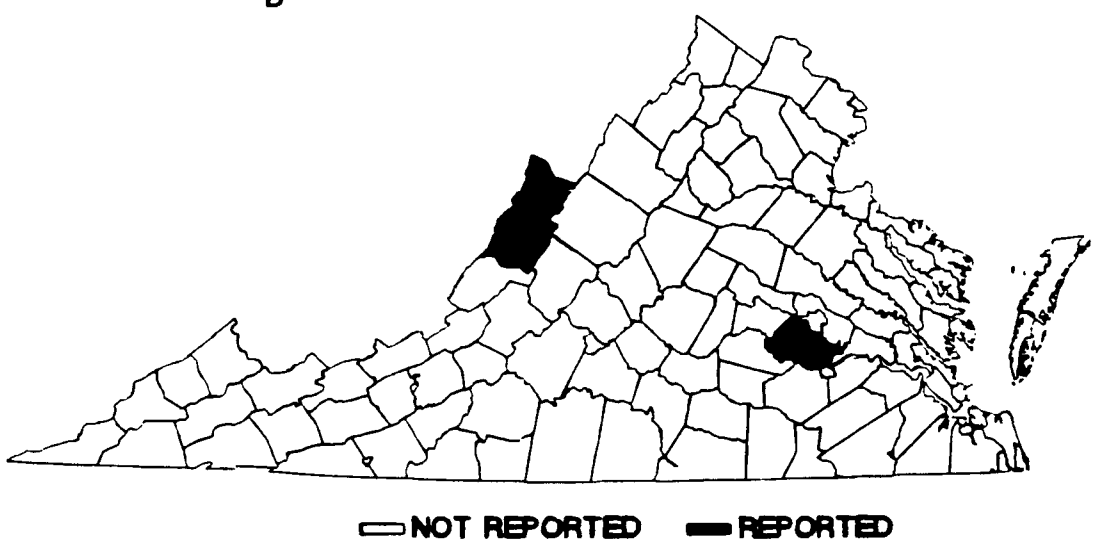
Distribution by County and Selected Cities
Gyrinus analis

A



Distribution by County and Selected Cities
Gyrinus bifarius

B



in both sexes. The lateral striae area strongly impressed and canaliculate, with lateral strial punctures much larger than those near the elytral suture. The venter is black with the anal sternite and epipleura obscurely reddish.

Range: Maine to Virginia and west to Indiana

Virginia records: This species has been reported from one county and two cities (Figure 14a). Borealis has only been found in the lowland slow moving streams in the southeastern area.

Reported from Isle of Wight county; and the cities of Chesapeake and Suffolk.

Habitat: The downstream side of logs and snags in small to large streams.

Gyrinus confinis LeConte

Diagnosis: Length 5.0-6.3mm. Width 2.8-3.4mm. The body form is rather large, narrow and slightly convex. The elytra are black and rather dull, with a greenish bronze shine. The elytra are heavily sculptured with scattered non-strial punctures in the female, and moderately sculptured with scattered non-strial punctures in the male. The strial punctures in both sexes are impressed and slightly larger laterally than along the suture. The 11th elytral striae is removed from lateral margin of the elytra.

Gyrinus confinis is similar to Gyrinus bifarius in Virginia. Both species have the non-strial punctures on the elytra and are about the same size, form, and color. The major differences are the amount of

bronzing and the form of the male genitalia. See the diagnosis of Gyrinus bifarius for diagnostic characters.

Range: Massachusetts to extreme western Virginia and west to New Mexico.

Virginia records: This species has only been reported from Highland County in Virginia (Figure 14b). G. confinis is considered a northern species with it southern limits occuring in Virginia, and the species is confined to the cooler mountainous areas of the State.

Habitat: This species was collected by Dr. James Matta in beaver ponds in Highland County. Hilsenhoff, 1972 also reports confinis to be found among the emergent vegetation in the slow moving waters of rivers.

Gyrinus elevatus LeConte

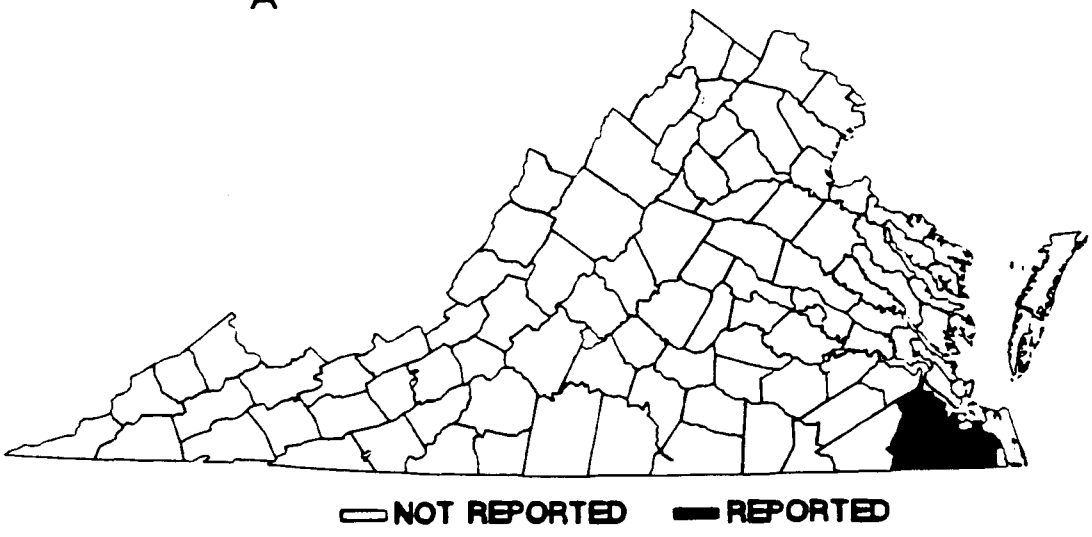
Diagnosis: Length 4.6mm-5.2mm. Width 2.5mm-2.7mm. The body form is small and strongly convex with the point of maximum elevation of the longitudinal profile being slightly in advance of the middle of the total length (Fall, 1922). The elytra are black with a distinct bronze sheen, but without any trace of non strial punctures or sculpture. The elytral punctures are much finer near the suture than near the margins. The 11th elytral stria is almost completely marginal except for a short distance at the middle, where it is distinctly non-marginal. The venter is reddish-yellow with the metasternum sometimes slightly darker in tint.

Gyrinus elevatus is similar to two other species found in Virginia, Gyrinus pachysomus and Gyrinus woodruffi. G. pachysomus has

Figure 14: Distribution map of: a) G. borealis, b) G. confinis.

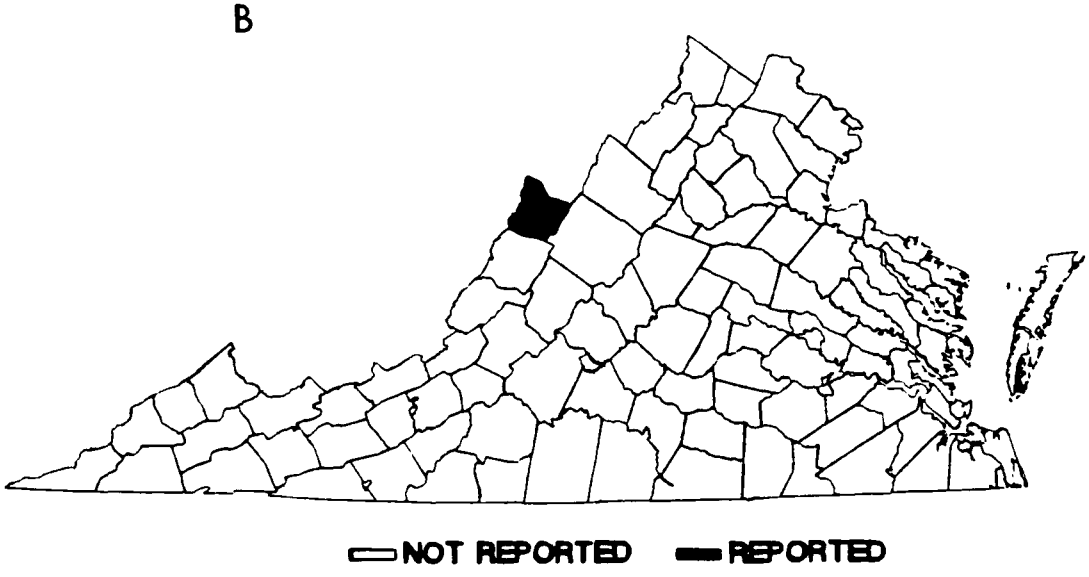
Distribution by County and Selected Cities
Gyrinus borealis

A



Distribution by County and Selected Cities
Gyrinus confinis

B



about the same body form and colorations, but it is a larger species than G. elevatus.

The body form and coloration of G. elevatus and G. woodruffi are very similar but G. woodruffi is smaller and the 11th elytral stria is not as close to the margin as in G. elevatus. These differences are very slight and in many cases there is a need to compare specimens of both species to make certain of identifications.

Range: Virginia to Florida.

Virginia records: This species has only been reported from Montgomery County in Virginia (Figure 15a). There has not been enough information gathered to determine any specific ranges in the State.

Habitat: This species is usually lentic in nature according to Young (1954). It occurs in small to large woodland ponds, but is sometimes found in sandy bottomed streams and larger upland streams. The author has not collected this species in Virginia.

Gyrinus frosti Fall

Diagnosis: Length 4.7-5.9mm. Width 2.8-3.4mm. The body form is broadly oval, moderately convex, and gibbous in profile. The elytra are black and rather dull in the female, shinier in the male. The elytra of the female are covered with a dense fine sculpturing and the sculpturing is less visible in the male. The non-strial punctures are scattered, with lightly impressed and fine strial punctures, which are slightly larger laterally than along the suture. The venter is black, with the anal sternite distinctly reddish-brown, and the epipleura

sometimes obscurely reddish-brown.

Range: Maine to Florida and west to Montana.

Virginia records: This species has been reported from nine counties and two cities (Figure 15b). The majority of the collections of G. frosti have been made in the eastern part of the State, with the only non-eastern county being Pittsylvania.

Reported from Caroline, Fauquier, Isle of Wight, Lancaster, New Kent, Pittsylvania, Surry, Sussex, and Westmoreland counties; and the cities of Chesapeake and Suffolk.

Habitat: This species has been collected from the backwaters of rivers and small streams and in shaded woodland pools throughout the state.

Gyrinus lugens LeConte

Diagnosis: Length 5.2-6.4mm. Width 2.8-3.5mm. The body form is broad, especially in female. The elytra of both sexes are black with a bronze sheen, moderately shiny in males, and duller in females. The elytra of the female is covered with dense reticulate sculpturing while the male is covered with finer sculpturing. The non-strial punctures are sparse in the male and slightly more evident in female, but the strial punctures not very noticable in either sex. The venter is black, with the anal sternite sometimes obscurely reddish-brown.

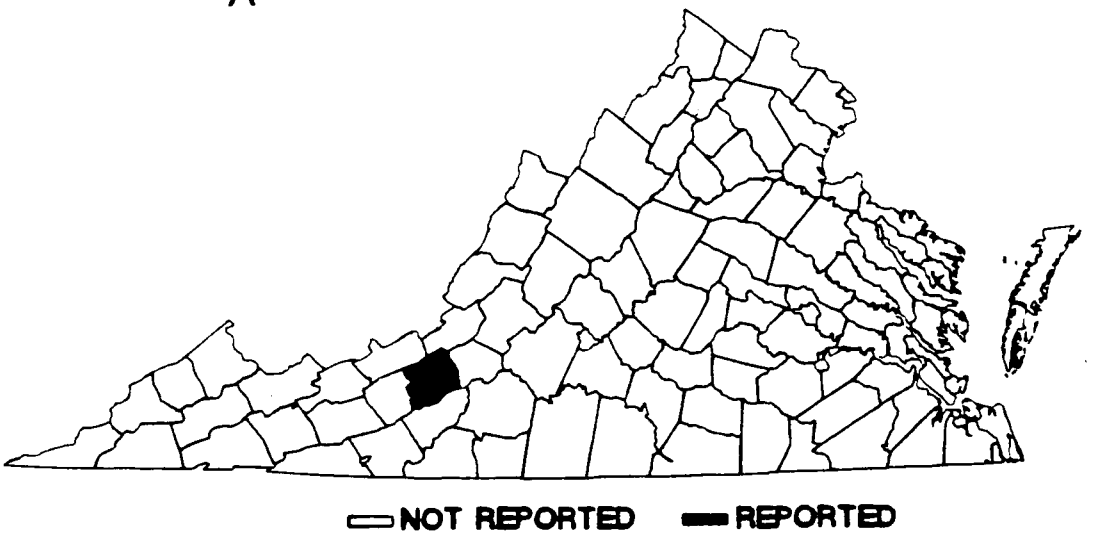
Range: Maine to Florida and west to South Dakota.

Virginia records: This species has been reported from four counties (Figure 16a). G. lugens is a mountainous species, it has only been reported from those counties in the western and central mountainous

Figure 15: Distribution map of: a) G. elevatus, b) G. frosti.

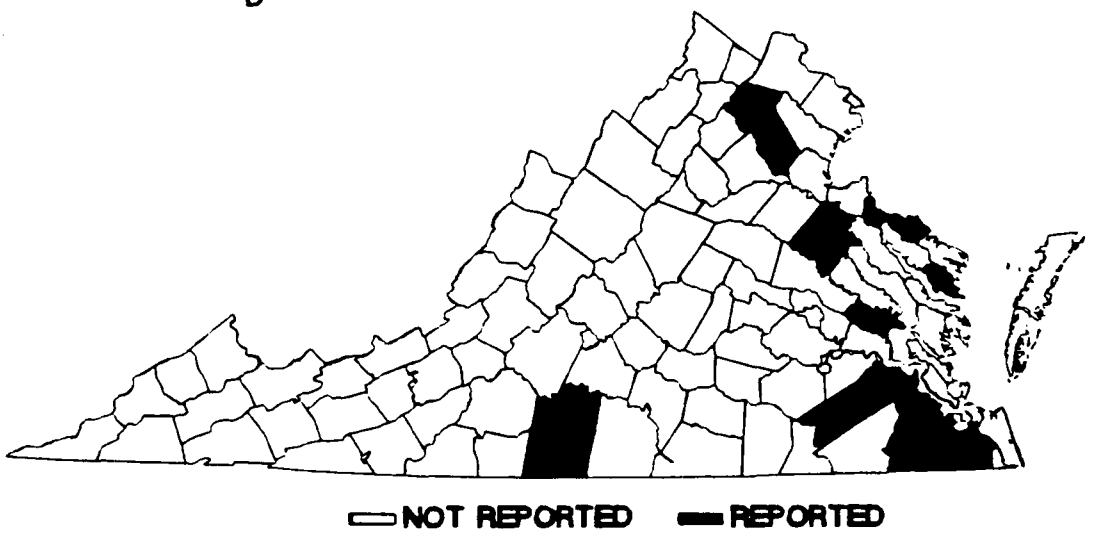
Distribution by County and Selected Cities
Gyrinus elevatus

A



Distribution by County and Selected Cities
Gyrinus frosti

B



areas of the State.

Reported from Bath, Mecklenburg, Richmond and Russell counties. Habitat: Hilsenhoff, 1972 reports this species from slow moving waters and behind logs and snags in rivers. No habitat information is available for the Virginia.

Gyrinus marginellus Fall

Diagnosis: Length 4.3mm. Width 2.2mm. The body form is narrow and strongly convex. The elytra are black, and highly polished but not bronzed. The elytra are without sculpturing or non-strial punctures. The lateral margins of the elytra are narrow, with the strial punctures slightly larger laterally than marginally. The 11th elytral striae is well removed from lateral margin.

Gyrinus marginellus is similar to two other species found in Virginia, Gyrinus aeneolus and Gyrinus woodruffi. These three species are very much alike in most of the major characteristics used to determine the Gyrinus species; however the elytra of G. marginellus are highly polished and not bronzed, whereas, the entire dorsal surface of G. aeneolus is highly bronzed, and the dorsal surface of G. woodruffi has a faint bronze luster in most specimens. In females the surface is dulled somewhat by fine alutaceous sculpture (Fall, 1922). Although these differences may seem easy to see, they are, in fact, very close and many misidentifications can occur when attempting to identify these species. The shape of the male genitalia is the best characteristic for distinguishing these species.

Range: Connecticut to Georgia and west to Minnesota.

Virginia records: This species has been reported from seven counties (Figure 16b). No generalization of the range can be drawn from the available information.

Reported from Caroline, Greensville, Henry, Highland, Prince George, Southampton and Stafford counties.

Habitat: This species is found in slow moving streams and rivers among the emergent vegetation (Hilsenhoff, 1972) and in beaver ponds (Matta, personal communication).

Gyrinus pachysomus Fall

Diagnosis: Length 5.5mm-6.2mm. Width 3.2mm-3.6mm. The body form is broadly oval and strongly convex. The elytra are black and highly polished without any trace of alutaceous sculpture and the sides are broadly bronzed. The strial punctures of the elytra are very much finer at the suture than near the lateral margins and the 11th elytral stria is rather close to the lateral margin. The venter is uniformly reddish-brown.

Gyrinus pachysomus is similar to Gyrinus elevatus within Virginia. Both species are similar in body form and markings. The major difference is in size, G. pachysomus is much longer and wider than G. elevatus. See the diagnosis of G. elevatus for other differences.

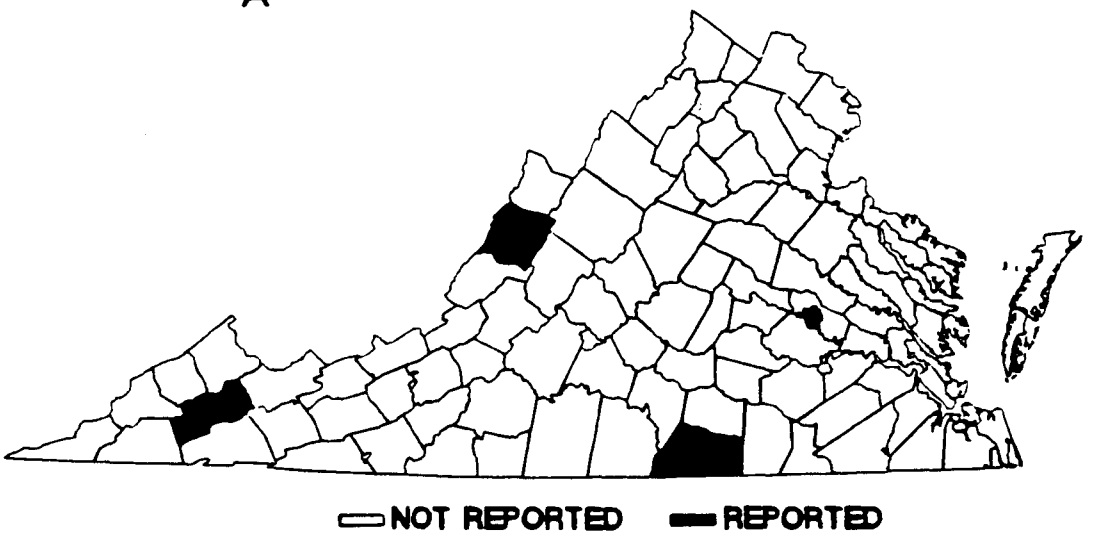
Range: Virginia to Florida, west to Alabama.

Virginia records: This species has been reported from three counties

Figure 16: Distribution map of: a) G. lugens, b) G. marginellus.

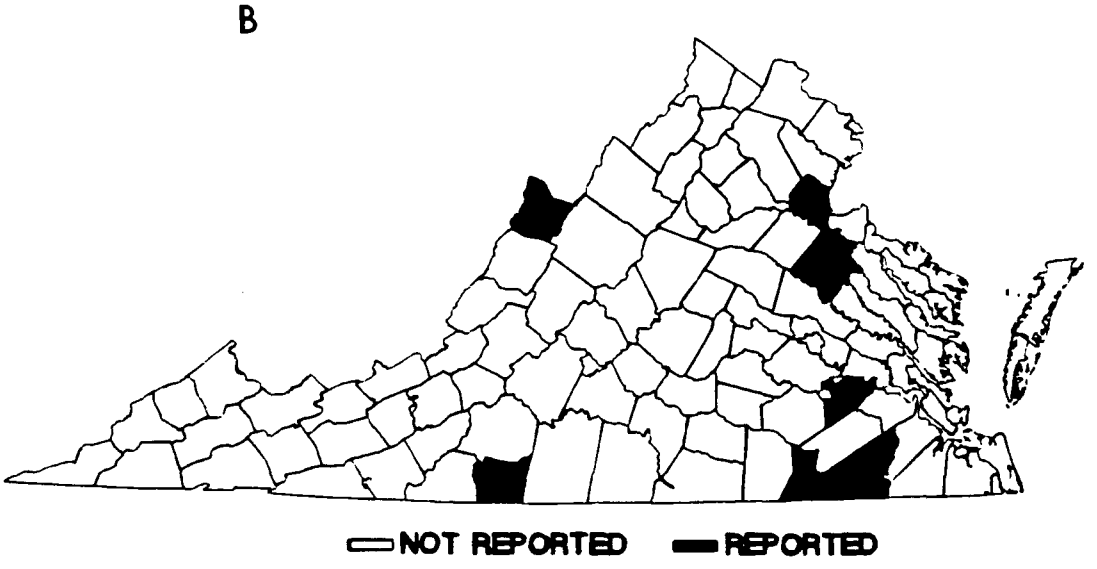
Distribution by County and Selected Cities
Gyrinus lugens

A



Distribution by County and Selected Cities
Gyrinus marginellus

B



and two cities (Figure 17a). All of the reported counties are on the coastal plain, and this along with the information on habitats suggests that pachysomus is a flatland stream species.

Reported from Greensville, Hanover, and Middlesex counties; and the cities of Chesapeake, Suffolk.

Habitat: This species is lotic in nature but can be found in standing waters occasionally. Young (1954) states that pachysomus is usually found in sandy-bottomed streams, but can be found in sandy-bottomed ponds or woodland ponds. Dr. James Matta has collected pachysomus in the ditches of the Dismal Swamp (Matta, 1979).

Gyrinus rockinghamensis LeConte

Diagnosis: Length 3.4mm-4.3mm. Width 1.75mm-2.2mm. The body form is small, narrow, and somewhat convex. The elytra are black and usually dulled. The scutellum is finely longitudinally carinate basally. The 11th elytral stria is very close to the lateral margin. The venter is entirely pale, with the mesosternum feebly sulcate (Fall, 1922).

Gyrinus rockinghamensis is very distinct from all species of Gyrinidae which are found in Virginia. The carinate scutellum is the distinguishing factor between rockinghamensis and all other species.

Range: Massachusetts to North Carolina and recorded from Florida.

Virginia records: This species has not been recorded within Virginia. G. rockinghamensis has been reported from North Carolina and may be found along the Virginia-North Carolina border.

Habitat: Swamps (Young, 1954).

Gyrinus woodruffi Fall

Diagnosis: Length 4.2mm-5.0mm. Width 2.2mm-2.8mm. The body form is rather narrowly oval but very convex. The elytra are black and highly polished There is no trace of alutaceous sculpture and there is a slight bronzed sheen towards the suture, which becomes more bronzed near the lateral margins. The 11th elytral stria are very far removed from the lateral margins which are narrowly reflexed. The venter is distinctly reddish-brown.

Within Virginia, Gyrinus woodruffi is very similar to Gyrinus aeneolus. Gyrinus woodruffi is more convex in body form and is not as distinctly bronzed as G. aeneolus. See the diagnosis for Gyrinus aeneolus above for more information.

Range: New York to Florida.

Virginia records: This species has been reported from seven counties and one city (Figure 17b). G. woodruffi has been collected in six coastal plain and only a single central county.

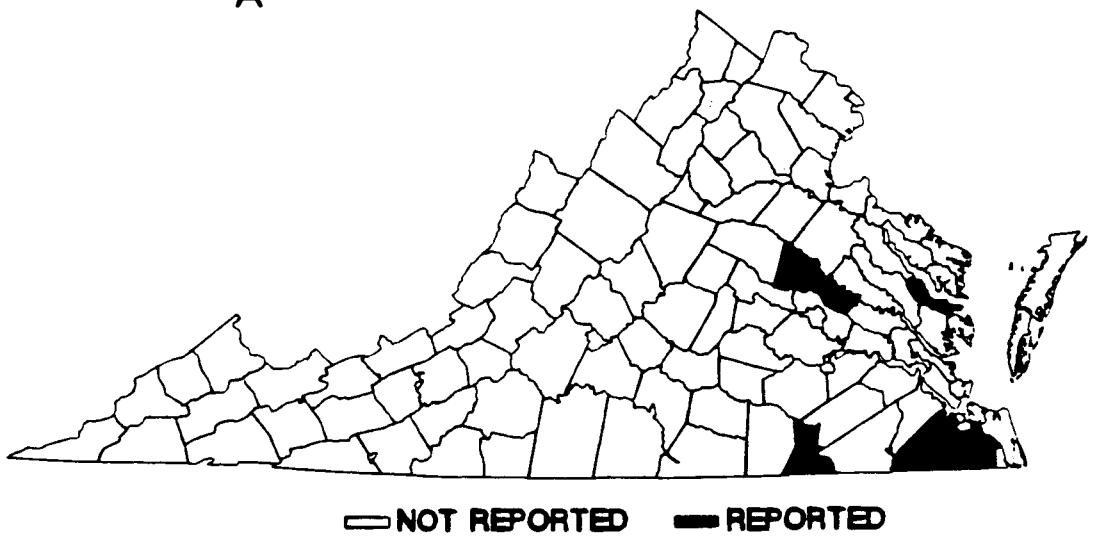
Reported from Arlington, Augusta, Caroline, Essex, Gloucester, Greensville, and Isle of Wight counties; and the city of Suffolk.

Habitat: This species can be found in both lentic and lotic habitats. The author has collected woodruffi in all types of habitats, including small to large shady streams and small to large shady ponds and swamps.

Figure 17: Distribution map of: a) G. pachysomus, b) G. woodruffi.

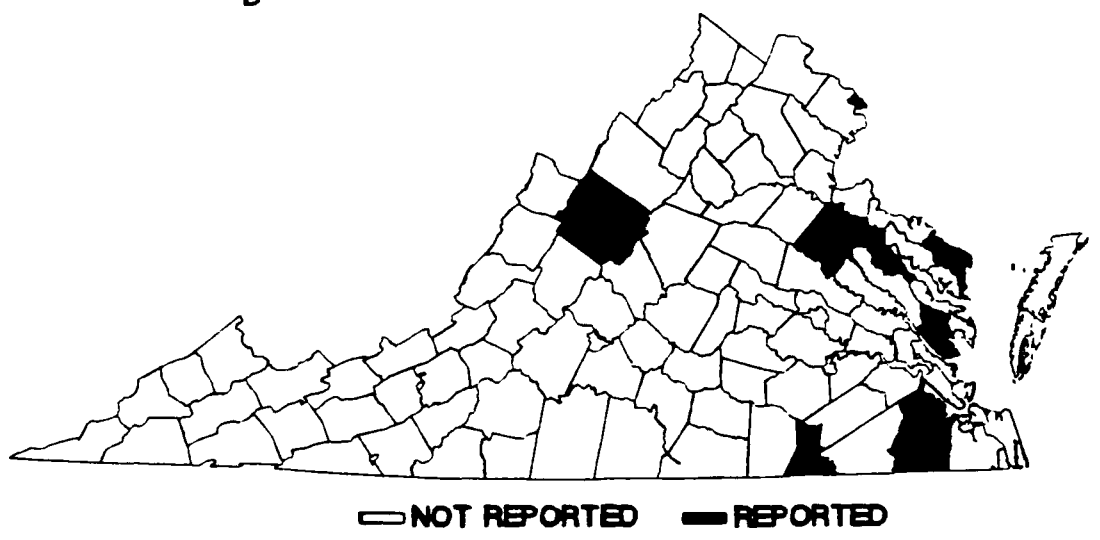
Distribution by County and Selected Cities
Gyrinus pachysomus

A



Distribution by County and Selected Cities
Gyrinus woodruffi

B



Genus Gyretes Brulle

The genus Gyretes is a small group of Gyrinidae found mostly in the southern states of the United States. Members of the genus are very similar to the genus Gyrinus except that the lateral margins of the pronotum and the elytra are pubescent, the elytra lack striae, the scutellum is not visable, and the terminal abdominal segment is conical in shape and not flattened (Figure 1c). The length of Gyretes ranges from 3mm to 5mm, this makes them somewhat smaller than Gyrinus. This genus is not presently reported within Virginia.

Range: Alabama, Florida, Mississippi.

Genus Spanglerogyrus Folkerts

This genus is only known from south-central Alabama, and contains only a single species, Spanglerogyrus albiventris. The Spanglerogyrin body length is less than 3mm, thus, making it the smallest North American Gyrinid. The distinguishing characters of this genus are that the dorsal and ventral eyes are almost in contact on the lateral margins of the head, separated only by a narrow ridge (Brigham and Brigham, 1982); and that the dorsal eye is larger that the ventral eye, a reversal in the eye morphology usually found in Gyrinidae (Steiner and Anderson, 1981).

A third difference between Spanglerogyrus and other Gyrinidae is in the modification of the middle and hind legs. Whereas, other species of Gyrinidae have the tibiae and tarsi of these appendanges shortened and flattened for swimming, Spanglerogyrus has the tibiae

greatly modified and pronounced, while the tarsi, though equipped with long natatory hairs not found in other Gyrinidae, remains relatively unmodified (Figure 1a) (Steiner and Anderson, 1982). Also the coxa of Spanglerogyrus do not fit into coxal grooves when not in the action of swimming, whereas, the coxa do fit into the grooves in other genera.

Many early workers believed Spanglerogyrus to be a primitive Gyrinid, but Steiner and Anderson (1981) state that S. albiventris has characters, such as the oar-like tibiae, that are not found in other Gyrinidae, and are not likely to have been features possessed by early ancestral Gyrinids. Therefore, it is difficult to determine whether Spanglerogyrus is a primitive or highly specialized Gyrinidae.

DISCUSSION

Twenty-one species of Gyrinidae were found to have distributions in Virginia, nine species of Dineutus and 12 species of Gyrinus. No species of either Gyretes or Spanglerogyrus were reported. See table 1 for comparison to other states. The species found in Virginia are distributed throughout the state with almost no regard to the geographic provinces. The major factor dictating their distribution seems to be the availability of either the lentic or lotic types of habitat. The only species in which definite ranges were identified were Dineutus carolinus, Dineutus ciliatus, and Dineutus robertsi. Dineutus carolinus exhibited a preference for the slow moving streams in the coastal plain area of the state and was not reported in any county west of the Fall Line.

Dineutus ciliatus and Dineutus robertsi are both restricted to piedmont-type streams throughout the state. This type of habitat is mainly restricted to the central areas of mountainous and upper coastal areas of the state. Dineutus ciliatus and Dinuetus robertsi were never collected together in the same stream. It would seem that the two species would be found together since they both inhabit similar habitats. In cases where D. ciliatus and D. robertsi were collected special note of the habitat was taken, but no specific differences in habitat preference were found. This allopatric distribution between two very similar species of Dineutus is contrary to what is seen in

Table 1: Number of species of Gyrinidae reported from surveys of states.

STATE	NUMBER OF SPECIES		
	DINUETUS	GYRINUS	GYRETES
Virginia	9	12	0
California [1]	1	7	1
Florida [2]	9	8	1
Maine [3]	6	13	0
Maine (vicinity) [3]	6	19	0
Minnesota [4]	4	27	0
North Carolina [5]	9	12	0
North Dakota [6]	3	8	0
South Carolina [5]	9	12	0
Wisconsin [7]	2	15	0

Sources [1] Leech, 1971; [2] Young, 1954; [3] Malcolm, 1971; [4] Ferkinhoff and Gundersen, 1983; [5] Brigham, 1982; [6] Gordon, 1965; [7] Hilsenhoff, 1972.

other species of Dineutus.

Within the state of Virginia the genus Dineutus can be divided into four distinctive groups according to the degree of similarity in morphology between the species. The first group consists of D. assimilis and D. carolinus, the second, D. discolor and D. serrulatus, the third, D .ciliatus and D. robertsi, and the fourth, D. emarginatus and D. nigrior. The last species of Dinuetus found in the state, D. horni, does not fit into any group. Each of these groups are defined by very similar characters such as toothed or rounded fore-femora, similar elytral shapes, size, color, etc. In most cases the two members of a group are found within the same aggregations or in separate aggregations within the same general area, usually within 10 meters or so of each other. This type of distribution seems logical on the basis that organisms within similar habitats usually develop similar morphologic characters, or to put this statement in another way, organisms with similar structures may inhabit similar areas. But in the case in the distribution of D. ciliatus and D. robertsi, this does not seem to apply and the reason for this is unknown.

State-wide distributions were not established for the species of Gyrinus since many of the species have been recorded from less than five counties. This lack of information is do to the difficulty of collecting these small organisms. Gyrinus have a tendancy to rest on emergent objects and may not be noticed by collectors. A second reason for the spotty distribution may have been because many areas of standing water were not accessable to the author.

Some degree of rafting behavior was noted in all species of Gyrinidae found in Virginia. Individuals exhibiting this behavior were usually in areas of running water. In these cases tight aggregations formed behind emergent rocks or in the eddies in bends of the stream. In areas of slow moving waters such tight aggregations were not frequently observed. Loose rafts were formed and reformed many times, with individuals seen leaving these groups and swimming in what seemed to be deliberate patterns in response to wave vibrations.

The reason for the two different types of rafting behavior observed would seem to be the amount of available quiet water areas. The tight rafts were formed where the fast flowing water moved around emergent structures. This allowed the gyrinids to stay in the protected areas. Conversely, in the areas of slow moving waters, the beetles were able to utilize a larger area to forage in, thus, the loose aggregations were formed in this habitat.

Species within both the Dineutus and Gyrinus were found to exhibit the two types of rafting behavior. The major factor determining what type of behavior was exhibited was the general habitat and not necessarily the species. Many species demonstrated both the loose and tight aggregations. The two exceptions to this are Dineutus discolor and Dineutus serrulatus. These two species are almost exclusively found in rapid running water and they usually form the loose aggregations. This is in response to the fact that there is usually very little available quiet water in these areas. Therefore, these two species would actively swim in the current and only form "tighter"

aggregations when resting near the shore. The other species of Dineutus form aggregations that seem dependant on the habitat type.

Species of Gyrinus formed the tight aggregations when in running water, but the same species would exhibit the loose aggregations when swimming in extremely slow moving water. Therefore, it would seem that the Gyrinus aggregations are more of a function of habitat type and not species preference.

The composition of the rafts observed varied widely. Rafts of different species composition were observed in the majority of case where aggregations of beetles were sampled. This was especially true of the Gyrinus. Rafting aggregations contained as many as four species. There were no specific group of species which were found together more than any other group within the rafts. The one factor which did seem to control the species within a given raft was habitat preference.

Multi-specific rafts were also observed within the Dineutus. As many as three species were observed together in these rafts. As would be expected, species with similar habitat preferences were found within the same groups. For example, Dineutus discolor was frequently found in aggregations with Dineutus serrulatus. Although D. serrulatus prefered larger streams or rivers and D. discolor prefered smaller streams or the slower areas of the large streams, the two species were often found together. In a large percentage of collections the species D. carolinus, D. emarginatus, and D. assimilis were also found within the same aggregations.

In a number of cases, multi-generic rafts were observed. As many as two species each of Dineutus and Gyrinus were found in these rafts. No reason for this type of rafting behavior was discovered.

While every attempt was made to sample as many of the geographic areas in the State as possible it was not possible to obtain many specimens from the western areas of the State. The extreme southwestern counties are the major area of missing data. The eastern, central and northern areas of the State were extensively sampled (Figure 18).

A second area of limited data in this survey is in the sampling of the ponds and other types of standing waters. The need to cover a large area in a limited amount of time led to the problem of missing many of the small ponds and other small bodies of standing water. This explains the scattered records of the species which are mainly pond-dwelling in nature. This also explains the distribution of many of the Gyrinus species. Ferkinhoff and Gundersen (1983) state that the majority of Gyrinus are found in lakes and ponds. Most of the county records in this paper reflect those Gyrinus found mainly in streams, except in those areas which were extensively collected, such as southeastern Virginia. In these areas many of the ponds were sampled by repeated collections and Gyrinus records are more complete.

The family Gyrinidae is known for its lack of good characters for identification to the specific level, however no new reliable characters were noted to simplify the identification. All species in which specimens were available were closely examined in order to identify any additional morphological characters which would aid in the

species identification. It would seem that gyrinids have developed very similar morphological forms do to the limited diversity of the habitat in which they live. The characters used for identification are adequate, but in many cases the differences are so slight that care must be taken in learning the family morphology before an identification of closely related species can be performed with a degree of certainty. The diagnosis for each species was written to highlight the comparision of the characters most useful in the identification of the species.

The identification keys were re-written using various existing keys as skeletons (Brigham, 1982; Fall, 1922; and Hatch, 1925a) and then, using only the characters which would simplify identification and apply only to the species reported in or possibly found in Virginia. Secondly, all keys apply to states east of the Mississippi river.

Figure 18: Map of the number of species found in counties sampled.

Location and number of species of Gyrinidae

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APPENDIX A

The Family Gyrinidae in North America

Subfamily Enhydrinae

Tribe Dineutini

Genus *Dineutus* MacLeay

Subgenus *Dineutus* s. str.

angustus LeConte	Florida, Texas, Virginia?
assimilis (Kirby)	Maine to Florida, west to New Mexico and Utah
carolinus LeConte	Virginia to Florida, west to Texas
discolor Aube	Maine to Florida, west to Texas; scattered as far west as Arizona
emarginatus emarginatus Say	Maine to South Carolina, west to Michigan
emarginatus floridanus Ochs	Florida
horni Roberts	Maine to Florida, west to Texas
mutchleri Ochs	Florida, Bahamas
nigrior Roberts	Maine to Georgia, west to North Dakota

productus Roberts	Florida, Louisiana, Illinois to Texas
serrulatus LeConte	Virginia south to Florida and Alabama
solitarius Aube	California
Subgenus *Cyclinus* Kirby	
ciliatus (Frosberg)	Maine to Florida, west to Oklahoma
robertsi Leng	Virginia to Georgia and Alabama
sublineatus Chevrolet	Arizona
Subfamily Gyrininae	
Tribe Gyrinini	
Genus *Gyrinus* Geoffrey	
minutus Linnaeus	Alaska east to Maine
rockinghamensis LeConte	Massachusetts to North Carolina, Florida
ventralis Kirby	Maine to Pennsylvania, west to Minnesota
fraternus Couper	Maine to Massachusetts, west to Indiana
aeneolus LeConte	Maine to Florida, west to Kansas
woodruffi Fall	New York to Florida

marginellus Fall	Connecticut to Georgia, west to Minnesota
dichrous LeConte	Maine west to Minnesota
latilimbus Fall	Maine to Massachusetts, west to Minnesota
bifarius Fall	Maine west to California, New York, Virginia
confinis LeConte	Massachussetts to extreme western Virginia, west to New Mexico
plicifer LeConte	N/A
pachysomus Fall	Virginia to Florida, west to Alabama
elevatus LeConte	Virginia to Florida
consobrinus LeConte	California, Colorado, South Dakota, Utah
aquiris LeConte	Michigan to Minnesota, Massachusetts, New York
lecontei Fall	Maine to Illinois, North Dakota, South Dakota
maculiventris LeConte	North Central states east of the Missouri River, Michigan, Montana,

		Montana, Illinois and, New Jersey
pleuralis	Fall	California, Colorado, Wyoming
affinis	Aube	Maine to Virginia, west to California
pectoralis	LeConte	Wisconsin northwest to North Dakota and west to Washington
parcus parcus	Say	Pennsylvania west to South Dakota and south to Texas, California
parcus californicus	Ochs	California
borealis	Aube	Maine to Virginia, west to Indiana
pugionis	Fall	Maine to Massachusetts, west to Wisconsin
pernitidus	LeConte	California
picipes	Aube	Alaska south to California
lugens	LeConte	Maine to Florida, west to South Dakota
analis	Say	Maine to Florida, west to Kansas and the Gulf Coast
opacus	Sahlberg	Alaska

wallisi Fall	Wisconsin to North Dakota
frosti Fall	Maine to Florida, west to Montana
gibber LeConte	North Carolina
impressicollis Kirby	Extreme north edge of United States
floridensis Ochs	Florida
gehringi Chamberlain	New Hampshire, Pennsylvania, Michigan
limbatus Say	Indiana
microtuberculatus Hatch	Washington
piceolus Blatchley	Indiana, Michigan, Minnesota
punctellus Ochs	California, Colorado, Montana, Nevada, Oregon, South Dakota

Subfamily Orectochilinae

Genus *Gyretes* Brulle'

iricolor Young	Alabama, Florida, Texas
sinuatus LeConte	Arizona, California, Texas

Subfamily Spanglerogyrinae

Genus *Spanglerogyrus* Folkerts

albiventris Folkerts	Alabama