

THE AQUATIC DRYOPOIDEA OF LOUISIANA
(COLEOPTERA: PSEPHENIDAE, DRYOPIDAE, ELMIDAE)¹

CHERYL B. BARR AND JOAN B. CHAPIN

DEPARTMENT OF ENTOMOLOGY, LOUISIANA AGRICULTURAL EXPERIMENT STATION,
LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER, BATON ROUGE, LOUISIANA 70803

ABSTRACT

A study of the aquatic Dryopoidea of Louisiana was conducted to determine species composition and distributional factors. From May 1979 to May 1981, 195 collections were taken at 191 sites in 59 of the state's 64 parishes with emphasis on lotic waters. Aquatic dryopoids were collected at 138 of these sites in 39 parishes. Additional records, collected either before or after the study through June 1984, are also reported. Twenty-five species were found to occur in the state: 1 Psephenidae, 4 Dryopidae, and 20 Elmidae. Twenty-two are reported for the first time, including one undescribed species of *Stenelmis* and 3 species of *Dubiraphia* that are possibly undescribed. Most of these are eastern and coastal plain species; none is western. Brief descriptions and a key to the species are provided, and several taxonomic problems are discussed. The 5 most common species in the state were *Stenelmis grossa* Sanderson (63% of collections), *Macronychus glabratus* Say (44%), *Ancyronyx variegata* (Germar) (35%), *Stenelmis bicarinata* LeConte (31%), and *Microcylloepus pusillus* (LeConte) (25%).

Species distribution within the state was examined in relation to vegetation patterns, physiography, and drainage basins. Twenty-four species occurred in pinelands, 16 in the alluvial plain, 13 in upland hardwood areas, 9 in oak-pine areas, 5 in the prairie, and one in the deltaic plain. The Lake Ponchartrain and Pearl River drainage basins had the greatest number of species, 20 and 21, respectively. Macro- and microhabitat preferences are reported for each species. The largest number of species were collected from streams with mixed sand and gravel substrates. Adult and/or larval dryopoids were found every month of the year except January. It is probable that both stages of all species occur year-round in Louisiana streams.

INTRODUCTION

The aquatic dryopoid beetles function as important members of the lotic community in streams and rivers and are represented in Louisiana by the

families Psephenidae, Dryopidae, and Elmidae. Aquatic members of the superfamily Dryopoidea typically inhabit riffles or rapids; however, several species prefer pools, a few may occur in lakes, and one species (*Pelonomus obscurus* LeConte) is strictly lentic. The common name riffle beetles is often applied to the group as a whole (Brown, 1976, 1987a).

Previous records and preliminary collecting indicated that the aquatic Dryopoidea are widely distributed in the state, exhibiting abundance and diversity of species in suitable habitats. This paper, based on the thesis project of the senior author (Barr, 1981), represents the first comprehensive study of the aquatic dryopoid fauna of Louisiana. Records of specimens collected outside of the study are also reported. Different geographical features of the state such as vegetation patterns, physiography, and drainage basins were examined in an effort to explain observed distribution patterns. Collections were made year-round so that seasonal and monthly occurrence could be documented. Many taxonomic problems exist within this group, several of which pertain to Louisiana species.

Life History

The life histories of most species are poorly known although several recent papers have been published (LeSage and Harper, 1976a, 1976b, 1977). A general overview of the biology of the Dryopoidea has been given by Brown (1976, 1987a). Most adult and larval

¹Approved for publication by the Director of the Louisiana Agricultural Experiment Station as manuscript number 86-17-0320.

elmids, adult dryopids, and larval psephenids are aquatic; larval dryopids and adult psephenids are semi-aquatic or terrestrial. Aquatic elmids have at least 5 larval instars. Pupation is terrestrial in all 3 families and occurs under logs, debris, and stones along the shore. Emerging adults of many species are attracted to lights. Adults of some species are flightless because the hind wings are vestigial or absent; other species include both alate and flightless forms. After entering the water, most adult elmids (Elminae) remain permanently waterbound, while some dryopids emerge periodically to fly at night. The typical elmids life cycle in Canada may last 3-4 years with one year spent in the adult stage (LeSage and Harper, 1976a). Laboratory survival of adult and larval elmids for more than 3 years has been recorded (Brown, 1973).

The aquatic stages are substrate clingers and are unable to swim. Long claws and streamlined or flattened bodies enable the beetles to grasp objects and move about even in strong currents. The various species inhabit a range of substrates, or microhabitats, such as waterlogged wood, leaf litter, root masses, aquatic plants, gravel, and rocks (Brown, 1966). Doyen and Ulrich (1978) classify the dryopids trophically as "collector-gatherers" and "scrapers," feeding on either decomposing organic matter or periphyton, which includes algae and diatoms.

Respiration in adult elmids and dryopids employs a hydrofuge ventral plastron functioning as an external gill into which oxygen diffuses directly from the water. This air store is in direct contact with the spiracles. Respiration in adult dryopids was examined by Harpster (1941, 1944), Davis (1942), Thorpe and Crisp (1949), and Thorpe (1950). The larvae of elmids and eu-

briine psephenids possess caudal tracheal gills which are retractile into a chamber closed by an operculum. Psephenine and eubrianacine psephenid larvae have external, ventral abdominal gills.

Various aspects of dryopoid ecology have been investigated by Sinclair (1964), Brusven (1970), Murvosh (1970), Davis and Finni (1974), Cowell and Carew (1976), Reisen (1977), Seagle and Hendricks (1978, 1979) and Seagle (1980).

Water Quality Requirements

The water quality requirements of aquatic dryopoids have been discussed by several authors. In general, the presence of the group has been considered indicative of clean water conditions (Gaufin and Tarzwell, 1952, 1956). Young (1961) stated that elmids are ". . . extremely sensitive to even mild pollution and quickly disappear from streams which receive even moderate amounts of industrial wastes." Hilsenhoff (1977) reported 17 species in Wisconsin, all from streams with excellent (clean, undisturbed) to fair (moderate enrichment or disturbance) water quality. The reaction of several dryopoid species to factors influencing water quality has led to their inclusion in lists of water quality indicator organisms. Ten taxa of dryopoids were listed by the United States Environmental Protection Agency in a macroinvertebrate pollution tolerance chart with ratings of intolerant, facultative, or tolerant (Weber, 1973). Mason et al. (1971), in studies of the Ohio River Basin, listed as facultative a genus and a species of Elmididae. Sinclair (1964) reported that several species of elmids are "tolerant of a wide variety of effluents, and may be found even in poorly aerated sections of polluted streams" in Tennessee. Forty species of dryopoids

were included in the EPA's Bio-Storet Master Species List (Weber, 1976), a computer-file directory of water quality indicator organisms.

Aquatic Dryopoids in the Southeastern States and Texas

Information concerning the distribution and biology of aquatic dryopoids in the southeastern states and Texas is fragmentary. Statewide surveys have been conducted in North Carolina, South Carolina, Florida, and Alabama. Twenty-eight species of Elmidae, 5 of Dryopidae, and 3 of Psephenidae were collected in North and South Carolina during a two-state survey (Brigham, 1982). A new species of *Stenelmis* (Elmidae) was described from North Carolina (White and Brown, 1976) and another from South Carolina (White, 1982). Morse et al. (1980) reported 17 species from Upper Three Runs Creek, a tributary of the Savannah River in South Carolina. Water quality information was published for 14 species collected from the Savannah River on the Georgia-South Carolina border by Patrick et al. (1966). Young (1954) listed, described, and provided keys to the 11 elmids and 3 dryopids occurring in Florida. Loding (1945), in a list of Alabama beetles, recorded 6 elmid, 4 dryopid, and 2 psephenid species. The Elmidae of Alabama were more recently studied by Eiland (1979) who furnished descriptions, keys, and natural history observations for 31 species in 9 genera. Brown (1980) described *Alabameubria starki*, a new genus and species of eubriine water penny, from larvae collected in Alabama. In 1979 Lago and Stanford reported *Psephenus herricki* (DeKay) (Psephenidae) as a new Mississippi state record. Eleven genera and 16 species, with notes on habitat and distribution, were reported by Burke (1963)

in a preliminary survey of Texas elmids. Brief descriptions, generic picture keys, distributions, and water quality requirements were given by Sinclair (1964) for the elmids of Tennessee. Seventeen species were listed.

Aquatic Dryopoids in Louisiana

Previously, only 2 families (Elmidae and Dryopidae), 7 genera, and 3 species were reported in the literature from Louisiana. Sanderson's (1938) revision of the genus *Stenelmis* included a description of *S. grossa* with paratypes from Louisiana. Hilsenhoff (1973) added 5 new species to the genus *Dubiraphia*, including *D. brevipennis* from Louisiana. In a paper illustrating the North American distributions of dryopoid genera, Brown (1975a) listed 6 genera for the state: *Ancyronyx*, *Dubiraphia*, *Macronychus*, *Microcylloepus*, *Stenelmis* (Elmidae), and *Helichus* (Dryopidae).

Summers (1874) reported *Pelonomus obscurus* LeConte (Dryopidae) from collections taken in the Lake Pontchartrain region. A species of *Dubiraphia* was found in Ekman dredge samples from Avoyelles Parish during a limnological survey of the Atchafalaya Basin by Bryan et al. (1976). Elmidae were reported from benthic samples and/or fish stomachs by Geagen and Allen (1960) while surveying fish productivity factors in lakes in Caddo, East Carroll, Natchitoches, and Evangeline parishes. Golden (1972), Twilley (1972), Staats (1973), and Rodgers (1977) reported the elmid genera *Ancyronyx*, *Dubiraphia*, and *Stenelmis* from Jackson and Winn parishes during studies of the effects of paper mill effluent on the fauna of the Dugdemona River. A summary of the published and unpublished literature records, excluding those of Barr (1981), is found in Table 1. Subsequent to this

TABLE 1. Published and unpublished literature records of aquatic Dryopoidea from Louisiana.

AUTHOR	LOCALITY
FAMILY DRYOPIDAE	
Genus <i>Helichus</i>	
Brown, 1975a	no localities given
Genus <i>Pelonomus obscurus</i>	
Summers, 1874	Lake Pontchartrain region
FAMILY ELMIDAE	
Caddo Lake, Caddo P.;	
Geagan and Allen, 1960	Cane River L., Natchitoches P.;
	Chicot Lake, Evangeline P.;
	Lake Providence, E. Carroll P.
Genus <i>Ancyronyx</i>	
Brown, 1975a	no localities given
Golden, 1972;	Dugdemonia River,
Twilley, 1972;	Jackson and Winn P.
Staats, 1973;	
Rodgers, 1977	
Genus <i>Dubiraphia</i>	
Brown, 1975a	no localities given
Bryan et al, 1976	Yellow Bayou, Avoyelles P.
Golden, 1972;	Dugdemonia River,
Twilley, 1972;	Jackson and Winn P.
Staats, 1973;	
Rodgers, 1977	
<i>Dubiraphia brevipennis</i>	
Hilsenhoff, 1973	Hammond, Tangipahoa P.
Genus <i>Macronychus</i>	
Brown, 1975a	no localities given
Genus <i>Microcylloepus</i>	
Brown, 1975a	no localities given
Genus <i>Stenelmis</i>	
Brown, 1975a	no localities given
Golden, 1972;	Dugdemonia River,
Twilley, 1972;	Jackson and Winn P.
Staats, 1973;	
Rodgers, 1977	
<i>Stenelmis grossa</i>	
Sanderson, 1938	Tallulah, Madison P.; Beauregard P.

study, a new species of *Dubiraphia*, *D. harleyi*, was described by Barr (1984).

Biogeography and Physiography
of Louisiana

Louisiana is located entirely within the Gulf Coastal Plain Physiographic Province, with the Mississippi River dividing the state into 2 sections—the East and West Gulf coastal plains (Thornbury, 1965). The area east of the river and north of Lake Pontchartrain is commonly termed the “Florida parishes” (East Baton Rouge, East & West Feliciana, Livingston, St. Helena, St. Tammany, Tangipahoa, and Washington parishes). The Mississippi Embayment (river and associated alluvial plain) has been postulated as a barrier to the westward expansion of several invertebrate and vertebrate species (Bick, 1957; Louton, 1975; Viosca, 1926). Louisiana has the lowest mean elevation of any state in the nation, 100 feet (30 m), with uplands rising to slightly more than 500 feet (150 m). The climate is warm-temperate to subtropical.

Although Louisiana is located in only one physiographic province, much diversity exists in lotic habitats. Clear sandy streams are common in the rolling hills of the north-central, central, west-central, and southeastern parts of the state. Swift, gravelly streams are also present in the “Florida parishes.” Although rock outcroppings are rare in Louisiana, soft sandstone and siltstone substrates occur in a few streams in Catahoula, Natchitoches, and West Feliciana parishes. Clay-bottomed channels predominate in the southwestern prairie regions. Muddy, sluggish waters, although common statewide, are the rule in the alluvial and deltaic areas.

Bick (1957) divided the state into 4 physiographic-vegetation zones in a study of the odonate fauna of Louisiana: 1) pinelands, 2) prairie, 3) al-

luvial plain, and 4) deltaic plain. The pinelands in the northwest include the Tertiary Uplands and have the highest elevations in the state. The southeast and west-central pinelands include all but one of the Pleistocene terraces in the state. Most of Louisiana's swift, clear streams are found only in pineland areas. Bick's prairie region in the southwest corresponds to Holland's Prairie terrace. Here the land is flat and mainly used for agriculture; a calcareous hardpan exists near the surface and streams are sluggish and very similar. The alluvial plain extends 25-50 miles (40-80 km) on either side of the Mississippi River north of Lake Pontchartrain,

and to a lesser extent along the Red and Ouachita rivers. This plain contains some of the best agricultural land in the state. Forested areas consist of bottom-land hardwood tracts including oak, gum, cypress, elm, and hackberry; streams are generally silty and very sluggish. The deltaic plain extends east and west across Louisiana in a band south of Lake Pontchartrain to the Gulf of Mexico. The area is primarily coastal marsh, progressing from fresh to brackish to saltwater. Freshwater habitats are abundant but essentially alike. Most streams, termed "bayous," are muddy and sluggish, and the majority are now channelized. These 4 zones of Bick and

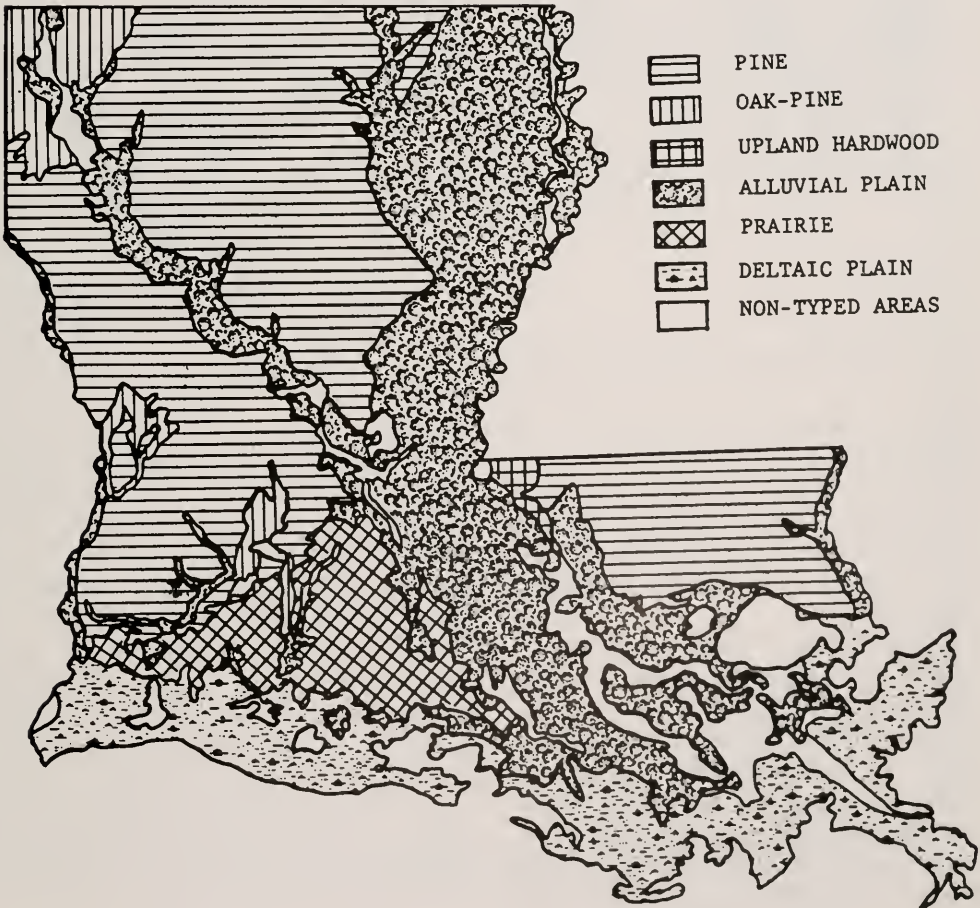


Fig. 1. The major physiographic-vegetation zones of Louisiana.

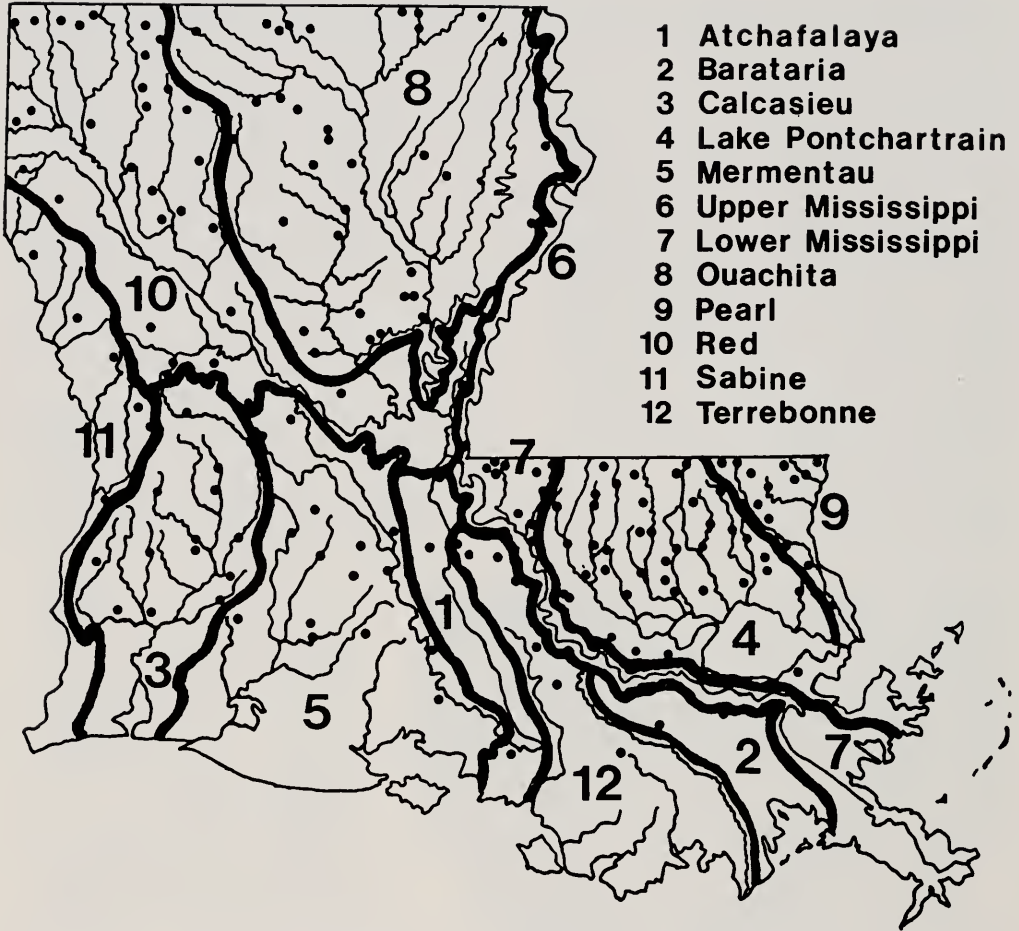


Fig. 2. The distribution of collection sites in the major river system drainage basins of Louisiana.

those appearing on a more detailed map of forest types (Louisiana Department of Natural Resources, 1974) were used in developing Figure 1. In this composite additional upland hardwood, oak-pine, and non-typed areas are distinguished.

The state is divided into 12 watersheds or drainage basins by the Louisiana Department of Natural Resources (1980) (Fig. 2): 1) Atchafalaya River, 2) Barataria Bay, 3) Calcasieu River, 4) Lake Pontchartrain, 5) Mermentau-Vermilion-Teche Rivers, 6) Upper Mississippi River, above Old River, 7) Lower Mississippi River, below

Old River, 8) Ouachita River, 9) Pearl River, 10) Red River, 11) Sabine River, and 12) Terrebonne. The Mermentau-Vermilion-Teche Basin is a composite of the drainages of the 3 rivers, and likewise, the Lake Pontchartrain Basin contains the separate watersheds of the Amite, Tickfaw, Tangipahoa, and Tchefuncte rivers. The "Florida parishes" include the latter basin as well as the Pearl River Basin and the upper part of the Lower Mississippi River Basin. The size and percentage of total land area of each basin are included in Table 2.

MATERIALS AND METHODS

Selection of Sites

One hundred ninety-five collections from 191 different sites in 59 of Louisiana's 64 parishes were made from May 1979 to May 1981 (Fig. 3). Two localities were sampled twice, and one was sampled 3 times. The 5 parishes not sampled are located in the coastal deltaic plain, an area that was found to be generally unproductive for dryopoids. All collections were made by the senior author. Topographic and parish highway maps (Louisiana Department of Transportation) were used to locate and name specific sites. Locality data provided by other aquatic collectors (Bick, 1957; Brown, pers. com., Mar. 6 1979; Louton, 1975; Stewart et al., 1976) were often utilized to pinpoint interesting or unique sites. Detailed locality data are

contained in Appendix I. In the Appendices and Systematic Treatment, numbers following the stream or locality name—i.e., (1), (2), etc.—differentiate multiple collections. Since the optimum habitat for almost all species is flowing water (Brown, 1976), collecting efforts were concentrated in streams and small rivers. Large, deep rivers were generally omitted from this survey because of sampling difficulties. Collecting was continual throughout the year.

Stream Types.—Sites were selected to provide a representative sample of the lotic situations and habitat diversity present in Louisiana. A classification of stream types was devised to categorize sites, thereby aiding in the selection process and the examination of data. Pennak (1971), in a synopsis of lotic habitat classification, stated that “perhaps no

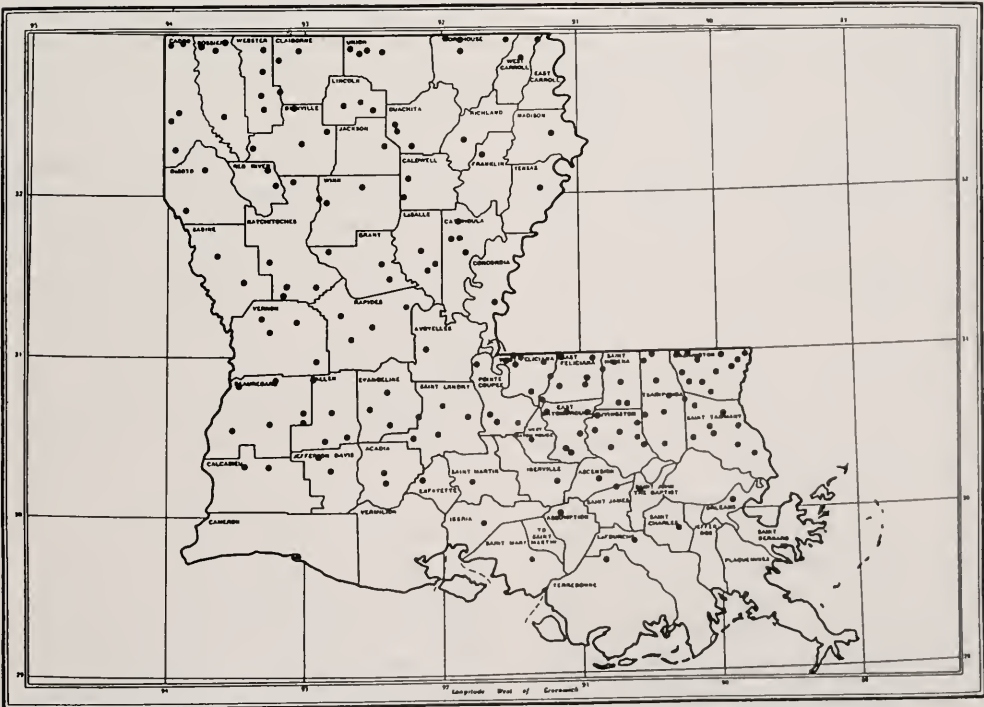


Fig. 3. The distribution of collection sites in Louisiana within parish boundaries.

single factor has greater biological significance than the physical nature of the substrate."

In the course of this study 14 types of streams were defined based on major substrate component (sand, mud, clay, gravel, rock) and size. In reality, streams rarely had uniform substrate compositions, but rather were combinations of 2 or more materials. Mixed sand and gravel streams were more common than either type alone, and it was often difficult to decide which was the dominant component. Streams that were primarily sandy or clayey often had shallow, gravelly riffles or runs, and nearly all had muddy or silty areas. Size designations were based on mean width at the collecting site, i.e., small, 0-20 ft (0-6 m); medium, 20-50 ft (6-15 m); and large, 50+ ft (15+ m). The number of streams of each type and percentage of the total number sampled during the study are given in Table 2. Small sandy streams accounted for 31% and all sandy streams for 48% of the streams sampled. Twenty-six percent were mud-bottomed, 14% were clay, 12% were gravel, and less than one percent were rock. Small, medium, and large streams and rivers accounted for 58%, 31%, and 11% of the total, respectively. The under-representation of rivers was due to sampling difficulties involving water depth.

The depth of a waterbody was often found to be related to both width and substrate. Streams and rivers with sand and gravel substrates were typically shallow, while the depth of mud-bottomed channels usually increased with width. A majority of the sites were shallow streams or rivers less than 3 feet (ca. 1 m) deep since it was possible to sample thoroughly such habitats. Stream bottom configurations varied from even with a uniform depth, to those with al-

ternating shallow riffles and deeper pools. Mud and clay streams were usually of the former type as were channelized watercourses. Clayey streams, however, sometimes had riffles. Riffle-pool types were typically sand and gravel. Sampling bias may have been a problem since all types of streams were not sampled equally. However, quantitative sampling would not have been feasible either because certain types of streams predominated in different parts of the state, and some types were very uncommon.

Physiographic-Vegetation Zones.—Collecting sites were chosen in, and categorized according to, the state's major physiographic-vegetation areas (Bick, 1957; Louisiana Department of Natural Resources, 1974) (Fig. 1) to determine their effect on species distribution. Although the coastal marsh region (deltaic plain) was largely excluded because of unsuitable habitat, a few unproductive collecting attempts were made.

Drainage Basins.—Different types of streams were surveyed in each of the 12 drainage basins (Louisiana Department of Natural Resources, 1980) (Fig. 2) except for the Upper Mississippi River Basin, which is a very narrow strip of land inside the levees. These basin designations were used to categorize collecting sites to determine if the distribution of dryopoids is governed or influenced by watershed. Seagle and Hendricks (1979) stated that "with more attention being focused on dryopoids as indicators of water quality, it is becoming more important to know the distribution of this group within drainage basins." Other studies that examined this aspect of riffle beetle distribution include Sanderson and Brown (1959),

Brown (1960), and Finni et al. (1978).

The size, percentage of total land area, number of sites sampled, and percentage of total sites sampled for each basin are given in Table 2. Comparison of these percentages indicates the amount of effort expended in relation to land area. Some basins were relatively "over-sampled" (Lake Pontchartrain, Lower Mississippi, Pearl), while others were "under-sampled" (Atchafalaya, Barataria, Sabine). The Lake Pontchartrain and Pearl River basins were sampled extensively because they were the richest in species. Few samples were taken south of Lake Pontchartrain in the Lower Mississippi and Barataria basins because the deltaic area was generally unproductive for dryopoids. The Atchafalaya Basin was largely inaccessible except by boat.

Monthly Records.—Sampling was conducted throughout the year so that adult and larval presence could be documented. Unfortunately, it was not possible to expend the same amount of collecting effort on the same sites or sample them each month. Data representing the monthly records for the species are contained in Table 5; the amount of collecting effort per month is shown as a percentage of the total. It can be seen that effort, and hence probably results, is biased towards the summer months of June, July, and August during which 62% of the sampling was done.

Sampling Techniques

Because dryopoid beetles do not swim and are closely associated with the immediate substrate, microhabitats frequented by various species were sampled extensively. In this case, a microhabitat is defined as the particular sub-

strate on which riffle beetles live. Seven major microhabitats were distinguished in Louisiana streams: gravel, root masses, waterlogged wood, allochthonous debris, vascular aquatic plants, aquatic moss, and rocks. Sand, alone or with small quantities of gravel, and mud were often sampled but found to be unproductive. Gravel nearly always was present in riffles; gravel in sandy streams was often found only beneath and downstream from a highway bridge or railroad bridge, indicating that it was not native. Submerged root masses of riparian vegetation were found along stream banks and most often in pools. These were either woody (willow, cypress, etc.) or herbaceous (grasses, emergent and shoreline plants). Debris, a combination of small sticks and leaf litter, was often found caught on snags in the current or layered in pools. Vascular aquatic plants were submerged (usually in the main current) or emergent (usually in pools and along banks), and included such genera as *Sparganium*, *Micranthemum*, *Potamogeton*, *Ludwigia*, *Alternanthera*, and *Polygonum*. The first 4 were often found in shallow, sunny riffles. Aquatic moss, usually *Fontinalis* spp., was only occasionally encountered on logs or other large objects in the main current or slower water near the shore. Rocks larger than gravel were rarely encountered during the study. Sometimes discarded concrete chunks were sampled. The only naturally rocky streams, with sandstone boulders, included in this study were located in southwest Natchitoches Parish. When possible, individual microhabitats were sampled separately, although combinations were sometimes unavoidable. All microhabitats available at a particular site were always sampled. Samples were also taken in both riffles and pools when these were present.

TABLE 2. Percentage and number of stream types, classified by major substrate component and mean width, sampled in the drainage basins of Louisiana from May 1979 to May 1981. Size and percentage of total land area are included for drainage basins.

BASIN % of Total (Size)	SAND		MUD		CLAY		GRAVEL		ROCK		% of Total (N)	# of Types
	%S ¹ (N)	%M ² %L ³ (N)	%S ¹ %M ² %L ³ (N)	%S ¹ %M ² %L ³ (N)	%S ¹ %M ² %L ³ (N)	%S ¹ %M ² %L ³ (N)						
ATCHAFALAYA												
4.0% (1,810 Mi ²)			50 (2)	25 (1)	25 (1)						2 (4)	3
BARATARIA												
2.7% (1,200 Mi ²)			50 (1)	50 (1)							1 (2)	2
CALCASIEU												
9.1% (4,105 Mi ²)	36 (5)	14 (2)	7 (1)	7 (1)	7 (1)	7 (1)					7 (14)	8
PONTCHARTRAIN												
12.6% (5,700 Mi ²)	19 (8)	33 (14)	2 (1)	7 (3)	10 (4)	2 (1)	10 (4)	2 (1)	5 (2)		22 (42)	11
MERMENEAU-VERMILION												
14.8% (6,730 Mi ²)	6 (1)	6 (1)	22 (4)	28 (5)	28 (5)						9 (18)	6
UPPER MISSISSIPPI												
0.7% (325 Mi ²)											0 (0)	0
LOWER MISSISSIPPI												
2.4% (1,100 Mi ²)	70 (7)	20 (2)						10 (1)			5 (10)	3
OUACHITA												
24.3% (11,000 Mi ²)	24 (10)	10 (4)	17 (7)	20 (8)	12 (5)		5 (2)	2 (1)			21 (41)	8
PEARL												
2.0% (890 Mi ²)	47 (8)	18 (3)					18 (3)	6 (1)			9 (17)	6

RED	46	6	9	3	14	3	11	3	3	3	18	10
17.2%	(16)	(2)	(3)	(1)	(5)	(1)	(4)	(1)	(1)	(1)	(35)	
(7,760 Mi ²)												
SABINE	83		17								3	2
6.3%	(5)		(1)								(6)	
(2,840 Mi ²)												
TERREBONNE	17		17	33	17	17	17				3	5
3.9%	(1)		(1)	(2)	(1)	(1)	(1)				(6)	
(1,750 Mi ²)												
% of Total	31	14	9	12	5	11	1	7	2	2	<1	
(N)	(60)	(28)	(18)	(23)	(10)	(22)	(3)	(13)	(5)	(3)	(1)	(195)

¹0-20 ft (0-6 m) wide²20-50 ft (6-15 m) wide³50 + ft (15 + m) wide

Collecting techniques were adopted largely from those described by Musgrave (1935a), Brown and Shoemaker (1964b), and Brown (1976). Branches and logs (wood) of a manageable size were removed from the water and searched; those too large to move were sampled *in situ* by rubbing or brushing the log surface while holding a net directly downstream to catch dislodged specimens. This same netting technique worked well when sampling aquatic plants and tree roots. In sand and gravel the net was held against the bottom while the substrate upstream was disturbed by foot (kick sampling). The net contents were searched in the net or after being placed in a large white enamel pan and allowed to partially dry. Upon drying, the normally sluggish beetles become more active and, therefore, more visible.

Sampling was not done quantitatively according to either a spatial or temporal scheme. A series of larval and adult dryopoids from each microhabitat was collected into separate, labeled vials of 95% ethyl alcohol. Genera with species difficult or impossible to identify in the field were collected in large series, while samples of rare or uncommon species included all individuals present. The number of specimens/species collected was recorded later when species identifications were completed. Samples of roots, plants, and debris were frequently brought back to the laboratory to be dried in a Berlese funnel. This technique sometimes yielded species that had been overlooked or were uncommon in field collections, especially in the genera *Dubiraphia* and *Microcylloepus* which are very small. A 15-watt, battery-powered, portable black light was used a few times for night collecting. Although some dryopoids are attracted to lights, the emphasis of this

study was placed on in-stream collections so that associations between beetle populations and habitat could be determined.

Species Identification and Laboratory Procedure

Specimens were identified by the senior author using the literature and keys of Brown (1970, 1976), Hilsenhoff (1973), Musgrave (1935b), Sanderson (1938, 1953, 1954), and White (1978). When available, determined specimens were used for comparison. Verifications of species identifications were provided by Dr. Harley P. Brown at the University of Oklahoma, Norman. Counts were made of the total number of specimens/species collected.

Specimens heavily encrusted with debris were cleaned before examination with concentrated hydrochloric acid for about one minute as described by Hilsenhoff (1973), followed by an ultrasonic "bath" to remove loosened material. Most specimens were examined from alcohol since these were already relaxed and easier to manipulate, especially if genitalia dissections became necessary. However, some details such as granulation and punctuation may be bolder when the specimen is at least partially dry.

When necessary for identification, especially in the genera *Stenelmis* and *Dubiraphia*, male genitalia were dissected and mounted. Most *Stenelmis* males can be distinguished from females by a ridge or bump on the inner surface of the middle tibia; otherwise, the tip of the penis can sometimes be seen protruding from the apex of the abdomen. Females have 2 genitalic structures, the styli, which often protrude. Genitalia were removed from specimens in the least destructive manner possible. Usually it was possible to extract the struc-

tures from the intact abdomen using fine-pointed pins; occasionally it was necessary to remove the abdomen first. The genitalia of *Stenelmis* spp. were each stored in a drop of glycerine in a microvial pinned beneath the specimen; those of *Dubiraphia* spp. were mounted on microscope slides with a water-soluble medium or placed in genitalia microvials.

Size ranges given in the text for all taxa except *Dubiraphia* spp. and problem species of *Stenelmis* are those of Brown (1976). The measurements of the known species of *Dubiraphia* are composites of Hilsenhoff's (1973) and our own, and are reported as elytral length only. All were made in dorsal view with a dry specimen. Total body length included the head, pronotum, and elytra; variability in the head position (extended or retracted) added additional variation to the measurement. Measurements of the male genitalia were made from the apex to the point where the penis and parameres join the basal lobe.

Representatives of species present at each site were mounted on card points and placed in the Louisiana State University Collection (LSUC) to serve as voucher specimens. Additional specimens were stored in rubber-stoppered vials containing 75% ethyl alcohol.

Additional Species Records

Collections of dryopoids made before and after this study, through June 1984, were examined and identified to supply possible additional records. These included specimens in the Louisiana State University Collection (LSUC) and a small collection from the University of Southwestern Louisiana (USL). These locality data are detailed in Appendix II and are cited in the species accounts and range maps. They

are also included in Tables 3 and 4 (shown by asterisks) but are not figured into the frequency of collection percentages which are derived from the field study. Records of Harley P. Brown (HPB) at the University of Oklahoma are also occasionally cited (Brown, pers. com., Mar. 6 1979). Numbers in parentheses—i.e., (1), (2), etc.—following the locality name differentiate multiple collections.

SYSTEMATIC TREATMENT

List of Louisiana Species

Family Psephenidae
Ectopria thoracica (Ziegler)

Family Dryopidae
Helichus basalis LeConte
Helichus fastigiatus (Say)
Helichus lithophilus (Germar)
Pelonomus obscurus LeConte

Family Elmidae
Ancyronyx variegata (Germar)
Dubiraphia brevipennis Hilsenhoff
Dubiraphia harleyi Barr
Dubiraphia parva Hilsenhoff ?
Dubiraphia vittata (Melsheimer)
Dubiraphia n. spp. A?, B?, C?
Gonielmis dietrichi (Musgrave)
Macronychus glabratus Say
Microcylloepus pusillus (LeConte)
Optioservus trivittatus (Brown)
Stenelmis antennalis Sanderson
Stenelmis bicarinata LeConte
Stenelmis convexula Sanderson
Stenelmis crenata (Say) ?
Stenelmis grossa Sanderson
Stenelmis lateralis Sanderson
Stenelmis sinuata LeConte
Stenelmis n. sp.

The basic anatomical terminology pertaining to adults, larvae, and genitalia used in this chapter is illustrated in Brown, 1976.

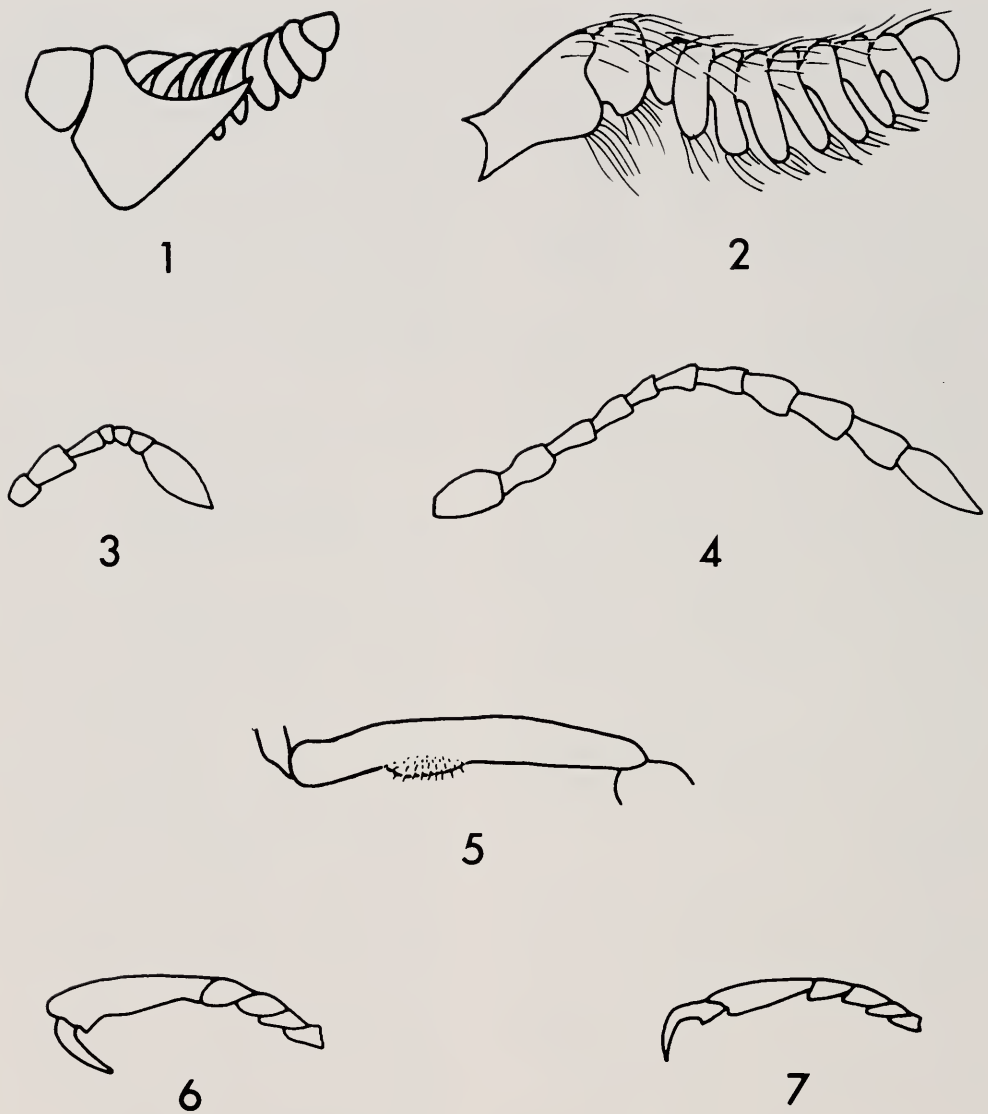


Fig. 4. 1-2. Antennae of adult Dryopidae: 1, *Helichus*; 2, *Pelonomus obscurus*. 3-4. Antennae of adult Elmidae: 3, *Macronychus glabratus*; 4, *Stenelmis*. 5. Middle tibia of adult male *Stenelmis* (Elmidae), inner surface with ridge, lateral aspect. 6-7. Tarsi of adult *Stenelmis* (Elmidae), lateral aspect: 6, with last segment longer than previous 4 combined; 7, with last segment shorter than previous 4 combined.

Key to Adults of the Families and
Species of Louisiana
Dryopoidea

- 1 Typically soft-bodied; front
coxae transverse and ex-
serted with deep grooves
posteriorly for reception

of legs; elytra black; pro-
notum black medially, yel-
low or orange laterally; 3-5
mm long, 2-3 mm wide
(Fig. 5.1); not aquatic, on
vegetation near water:
.... PSEPHENIDAE *Ectopria*
thoracica

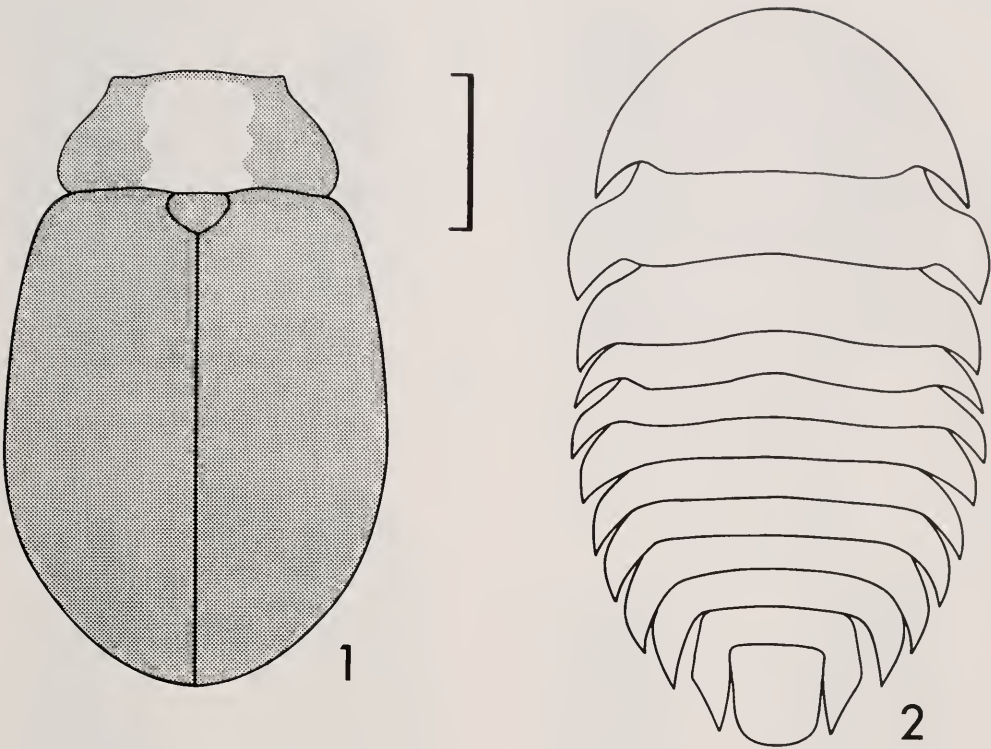


Fig. 5. 1-2. Psephenidae, *Ectopria thoracica*: 1, adult, pronotum and elytra, dorsal aspect; 2, larva, dorsal aspect. Scale bar = 1.0 mm.

- Typically hard-bodied; front coxae rounded or transverse, not exserted; aquatic

2
- 2(1) Anterior coxae globular and without exposed trochantins; antennae usually fili-form, not pectinate (Figs. 4.3, 4.4); less than 4 mm long:

ELMIDAE 6
- Anterior coxae transverse and with exposed trochantins; antennae very short, 8 distal segments pectinate (Figs. 4.1, 4.2); more than 4 mm long:

..... DRYOPIDAE 3
- 3(2) Second segment of antenna enlarged and heavily sclerotized, forming a triangu-

4(3) lar shield (Fig. 4.1); bases of antennae widely separated; head not prominent; body, excluding eyes and antennae, partly or completely covered with tomentum: *Helichus* 4
- Second segment of antenna not enlarged (Fig. 4.2); bases of antennae very close together; head prominent; entire body, including eyes and antennae, covered with short, erect pubescence; reddish to dark brown; 4.8-6.5 mm long, 2.0-2.5 mm wide (Fig. 6.4):

..... *Pelonomus obscurus*
- 4(3) Dorsum uniformly covered

- with fine, recumbent pubescence, without shiny sutural area except for scutellum; 4.4-5.8 mm long, 2.0-2.5 mm wide (Fig. 6.3): *Helichus lithophilus*
- Dorsum tomentose laterally with glabrous or sparsely pubescent shiny sutural area 5
- 5(4) First elytral stria faint, almost impunctate, at most with small punctures not extending to scutellum; hind coxa of male without ventrally-directed tooth-like process; brown to black; 4.3-5.5 mm long, 2.0-2.5 mm wide (Fig. 6.1):
 *Helichus basalis*
- First elytral stria distinct, punctures larger and deeper, extending to scutellum; hind coxa of male with ventrally-directed tooth-like process; brown to black; 4.5-5.5 mm long, 2.2-2.5 mm wide (Fig. 6.2): 5
- 6(2) *Helichus fastigiatus*
- Hind coxae semi-globular and smaller than other coxae; posterior margin of prosternal process almost as wide as head 7
- Hind coxae transverse and the same size or slightly larger than other coxae; posterior margin of prosternal process much narrower than head 8
- 7(6) Shiny dark brown or black with golden or silvery sublateral bands of tomentum; elytron with sublateral carina; antennae short, with 7 segments, apical segment enlarged (Fig. 4.3); 2.50-3.50 mm long, 1.00-1.30 mm wide (Fig. 7.6):
 *Macronychus glabratus*
- Elytron black, conspicuously marked with C-shaped vitta and elongate apical spot, without sublateral carina; antennae filiform, with 11 segments; 2.10-

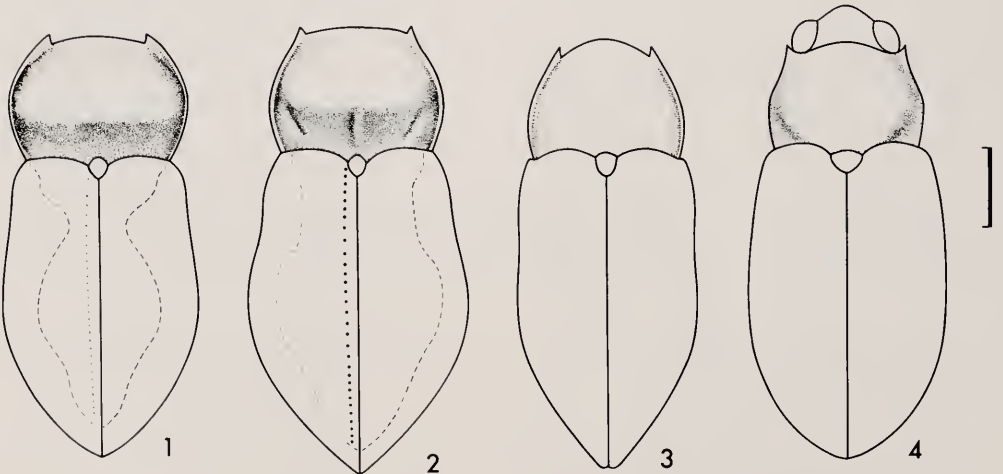


Fig. 6. 1-3. Adult Dryopidae, pronotum and elytra, dorsal aspect: 1, *Helichus basalis*; 2, *H. fastigiatus*; 3, *H. lithophilus*. 4. Adult Dryopidae, dorsal aspect, *Pelonomus obscurus*. Scale bar = 1.0 mm.

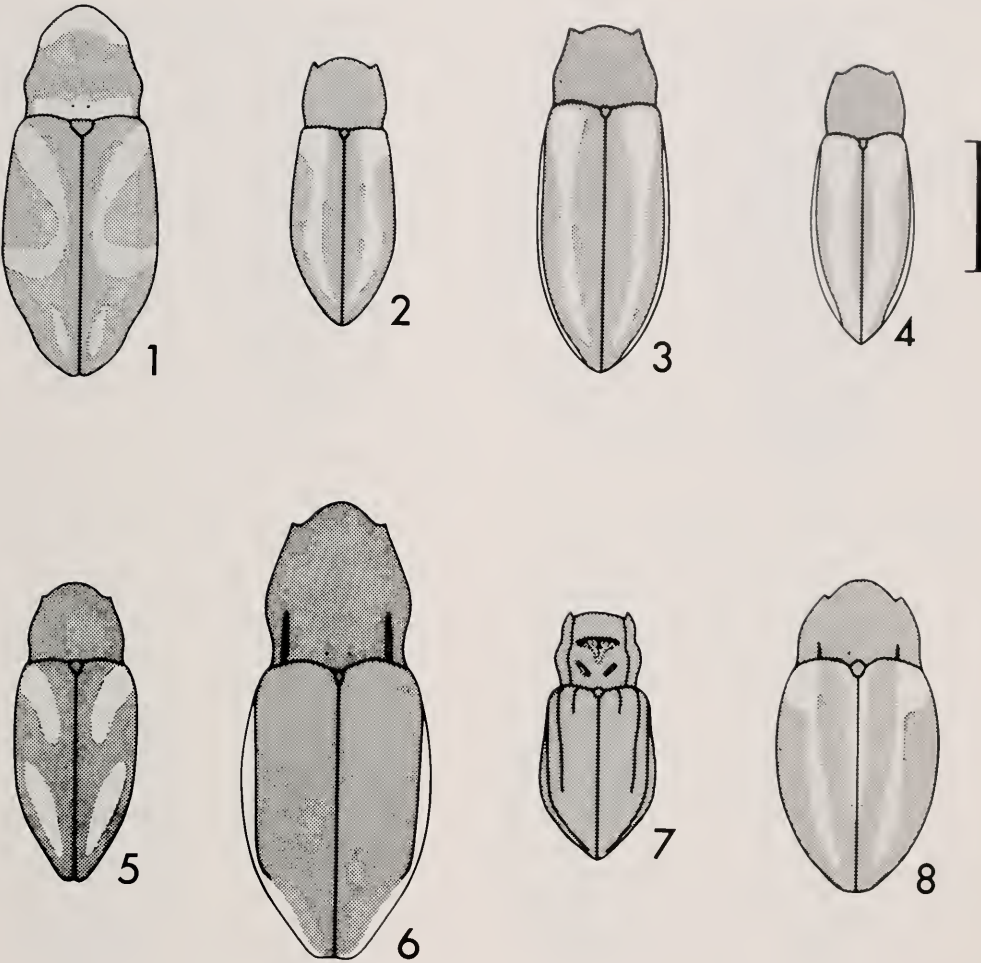


Fig. 7. 1-8. Adult Elmidae, pronotum and elytra, dorsal aspect: 1, *Ancyronyx variegata*; 2, *Dubiraphia brevipennis*; 3, *D. harleyi*; 4, *D. vittata*; 5, *Gonielmis dietrichi*; 6, *Macronychus glabratus*; 7, *Microcylloepus pusillus*; 8, *Optioservus trivittatus*. Scale bar = 1.0 mm.

- | | | |
|--|---|--|
| <p>2.60 mm long, 0.90-1.10 mm wide (Fig. 7.1):
 <i>Ancyronyx variegata</i></p> | <p>8(6) Anterior tibia without fringe of tomentum; males of most species with swelling or ridge on inner surface of each middle tibia (Fig. 4.5); elytron immaculate, vittate, or with vitta broken into humeral and apical spots: <i>Stenelmis</i> 9
 Anterior tibia with medial</p> | <p>fringe of tomentum; males without swelling or ridge on inner surface of each middle tibia; elytral characters variable 16
 9(8) Surface of femur punctate, not granulate; lateral processes on penis subangulate anteriorly (Fig. 9.5); elytron bimaculate, often faintly; 3.25-3.60 mm long, 1.25-1.40 mm wide (Fig. 8.5): <i>Stenelmis grossa</i></p> |
|--|---|--|

- Surface of femur granulate; lateral processes on penis, if present, rounded; elytron variable 10
- 10(9) Elytral vitta broad, covering umbone at humeral angle and nearly all of space between first stria and sixth interval; 2.65-3.00 mm long, 0.95-1.10 mm wide (Figs. 8.6, 9.6): *Stenelmis lateralis*
- Elytral vitta or humeral spot narrower, inside sixth interval and not covering umbone 11
- 11(10) Antenna bicolored, distal segments black and basal 3-6 segments testaceous; elytron with distinct vitta or maculae; 2.50-2.70 mm long, 1.00 mm wide (Figs. 8.1, 9.1): *Stenelmis antennalis*
- Antenna testaceous, not bicolored; elytron variable 12
- 12(11) Last tarsal segment shorter than previous 4 combined (Fig. 4.7); body robust; in dorsal view, lateral margins of pronotum in anterior third slightly rounded and either parallel or angled anteromedially, appearing to clasp head; 3.30-3.70 mm long, 1.25-1.50 mm wide (Figs. 8.4, 9.4): ... *Stenelmis crenata?*
- Last tarsal segment slightly or distinctly longer than previous 4 combined (Fig. 4.6); other characters variable 13
- 13(12) Penis without lateral processes (Fig. 9.8); ridge or bump present on middle tibia of male; elytron distinctly or faintly vittate, bimaculate, or immaculate; 2.50-2.80 mm long, 0.90-1.00 mm wide (Fig. 8.8): *Stenelmis* n. sp.
- Penis with rounded or elongate lateral processes (Figs. 9.2, 9.3, 9.7); middle tibia of male with or without ridge; elytron usually bimaculate, often faintly; 2.85-3.70 mm long, 1.00-1.50 mm wide 14
- 14(13) Middle tibia of male with ridge; penis with widely rounded lateral processes (Fig. 9.3); body appearing convex and smooth; elytral striae, pronotal tubercles and sulcus not prominent; 3.09-3.64 mm long, 1.21-1.44 mm wide (Fig. 8.3): *Stenelmis convexula*
- Middle tibia of male without ridge; penis with narrowly rounded lateral processes (Figs. 9.2, 9.7); body not appearing convex and smooth; elytral striae, pronotal tubercles and sulcus prominent 15
- 15(14) Lateral margins of pronotum strongly divergent in anterior third, resembling loose collar behind head; elytral striae with large, deep punctures; tubercles of pronotum very prominent, basal tubercle carinate; 3.20-3.45 mm long, 1.20-1.35 mm wide (Figs. 8.7, 9.7): *Stenelmis sinuata*
- Lateral margins of pronotum parallel or weakly divergent in anterior third; elytral striae with punctures

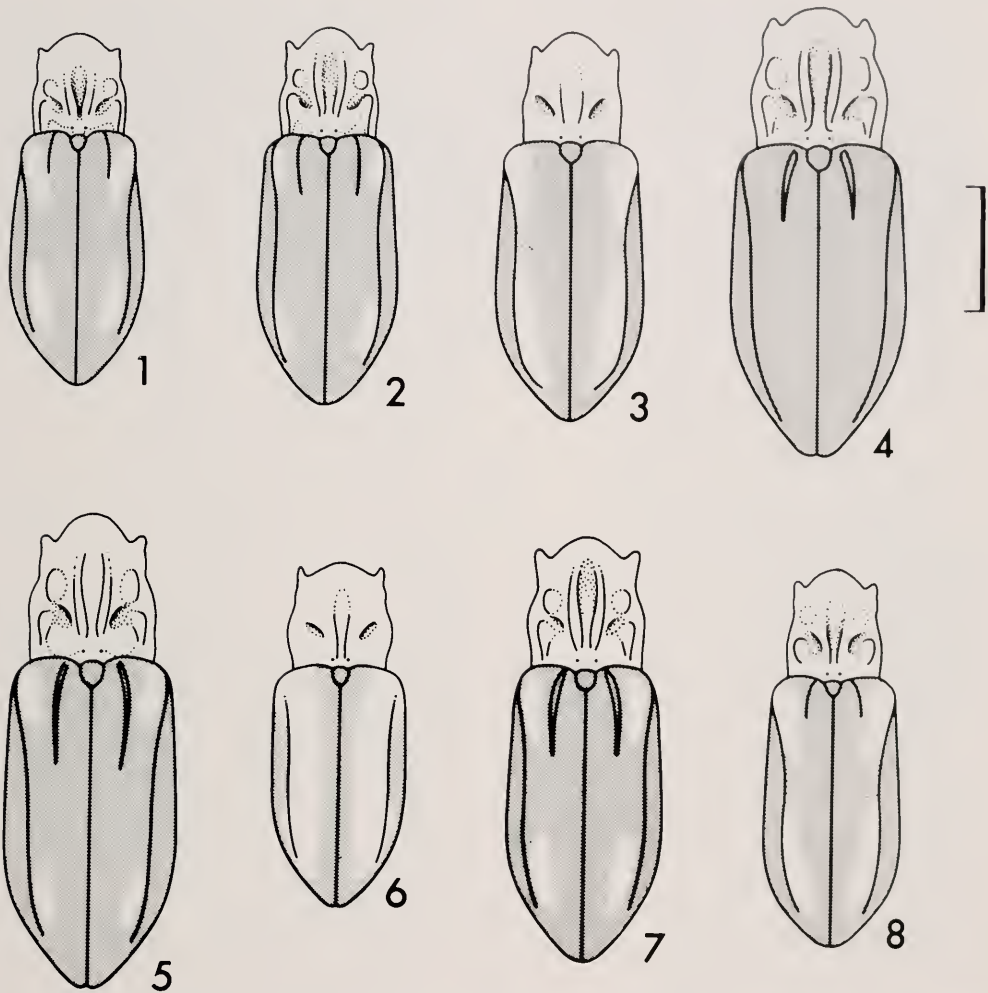


Fig. 8. 1-8. Adult Elmidae, *Stenelmis*, pronotum and elytra, dorsal aspect: 1, *S. antennalis*; 2, *S. bicarinata*; 3, *S. convexula*; 4, *S. crenata*?; 5, *S. grossa*; 6, *S. lateralis*; 7, *S. sinuata*; 8, *Stenelmis* n. sp. Scale bar = 1.0 mm.

- | | |
|---|--|
| not so large and deep; tubercles of pronotum not as prominent, basal tubercle not carinate; 2.94-3.46 mm long, 1.05-1.32 mm wide (Figs. 8.2, 9.2):
..... <i>Stenelmis bicarinata</i> | 17(16) Pronotum with 2 longitudinal carinae and transverse impression anterior to middle; body pitted and ridged, brown to black; elytron unmarked, bimaculate, or vittate; 1.65-2.20 mm long, 0.68-0.90 mm wide (Fig. 7.7):
..... <i>Microcylloepus pusillus</i> |
| 16(8) Pronotum with sublateral carinae for entire length or present in basal third only 17
Pronotum without sublateral carinae 18 | Pronotum with 2 short basal carinae and no transverse impression; body rather |

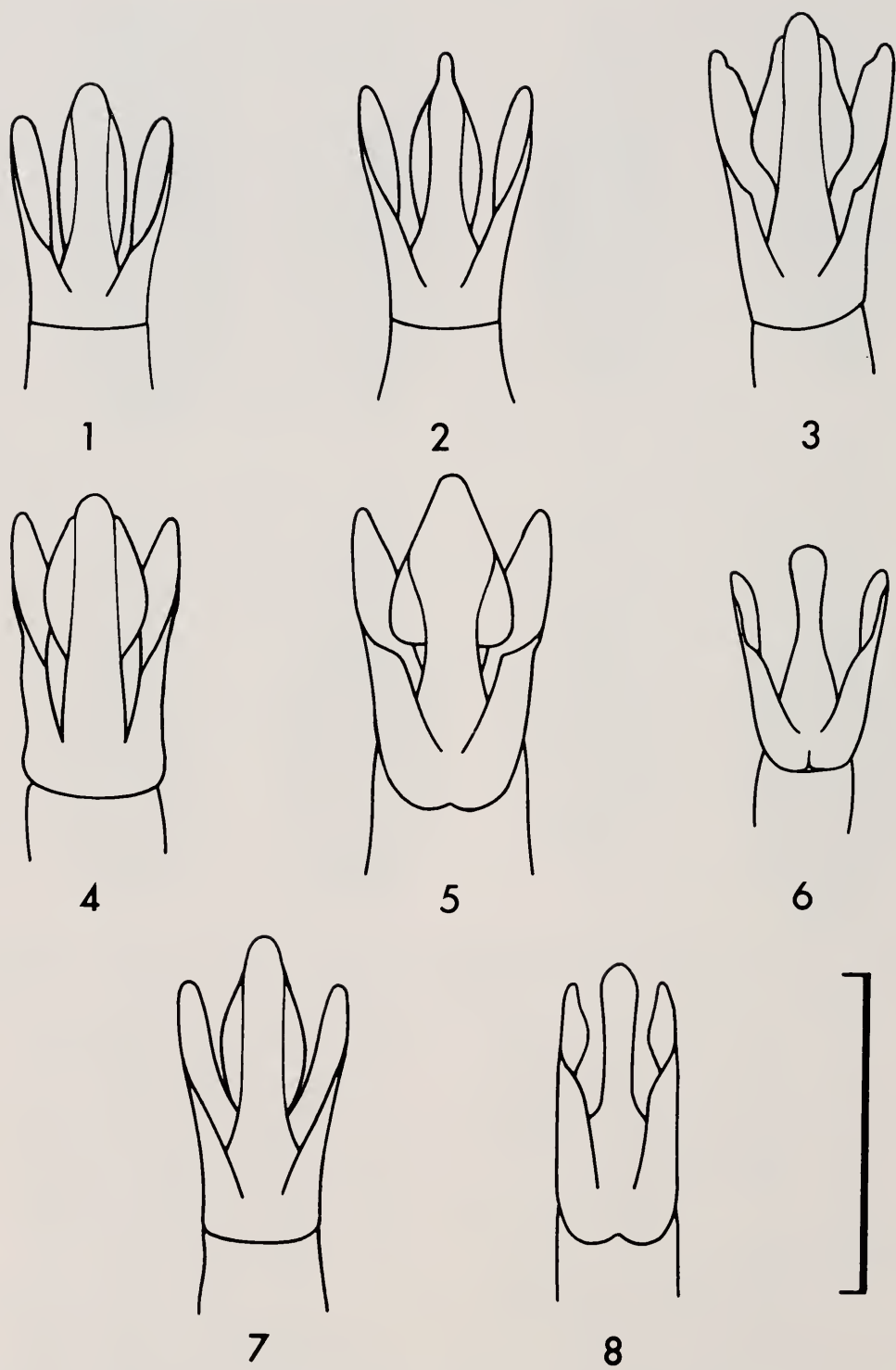


Fig. 9. 1-8. Adult Elmidae, *Stenelmis*, male genitalia, dorsal aspect: 1, *S. antennalis*; 2, *S. bicarinata*; 3, *S. convexula*; 4, *S. crenata*?; 5, *S. grossa*; 6, *S. lateralis*; 7, *S. sinuata*; 8, *Stenelmis* n. sp. Scale bar = 0.5 mm.

- smooth and convex, dark brown; each elytron with both sutural and medial vittae; 1.69-2.19 mm long, 0.78-1.14 mm wide (Fig. 7.8): *Optioservus trivittatus*
- 18(16) Elytron black with 2 oblique yellow or testaceous spots; legs black with yellow tibiae; 2.0-2.6 mm long, 0.95-1.10 mm wide (Fig. 7.5): *Gonielmis dietrichi*
- Elytron black or dark brown with an entire longitudinal vitta or with vitta broken into 2 spots: .. *Dubiraphia* 19
- 19(18) Penis usually longer than 0.31 mm 20
- Penis usually shorter than 0.31 mm 21
- 20(19) Penis measuring 0.31-0.37 mm, abruptly narrowed at apical third to half or evenly tapered; elytron vittate, vitta covering 3-4 intervals at widest point posterior to humerus; elytron 1.25-1.40 mm long: *Dubiraphia parva*?
- Penis measuring 0.39-0.45 mm, narrow and evenly tapered to tip (Fig. 10.2); elytron vittate, vitta covering 1 1/2 to 2 1/2 intervals at widest point posterior to humerus; elytron 1.65-2.02 mm long (Fig. 7.3): .
..... *Dubiraphia harleyi*
- 21(19) Elytron 1.04-1.28 mm long, vitta or apical macula covering 2 intervals at widest point posterior to humerus; penis 0.22-0.28 mm long; femur light, only slightly darker than tibia and tarsus:
..... *Dubiraphia* n. sp. C?
- Elytron usually longer than 1.29 mm; other characters variable 22
- 22(21) Elytral vitta or apical macula narrow, covering 1 to 3 intervals at widest point posterior to humerus 23
- Elytral vitta or apical macula wide, covering 4 to 5 intervals at widest point posterior to humerus 24
- 23(22) Penis stout, width 2 to 2 1/2 times width of paramere at midlength, tip broadly rounded; femur and tibia darker than tarsus; elytron 1.33-1.57 mm long:

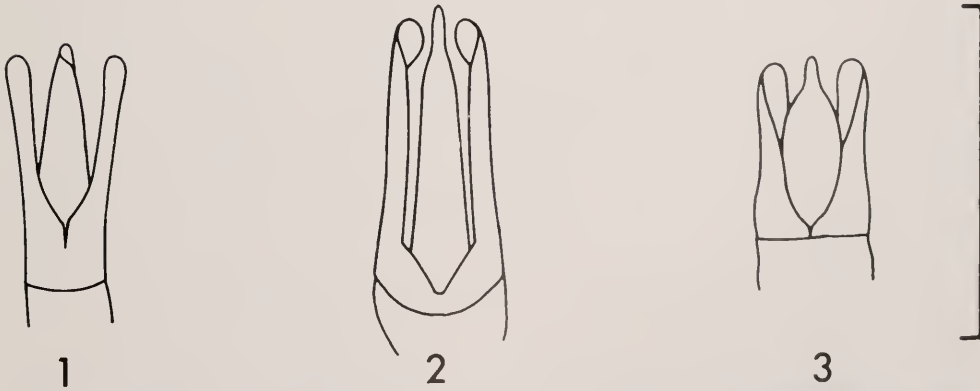


Fig. 10. 1-3. Adult Elmidae, *Dubiraphia*, male genitalia, dorsal aspect: 1, *D. brevipennis*; 2, *D. harleyi*; 3, *D. vittata*. Scale bar = 0.5 mm.

..... *Dubiraphia* n. sp. B?
Penis narrower, width no more than 1/2 times width of paramere at midlength, tip narrowly rounded (Fig. 10.1); femur bicolored, dark basally and light apically, or entirely dark; tibia and tarsus light; elytron 1.30-1.53 mm long (Fig. 7.2): ... *Dubiraphia brevipennis*

24(22) Penis stout, at least 2 times width of paramere at midlength, sides convex to near distinctly narrowed tip (Fig. 10.3); elytron vittate or occasionally bimaculate; palpi testaceous like antennae or darker; elytron 1.30-1.83 mm long (Fig. 7.4): .. *Dubiraphia vittata* 2(1)
Penis narrow, 1 1/2 to 2 times width of paramere at midlength, sides straight to tip; elytron vittate; palpi testaceous; elytron 1.38-

1.55 mm long:
..... *Dubiraphia* n. sp. A?

Key to Larvae of the Families
and Genera of Louisiana
Dryopoidea

1 Broadly ovoid in shape and very flat; lateral margins of each segment greatly expanded; head completely concealed dorsally by pronotum (Fig. 5.2): ..
.... PSEPHENIDAE *Ectopria*
Less broad and flat, usually slender, round or triangular in cross-section; head exposed in dorsal view (Figs. 11.1-11.6):
..... ELMIDAE 2
Last abdominal segment very long and slender, at least 4 times longer than wide; operculum confined to posterior third of this segment (Fig. 11.2): . *Dubiraphia*

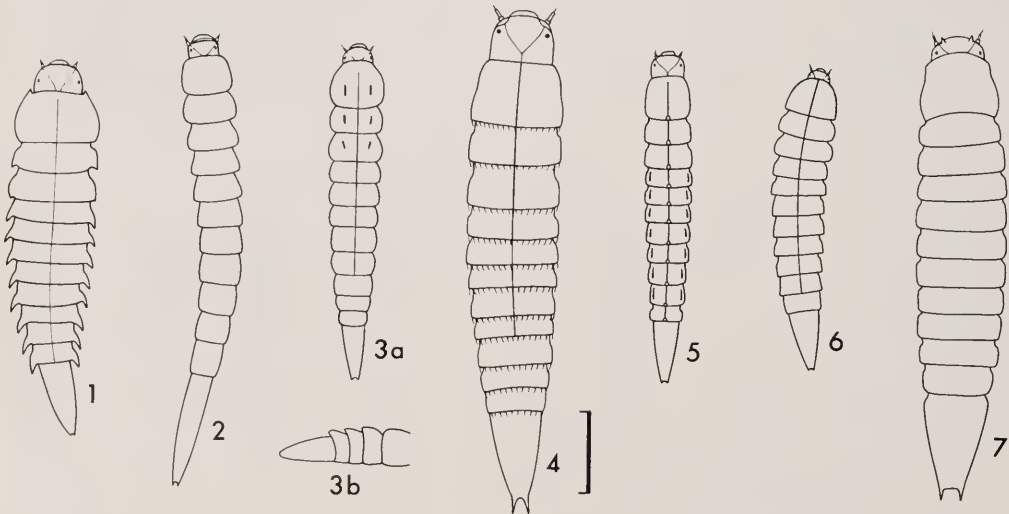


Fig. 11. 1-7. Larval Elmidæ: 1, *Ancyronyx*, dorsal aspect; 2, *Dubiraphia*, dorsal aspect; 3, *Gonielmis*, a, dorsal aspect, b, lateral aspect, distal segments; 4, *Macronychus*, dorsal aspect; 5, *Microcylloepus*, dorsal aspect; 6, *Optioservus*, dorsal aspect; 7, *Stenelmis*, dorsal aspect. Scale bar = 1.0 mm.

- 3(2) Last abdominal segment not especially long or slender, less than 4 times longer than wide; operculum not confined to posterior third 3
- 3(2) Prothorax with posterior sternum so that procoxal cavities are closed posteriorly 4
- Prothorax without posterior sternum so that procoxal cavities are open posteriorly 6
- 4(3) Posterolateral margins of abdominal segments 1-8 produced into hooked or toothed processes; body rather robust (Fig. 11.1): *Ancyronyx*
- Posterolateral margins of abdominal segments without such processes; body elongate or robust 5
- 5(4) Apical abdominal segment with 2 prominent posterolateral spines; narrow mid-dorsal stripe, if present, not enlarged into spots at posterior margin of each sclerite; color light to dark brown (Fig. 11.7): .. *Stenelmis*
- Apical abdominal segment without posterolateral spines; narrow mid-dorsal stripe enlarged into spots at posterior margin of each sclerite; color dark brown to black (Fig. 11.5): *Microcylloepus*
- 6(3) Mesopleuron composed of one part; pronotum expanded laterally, appearing hood-like; body triangular in cross-section, rather robust (Fig. 11.6): *Optioservus*

- Mesopleuron composed of 2 parts; pronotum not expanded laterally; body variable 7
- 7(6) Abdominal segments 1-6 with pleura, not humped dorsally, each with a posterior fringe of hairs; last abdominal segment with 2 long, narrowly separated apical spines (Fig. 11.4): *Macronychus*
- Abdominal segments 1-7 with pleura, humped dorsally and bearing conspicuous scale-like hairs; last abdominal segment slightly emarginate at apex, not spined (Fig. 11.3): *Gonielmis*

Survey of Louisiana Taxa

Superfamily Dryopoidea

Dryopoid affinities and characteristics were examined by Crowson (1955) who classified the superfamily in the Suborder Polyphaga, Series Dascilliformia, along with the Dascilloidea, Byrrhoidea, Buprestoidea, Rhipicerioidea, Elateroidea, and Cantharoidea. Arnett (1960) placed the Dryopoidea in the Series Elateriformia and excluded the Dascilloidea from the group. A phylogeny of the Dryopoidea based on Hennig's principles of phyletic classification was proposed by Crowson in 1978; he retained the Dryopoidea within the Series Elateriformia along with the Byrrhoidea, Elateroidea, Cantharoidea, and Armatopoidea. According to Crowson (1955), the dryopoids probably arose from common stock with the dascilloids and byrrhoids and may have been ancestral to the buprestoids, rhipiceroids, and elateroids. Ancestral Dryopoidea have been traced to the early Jurassic

Period, and it is likely that the evolutionary bifurcations resulting in our modern families were completed early in the Cretaceous Period (Crowson, 1978).

Synoptic works on the Dryopoidea were published by LeConte (1852) and Horn (1870) under the name Parnidae and included genera now placed in the families Psephenidae, Dryopidae, Elmidae, and Limnichidae. LeConte introduced a new criterion for identification based on tarsal structure, divided the family into 3 groups (Eurypalpin, Dryopini, Elmini), added a genus (*Eurypalpus* = *Psephenus*) previously assigned to another family, and provided Latin descriptions and English notes for several species. In a similar synoptic paper LeConte (1853) examined genera in the family Atopidae which are now placed in the Psephenidae and Ptilodactylidae. Horn (1870) proposed a classification based on LeConte's work which divided the Parnidae into the subfamilies (*sic*) Psephenidae, Parnidae, and Elmidae. The paper included keys to the subfamilies, tribes, genera, and species and a description and discussion of each species.

Hinton (1939b) revised the systematics of the group by elevating the Dryopidae (= Parnidae) to superfamily status and naming the Psephenidae, Dryopidae, Elmidae, and Limnichidae (formerly in Byrrhidae) as families, thus forming the basis for our modern classification. This extensive taxonomic-morphological paper presented detailed descriptions and comparisons of the internal and external anatomy of larvae, pupae, and adults to support these revisions.

In his work on the Coleoptera, Crowson (1955) included 8 families in the Dryopoidea: Chelonariidae, Dryopidae, Elmidae, Eurypogonidae, Heteroceridae, Limnichidae, Psephenidae, and

Ptilodactylidae. In 1978 he added Eulichidae (formerly in Ptilodactylidae) to the list and excluded the Eurypogonidae which he had placed in a new superfamily, Artematopoidea, in 1973. Arnett (1960, 1962) listed 7 families, placing the Eurypogonidae and most of the genera now included in Psephenidae and Ptilodactylidae in the Dascillidae. According to Borror et al. (1981), the superfamily is composed of 10 families, those of Arnett plus Callirhipidae, Brachypsectridae, and Artematopidae (= Eurypogonidae).

The aquatic dryopoids of the United States, including members of the families Chelonariidae, Dryopidae, Elmidae, Limnichidae, Psephenidae, and Ptilodactylidae, were treated in a comprehensive work by Brown (1976). Introductory information on collection, preservation, and anatomy was included along with illustrated adult and larval keys and notes on habitat and distribution of species. Brown (1981b) later presented corrections and additions to update his manual. The Chelonariidae were recently removed from the list of aquatic dryopoids because the larvae were found to be terrestrial (Spangler, 1980). In another paper Brown (1975a) illustrated the distributions of dryopoid and dascilloid genera in the United States. The larval morphology of the Dryopidae, Elmidae, and Limnichidae, treated as subfamilies of Dryopidae, was studied at the generic level by Bertrand (1955, 1965) and West (excluding Limnichidae) (1929b).

Crowson (1955) stated that aquatic adaptations in the Dryopoidea seem to be "basic" in the larvae rather than in the adults, the opposite of the situation in the Hydrophiloidea. The most characteristic adaptations of dryopoid larvae are retractile tracheal gills in the rectum or ninth abdominal segment cov-

ered by a ventral operculum. Although terrestrial larvae often lack gills and opercula, they usually can be recognized by well-developed, articulated, setose mandibular prosthecae and a free labrum. Dryopoid adults are more difficult to characterize since they often have features in common with the byrrhoids, dascilloids, and/or rhipiceroids. Crowson claimed that adults usually possess one or more of the following characteristics: "crenulate hind margin of the pronotum, distinct transverse suture in the metasternum, distinct frontoclypeal suture, last tarsal segment as long as rest together, middle or hind coxae separated."

As a result of this present study, aquatic members of the families Psephenidae, Dryopidae, and Elmidae have been found to occur in Louisiana. Although the state has several terrestrial species of Limnichidae and Ptilodactylidae, aquatic species of these families are apparently very rare or absent.

Family Psephenidae Lacordaire, 1854

Psephenid adults are characterized by being typically soft-bodied and depressed with the mandibles concealed and the labrum invisible anteriorly. Larvae, commonly called water pennies, are round or oval (onisciform) and very flat with the head concealed by expanded pronotal margins. While the larvae are strictly aquatic, adults generally do not enter the water except to oviposit (Brown, 1976).

Distributed worldwide, Psephenidae is a small family with 17 North American representatives in 6 genera (Brigham, 1981; Brown, 1981a, 1983a). Larvae of the 3 subfamilies Eubrianacinae, Psepheninae, and Eubriinae are separable on the basis of gill, opercular, and abdominal sclerite charac-

teristics. The Eubrianacinae is comprised of one western species, *Eubrianax edwardsii* (LeConte). Six of the 7 species of Psepheninae are also western. The genus *Psephenus* was revised by Brown and Murvosh in 1974. The ecology of *Psephenus herricki* (DeKay), the widespread eastern species, has been studied by Murvosh (1970). Although this species has been reported from the nearby states of Arkansas, Mississippi, and Alabama, it has not been collected and probably does not occur here since Louisiana is located entirely south of the Fall Line (Murvosh, 1970).

Five of the 9 North American species of Eubriinae are eastern, only one of which is widespread. Larval eubriines, commonly called false water pennies, are distinguished by the absence of abdominal gills except for 3 tufts enclosed in an operculate chamber on the ninth abdominal segment. According to Brigham (1981), this group should be given family status. In the past, Eubriinae was usually placed in the family Dascillidae on the basis of adult characters (Arnett, 1962). Larval Eubriinae were thought to be larval dryopids (e.g., *Helichus*) until reared by Bertrand (1939). This error is carried in a number of publications including Peterson (1967) and Pennak (1978). The subfamily was reviewed briefly by Brown (1980) in a paper that described a new species, *Alabameubria starki*, from larvae collected in Alabama. The group, treated as a family (Eubriidae), was also discussed by Brigham (1981). A catalog of the Psephenidae was recently published (Brown, 1983a).

There are few studies of the group at the family level. The respiratory adaptations, biology, and taxonomy of the psephenids were examined by Hinton (1955) in a paper which emphasized anatomical and morphological charac-

teristics. General treatment of the family is included in Brown's (1976) aquatic dryopoid manual.

Genus *Ectopria* LeConte, 1853

Ectopria larvae are distinctively flattened dorso-ventrally and are oval in outline with the lateral margins of each body segment greatly expanded. The pronotum completely conceals the head from dorsal view. Gills are caudal and retractile into an operculate chamber; external, ventral abdominal gills are absent. Larvae cannot be identified to species (Brigham, pers. com., Mar. 22 1984).

The genus may be restricted to the New World with 3 Nearctic and 4 Neo-

tropical species (Brigham, 1981; Brown, 1981a). In 1981 Brigham described a new eastern United States species, *Ectopria leechi*, resurrected *E. thoracica* (Ziegler), and provided a key to separate the 3 Nearctic species. The life history of *Ectopria nervosa* was studied by Schafer (1950). *Ectopria* is the only psephenid known to occur in Louisiana.

Ectopria cf. *E. thoracica* (Ziegler)

Figs. 5.1, 5.2; Map, Fig. 12

Eubria thoracica Ziegler, 1844, *Proc. Acad. Nat. Sci. Phila.* 2:269.

DIAGNOSTIC DESCRIPTION:

ADULTS—Not aquatic; see Fig. 5.1 and key. LARVAE—See Fig. 5.2.

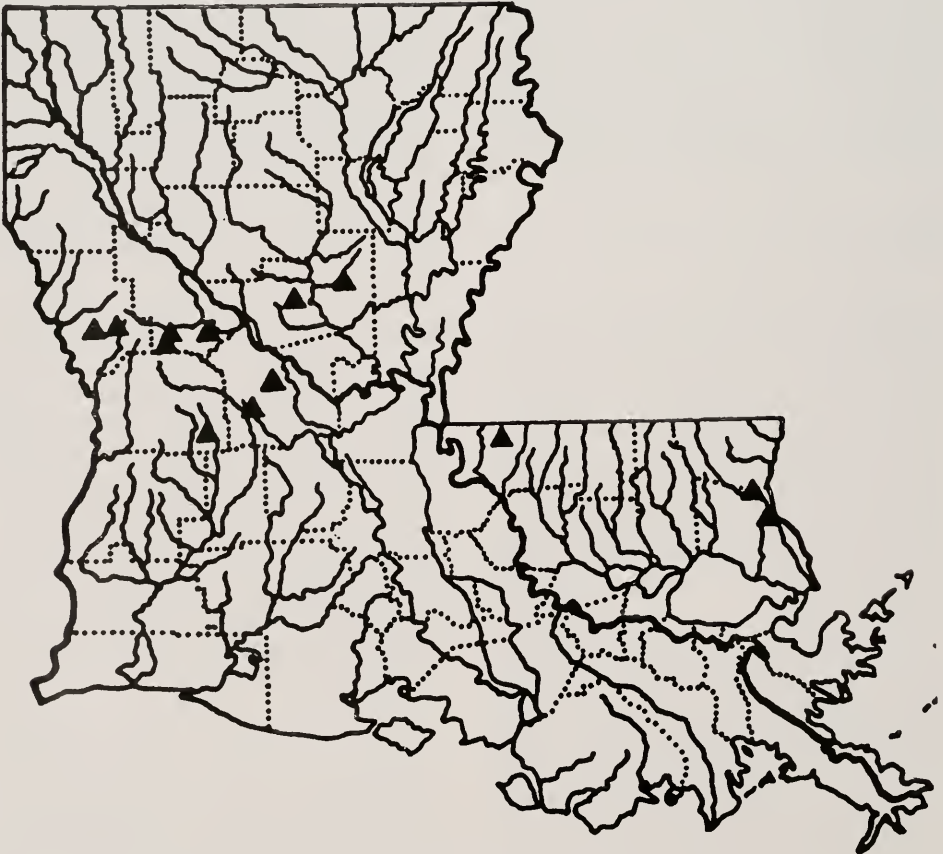


Fig. 12. The known distribution of Psephenidae, *Ectopria thoracica*, in Louisiana.

COMMENTS: The flattened, oval-shaped larvae of the family are distinctive. The concealed head and antennae separate psephenid larvae from members of other aquatic beetle families. An *Ectopria* larva may be distinguished from *Psephenus herricki*, the widespread eastern water penny, by its lack of external abdominal gills. Although *E. thoracica* and *E. nervosa* occur sympatrically, the latter species is very uncommon. Only adult *E. thoracica* have been collected at black light in Louisiana. Our larval specimens are almost certainly *E. thoracica* despite the fact that larvae cannot be determined to species (Brigham, pers. com., Mar. 22 1984) and will be referred to as such in the text and tables. The following records are for larvae, unless otherwise indicated.

SPECIMENS EXAMINED: 5 adults, 28 larvae.

GEOGRAPHIC RANGE: Entire eastern North America from Quebec and Ontario to Florida, west to Iowa, Missouri, Oklahoma, and Louisiana (Barr, 1981; Brigham, pers. com., Mar. 22 1984; Brown, 1983c).

DISTRIBUTION IN LOUISIANA: Scattered locations in the central, east-central, west-central, and southeastern ("Florida parishes") parts of the state. Occurs in the following drainage basins: Calcasieu River, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, and Sabine River (Fig. 12).

LOUISIANA RECORDS: GRANT P.—Gray Branch; LA SALLE P.—Trout Creek; NATCHITOCHE P.—Bayou Pierre, Kisatchie Bayou, Kisatchie Bayou Campgrd. (adult) (LSUC), Little Bayou Pierre, Little Bayou Pierre (adults) (LSUC), Little Bayou Pierre (HPB); RAPIDES P.—Castor Creek, Spring Creek; SABINE P.—Lewing Creek, 6 mi W of Florien (adult)

(LSUC); ST. TAMMANY P.—Mill Creek, Talisheek Creek (2); VERNON P.—Sixmile Creek; WEST FELICIANA P.—West Fork Thompson Creek.

HABITAT: Primarily in small- to medium-sized sandy streams, occasionally in clay-bottomed creeks. Found on a variety of substrates including wood, moss, roots, gravel, and rock.

Family Dryopidae Erichson, 1847

Adult dryopids, aquatic or riparian, are distinguished by hard bodies, distinctive short antennae with last 8 segments typically pectinate, transverse anterior coxae with exposed trochantins, non-retractile legs, and 5 tarsal segments. They are often called long-toed water beetles because of their long tarsal claws. The terrestrial larvae are cylindrical (elateroid) with reduced abdominal sternites and pleurites, and without retractile gills and opercula.

The dryopid fauna of America north of Mexico is composed of 12 species in the genera *Dryops*, *Helichus*, and *Pelonomus* (Brown, 1981a, 1983b). Four of the 6 primarily eastern species in the latter 2 genera occur in Louisiana.

There are few comprehensive treatments of the Dryopidae at the family level. Brown (1970) published a key to the New World genera with comments on their occurrence. The family is most thoroughly covered in Brown (1976).

Genus *Helichus* Erichson, 1847

Adult beetles in the genus *Helichus* are characterized by their widely separated, pectinate antennae, the second segment of which is expanded into a heavily sclerotized triangular shield (Fig. 4.1). The terrestrial larvae were most recently described by Ulrich (1986).

Species of *Helichus* occur in North and South America and the Old World. This is the largest dryopid genus in North America with 10 species; 3 of the 4 eastern species are found in Louisiana. A synopsis of the genus with a key, species descriptions, and illustrations of male genitalia was published by Musgrave (1935b). Hinton described 4 new species in 1935 (1935a), and in 1937 commented on several errors in Musgrave's (1935b) paper and proposed corrections. One of the species discussed was *H. fastigiatus* (Say) which occurs in Louisiana. Nelson (1981) noted taxonomic problems and errors existing within the genus and proposed solutions. He is currently working on a revision.

Helichus basalis LeConte, 1852

Fig. 6.1; Map, Fig. 13.1

Helichus basalis LeConte, 1852, *Proc. Acad. Nat. Sci. Phila.* 6:43.

DIAGNOSTIC DESCRIPTION:

ADULTS—Brown to black; thorax depressed behind middle; elytron with bronze tomentum laterally, usually with shiny glabrous to sparsely pubescent sutural area widest basally and narrowed apically, rarely pubescent medially; each elytral stria indistinct, with small shallow punctures becoming impunctate near base; first stria not extending to scutellum (Fig. 6.1); male genitalia with slender, acutely-pointed parameres; 4.3-5.5 mm long, 2.0-2.5 mm wide. LARVAE—Not aquatic.

COMMENTS: Adult males and females may be confused with *H. fastigiatus* females, but they differ by having shallower elytral punctures with the first elytral stria not reaching the scutellum. There is considerable variation in the amount of medial "rubbing" present on the elytral disk, ranging from bare to sparsely pubescent.

SPECIMENS EXAMINED: 199 adults.

GEOGRAPHIC RANGE: Entire eastern North America from Quebec to Georgia, west to Kansas and eastern Texas (Brown, 1976, 1983c; LeSage and Harper, 1975). Louisiana records may be the most southern for the species.

DISTRIBUTION IN LOUISIANA: Northwestern, north-central, west-central, and southeastern (northwestern "Florida parishes") areas of the state; absent from the southwestern prairie and the alluvial and deltaic plains. Occurs in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Ouachita River, Red River, and Sabine River (Fig. 13.1).

LOUISIANA RECORDS: ALLEN P.—Soapstone Creek; BIENVILLE P.—Cypress Creek, Redfield Branch, NE Bienville (HPB), SE Arcadia (HPB); BOSSIER P.—trib. Little Cypress Bayou; CADDO P.—Cypress Bayou, Shettleworth Bayou; CALDWELL P.—trib. Flat Creek; CATAHOULA P.—Haggerty Creek; CLAIBORNE P.—Middle Fork Bayou d'Arbonne; DE SOTO P.—Bull Bayou; EAST FELICIANA P.—Foster Creek, Hurricane Creek, Little Comite Creek (LSUC), Sandy Creek (1,2), Sandy Creek (HPB), Woodland Creek; GRANT P.—Nantachie Creek; JACKSON P.—trib. Edwards Branch; LINCOLN P.—trib. Choudrant Creek; NATCHITOCHES P.—Antoine Creek, Bayou Pierre; RAPIDES P.—Germany Branch (HPB), Hemphill Creek; RED RIVER P.—trib. Black Lake Bayou, trib. Brushy Creek; SABINE P.—Lewing Creek; VERNON P.—Calcasieu River; WEST FELICIANA P.—Bayou Sara, Tunica Bayou, West Fork Thompson Creek; WINN P.—E trib. Kiesche Creek, Mill Creek.

HABITAT: Small- to medium-sized streams with sand, gravel, or rarely clay substrates. Most often collected on roots, wood, or gravel.

Helichus fastigiatus (Say, 1824)

Fig. 6.2; Map, Fig. 13.2

Parnus fastigiatus Say, 1824, Appendix Vol. II, Keating's Expedition to Source of St. Peter's River Under Major Long, p. 275.

DIAGNOSTIC DESCRIPTION:

ADULTS—Brown to black; thorax depressed behind middle; elytron with bronze tomentum laterally, and shiny glabrous to sparsely pubescent sutural area widest basally and narrowed apically; each elytral stria very distinct, with large punctures even near base; first stria extending to scutellum (Fig. 6.2); hind coxa of male with prominent ventrally-directed, tooth-like process; male genitalia with stout, blunt-tipped parameres; 4.5-5.5 mm long, 2.2-2.5 mm wide. **LARVAE**—Not aquatic.

COMMENTS: The characteristic hind coxal teeth of the male are best seen in lateral view. The female is distinguished from both sexes of *H. basalis* by the presence of very distinct elytral striae, the first of which extends to the scutellum. The size of the dorso-medial bare to sparsely pubescent elytral area varies among individuals.

SPECIMENS EXAMINED: 24 adults.

GEOGRAPHIC RANGE: Entire eastern North America from New Brunswick and Quebec to Florida, west to eastern Kansas and Oklahoma, and north to Illinois (Brown, 1983c; LeSage and Harper, 1975).

DISTRIBUTION IN LOUISIANA: Scattered localities in the north-central and southeastern (northern "Florida parishes") areas of the state; absent from the southwestern prairie and the

alluvial and deltaic plains. Occurs in the following drainage basins: Lake Pontchartrain, Lower Mississippi River, Ouachita River, Pearl River, and Red River (Fig. 13.2). This species is much less common than either *H. basalis* or *H. lithophilus* (Germar).

LOUISIANA RECORDS: BIENVILLE P.—Redfield Branch, NE Bienville (HPB); CATAHOULA P.—trib. Birds Creek; EAST FELICIANA P.—Hurricane Creek, Woodland Creek; GRANT P.—Gray Branch; JACKSON P.—trib. Edwards Branch; LA SALLE P.—Doyle Branch; RAPIDES P.—Loving Creek (USL); RED RIVER P.—trib. Brushy Creek; WASHINGTON P.—Bogue Chitto River, Bogue Lusa Creek, Bonner Creek, Crains Creek, Hays Creek (USL), North Carson Creek; WEST FELICIANA P.—Tunica Bayou.

HABITAT: Small- to medium-sized streams with sand and/or gravel substrates. Most often collected on wood or roots.

Helichus lithophilus (Germar, 1824)

Fig. 6.3; Map, Fig. 13.3

Elmis lithophila Germar, 1824, *Insectorum Species Novae aut Minus Cognitae, Descriptionibus Illustratae*, p. 88.

DIAGNOSTIC DESCRIPTION:

ADULTS—Golden-brown to dark brown; thorax not depressed behind middle; body uniformly covered with fine, silky pubescence except for shiny scutellar area; each elytral stria composed of small, barely visible punctures (Fig. 6.3); male genitalia very long and slender; 4.4-5.8 mm long, 2.0-2.5 mm wide. **LARVAE**—Not aquatic.

COMMENTS: This species is unlikely to be mistaken for either *H. basalis* or *H. fastigiatus*. Specimens appear glossy and more streamlined, without distinct elytral striae or dorsal "rubbed" patches.

SPECIMENS EXAMINED: 277 adults.

GEOGRAPHIC RANGE: Entire eastern North America from Quebec and Ontario to Florida, west to eastern Kansas, Oklahoma, and Texas and north to Iowa and Wisconsin (Brown, 1983c).

DISTRIBUTION IN LOUISIANA: Central and southeastern ("Florida parishes") areas of the state; absent from the southwestern prairie and the deltaic plain. Rarely collected in the alluvial plain. Occurs in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River (black light only), Red River, and Sabine River (Fig. 13.3).

LOUISIANA RECORDS: CATAHOULA P.—Bushley Creek, Bushley Creek (LSUC), Haggerty Creek; DE SOTO P.—Caney Bayou; EAST BATON ROUGE P.—Baton Rouge (3) (LSUC), Beaver Pond Bayou; EAST FELICIANA P.—Redwood Creek, Sandy Creek (2), Sandy Creek (HPB); GRANT P.—4-H Camp Grant Walker (LSUC), Nantachie Creek, Stuart Lake Rec. Area (LSUC); LA SALLE P.—Hemphill Creek; LIVINGSTON P.—Denham Springs (LSUC), Hog Branch; NATCHITOCHES P.—Antoine Creek, Bayou Pierre, Kisatchie Bayou, Santabarb Creek; RAPIDES P.—Castor Creek, Hemphill Creek, Spring Creek; SABINE P.—Lewing Creek; ST. TAMMANY P.—Honey Island Nature Trail (LSUC); TANGIPAHOA P.—Big Creek, Terrys Creek; VERNON P.—Anacoco Bayou (USL), Calcasieu River, Liberty Creek; WEST FELICIANA P.—Alexander Creek, Baker Creek, Bayou Sara, Tunica Bayou, West Fork Thompson Creek; WINN P.—Mill Creek.

HABITAT: Small- to medium-sized streams with sand, gravel, or rarely clay or mud substrates. Most often collected on wood or roots.

Genus *Pelonomus* Erichson, 1847

Pelonomus adults are entirely covered by short erect pubescence including the eyes and antennae. The pectinate antennae do not have the second segments enlarged (Fig. 4.2), and the antennal bases are approximate. The terrestrial larvae were described by Bertrand (1955).

This genus of 12 species is primarily Neotropical in distribution with only one North American representative. *Pelonomus obscurus* LeConte is a riparian or semiaquatic species occurring in swamps and ponds (Brown, 1976).

Pelonomus obscurus LeConte, 1852

Figs. 4.2, 6.4; Map, Fig. 13.4

Pelonomus obscurus LeConte, 1852, *Proc. Acad. Nat. Sci. Phila.* 6:42.

DIAGNOSTIC DESCRIPTION:

ADULTS—Reddish to dark brown; entire body, including antennae (Fig. 4.2) and eyes, covered with short, erect pubescence; 4.8-6.5 mm long, 2.0-2.5 mm wide (Fig. 6.4). LARVAE—Not aquatic.

SPECIMENS EXAMINED: 36 adults.

GEOGRAPHIC RANGE: Southeastern United States from South Carolina to Florida, west to Kansas and Texas, and north to southern Illinois and Indiana (Brown, 1983c). There is a single published record from Quebec (LeSage and Harper, 1975).

DISTRIBUTION IN LOUISIANA: Records only from scattered locations in the southern quarter of the state; all probably collected at light (Fig. 13.4). The species was not collected during this study.

LOUISIANA RECORDS: CALCASIEU P.—Sam Houston Jones St. Pk. (LSUC); EAST BATON ROUGE P.—Baton Rouge (4) (LSUC); IBERVILLE P.—St. Gabriel Expt. Sta. (1,2,3) (LSUC); JEFFERSON P.—Grand Isle (LSUC), Grand Isle St. Pk. (LSUC); ST. MARTIN P.—Parks (LSUC).

HABITAT: Since no specimens were collected during this study, habitat details are unknown. See Brown, 1976.

Family Elmidae Shuckard, 1839

Adult Elmidae are typically hard-bodied, having rounded or globular anterior coxae without exposed trochantins, non-retractile legs, 5 tarsal segments and long tarsal claws, and usually slender, 11-segmented antennae. The elongate larvae have retractile gills and opercula bearing internal hooks, and the abdominal sternites or pleurites are not reduced in the anterior 6 segments. Elmids are aquatic in both the adult and larval stages. The common name riffle beetles is applied to the family in the strict sense.

Elmidae is the largest dryopoid family in North America with about 90 described species in 27 genera (Brown, 1983c; Brown, pers. com., Mar. 10 1984). *Dubiraphia*, *Microcyloepus*, *Optioservus*, and *Stenelmis* are transcontinental in distribution; *Ancyronyx*, *Gonielmis*, *Macronychus*, *Oulimnius*, and *Promoresia* occur in the East and Southeast. Eighteen other genera are confined to the West; 9 of these are northward extensions of a larger Mexican and Neotropical fauna and are distributed primarily in the Southwest. Six genera, including *Macronychus*, *Optioservus*, and *Stenelmis*, also occur in the Old World. The above distributions are taken primarily from Brown (1975a, 1981a).

The family has been divided into the subfamilies Larainae and Elminae. The

western Larainae consists of 3 species in the genera *Lara* and *Phanocerus*. Adults of this subfamily are riparian, or at most, semi-aquatic. The majority of species belong to the Elminae which are the most completely aquatic of all beetles (Brown, 1987a). Seven of the 25 Nearctic genera in this subfamily occur in Louisiana: *Ancyronyx*, *Dubiraphia*, *Gonielmis*, *Macronychus*, *Microcyloepus*, *Optioservus*, and *Stenelmis*.

The elmids have been known by various family names in the past including Elminthidae, Helminthidae, and Helmidae. More than one-half of the Nearctic species were originally described in the genus *Elmis* Latreille (= *Helmis*), now restricted to the Old World. Sanderson (1953, 1954) revised the Nearctic Elmidae in a landmark paper in which he described 7 genera, gave genotype information, and provided keys to the genera of adults and larvae. Brown (1976) discussed the biology, distribution, and taxonomy of the group. In 1978 Brown and White presented aids for the separation of several very similar species. Papers dealing with immature forms are Bertrand (1955, 1965) on the genera, and LeSage and Harper (1976b, 1977) on 5 species.

The taxonomy of the Elmidae will undoubtedly undergo considerable supplementation in the future. Several genera are in need of revision (Brown, 1975b), and many new species are awaiting description. Several genera have larvae which are presently inseparable at the species level.

Genus *Ancyronyx* Erichson, 1847

Ancyronyx is a monotypic genus which occurs only in the eastern and central United States. *Ancyronyx variegata* (Germar) was originally described in the genus *Macronychus*. The larvae were described by Bertrand (1955,



Fig. 13. The known distribution of Dryopidae and Elmidae in Louisiana: 1-4. Dryopidae: 1, *Helichus basalis*; 2, *H. fastigiatus*; 3, *H. lithophilus*; 4, *Pelonomus obscurus*. 5-6. Elmidae: 5, *Ancyronyx variegata*; 6, *Dubiraphia brevipennis*.

1965); adults and larvae were included in Sanderson's (1953) revision of the Elmidae.

Ancyronyx variegata (Germar, 1824)

Figs. 7.1, 11.1; Map, Fig. 13.5

Macronychus variegatus Germar, 1824, *Insectorum Species Novae aut Minus Cognitae, Descriptionibus Illustratae*, p. 89.

DIAGNOSTIC DESCRIPTION:

ADULTS—Black with conspicuous yellow or testaceous spots and bands; pronotum smooth with anterior and posterior yellow transverse bands; prosternal process posteriorly nearly as wide as head; elytron smooth with C-shaped vitta anteriorly and elongate subapical spot (Fig. 7.1); hind coxa semiglobular, smaller than other coxae; each tarsal claw with basal tooth; 2.10-2.60 mm long, 0.90-1.10 mm wide. LARVAE—Body robust, brown; prothorax with posterior sternum (so that procoxal cavities are closed posteriorly); abdominal segments 1-8 with posterolateral margins produced into hooked or toothed processes; last abdominal segment not slender and elongate, not spined apically (Fig. 11.1).

COMMENTS: The elytral color pattern is distinctive. When the elytra are encrusted with debris and the pattern is obscured, which is often the case, the species may be recognized by very long, spider-like legs striped black and yellow. The larvae are broad, and unlike other elmids, have lateral abdominal margins that resemble the teeth of a saw.

SPECIMENS EXAMINED: 192 adults, 51 larvae.

GEOGRAPHIC RANGE: Entire eastern North America from Quebec and Ontario to Florida, west to Wisconsin, Kansas, Oklahoma, and Texas (Brown, 1983c).

DISTRIBUTION IN LOUISIANA: North-central, central, west-central, and

southeastern ("Florida parishes") areas of the state. Occurs in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, and Sabine River (Fig. 13.5).

LOUISIANA RECORDS: ALLEN P.—Soapstone Creek, trib. Calcasieu River; BEAUREGARD P.—Bundick Creek (1,2); CALDWELL P.—Castor Creek; CATAHOULA P.—trib. Birds Creek, Bushley Creek (LSUC); EAST BATON ROUGE P.—Beaver Pond Bayou, Comite River (1); EAST FELICIANA P.—Redwood Creek, Sandy Creek (2); GRANT P.—Big Creek, Gray Branch, Nantachie Creek; JACKSON P.—trib. Edwards Branch; LA SALLE P.—Hemphill Creek; LIVINGSTON P.—Hog Branch, Little Natalbany River (HPB), Tickfaw River (HPB,USL), trib. Natalbany River; NATCHITOCHES P.—Santabarb Creek; OUACHITA P.—Guyton Creek; RAPIDES P.—Spring Creek; SABINE P.—Lewing Creek; ST. HELENA P.—Darling Creek, East Hog Branch, Twelvemile Creek; ST. TAMMANY P.—Abita Creek, Bogue Falaya River, East Fork Little Bogue Falaya River, Gum Creek, Mill Creek, Talisheek Creek (2), Tchefuncte River; TANGIPAHOA P.—Big Creek (USL), Chappepeela Creek (1,2), Natalbany River, Selzers Creek, Tangipahoa River, Terrys Creek, creek w of Hammond (HPB); UNION P.—Little Corney Bayou; VERNON P.—Calcasieu River, East Anacoco Creek, Sixmile Creek; WASHINGTON P.—Bogue Chitto River, Bogue Lusa Creek, Hays Creek (USL), Mill Creek, North Carson Creek, Silver Creek; WEBSTER P.—Caney Creek; WEST FELICIANA P.—Baker Creek, Thompson Creek (HPB), West Fork Thompson Creek.

HABITAT: Sandy and/or gravelly streams and rivers of all sizes, rarely in mud- or clay-bottomed streams. Most often collected on wood or roots.

Genus *Dubiraphia* Sanderson, 1954

Pronotum without carinae, each elytron with a longitudinal vitta or 2 maculae, prosternal process posteriorly much narrower than the head, transverse hind coxae, and fringes of tomentum on the anterior tibiae distinguish adult *Dubiraphia* from other genera of elmids in Louisiana. The larvae are easily recognized, having a very long and slender apical abdominal segment with the operculum confined to the posterior third (Fig. 11.2). Larval *Dubiraphia* cannot be identified to species.

Dubiraphia is indigenous to North America and is one of the most widely distributed genera on the continent. Eleven species have been described and several others are awaiting description.

The genus was erected by Sanderson (1954) to include 4 of the species listed in Hinton's (1936) recharacterization of *Simsonia*. Sanderson referred to the original description of *Simsonia* and cited features not applicable to North American species. Hilsenhoff (1973) doubled the size of the genus with the addition of 5 new species, including *D. brevipennis* from Louisiana. This publication provided a key to the species of the central United States and photographs of male genitalia. The genus is badly in need of revision because of numerous undescribed taxa and systematic problems, particularly in the Southeast (Brown, 1975b; Brown, pers. com., June 18 1980). A new species, *D. harleyi*, was recently described from Louisiana (Barr, 1984). A generic description of the larvae of *Dubiraphia* was published by Bertrand in 1955.

Four described and perhaps 3 undescribed species of *Dubiraphia* are known from Louisiana (Barr, 1984; Brown, pers. com., June 18 1980). While some specimens of these "new species" are readily separable from known species, other individuals have characteristics which overlap those of *D. brevipennis* and *D. vittata* Melsheimer. For the purposes of this study, those not keying out in Hilsenhoff (1973) and Barr (1984) are tentatively designated *Dubiraphia* n. spp. A?, B?, and C?. The descriptions and characters given should be considered preliminary at best, as a revision of the genus will likely be necessary to solve the problems involved. For these reasons, laypersons are advised not to attempt species identifications. Dissection of male genitalia is nearly always necessary for identification. The male genitalia of our known species, except *D. parva*?, are illustrated in Figures 10.1-10.3.

Dubiraphia brevipennis Hilsenhoff, 1973
Figs. 7.2, 10.1; Map, Fig. 13.6

Dubiraphia brevipennis Hilsenhoff, 1973,
Ann. Entomol. Soc. Amer. 66(1):60.

DIAGNOSTIC DESCRIPTION:

ADULTS—Palpi and antennae testaceous; elytral length 1.30-1.53 mm; elytron usually vittate, less often bimaculate; vitta or maculae narrow, occupying approximately 3 intervals (from stria 3 to interval 6) at widest point posterior to humerus (Fig. 7.2); femur typically bicolored, darker basally than apically, sometimes entirely dark; tibia and tarsus testaceous; male with penis rather narrow, not more than 1 1/2 times as wide as paramere at midlength, evenly tapered from base to near narrowly rounded tip, length 0.24-0.31 mm; parameres broad, tips broadly rounded and usually wider than at midlength (Fig. 10.1).

COMMENTS: Individuals with bi-colored femora are easy to identify. The narrow vittae may resemble those of *D. parva* Hilsenhoff, but *D. brevipennis* has smaller genitalia. When the femora are dark the narrower penis separates this species from *Dubiraphia* n. sp. B?.

SPECIMENS EXAMINED: 154 adults.

GEOGRAPHIC RANGE: Largely unknown; recorded from Louisiana, Alabama, Mississippi, Texas, and Kansas (Brown, pers. com., June 25 1981; Brown, 1983c; Brown and Huggins, 1977; Eiland, 1979).

DISTRIBUTION IN LOUISIANA: Common in the southeast ("Florida parishes"), less common in the west-central and southwestern regions. Occurs in the drainage basins of the Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Pearl River, and Sabine River (Fig. 13.6).

LOUISIANA RECORDS: CALCASIEU P.—Buxton Creek; EAST BATON ROUGE P.—Comite River (1); EAST FELICIANA P.—Amite River, Redwood Creek, Sandy Creek (2); JEFFERSON DAVIS P.—trib. East Bayou Lacassine; LIVINGSTON P.—Hog Branch; SABINE P.—Lewing Creek; ST. HELENA P.—Darling Creek, Tickfaw River; TANGIPAHOA P.—Natalbany River, Tangipahoa River, Terrys Creek, creek w of Hammond (HPB); VERNON P.—Sixmile Creek; WASHINGTON P.—Bogue Chitto River, Mill Creek, Pushepatapa Creek, Silver Creek; WEST FELICIANA P.—West Fork Thompson Creek.

HABITAT: Found most often on roots and aquatic plants occurring in sandy and gravelly streams or occasionally those with a clay substrate.

Dubiraphia harleyi Barr, 1984
Figs. 7.3, 10.2; Map, Fig. 14.1

Dubiraphia harleyi Barr, 1984, *J. Kans. Entomol. Soc.* 57(2):336-339.

DIAGNOSTIC DESCRIPTION:

ADULTS—Palpi darker than antennae; basic body color black; large, elytral length 1.67-2.02 mm; elytron with straight, narrow vitta covering 1 1/2 to 2 1/2 intervals (usually stria 3 to interval 6) at widest point posterior to humerus (Fig. 7.3); femur and tibia black with silvery sheen, darker than tarsus; male with penis very long and slender, basal three-fourths tapered evenly to elongated tip, length 0.39-0.45 mm; parameres very narrow, narrowest at mid-length and flared at tips, more darkly sclerotized than penis (Fig. 10.2).

COMMENTS: This species is quite distinctive. It is by far the largest *Dubiraphia* in the state, as long as the more northern *D. robusta* Hilsenhoff and almost as long as *D. bivittata* (LeConte). The body is entirely dark dorsally except for 2 very narrow, straight vittae. It keys to *D. robusta* in Hilsenhoff (1973) except for the very different genitalia which are very long and slender and have unique parameres.

SPECIMENS EXAMINED: 159 adults.

GEOGRAPHIC RANGE: Unknown; Louisiana (Barr, 1984).

DISTRIBUTION IN LOUISIANA: Scattered localities in the east-central and southeastern ("Florida parishes") regions. Drainage basins involved are the Atchafalaya River, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, and Pearl River (Fig. 14.1).

LOUISIANA RECORDS: AVOYELLES P.—Coulee des Grues, Cou-

lee des Grues (LSUC); LA SALLE P.—Hemphill Creek; ST. LANDRY P.—Bayou Petite Prairie; WASHINGTON P.—Bonner Creek; WEST FELICIANA P.—West Fork Thompson Creek.

HABITAT: Strikingly different types of stream situations ranging from clear, sandy creeks to large, muddy bayous and agricultural drainage ditches. Collected primarily on tree and aquatic plant roots, sometimes on wood.

Dubiraphia parva Hilsenhoff, 1973 ?
Map, Fig. 14.2

Dubiraphia parva Hilsenhoff, 1973, *Ann. Entomol. Soc. Amer.* 66(1):61.

DIAGNOSTIC DESCRIPTION:

ADULTS—Palpi and antennae testaceous; elytral length 1.25-1.40 mm; elytron with narrow vitta or maculae covering 3 or 4 intervals (from intervals 3 to 6 or 3 to 7) at widest point posterior to humerus; femur usually bicolored with basal three-fourths dark and apical fourth light, but may be entirely dark; tibia light, often with dark apex; male with penis usually abruptly narrowed near middle with apical third to half very slender, or less often tapered evenly from base to tip, length 0.31-0.37 mm; parameres narrow, tips narrowly rounded and truncate on inner margins (Figs 7.2 and 7.3).

COMMENTS: We hesitate to report this species since we are far from its reported range and have only a few specimens from a single locality. It is similar to *D. brevipennis*, but the male genitalia are longer and the parameres have narrow tips which are truncate on the inner margins. The shape of the penis was found to be variable as mentioned in the the original description. Individuals with the penis suddenly constricted are distinctive; those with the organ gradually tapered could be mistaken for *D. brevipennis*. Most of our specimens have

bicolored femora, unlike Hilsenhoff's type. There is also the possibility that this may be an undescribed species. The genitalia average larger than those of all but *D. harleyi*.

SPECIMENS EXAMINED: 13 adults.

GEOGRAPHIC RANGE: Largely unknown; Oklahoma, Mississippi, and Louisiana (Barr, 1981; Brown, pers. com., June 25 1981; Hilsenhoff, 1973).

DISTRIBUTION IN LOUISIANA: Collection made at a single locality in the north-central part of the state in Catahoula Parish; Ouachita River drainage (Fig. 14.2).

LOUISIANA RECORD: CATAHOULA P.—Bushley Creek.

HABITAT: Shallow sandy stream about 35 ft (56 m) wide, water turbid and reddish in color. Beetles were collected from tree roots.

Dubiraphia vittata (Melsheimer, 1844)
Figs. 7.4, 10.3; Map, Fig. 14.3

Elmis vittatus Melsheimer, 1844, *Proc. Acad. Nat. Sci. Phila.* 2:99.

DIAGNOSTIC DESCRIPTION:

ADULTS—Palpi testaceous to rufo-testaceous, usually darker than antennae; elytral length 1.30-1.83 mm; elytron usually vittate, less often bimaculate, vitta or maculae broad and fairly constant in width, generally occupying 5 intervals (from stria 2 to interval 7) at widest point posterior to humerus (Fig. 7.4); femur and tibia darker than tarsus, joint may be light; male with penis stout and convex, at least 2 times width of paramere at midlength, distinctly narrowed in apical fourth, length 0.24-0.31 mm; parameres broad, tips broadly rounded (Fig. 10.3).

COMMENTS: The wide vittae and broad penis distinguish this species. The species may be inseparable from

Dubiraphia n. sp. A? unless the genitalia are examined.

SPECIMENS EXAMINED: 198 adults.

GEOGRAPHIC RANGE: Widespread in the East and Midwest from Quebec and Ontario to Florida and possibly as far west as Idaho, Utah, and Arizona (Brown, 1983c; Brown, pers. com., Mar. 10 1984). Records from Louisiana may be the most southern for the species.

DISTRIBUTION IN LOUISIANA: Common in the central, west-central, southeastern ("Florida parishes") areas; scattered localities in the northwestern and north-central parts of the state. Collected in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, and Sabine River (Fig. 14.3).

LOUISIANA RECORDS: BEAUREGARD P.—Bundick Creek (2), Hickory Branch, Johns Gully; CADDOP.—Cypress Bayou; EAST BATON ROUGE P.—Beaver Bayou, Comite River (1); EAST FELICIANA P.—Foster Creek, Woodland Creek; LA SALLE P.—Trout Creek; LIVINGSTON P.—Spillers Creek, trib. Natalbany River, West Colyell Creek; RAPIDES P.—Spring Creek; SABINE P.—Bayou Scie; ST. HELENA P.—East Hog Branch, Twelvemile Creek; ST. TAMMANY P.—Abita Creek, Bogue Falaya River, Gum Creek, Mill Creek, Talisheek Creek (2); TANGIPAHOA P.—Hamilton Creek (LSUC), Natalbany River; VERNON P.—Liberty Creek, Sixmile Creek; WASHINGTON P.—Bonner Creek, North Carson Creek, Pushepatapa Creek, Silver Creek.

HABITAT: Collected on tree and aquatic plant roots in all kinds of streams, but the majority of these had sand substrates.

Dubiraphia new species A ?

Map, Fig. 14.4

DIAGNOSTIC DESCRIPTION:

ADULTS—Palpi testaceous; elytral length 1.38-1.55 mm; elytron with wide vitta covering about 4 intervals (from stria 2 to 5 or 2 to 6) at widest point posterior to humerus; femur and tibia darker than tarsus; male with penis rather narrow, 1 1/2 to 2 times width of paramere at midlength, nearly parallel-sided to short, pointed tip, length 0.25-0.26 mm; parameres broad, tips broadly rounded and flared.

COMMENTS: This species strongly resembles *D. vittata*, but may be separated on the basis of its much narrower penis. Also, the palpi are testaceous whereas those of *D. vittata* are usually darker.

SPECIMENS EXAMINED: 43 adults.

GEOGRAPHIC RANGE: Unknown; Louisiana (Barr, 1981).

DISTRIBUTION IN LOUISIANA: Collected from only a few scattered streams in the northwestern, central, and southeastern ("Florida parishes") areas; Calcasieu River, Lake Pontchartrain, Mermentau-Vermilion-Teche Rivers, and Red River drainage basins (Fig. 14.4).

LOUISIANA RECORDS: CADDOP.—Cypress Bayou; EAST FELICIANA P.—Redwood Creek; EVANGELINE P.—Bayou Nezpique (1); LIVINGSTON P.—West Colyell Creek; TANGIPAHOA P.—Chappepeela Creek (2); VERNON P.—Sixmile Creek; WASHINGTON P.—Mill Creek.

HABITAT: Occurs in different types of watercourses, including those with sand, mud, or clay substrates and with current velocities ranging from none to swift. Inhabits tree roots and aquatic plants.



Fig. 14. The known distribution of Elmidae in Louisiana: 1, *Dubiraphia harleyi*; 2, *D. parva*?; 3, *D. vittata*; 4, *Dubiraphia* n. sp. A?; 5, *Dubiraphia* n. sp. B?; 6, *Dubiraphia* n. sp. C?.

Dubiraphia new species B ?

Map, Fig. 14.5

DIAGNOSTIC DESCRIPTION:

ADULTS—Color of palpi variable, ranging from lighter than antennae to slightly darker; elytral length 1.33-1.57 mm; elytron usually vittate, sometimes maculate, vitta or maculae very narrow, 1 to 3 intervals (intervals 3 or 4 to 5 or 6) at widest point posterior to humerus, often faint posteriorly; femur and tibia with bronze sheen, darker than tarsus; male with penis broad, 2 to 2 1/2 times width of paramere at midlength, tip short and bluntly rounded, length 0.25-0.31 mm; parameres wide with broadly rounded, flared tips.

COMMENTS: The broad penis separates this species from *D. brevipennis* and *D. parva*, which also have narrow vittae. The genitalia are similar to those of *D. vittata*.

SPECIMENS EXAMINED: 206 adults.

GEOGRAPHIC RANGE: Unknown; Louisiana (Barr, 1981).

DISTRIBUTION IN LOUISIANA: Occurs in the north-central, southwestern, south-central, and southeastern ("Florida parishes") areas of the state in the drainages of the Atchafalaya River, Calcasieu River, Lake Pontchartrain, Mermentau-Vermilion-Teche Rivers, Ouachita River, and Pearl River (Fig. 14.5).

LOUISIANA RECORDS: ACADIA P.—Bayou Plaquemine Brule, Long Point Gully; ALLEN P.—Bayou Blue; CALCASIEU P.—Indian Bayou; EVANGELINE P.—Bayou Grand Louis, Bayou Nezpique (1,2); JEFFERSON DAVIS P.—trib. East Bayou Lacassine; LIVINGSTON P.—Hog Branch; MOREHOUSE P.—Chemin-a-Haut Bayou (2); POINTE COUPEE P.—Bayou Latenache Drainage Canal; ST. HELENA P.—Darling Creek

(LSUC); ST. LANDRY P.—Bayou Mallet; ST. TAMMANY P.—Talisheek Creek (2); UNION P.—Meridian Creek; WASHINGTON P.—Hays Creek.

HABITAT: Most specimens were found on roots, many on waterlogged wood. Although all types of streams were represented, mud and clay substrates constituted the majority.

Dubiraphia new species C ?

Map, Fig. 14.6

DIAGNOSTIC DESCRIPTION:

ADULTS—Palpi usually testaceous, rarely darker than antennae; small, elytral length 1.04-1.28 mm; elytron usually bimaculate, sometimes vittate, vitta or maculae narrow and straight, covering about 2 intervals (from stria 3 to interval 5) at widest point posterior to humerus; femur testaceous to golden brown and only slightly darker than tibia and tarsus (hind leg is darkest); male with penis 1 1/2 to 2 1/2 times width of paramere at midlength, sides evenly narrowed to rounded tip, length 0.22-0.28 mm; parameres broad and rounded at tips.

COMMENTS: Most individuals are distinctly smaller than those of other species of *Dubiraphia*, but the largest specimens (females) may be confused with *D. brevipennis*.

SPECIMENS EXAMINED: 80 adults.

GEOGRAPHIC RANGE: Unknown; Louisiana (Barr, 1981).

DISTRIBUTION IN LOUISIANA: Records from scattered localities in the east-central, central, west-central, and southeastern ("Florida parishes") parts of the state, nearly all of which are in different drainage basins. These are the Calcasieu River, Lake Pontchartrain, Mermentau-Vermilion-Teche Rivers,

Ouachita River, Red River, and Sabine River drainages (Fig. 14.6).

LOUISIANA RECORDS: BEAUREGARD P.—Bundick Creek (2); CATAHOULA P.—Bushley Creek; EAST BATON ROUGE P.—Beaver Pond Bayou; NATCHITOCHE P.—Santabarb Creek; RAPIDES P.—Spring Creek; VERNON P.—East Anacoco Creek, Sixmile Creek.

HABITAT: Nearly all specimens were collected in small- and medium-sized streams with sand and gravel substrates. Preferred microhabitats are aquatic moss and tree roots.

Genus *Gonielmis* Sanderson, 1954

Gonielmis is a monotypic genus occurring only in the southeastern United States. Diagnostic characters are provided in the species description of *G. dietrichi* which follows. This species was described as *Helmis dietrichi* by Musgrave (1933) and was later referred to as *Simsonia dietrichi* by Hinton (1936) and by Young (1954). The genus *Gonielmis* was erected for this species by Sanderson in 1954, who indicated that *Simsonia* should be restricted to Australian species. Bertrand (1955) described the larvae.

Gonielmis dietrichi (Musgrave, 1933)

Figs. 7.5, 11.3; Map, Fig. 15.1

Helmis dietrichi Musgrave, 1933, *Proc. Entomol. Soc. Wash.* 35(4):54.

DIAGNOSTIC DESCRIPTION:

ADULTS—Body elongate and spindle-shaped, black; pronotum and elytra without carinae; elytron with 2 oblique, elongate yellow or testaceous spots (Fig. 7.5); prosternal process posteriorly much narrower than width of head; hind coxa transverse and same size or larger than other coxae; lateral margin

of fourth abdominal sternite with lobe bent upward to clasp epipleuron; leg dark with yellow tibia; anterior tibia with medial fringe of tomentum; 2.0-2.6 mm long, 0.95-1.10 mm wide. LARVAE—Brown; prothorax without posterior sternum; mesopleuron divided into 2 parts; abdominal segments 1-7 with pleura, humped dorsally and bearing conspicuous scale-like hairs; last abdominal segment slightly emarginate at apex, not spined (Fig. 11.3).

COMMENTS: Oblique elytral maculae are unique among Louisiana elmids, and the distinctive spindle-shaped body is recognizable even in encrusted specimens. The larvae are distinguished by dorsal abdominal humps which are most prominent posteriorly.

SPECIMENS EXAMINED: 52 adults, 240 larvae.

GEOGRAPHIC RANGE: The Atlantic and East Gulf Coastal Plain provinces only; South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana (Barr, 1981; Brown, 1983c). Sinclair's (1964) Tennessee record was in error (Brown and White, 1978). Louisiana records are the most western for the species.

DISTRIBUTION IN LOUISIANA: Collected only in the southeastern part of the state in Washington and St. Tammany parishes from the Pearl River and Lake Pontchartrain drainage basins (Fig. 15.1).

LOUISIANA RECORDS: ST. TAMMANY P.—Bogue Falaya River; WASHINGTON P.—Bogue Lusa Creek, Bonner Creek, Crains Creek, Foster Creek, Muster Ground Creek, Pushepatapa Creek, Silver Creek.

HABITAT: Collected only from small- to medium-sized, acidic, spring-fed streams with sand and/or gravel substrates. Usually found on roots or aquatic moss, less often on wood or plants.

Genus *Macronychus* Müller, 1806

Adults of this genus have short, 7-segmented antennae with the apical segments enlarged (Fig. 4.3), a pronotum with 2 basal sublateral carinae, each elytron with one sublateral carina, the prosternal process posteriorly nearly as wide as head, and the hind coxae semiglobular and smaller than other coxae. The larvae have open procoxal cavities, divided mesopleural sclerites, and pleura on abdominal segments 1-6 only.

One species, *Macronychus glabratus* Say, occurs in eastern North America; Old World species include 2 from the Orient and one from Europe. Hinton redescribed *Macronychus* and described a new species in a 1940 synopsis. The genus was reviewed by Sanderson (1954) in his revision of Nearctic elmids genera. A description of the larvae of *Macronychus* was published by Bertrand (1955); the larvae and pupae of *M. glabratus* were described by LeSage and Harper (1976b, 1977). Various aspects of the life cycle and behavior of this species have been detailed by West (1929a), Davis and Finni (1974), and LeSage and Harper (1976a).

Macronychus glabratus Say, 1825

Figs. 4.3, 7.6, 11.4; Map, Fig. 15.2

Macronychus glabratus Say, 1825, *J. Acad. Nat. Sci. Phila.* 5:187.

DIAGNOSTIC DESCRIPTION:

ADULTS—Dark brown to black, shining; sublateral elytral carina bordering a conspicuous silvery or golden lateral band of tomentum; 2.50-3.50 mm long, 1.00-1.30 mm wide (Fig. 7.6). LARVAE—Dark brown; prothorax without posterior sternum; mesopleuron divided into 2 parts; abdominal segments 1-6 with pleura and without lateral processes or dorsal humps, posterior margin of each segment with fringe of long

hairs; last abdominal segment bearing 2 long, narrowly separated apical spines (Fig. 11.4).

COMMENTS: The species is characterized by a shiny dark brown to black body with broad lateral stripes of silver or gold. The very short antennae are unique and permit easy identification of encrusted individuals. Larvae most closely resemble those of *Stenelmis* and *Microcylloepus*, but both of these have a post-sternum.

SPECIMENS EXAMINED: 576 adults, 91 larvae.

GEOGRAPHIC RANGE: Entire eastern North America from Quebec and Ontario to Florida, west to North Dakota, Kansas, Oklahoma, and Texas (Brown, 1983c).

DISTRIBUTION IN LOUISIANA: North-central, central, west-central, and southeastern ("Florida parishes") areas of the state. Occurs in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, and Sabine River (Fig. 15.2).

LOUISIANA RECORDS: ALLEN P.—Bundicks Creek (USL), Calcasieu River; BEAUREGARD P.—Bundick Creek (1,2), Bundicks Lake (USL), Johns Gully, Whisky Chitto Creek (USL); BIENVILLE P.—Cypress Creek, Sixmile Creek, SE Arcadia (HPB); CATAHOULA P.—Bushley Creek, Bushley Creek (LSUC), trib. Birds Creek; EAST BATON ROUGE P.—Baton Rouge (1) (LSUC), Beaver Pond Bayou, Comite River (1,2); EAST FELICIANA P.—Amite River, Redwood Creek, Sandy Creek (1,2), Woodland Creek; GRANT P.—Big Creek, Big Creek' (HPB), Gray Branch, Nantachie Creek; LA SALLE P.—Doyle Branch, Hemphill Creek; LIVINGSTON P.—Hog Branch, Hog Branch

(LSUC), Little Colyell Creek, Tickfaw River (HPB), Tickfaw River (USL); NATCHITOCHES P.—Bayou Pierre, Kisatchie Bayou, Santabarb Creek; RAPIDES P.—Castor Creek, Hemphill Creek, Spring Creek; RED RIVER P.—trib. Black Lake Bayou; SABINE P.—Lewing Creek; ST. HELENA P.—Darling Creek, East Hog Branch, Tickfaw River, Twelvemile Creek; ST. TAMMANY P.—Abita Creek, Bogue Falaya River, East Fork Little Bogue Falaya River, Tchefuncte River; TANGIPAHOA P.—Big Creek, Big Creek (USL), Chappepeela Creek (1), Natalbany River, Tangipahoa River, Tangipahoa River (USL), Terrys Creek, creek w of Hammond (HPB); VERNON P.—East Anacoco Creek, Liberty Creek, Sixmile Creek; WASHINGTON P.—Bogue Chitto River, Bogue Lusa Creek, Bonner Creek, Crains Creek, Hays Creek, Hays Creek (USL), Lawrence Creek, Muster Ground Creek, Pushepatapa Creek, Silver Creek, Tchefuncte River (USL); WEBSTER P.—Caney Creek; WEST FELICIANA P.—Baker Creek, Bayou Sara, Thompson Creek, Thompson Creek (HPB), Tunica Bayou, West Fork Thompson Creek; WINN P.—Mill Creek.

HABITAT: Sandy and/or gravelly streams and rivers of all sizes, rarely in mud- or clay-bottomed streams. Most often collected on wood, but may be present in a variety of microhabitats.

Genus *Microcylloepus* Hinton, 1935

Adults of this genus are characterized by a pronotum with a transverse sulcus anterior to the middle, a median longitudinal depression, 2 posterior oblique grooves, and 2 sublateral carinae (Fig. 7.7); the prosternal process posteriorly much narrower than width of head; the hind coxae transverse; and the anterior tibiae with medial fringes

of tomentum. The larvae have closed procoxal cavities and a narrow mid-dorsal stripe which is enlarged into spots at the posterior margins of the sclerites.

Microcylloepus is primarily Neotropical, with only 4 of the 25 described species occurring in North America. *Microcylloepus pusillus* (LeConte) is transcontinentally distributed and is possibly a species complex (Brown, 1975b). The remaining 3 species are restricted to hot springs in the West.

Hinton erected and described this genus (1935b) and enumerated adult and larval characters to separate *Microcylloepus* from closely related *Heterelmis* (1939a). Differences between these genera were also discussed by Sanderson (1953). Musgrave (1933) gave subspecific status to 4 eastern geographical variants of *M. pusillus*. These 4, plus one western subspecies, were recognized by Brown (1976). Specimens keying to 3 subspecies have been collected in Louisiana.

Microcylloepus pusillus (LeConte, 1852)

Figs. 7.7, 11.5; Map, Fig. 15.3

Stenelmis pusilla LeConte, 1852, *Proc. Acad. Nat. Sci. Phila.* 6:44.

DIAGNOSTIC DESCRIPTION:

ADULTS—Brown to black, body carinate and deeply punctate; elytron unmarked, with one longitudinal vitta, or bimaculate; 1.65-2.20 mm long, 0.68-0.90 mm wide (Fig. 7.7). **LARVAE**—Dark brown to black with narrow white mid-dorsal stripe enlarged into spot at posterior margin of each sclerite, usually also with narrow sublateral stripes; prothorax with posterior sternum; posterolateral margins of abdominal segments without processes; last abdominal segment without apical spines (Fig. 11.5).

COMMENTS: Easily identified, *M. pusillus* is very carinate and punctate

dorsally, while species of a similar size (*G. dietrichi*, *Optioservus trivittatus* (Brown), *Dubiraphia* spp.) are smooth dorsally. Specimens keying to the subspecies *M. p. pusillus* (LeConte) (elytra quadrimaculate), *M. p. aptus* (Musgrave) (elytra bivittate), and *M. p. loedingi* (Musgrave) (elytra immaculate) have been collected in the state. *Microcylloepus p. aptus* is reported here outside of the published range (Brown, 1983c). Problems arose with subspecific designations so we have chosen to report our collections at the species level. A series of specimens exhibiting a range of elytral characters from vittate to maculate were collected at one locality; marked and unmarked individuals were collected together at another site. Specimens from 6 sites could not be confidently assigned to a subspecies. These appeared to be intermediate between *M. p. aptus* and *M. p. pusillus* with the vittae complete medially and interrupted laterally. Quadrimaculate individuals were most numerous in the collections; immaculate ones were the least common and were taken only in the "Florida parishes." Larval *M. pusillus* superficially resemble small *Stenelmis* larvae, but the latter never have a series of white spots located on the mid-dorsal stripe.

SPECIMENS EXAMINED: 232 adults, 154 larvae.

GEOGRAPHIC RANGE: Quebec and the entire United States from Maine to Florida, west to Oregon, California, and Mexico. The eastern subspecies: *M. p. pusillus* from Maine to Florida and west to California, *M. p. aptus* from Virginia to northern Florida, *M. p. loedingi* in the Atlantic and Gulf coastal plains, and *M. p. perditus* (Musgrave) from Florida (Brown, 1983c; Morse et al., 1980).

DISTRIBUTION IN LOUISIANA: North-central, east-central, west-cen-

tral, central, and southeastern ("Florida parishes") areas of the state. Occurs in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, and Sabine River (Fig. 15.3).

LOUISIANA RECORDS: BEAUREGARD P.—Bundick Creek (2); CATAHOULA P.—Bushley Creek (LSUC), trib. Birds Creek; EAST BATON ROUGE P.—Beaver Pond Bayou (LSUC), Comite River (1); EAST FELICIANA P.—Amite River; GRANT P.—Big Creek, Gray Branch; JACKSON P.—trib. Edwards Branch; LA SALLE P.—Doyle Branch, Hemphill Creek; LIVINGSTON P.—Hog Branch; NATCHITOCHES P.—Bayou Pierre; OUACHITA P.—Guyton Creek; RAPIDES P.—Spring Creek; SABINE P.—Lewing Creek; ST. HELENA P.—East Hog Branch, Tickfaw River; ST. TAMMANY P.—Abita Creek, Bogue Falaya River, East Fork Little Bogue Falaya River, Gum Creek, Talisheek Creek (2); TANGIPAHOA P.—Tangipahoa River, Terrys Creek, creek w of Hammond (HPB); UNION P.—Little Corney Bayou, Meridian Creek; VERNON P.—East Anacoco Creek, Sixmile Creek; WASHINGTON P.—Bogue Chitto River, Bogue Lusa Creek, Foster Creek, Hays Creek, Mill Creek, Muster Ground Creek, Pushepatapa Creek, Silver Creek; WEST FELICIANA P.—Bayou Sara, West Fork Thompson Creek.

HABITAT: Sandy and/or gravelly streams and rivers of all sizes, rarely in clay-bottomed streams. Most often collected on roots and aquatic moss.

Genus *Optioservus* Sanderson, 1954

Optioservus adults may be distinguished from those of other Louisiana



Fig. 15. The known distribution of Elmidæ in Louisiana: 1, *Gonielmis dietrichi*; 2, *Macronychus glabratus*; 3, *Microcylloepus pusillus*; 4, *Optioservus trivittatus*; 5, *Stenelmis antennalis*; 6, *S. bicarinata*.

genera by their plump, robust form, very short basal sublateral pronotal carinae, lack of elytral carinae, transverse hind coxae, and each anterior tibia with a medial fringe of tomentum. The dark brown larvae are triangular in cross-section and have a laterally expanded, hood-like pronotum, open procoxal cavities, and undivided mesopleural sclerites. Larval *Optioservus* cannot be identified to species.

This genus, with 22 species, is native to North America and Japan. Here it is distributed transcontinentally, but six of the 13 species are primarily eastern. One species, *Optioservus trivittatus* (Brown), occurs in Louisiana.

Sanderson (1954) erected the genus to include species previously in *Elmis*, *Helmis*, *Limnius*, and *Heterlimnius*. Due to his untimely death, Collier's (1969) revision of the genus remains unpublished except for descriptions of 2 new species authored by Collier and included in Brown (1976). *Optioservus* was revised again in 1978 by White who described 3 new species and relegated 4 others to synonymy. The larvae were described by Bertrand (1955).

Optioservus trivittatus (Brown, 1930)

Figs. 7.8, 11.6; Map, Fig. 15.4

Limnius trivittatus Brown, 1930, *Canadian Entomol.* 62:91.

DIAGNOSTIC DESCRIPTION:

ADULTS—Dark brown; elytron with sutural and medial testaceous vittae; 1.69-2.19 mm long, 0.78-1.14 mm wide (Fig. 7.8). LARVAE—See Fig. 11.6.

COMMENTS: No other elmids in Louisiana has such a plump, rounded body form, or a sutural vitta. Occasional individuals have a lateral vitta on the elytral margin. Larvae of *Optioservus* are similar to those of *M. glabratus* in that they lack a posterior sternum. They differ in having undivided mesopleural

sclerites, the body triangular in cross-section, and a hood-like pronotum with expanded lateral margins.

SPECIMENS EXAMINED: 42 adults, 62 larvae.

GEOGRAPHIC RANGE: Eastern North America from Quebec to northern Alabama, west to Wisconsin, Indiana, and Louisiana (Barr, 1981; Eiland, 1979; White, 1978). There is a questionable record from Missouri (Brown, pers. com., Mar. 10 1984). Louisiana records represent a significant southwestward extension of the range for the species given by White.

DISTRIBUTION IN LOUISIANA: Collected only at 2 sites in Washington Parish from the Pearl River drainage basin in the southeastern part of the state (Fig. 15.4).

LOUISIANA RECORDS: WASHINGTON P.—Mill Creek, Muster Ground Creek.

HABITAT: These sites are small streams with sand and gravel substrates and brown-stained, acidic waters. All specimens were collected in gravelly riffles or narrow chutes about one-half meter deep with gravel substrates.

Genus *Stenelmis* Dufour, 1835

Adult *Stenelmis* have the prosternal process narrower posteriorly than the width of the head, have transverse hind coxae, and lack tomentum on the anterior tibiae. In addition to the characters given in the key, the larvae have the propleura undivided, the mesopleura divided, and 2 distinct frontal teeth on the anterior margin of the head (Fig. 11.7).

Stenelmis is the most widely distributed elmids genus with many representatives in Europe, Asia, and Africa. It is the largest genus in North America, with all but one of the 29 described species occurring east of the 100th meri-

dian. Seven described and 2 probably undescribed species occur in Louisiana.

Sanderson (1938) revised the genus in North America, describing 18 new species and reducing 4 to synonymy. Some of the paratypes of *S. grossa* were from Louisiana. His monograph discussed the life history and distribution of the species as well as the morphology and taxonomy. Since 1938 only 4 new species have been described. Revision of the genus is needed due to the presence of several undescribed species (Brown, 1975b). Kurt Schmude at the University of Wisconsin has recently undertaken this study as a Ph.D. dissertation project. Dissection of male genitalia is often necessary to separate the species.

Larval *Stenelmis* cannot be identified to species. Although the larvae of 11 described and 3 undescribed species were characterized by Shepard (1980), the larvae of many species are unknown. Three of the species treated by Shepard occur in Louisiana. The life history, larvae, and pupae of *S. crenata* (Say) were described by LeSage and Harper (1976a, 1976b, 1977).

Stenelmis antennalis Sanderson, 1938
Figs. 8.1, 9.1; Map, Fig. 15.5

Stenelmis antennalis Sanderson, 1938, *Univ. Kansas Sci. Bull.* 25(22):695.

DIAGNOSTIC DESCRIPTION:

ADULTS—Body black; antenna bicolored, basal 3-6 segments testaceous, remainder black; elytron distinctly vittate or bimaculate, humeral spot not covering umbone (Fig. 8.1); surface of femur granulate; last tarsal segment distinctly longer than other 4 combined (Fig. 4.6); male with swelling or ridge on inner surface of middle tibia (Fig. 4.5); penis slender and blunt-tipped, lateral processes narrowly elongated (Fig. 9.1); 2.50-2.70 mm long, 1.00 mm wide.

COMMENTS: This species and *S. lateralis* are the smallest members of the genus occurring in the state. The bicolored antennae are diagnostic; the number of testaceous vs. black segments varies. The vittae may be entire or broken, contrary to Sanderson's (1938) description of "always entire."

SPECIMENS EXAMINED: 25 adults.

GEOGRAPHIC RANGE: The Atlantic and Gulf coastal plains from South Carolina to Louisiana (Barr, 1981; Brown, 1983c). Louisiana records represent a westward extension of the known range and include the first from west of the Mississippi River.

DISTRIBUTION IN LOUISIANA: West-central, central, and southeastern ("Florida parishes") areas of the state, occurring in the following drainage basins: Calcasieu River, Lake Pontchartrain, Ouachita River (black light only), Pearl River, and Sabine River (Fig. 15.5).

LOUISIANA RECORDS: BEAUREGARD P.—Bundicks Lake (USL); EAST FELICIANA P.—Amite River; GRANT P.—Stuart Lake Rec. Area (LSUC); ST. HELENA P.—Tickfaw River; ST. TAMMANY P.—Bogue Falaya River; TANGIPAHOA P.—Terrys Creek; VERNON P.—East Anacoco Creek; WASHINGTON P.—Bogue Chitto River, Bogue Lusa Creek, Crains Creek, Muster Ground Creek.

HABITAT: Specimens were collected from sandy and gravelly streams on wood, moss, and roots.

Stenelmis bicarinata LeConte, 1852
Figs. 8.2, 9.2; Map, Fig. 15.6

Stenelmis bicarinatus LeConte, 1852, *Proc. Acad. Nat. Sci. Phila.* 6:44.

DIAGNOSTIC DESCRIPTION:

ADULTS—Body medium to dark brown; pronotum indistinctly to dis-

tinctly granulate, tubercles prominent, median sulcus deep with ridged margins; lateral margins of pronotum in dorsal view not strongly divergent in anterior third, either parallel-sided or only slightly divergent; elytron bimaculate, often faintly, humeral spot not covering umbone; elytron with base of third interval moderately elevated, each stria with distinct punctures becoming fainter at posterior third (Fig. 8.2); surface of femur granulate; last tarsal segment distinctly longer than previous 4 combined (Fig. 4.6); male without swelling or ridge on inner surface of middle tibia; penis slender and narrowed apically, lateral processes narrowly elongated (Fig. 9.2); 2.94-3.46 mm long, 1.05-1.32 mm wide.

COMMENTS: Sanderson's (1938) widely followed redescription of *S. bicarinata* was apparently in error, and does not fit LeConte's type (Brown, 1987b). The real *S. bicarinata* keys out to *S. convexula* in Brown (1976) but may be distinguished from it by the following characters: male without ridge on middle tibia; penis with narrow, elongate lateral processes; elytra not very convex, striae and basal elevations of third intervals more distinct; and more prominent pronotal tubercles and sulcus. *Stenelmis bicarinata* is also quite similar in appearance to *S. sinuata* LeConte, but the latter has the lateral margins of the pronotum strongly divergent in the anterior third, and is more strongly sculptured with larger, deeper punctures on the elytra and very prominent pronotal tubercles.

SPECIMENS EXAMINED: 649 adults.

GEOGRAPHIC RANGE: From central Ohio and Indiana south to Florida and west to Oklahoma and Texas (Brown, 1987b). Uncommon except in the southern part of its range (Brown, pers. com., Mar. 10 1984).

DISTRIBUTION IN LOUISIANA: Central, west-central, and southeastern ("Florida parishes") areas of the state. Occurs in the following drainage basins: Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, and Sabine River (Fig. 15.6).

LOUISIANA RECORDS: ALLEN P.—Calcasieu River, Soapstone Creek; BEAUREGARD P.—Bundick Creek (1,2), near Rosepine (LSUC); CATAHOULA P.—Bushley Creek; EAST BATON ROUGE P.—Baton Rouge (2) (LSUC), Beaver Pond Bayou, 1.2 mi S Central (2) (LSUC); EAST FELICIANA P.—Amite River, Idlewild Expt. Sta. (LSUC), Sandy Creek (2); GRANT P.—Big Creek, Big Creek (HPB), Gray Branch, Nantachie Creek, Stuart Lake Rec. Area (LSUC); JACKSON P.—trib. Edwards Branch; LIVINGSTON P.—Hog Branch, Little Natalbany River (HPB), Tickfaw River (HPB); NATCHITOCHES P.—Antoine Creek, Bayou Pierre, Kisatchie Bayou, Little Bayou Pierre, Malaudos Creek, Santabarb Creek; OUACHITA P.—Guyton Creek; RAPIDES P.—Castor Creek, Hemphill Creek, Spring Creek; RED RIVER P.—trib. Black Lake Bayou; SABINE P.—Bayou Scie, Lewing Creek; ST. HELENA P.—Twelvemile Creek; ST. TAMMANY P.—Abita Creek, East Fork Little Bogue Falaya River, Honey Island Nature Trail (LSUC), 1-10 at Pearl River (LSUC), Talisheek Creek (2); TANGIPAHOA P.—Big Creek, Natalbany River, Tangipahoa River, Terrys Creek, creek w of Hammond (HPB); VERNON P.—East Anacoco Creek, Liberty Creek, Six-mile Creek; WASHINGTON P.—Bogue Lusa Creek, Foster Creek, Muster Ground Creek, Pushepatapa Creek, Silver Creek; WEST FELICIANA P.—Bayou Sara.

HABITAT: Streams of all sizes, usually with sand and/or gravel substrates but occasionally clay- or mud-bottomed. Most often collected on wood, gravel, and roots.

Stenelmis convexula Sanderson, 1938

Figs. 8.3, 9.3; Map, Fig. 16.1

Stenelmis convexula Sanderson, 1938, *Univ. Kansas Sci. Bull.* 25(22):704.

DIAGNOSTIC DESCRIPTION:

ADULTS—Body medium to dark brown; pronotum indistinctly granulate to smooth, often shiny, tubercles not prominent, median sulcus shallow with rounded margins; lateral margins of pronotum in dorsal view parallel-sided; elytron vittate or bimaculate, often faintly, humeral spot not covering umbone; elytron very smooth and convex, usually with little or no basal elevation of third interval, punctures of striae shallow (Fig. 8.3); surface of femur granulate; last tarsal segment distinctly longer than previous 4 combined (Fig. 4.6); male with swelling or ridge on inner surface of middle tibia (Fig. 4.5); penis slender, lateral processes broadly rounded (Fig. 9.3); 3.09-3.64 mm long, 1.21-1.44 mm wide.

COMMENTS: Unlike *S. bicarinata*, males of this species have a ridge on the middle tibia (contrary to Brown's 1976 key). In addition, the elytra are more convex and smooth, appearing inflated especially between humeri, with shallow striae and little or no basal elevation of the third intervals. The pronotum is also smooth with tubercles indistinct and median sulcus shallow.

SPECIMENS EXAMINED: 119 adults.

GEOGRAPHIC RANGE: The Atlantic and East Gulf coastal plains from South Carolina to Louisiana (Barr, 1981; Brigham, 1982; Brown, pers. com., Mar. 10 1984). Reports of this

species in Oklahoma and Texas (e.g., Brown, 1956, 1976; Sanderson and Brown, 1959) concern *S. bicarinata*, with which *S. convexula* has been widely confused. Louisiana records are the most western for the species.

DISTRIBUTION IN LOUISIANA:

Collected only in the southeastern ("Florida parishes") part of the state in the Lake Pontchartrain and Pearl River drainage basins (Fig. 16.1).

LOUISIANA RECORDS:

ST. HELENA P.—Darling Creek; **ST. TAMMANY P.**—Bogue Falaya River, East Fork Little Bogue Falaya River, Honey Island Nature Trail (LSUC); **TANGIPAHOA P.**—Big Creek; **WASHINGTON P.**—Bogue Lusa Creek, Crains Creek, Mill Creek, Muster Ground Creek, Silver Creek.

HABITAT: Small- and medium-sized sandy streams often with gravelly riffles. Most often collected on wood, gravel, and aquatic plants.

Stenelmis crenata (Say, 1824) ?

Figs. 8.4, 9.4; Map, Fig. 16.2

Elmis crenatus Say, 1824, Appendix Vol. II, Keating's Expedition to Source of St. Peter's River Under Maj. Long, p. 275.

DIAGNOSTIC DESCRIPTION:

ADULTS—Body dark brown; in dorsal view lateral margins of pronotum in anterior third slightly rounded and either parallel or angled anteromedially, appearing to clasp head; elytron faintly vittate, bimaculate, or nearly immaculate in Louisiana specimens, humeral spot not covering umbone; elytron with base of third interval strongly elevated (Fig. 8.4); surface of femur granulate; last tarsal segment not distinctly longer than previous 4 combined (Fig. 4.7); male with very indistinct swelling or ridge, perhaps only a few enlarged spines, on inner surface of middle tibia; penis stout and blunt-tipped, lateral

processes broadly rounded (Fig. 9.4); 3.31-3.67 mm long, 1.27-1.47 mm wide.

COMMENTS: There is considerable doubt as to whether Louisiana specimens are *S. crenata* or represent an undescribed species. Material redescribed by Sanderson (1938) as *S. crenata* may not be conspecific with the species Say described from Pennsylvania (Brown, pers. com., Jan. 29 1984, Apr. 19 1984). In addition, there are the following differences between our specimens and Sanderson's redescription: (1) the elytra are significantly longer and do not appear as described, (2) the elytral vittae/maculae are very faint to invisible, (3) the male mesotibial ridges are barely visible. The shape of the pronotum is characteristic and unlike that of other Louisiana species. *Stenelmis crenata*? is more robust than either *S. sinuata* or *S. bicarinata* and is much more granulate than the latter. *Stenelmis lateralis* is our only other species having the last tarsal segment not distinctly longer than the previous 4 combined.

SPECIMENS EXAMINED: 15 adults.

GEOGRAPHIC RANGE: Entire eastern North America from Newfoundland and Quebec to northern Florida, west to Minnesota, Kansas, Oklahoma, and Texas (Brown, 1976, 1983c).

DISTRIBUTION IN LOUISIANA: Collected only in the southeastern ("Florida parishes") part of the state in the Lake Pontchartrain, Lower Mississippi River, and Pearl River drainage basins (Fig. 16.2).

LOUISIANA RECORDS: EAST FELICIANA P.—Hurricane Creek, Woodland Creek; WASHINGTON P.—Hays Creek, Mill Creek, Silver Creek; WEST FELICIANA P.—Bayou Sara, W. Feliciana Parish (LSUC).

HABITAT: Small- and medium-sized streams with sand and gravel substrates, most often on gravel and roots.

Stenelmis grossa Sanderson, 1938
Figs. 8.5, 9.5; Map, Fig. 16.3

Stenelmis grossa Sanderson, 1938, *Univ. Kansas Sci. Bull.* 25(22):686.

DIAGNOSTIC DESCRIPTION:

ADULTS—Dark brown to black; shape of lateral pronotal margins very variable; elytron bimaculate, often faintly, humeral spot not covering umbone; elytron with base of third interval strongly elevated (Fig. 8.5); surface of femur punctate; last tarsal segment distinctly longer than previous 4 combined (Fig. 4.6); male with swelling or ridge on inner surface of middle tibia (Fig. 4.5); penis stout, lateral processes subangulate anteriorly (Fig. 9.5); large, 3.25-3.60 mm long, 1.25-1.40 mm wide.

COMMENTS: *Stenelmis grossa* may superficially resemble *S. sinuata*, but it is our only species without granulate femora. This character is best seen when the beetle is dry. The elytra range from faintly quadrimaculate to immaculate, and the shape of the lateral pronotal margins is extremely variable.

SPECIMENS EXAMINED: 937 adults.

GEOGRAPHIC RANGE: The Gulf Coastal Plain only; Alabama, Mississippi, Louisiana, Arkansas, Texas, and Oklahoma (Brown, 1983c; Eiland, 1979).

DISTRIBUTION IN LOUISIANA: Statewide with the exception of the deltaic plain. Rare in the alluvial plains of the Red and Mississippi rivers. Occurs in the following drainage basins: Atchafalaya River, Calcasieu River, Lake Pontchartrain, Lower Mississippi River, Mermentau-Vermilion-Teche Rivers, Ouachita River, Pearl River, Red River, Sabine River, and Terrebonne (Fig. 16.3).

LOUISIANA RECORDS: ACADIA P.—Bayou Plaquemine Brule, Long Point Gully; ALLEN P.—Bayou Blue, Calcasieu River, Mitchell Creek, Soap-

stone Creek, trib. Calcasieu River; A-VOYELLES P.—Coulee des Grues (LSUC); BEAUREGARD P.—Bundick Creek (2), Hickory Branch, Johns Gully; BIENVILLE P.—Cypress Creek, Leatherman Creek, Redfield Branch, SE Arcadia (HPB), NE Bienville (HPB); BOS-SIER P.—Martin Creek, trib. Little Cypress Bayou; CADDO P.—Cypress Bayou, Flag Branch, Myrtis Mill Creek, Pawpaw Bayou, Shettleworth Bayou; CALCASIEU P.—Buxton Creek; CALDWELL P.—Castor Creek, trib. Flat Creek; CATAHOULA P.—Bushley Creek, Bushley Creek (LSUC), Haggerty Creek, trib. Birds Creek; CLAIBORNE P.—Middle Fork Bayou d'Arbonne; DE SOTO P.—Bull Bayou, Caney Bayou; EAST BATON ROUGE P.—Beaver Bayou, 1.2 mi S Central (1) (LSUC); EAST FELICIANA P.—Amite River, Little Comite Creek (LSUC), Redwood Creek; EVANGELINE P.—Bayou des Cannes, Bayou Cocodrie (USL), Bayou Grand Louis, Bayou Nezpique (1,2); GRANT P.—Gray Branch, Nantachie Creek, Stuart Lake Rec. Area (LSUC); JACKSON P.—trib. Edwards Branch; JEFFERSON DAVIS P.—Bayou Serpent, trib. East Bayou Lacassine; LA SALLE P.—Doyle Branch, Hemphill Creek; LINCOLN P.—trib. Choudrant Creek; LIVINGSTON P.—Blood River, Little Colyell Creek, Spillers Creek, trib. Natalbany River, West Colyell Creek; MOREHOUSE P.—Chemin-a-Haut Bayou (2); NATCH-ITOCHE P.—Malaudos Creek, Santabarb Creek; OUACHITA P.—Guyton Creek; POINTE COUPEE P.—Bayou Grosse Tete, Bayou Latenache Drainage Canal; RAPIDES P.—Castor Creek, Germany Branch (HPB), Hemphill Creek, Spring Creek; RED RIVER P.—trib. Black Lake Bayou, trib. Brushy Creek; SABINE P.—Bayou Scie; ST. HELENA P.—East Hog Branch; ST.

LANDRY P.—Bayou Mallet, Little Wauksha Bayou; ST. TAMMANY P.—Abita Creek, East Bedico Creek, Gum Creek, Honey Island Nature Trail (LSUC), Talisheek Creek (2); TAN-GIPAHOA P.—Selzers Creek; UNION P.—Bayou de Loutre, Cypress Creek, Little Corney Bayou, Meridian Creek; VERNON P.—Calcasieu River, East Anacoco Creek, Liberty Creek; WASHINGTON P.—Bonner Creek, Foster Creek, Mill Creek, North Carson Creek, Junction La. 16 & 60 (USL); WEBSTER P.—Caney Creek, Holder Creek, Indian Creek; WEST BATON ROUGE P.—Bayou Poydras; WEST FELICIANA P.—Alexander Creek, West Fork Thompson Creek; WINN P.—E trib. Kiesche Creek, Mill Creek.

HABITAT: Found in all types of streams and rivers, occurs most often on gravel, wood, or roots.

Stenelmis lateralis Sanderson, 1938

Figs. 8.6, 9.6; Map, Fig. 16.4

Stenelmis lateralis Sanderson, 1938, *Univ. Kansas Sci. Bull.* 25(22):672.

DIAGNOSTIC DESCRIPTION:

ADULTS—Dark brown to black; elytron distinctly vittate, vitta broad, covering umbone and widened in apical third, extending from stria 1 to interval 6 (Fig. 8.6); surface of femur granulate; apical tarsal segment not distinctly longer than previous 4 combined (Fig. 4.7); male with swelling or ridge on inner surface of middle tibia (Fig. 4.5); penis narrowed medially and blunt-tipped, lateral processes absent (Fig. 9.6); 2.65-3.00 mm long, 0.95-1.10 mm wide.

COMMENTS: Unmistakable due to its small size and broad elytral vittae which cover most of the elytral space and extend laterad at the umbones and near the apices. The last tarsal segment is not distinctly longer than the previous 4 combined, a character that it shares



Fig. 16. The known distribution of Elmidae in Louisiana: 1, *Stenelmis convexula*; 2, *S. crenata*?; 3, *S. grossa*; 4, *S. lateralis*; 5, *S. sinuata*; 6, *Stenelmis* n. sp.

with *S. crenata*?. Like *Stenelmis* n. sp., this species has no lateral processes on the penis.

SPECIMENS EXAMINED: 9 adults.

GEOGRAPHIC RANGE: Scattered locations in the eastern and midwestern United States; recorded from Pennsylvania, Virginia, South Carolina, Tennessee, Missouri, Kansas, Oklahoma, Arkansas, Louisiana, Mississippi, and Alabama (Barr, 1981; Brown, 1976, 1983c; Eiland, 1979; Huggins et al., 1976; Morse et al., 1980). Louisiana records may be the most southern for the species.

DISTRIBUTION IN LOUISIANA: Collected only at 3 locations in the southeastern ("Florida parishes") part of the state in the Lake Pontchartrain and Pearl River drainage basins (Fig. 16.4).

LOUISIANA RECORDS: EAST BATON ROUGE P.—1.2 mi S Central (2) (LSUC); EAST FELICIANA P.—Idlewild Expt. Sta. (LSUC); WASHINGTON P.—Mill Creek.

HABITAT: The Washington Parish site is a small stream with a sand and gravel substrate and brown-stained, acidic waters. The beetles were collected in gravel riffles.

Stenelmis sinuata LeConte, 1852

Figs. 8.7, 9.7; Map, Fig. 16.5

Stenelmis sinuatus LeConte, 1852, *Proc. Acad. Nat. Sci. Phila.* 6:44.

DIAGNOSTIC DESCRIPTION:

ADULTS—Dark brown to black; pronotum distinctly granulate and with prominent tubercles, basal tubercles carinate; lateral margins of pronotum crenate and strongly divergent in anterior third; elytron usually bimaculate, often faintly, humeral spot not covering umbone; elytron with base of third interval strongly elevated, each stria with large, deep punctures (Fig. 8.7); surface

of femur granulate; last tarsal segment only slightly longer than previous 4 combined; male without swelling or ridge on inner surface of middle tibia; penis slender and blunt-tipped, lateral processes narrowly rounded (Fig. 9.7); 3.20-3.45 mm long, 1.20-1.35 mm wide.

COMMENTS: This species differs from *S. crenata*? in having the last tarsal segment slightly longer than the previous 4 combined and by having the pronotum flared outward in the anterior third. The degree of pronotal flaring and lateral situation varies among individuals. *Stenelmis bicarinata* does not exhibit this pronotal character, and in addition, larger pronotal granulations and deeper elytral punctures cause *S. sinuata* to appear much more sculptured. Most specimens exhibit faint maculae, but a few are unmarked. Louisiana males have no mesotibial ridges. Sanderson (1938) concluded, probably from the lack of such ridges, that all of the 11 specimens he examined were females. Brown (pers. com., Feb. 25 1981, Jan. 29 1984) believes that this species may ultimately be split on the basis of genitalic differences. It appears that all of our specimens are of the same type.

SPECIMENS EXAMINED: 76 adults.

GEOGRAPHIC RANGE: The Atlantic and East Gulf coastal plains of the southeastern United States from South Carolina to Louisiana (Brown, 1983c). Louisiana records are the most western for the species.

DISTRIBUTION IN LOUISIANA: Collected only in the southeastern part of the state in St. Tammany and Washington parishes from the Pearl River and adjacent Lake Pontchartrain drainage basins (Fig. 16.5).

LOUISIANA RECORDS: ST. TAMMANY P.—Gum Creek, Talisheek

Creek (1,2); WASHINGTON P.—Bonner Creek, Foster Creek, Mill Creek, North Carson Creek, Pushepatapa Creek, Silver Creek.

HABITAT: Small- and medium-sized streams with sand and/or gravel substrates. Present in a variety of microhabitats, but most often on gravel, roots, and wood.

Stenelmis new species near
decorata Sanderson, 1938

Figs. 8.8, 9.8; Map, Fig. 16.6

DIAGNOSTIC DESCRIPTION:

ADULTS—Dark brown; pronotum nearly equal in width at base and apex; elytron vittate, bimaculate, or nearly immaculate, humeral spot not covering umbone (Fig. 8.8); surface of femur granulate; last tarsal segment longer than previous 4 combined (Fig. 4.6); male with swelling or ridge on inner surface of middle tibia (Fig. 4.5); penis slender and blunt-tipped, lateral processes absent (Fig. 9.8); 2.50-2.80 mm long, 0.90-1.00 mm wide.

COMMENTS: Description of this species is pending. It is most closely related to *S. decorata*, a more northern and eastern species, which also lacks lateral processes on the penis. Unlike that species, the elytral vittae are not always entire. The new species is also considerably smaller. The genitalia are similar to those of *S. lateralis*, which also lacks lateral processes, but *S. lateralis* has much broader elytral vittae.

SPECIMENS EXAMINED: 120 adults.

GEOGRAPHIC RANGE: Alabama to Texas (Brown, pers. com., May 30 1980).

DISTRIBUTION IN LOUISIANA: North-central, central, and southeastern ("Florida parishes") parts of the state. Collected at only a few localities in the Lake Pontchartrain, Ouachita River,

Pearl River, and Mermentau-Vermilion-Teche Rivers drainage basins (Fig. 16.6).

LOUISIANA RECORDS: ACADIA P.—Long Point Gully; EAST BATON ROUGE P.—1.2 mi S Central (2) (LSUC); EVANGELINE P.—Bayou des Cannes; GRANT P.—Stuart Lake Rec. Area (LSUC); JEFFERSON DAVIS P.—trib. East Bayou Lacassine; LIVINGSTON P.—Denham Springs (LSUC); MOREHOUSE P.—Chemin-a-Haut St. Pk. (LSUC); ST. TAMMANY P.—Honey Island Nature Trail (LSUC).

HABITAT: Clay- or mud-bottomed streams and rivers, on wood or gravel.

DISTRIBUTIONAL PATTERNS OF SPECIES

Geographical Distribution

General.—The dryopoid fauna of Louisiana consists mainly of eastern and coastal plain species. Eastern species are defined as those occurring primarily east of the 100th meridian (from North Dakota to Texas), while coastal plain species occur in the coastal plain from New Jersey southwest to Texas (Bick, 1957). Although several western species occur in Texas, none has been collected in Louisiana. Eleven of the 25 dryopoids occurring in the state are eastern species: *Ectopria thoracica*, *Helichus basalis*, *H. fastigiatus*, *H. lithophilus*, *Pelonomus obscurus*, *Ancyronyx variegata*, *Macronychus glabratus*, *Optioservus trivittatus*, *Stenelmis bicarinata*, *S. crenata*?, and *S. lateralis*. The records of *O. trivittatus* from the "Florida parishes" represent a significant range extension for the species to the southwest. White (1978) reported it from as far south as eastern Tennessee; however, there are recent unpublished records of the species from northern Alabama (Eiland, 1979) and southern Mississippi (Stark, pers. com.,

Jan. 9 1981). Localities for *H. basalis* and *S. lateralis* in the "Florida parishes" are possibly the most southern records. Six dryopoids are coastal plain species: *G. dietrichi*, *S. antennalis*, *S. convexula*, *S. grossa*, *S. sinuata*, and *Stenelmis* n. sp. The *G. dietrichi*, *S. antennalis*, *S. convexula*, and *S. sinuata* records are westward range extensions. Six species were collected only east of the Mississippi River: *G. dietrichi*, *O. trivittatus*, *S. convexula*, *S. crenata*?, *S. lateralis*, and *S. sinuata*. *Dubiraphia parva* was the only species collected exclusively west of the river. The records of *S. antennalis* from Beauregard, Grant, and Vernon parishes are the first reports of this species west of the river. *Dubiraphia vittata* and *M. pusillus* are nearly transcontinental in distribution. The complete ranges of *D. brevipennis*, *D. harleyi*, *D.*

parva?, and *Dubiraphia* n. spp.? are not known.

Of the 191 sites sampled, 138 were productive (i.e., dryopoids were collected). The 53 unproductive sites are scattered throughout the state, but certain patterns were observed and will be discussed in the following section on physiography and vegetation.

Species were not uniformly distributed in the state; while some areas were rich in species, others appeared to be entirely devoid of dryopoids. Some species were widespread and common almost everywhere; others had very localized distributions or were infrequently collected at scattered localities. The commonness of each species in the state was calculated as a percentage of the total number of productive collections (N = 142), illustrated

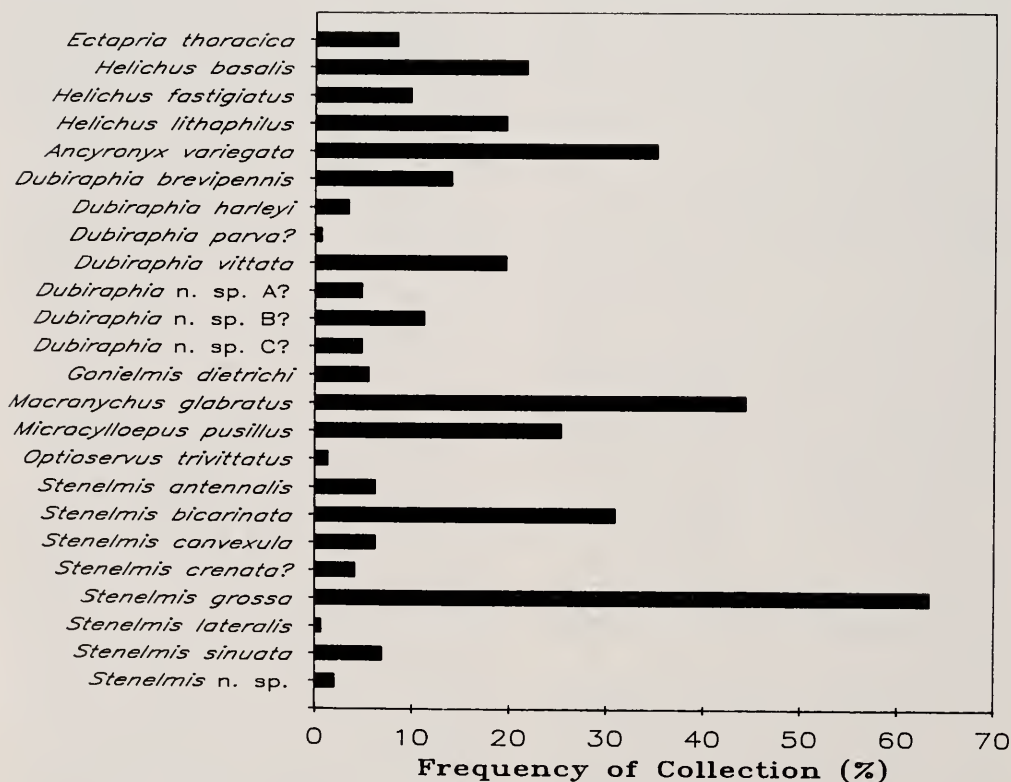


Fig. 17. Commonness of dryopoid species in Louisiana based on frequency of collection (N = 142).

in Figure 17. Productive collections exceeded productive sites (138) due to multiple collections at 3 sites (see Materials and Methods, Selection of Sites). *Stenelmis grossa* was the most frequently collected species occurring in 63% of the samples, followed by *M. glabratus* in 44%, *A. variegata* in 35%, *S. bicarinata* in 31%, and *M. pusillus* in 25%. Less than 3% of samples included *D. parva?*, *O. trivittatus*, *S. lateralis*, or *Stenelmis* n. sp. *Pelonomus obscurus* was not collected during the study.

Excluding the coastal area south of Lake Pontchartrain, a general decrease in the number of species was noted from south to north, as well as east to west in the southern half of the state. Eleven species were collected in the 2 northernmost tiers of parishes while all 25 species occurred in the parishes to the south. Seven species of dryopoids are curiously absent from the northern quarter of the state but occur in central and west-central Louisiana: *E. thoracica*, *H. lithophilus*, *D. brevipennis*, *D. harleyi*, *D. parva?*, *Dubiraphia* n. sp. C?, and *S. antennalis*. The ranges of all of these species except *D. harleyi*, *Dubiraphia* n. sp. C?, and *S. antennalis* are known to extend north of Louisiana. There were no species unique to the northern part of the state.

LeSage and Harper (1975) concluded that latitude and physiography determined by underlying geologic formations were probably the major factors governing the distribution of dryopoid species in Quebec. They noted a decrease in the number of species from south-to-north, with 31 species occurring near the 45th parallel decreasing to only 2 north of the 50th parallel. It was also observed that Quebec's 3 major geologic regions each had a distinctive dryopoid fauna and water chemical characteristics. Mingo (1979), in a study

of riffle beetle distribution in Maine, found that an interaction of latitude and altitude was responsible for observed patterns, with the effects of latitude similar to those noted by LeSage and Harper. All but one of 27 species occurred at the 45th parallel, decreasing to 10 species at about the 47th parallel in northern Maine. The north-south distributions of Louisiana dryopoids are somewhat similar to the latitude effects described by LeSage and Harper and Mingo. However, in Quebec and Maine it is likely that the species involved are at the northernmost limits of their ranges at those latitudes, and hence exhibit a south-to-north decline. In Louisiana the number of coastal plain species decreases northward as the Fall Line, which passes through southern Arkansas, is approached. All of the 6 coastal plain species in the state occur east of the Mississippi River, 3 of them occur west of the river in central Louisiana, but only 2, *S. grossa* and *Stenelmis* n. sp., reach the northern boundaries of the state. It would be interesting to know if a similar north-south trend occurs in Mississippi.

Twenty-four species were collected east of the Mississippi River and 19 west of the river. Fifteen were found in the westernmost parishes. Of the 6 found exclusively east of the river, 3 are coastal plain species and 3 are eastern species. All of these occurred solely in sandy/gravelly streams. Thirteen of the 19 species found west of the river were collected in the alluvial plain where streams are typically sluggish and mud- or clay-bottomed. Four of the remaining 6 species were collected only from sandy/gravelly streams; 2 were found both in sandy- and clay-bottomed streams. None were from streams with mud substrates. Because of lack of habitat diversity, it appears that the Mis-

TABLE 3. Frequency of collection of dryopoid species in the physiographic-vegetation zones of Louisiana from May 1979 to May 1981. * denotes non-study record.

SPECIES	% PINE- LANDS (N)	% OAK/ PINE (N)	% UPLAND HARDWOOD (N)	% PRAIRIE (N)	% ALLUVIAL PLAIN (N)	% DELTAIC PLAIN (N)	Total N	# of Zones
<i>E. thoracica</i>	91.67 (11)		8.33 (1)				12	2
<i>H. basalis</i>	77.42 (24)	9.68 (3)	12.90 (4)				31	3
<i>H. fastigiatus</i>	92.86 (13)		7.14 (1)				14	2
<i>H. lithophilus</i>	78.57 (22)		17.86 (5)		3.57 (1)		28	3
<i>P. obscurus</i>					*	*	0	2
<i>A. variegata</i>	84.00 (42)	6.00 (3)	4.00 (2)		6.00 (3)		50	4
<i>D. brevipennis</i>	80.00 (16)		5.00 (1)	5.00 (1)	10.00 (2)		20	4
<i>D. harleyi</i>	40.00 (2)		20.00 (1)	20.00 (1)	20.00 (1)		5	4
<i>D. parva?</i>	100.00 (1)						1	1
<i>D. vittata</i>	82.14 (23)		3.57 (1)		14.29 (4)		28	3
<i>D. n. sp. A?</i>	85.71 (6)				14.29 (1)		7	2
<i>D. n. sp. B?</i>	62.50 (10)			18.75 (3)	18.75 (3)		16	3
<i>D. n. sp. C?</i>	85.71 (6)	14.29 (1)					7	2

<i>G. dietrichi</i>	87.50 (7)				12.50 (1)	8	2
<i>M. glabratus</i>	82.54 (52)	4.76 (3)	6.35 (4)		6.35 (4)	63	4
<i>M. pusillus</i>	83.33 (30)	2.78 (1)	5.56 (2)		8.33 (3)	36	4
<i>O. trivittatus</i>	100.00 (2)					2	1
<i>S. antennalis</i>	88.89 (8)	11.11 (1)				9	2
<i>S. bicarinata</i>	88.64 (39)	6.82 (3)	2.27 (1)		2.27 (1)	44	4
<i>S. convexula</i>	100.00 (9)				*		
<i>S. crenata?</i>	83.33 (5)		16.67 (1)			9	2
<i>S. grossa</i>	66.67 (60)	14.44 (13)	2.22 (2)	3.33 (3)	13.33 (12)	6	2
<i>S. lateralis</i>	100.00 (1)					90	5
<i>S. sinuata</i>	70.00 (7)				30.00 (3)	1	1
<i>S. n. sp.</i>	*	33.33 (1)		33.33 (1)	33.33 (1)	10	2
# of Species (N = 25)	24	9	13	5	16	1	
% of Total	96.00	36.00	52.00	20.00	64.00	4.00	
# of Collections (N = 142)	102	14	6	4	16	0	
% of Total	71.83	9.86	4.23	2.82	11.27	0	

Mississippi Embayment is a partial barrier to westward dispersal of riffle beetles in Louisiana. Species that prefer sandy/gravelly streams may not be able to disperse the 50-100 mi (80-160 km) distance across the Mississippi alluvial plain to suitable habitat. Findings in this respect agree with those of Bick (1957) and Louton (1975). Unfortunately, little information is available about how far aquatic dryopoids disperse.

Physiographic-Vegetation Zones.—The frequency of collection of species from 5 of the zones illustrated in Figure 1 are contained in Table 3. A total of 72% of the productive collections were from pineland streams, 11% were from the alluvial plain, and 10%, 4%, and 3% were from oak-pine, upland hardwood, and prairie areas, respectively. No dryopoids were found in the deltaic plain during the study; however, *P. obscurus* had been previously collected in the region. All of the sites sampled in the area were probably unproductive because of habitat unsuitability. Likewise, riffle beetles were not found in the Mississippi River alluvial plain in the northeast corner of the state above Avoyelles Parish despite several collecting attempts. This highly agricultural area has been known for extensive pesticide use in past years, a factor that may have eliminated or reduced dryopoid populations, if, in fact, they ever existed. There are 2 literature records from this area, *S. grossa* from East Carroll and Madison parishes (Table 1).

The species richness of zones can be compared by noting the total number of species occurring in each (Table 3). Non-study records, denoted by asterisks, are also shown. Twenty-four species have been collected in the pine-lands, 16 in the alluvial plain, 13 in upland hardwoods, 9 in oak-pine areas, 5

in the prairie, and one in the deltaic plain. Only the pineland zone had unique species (*D. parva*?, *O. trivittatus*, and *S. lateralis*) not occurring elsewhere, but the sample sizes for these were very small (<3). The majority of collections of 20 other species were from the pine-lands. Besides *P. obscurus*, *Stenelmis* n. sp. was the only species not collected in pine areas during the study. However, it has been taken at lights in the pinelands of East Baton Rouge, Livingston, and Morehouse parishes. *Stenelmis grossa* was found in all zones except the deltaic plain. *Pelonomus obscurus* has been collected by others in the alluvial and deltaic plains.

Although dryopoids are much less mobile than Odonata, a pattern of distribution strikingly similar to that noted by Bick (1957) was observed. Bick found that the greatest number of species occurred in pine-lands, many exclusively, while only one was restricted to the delta and none to the prairie or alluvium. He also stated that the prairie, alluvial, and deltaic regions offered little variety in habitat and shared many of the same species. His conclusion that varied topography and habitat diversity in the pine-lands are responsible for species richness seems applicable to dryopoids as well. However, the absence of all species except *P. obscurus* from the deltaic plain and the Mississippi alluvial plain south of Lake Pontchartrain is puzzling, since a few species do occur in similar lentic or very slow current situations elsewhere in the state.

Drainage Basins.—Species richness of basins (Fig. 2) can be compared by noting the total number of species (Table 4) that were collected in each. Non-study records, denoted by asterisks, are also shown. The greatest number of species, 21, were found in the Pearl

River Basin which has the second smallest land area, 2% (Table 2); *H. basalis*, *P. obscurus*, *D. parva?*, and *Dubiraphia* n. sp. C? were not collected. The second largest number of species, 20, were collected in the Lake Pontchartrain Basin. The only species not recorded there were *E. thoracica*, *P. obscurus*, *D. harleyi*, *D. parva?*, and *O. trivittatus*. *Ectopria thoracica* probably does occur in the basin since it was collected in the Pearl River Basin to the east and the Lower Mississippi River Basin to the west. Three basins had poor dryopoid faunas. No riffle beetles were collected in the Barataria Bay Basin during the present study, but an earlier collection of *P. obscurus* from the area was examined. Only *S. grossa* was collected in the Terrebonne Basin at sites located in the upper portion. Three species, *D. harleyi*, *Dubiraphia* n. sp. B?, and *S. grossa*, were recorded from the upper Atchafalaya River Basin. Twelve or more species occurred in each of the remaining basins except for the Upper Mississippi River Basin which was not sampled. One of the factors involved in the comparatively greater species richness of the Pearl River and Lake Pontchartrain basins is that they have 4 species (*G. dietrichi*, *O. trivittatus*, *S. convexula*, and *S. sinuata*) that are at the western limits of their ranges in the eastern "Florida parishes" and do not cross the Mississippi Embayment to the western basins. Habitat variety, discussed by Bick (1957) in reference to physiographic-vegetation zones, is probably also important in influencing the species richness of drainage basins. The Lake Pontchartrain Basin, with the second greatest number of species, had the greatest number of stream types or substrates (Table 2); only one or 2 substrates (mud and/or clay) were present in the relatively unproductive Atchafalaya, Bara-

taria, and Terrebonne basins. In contrast, while only 2 substrates each were sampled in the Sabine (sand and mud), and Lower Mississippi and Pearl (sand and gravel) drainages, these yielded 12, 14, and 21 species, respectively. Therefore, it is apparent that more than just substrate diversity within basins is involved. The availability of microhabitats within the stream, related to stream type, is also undoubtedly a factor.

In reporting Oklahoma dryopoid records, Sanderson and Brown (1959) and Brown (1960) noted that each species had been collected in only one major watershed, and then usually just in a limited part, suggesting ecological differences in streams. In Louisiana it appears that while some species seem to be restricted to certain watersheds, others are widespread and occur in many. Table 4 gives the frequency of collection of dryopoid species within 11 of the state's 12 drainage basins, including non-study records denoted by asterisks. *Stenelmis grossa* was collected in 10 basins, followed by *H. lithophilus*, *A. variegata*, *D. vittata*, *M. glabratus*, *M. pusillus*, and *S. bicarinata* in 8, and *E. thoracica* in 7. The most restricted species were *D. parva?* in the Ouachita Basin and *O. trivittatus* in the Pearl Basin; *G. dietrichi*, *S. convexula*, *S. lateralis*, and *S. sinuata* were collected only in the Pearl and Lake Pontchartrain basins; *S. crenata?* was collected in all 3 basins of the "Florida parishes." *Helichus basalis*, a common species collected at 31 sites in 6 basins, was apparently absent from the Pearl River Basin although it occurs farther east in Alabama and west in Louisiana. Like *H. lithophilus*, it may be found with additional collecting.

In general, it appears that most Louisiana species do not exhibit watershed or drainage basin specificity. Essentially the same species are found

in the central and west-central parts of the state in the adjacent sections of 5 drainage basins, all of which are within the pinelands. The species assemblages in the 3 basins of the "Florida parishes" are similar, excluding those species which reach their western limits in the Pearl River and adjacent Lake Pontchartrain basins.

Seagle and Hendricks (1979) classified 15 dryopoids as upper and/or lower basin species in their study of the South Fork of the Shenandoah River Basin, Virginia. They found that 2 species, including *A. variegata*, were restricted to the upper basin and 2 to the lower basin; the remainder were non-specific. A decrease in abundance and species diversity was also noted from upstream to downstream (1978). Likewise, Mingo (1979) divided the species in his study into upland, lowland, and generally distributed species. Although Louisiana exhibits little topographical variation, rolling uplands are present in the northern "Florida parishes" and in most of the west and central regions. The upper and lower portions of drainage basins can be delineated geographically. Several species have been collected only in the upper or upland regions of some or all of their basins. In the "Florida parishes," records of *H. fastigiatus*, *G. dietrichi*, *O. trivittatus*, *S. antennalis*, *S. crenata*?, and *S. lateralis* were clustered in the uplands of the 3 basins. Ten species were absent from the prairie region of the lower Mermentau-Vermilion-Teche Basin, but occurred in the pinelands of the upper basin and lower portions of adjacent basins: *E. thoracica*, *H. fastigiatus*, *H. lithophilus*, *A. variegata*, *D. vittata*, *Dubiraphia* n. sp. C?, *M. glabratus*, *M. pusillus*, *S. antennalis*, and *S. bicarinata*. In this case, however, it appears that absence is governed by the lack of suitable

habitat in the prairie region rather than by preference for a particular section of the basin. Contrary to Young (1954), LeSage and Harper (1975), and Mingo (1979), *A. variegata* was not found to be exclusively an upland or upper basin species in Louisiana.

Seasonal and Monthly Occurrence

LeSage and Harper (1976a) reported a 3-4 year life cycle for 5 species of elmids in Quebec, with overwintering occurring in both adult and larval stages. Psephenid larvae and the adults and larvae of several elm mid species were reported as occurring year-round in Wisconsin by Hilsenhoff et al. (1972). Similarly, adults and larvae have been collected in Louisiana during all seasons, although it is likely that subadult stages, and therefore life cycles, are shorter due to our mild climate.

Data representing monthly records for the species are contained in Table 5. As mentioned previously, results are probably biased towards the summer months of June, July, and August during which 62% of the sampling was done. Also, the most common species in the state, indicated by the number of sites at which each occurred, have the most complete monthly records. Thus, while the presence of a species is an absolute, its absence for a particular month may or may not be of significance.

Adult and larval dryopoids were collected during 11 and 10 months of the year, respectively. The adults and/or larvae of the following have been collected during all seasons: *H. basalis*, *H. fastigiatus*, *A. variegata*, *D. vittata*, *M. glabratus*, *M. pusillus*, *S. bicarinata*, *S. grossa*, and *Stenelmis* larvae. With the exception of *H. fastigiatus* and addition of *H. lithophilus*, these are also the most com-

mon species in the state, each occurring in more than 27 samples. Although January is devoid of species records, adults and larvae are undoubtedly present since samples including the following species were taken December 26, 28, and 29: *E. thoracica*, *H. basalis*, *H. lithophilus*, *A. variegata*, *M. glabratus*, *M. pusillus*, *S. bicarinata*, *S. grossa*, and *Stenelmis* larvae. *Dubiraphia* larvae were collected only from April to November; adults showed a similar concentration except for the record of *D. vittata* in February.

It seems likely that additional sampling in appropriate localities would verify year-round distributions for the aquatic adults and larvae of all species. However, adults appeared to be scarcer in the colder months because of depressed population levels and/or reduced activity.

CONCLUSION

A total of 5,688 specimens, 4,060 adults and 1,628 larvae, were collected and examined during the study. An additional 209 adult specimens and 19 larvae have been examined since then. Twenty-five species of aquatic Dryopoidea have been found in Louisiana, one psephenid, 4 dryopids, and 20 elmids. One of these, *Pelonomus obscurus*, was not collected during this study. Twenty-two species are reported in the state for the first time, including one undescribed species of *Stenelmis* and possibly 3 of *Dubiraphia*. Taxonomic problems involving Louisiana species exist in the genera *Dubiraphia*, *Stenelmis*, and perhaps *Microcylloepus*.

Thirty-six species of aquatic Dryopoidea have been reported from North and South Carolina (Brigham, 1982), 32 from Pennsylvania (Finni et al., 1978), 31 from Quebec (LeSage and Harper, 1975), 30 from Wisconsin

(Hilsenhoff, 1975), 26 from Maine (Mingo, 1979) and California (Leech and Chandler, 1956), 22 from Oklahoma (Brown, 1956, 1960, 1966; Brown and Shoemaker, 1964a; Sander-son and Brown, 1959), and 14 from Florida (Young, 1954). In studies of Dryopidae and Elmidae only, 24 species were recorded from Indiana (Finni and Skinner, 1975) and 23 from Kansas (Huggins, et al., 1976; Brown and Huggins, 1977). Eiland (1979) found 31 species of Elmidae in Alabama. Louisiana, with 25 species, apparently has a more restricted fauna than most of the states that have been surveyed. However, considering that the state lies within a single physiographic province and lacks the rocky streams which are reported to be choice riffle beetle habitat, the number of species occurring here is considerable.

The dryopoid fauna of Louisiana consists mainly of eastern and coastal plain species, 11 and 6 species, respectively. Two are distributed transcontinentally, while the ranges of the remaining 6 species are largely unknown. No western species were encountered. The records of 7 species may represent southward and/or westward range extensions; 4 of these are coastal plain species at the western limits of their ranges in the "Florida parishes." *Optioservus trivittatus* was found a considerable distance outside of its published range. *Stenelmis antennalis* is reported for the first time west of the Mississippi River.

The most common species in the state were *S. grossa* in 63% of the collections, *M. glabratus* in 44%, *A. variegata* in 35%, *S. bicarinata* in 31%, and *M. pusillus* in 25%. In general, the number of species decreases from south to north (excluding the deltaic plain) and from east to west in the southern half of the

TABLE 5. Monthly records of dryopoid larvae (L) and adults (A) in Louisiana from May 1979 to May 1981.

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	# of Months (L/A)
<i>E. thoracica</i>					L	L	L		L			L	5/-
<i>H. basalis</i>		A			A	A	A	A	A		A	A	-8
<i>H. fastigiatus</i>		A		A		A	A	A	A				-6
<i>H. lithophilus</i>						A	A	A	A	A	A	A	-7
<i>A. variegata</i>		L		L/A	A	L/A	L/A	L/A	L/A	A	L/A	L/A	8/9
<i>D. brevipennis</i>				A	A	A	A	A	A		A		-7
<i>D. harleyi</i>						A		A					-3
<i>D. parva?</i>							A						-1
<i>D. vittata</i>		A		A	A	A	A	A	A		A		-8
<i>D. n. sp. A?</i>				A	A	A	A	A	A		A		-7
<i>D. n. sp. B?</i>					A	A	A	A	A				-5
<i>D. n. sp. C?</i>							A		A		A		-3
<i>D. spp. larvae</i>				L	L	L	L	L	L		L		7/-
<i>G. dietrichi</i>				L/A	L/A		A	L/A					3/4
<i>M. glabratus</i>		L/A		L/A	L/A	A	L/A	L/A	L/A	L/A	L/A	L/A	9/10
<i>M. pusillus</i>		A		L/A	A	A	L/A	L/A	L/A			L/A	5/8
<i>O. trivittatus</i>				L/A			A	L/A					2/3
<i>S. antennalis</i>				A	A	A	A	A					-5
<i>S. bicarinata</i>				A	A	A	A	A	A		A	A	-8
<i>S. convexula</i>				A	A	A	A	A					-5
<i>S. crenata?</i>		A		A				A					-3
<i>S. grossa</i>		A	A	A	A	A	A	A	A	A	A	A	-11
<i>S. lateralis</i>								A					-1

<i>S. sinuata</i>	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A</
-------------------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	-----

state, perhaps due to the northern and western boundaries of the coastal plain species. The Mississippi alluvial plain apparently acts as a partial barrier to westward dispersal of species.

The pineland physiographic-vegetation zone was the richest in number of species with 24, while 16 species occurred in the alluvial plain, 13 in the upland hardwoods, 9 in oak-pine areas, 5 in the prairie, and one in the deltaic plain. Habitat diversity resulting from a variety of stream types probably affects the species richness of zones in a positive manner.

The Pearl River and Lake Pontchartrain drainage basins had the greatest number of species, 21 and 20, respectively. This is probably partly due to the presence of a variety of habitats and microhabitats and partly to the fact that several coastal plain species are at the limit of their ranges in these basins and occur no farther west in the state. Six species were found exclusively in the 3 basins of the "Florida parishes" east of the Mississippi River. Only *P. obscurus* has been recorded from the Barataria Bay Basin and only *S. grossa* from the Terrebonne Basin. *Stenelmis grossa* occurred in 10 of the 12 basins, followed by *H. lithophilus*, *A. variegata*, *D. vittata*, *M. glabratus*, *M. pusillus* and *S. bicarinata* in 8, and *E. thoracica* in 7. Most species did not exhibit watershed specificity or upper/lower basin distinctions. Those restricted to a single basin had sample sizes of one or 2 collections only. Some of the species occurring in the "Florida parishes" were collected in the upland areas only.

Monthly data indicate that the adults and larvae of all species are probably present year-round in Louisiana streams.

The largest number of species were collected in streams with sand and

gravel substrates. Excluding uncommon rocky streams, the smallest number of species were found in mud-bottomed watercourses. Many species exhibited microhabitat preferences. Future publications will further examine habitat and microhabitat selection by the aquatic dryopoids of Louisiana.

ACKNOWLEDGMENTS

The senior author would like to thank the members of her former graduate advisory committee, Dr. H. Bruce Boudreaux, Dr. Dan F. Clower, Dr. L. D. Newsom, and Dr. Abe D. Oliver, for their constructive criticisms of the research proposal and thesis on which this manuscript is based. The Department of Entomology and the Louisiana Agricultural Experiment Station are thanked for their financial support and generous travel provisions without which this project would not have been possible. The Department of Entomology also provided equipment, laboratory facilities, and the use of a computer terminal for manuscript preparation.

The Department of Experimental Statistics, including graduate assistants Michael T. Kearny and Glenn H. Itano, was instrumental in computer programming and consulting, and provided access to a computer terminal which proved invaluable during the study. A computer terminal at the Division of Research Services was also used in the early stages of manuscript preparation.

We are especially indebted to Dr. Harley P. Brown of the University of Oklahoma, Norman, a leading authority on aquatic dryopoids, for his species verifications and loans/donations of determined specimens. His advice and criticism throughout this study and preparation of the manuscript have been invaluable.

Karen Westphal's artistic contributions are also greatly appreciated. She was responsible for inking and supplying detail and finishing touches to the illustrations.

And lastly, the senior author wishes to express appreciation to her husband, James E. Barr, Sr., who served as chauffeur and equipment bearer on innumerable collecting trips, computer consultant and programmer many late nights on the terminal, and principal source of moral support always.

LITERATURE CITED

- ARNETT, R. H., JR. 1960. The beetles of the United States (A manual for identification). Part I. The Catholic University of America Press, Washington, D.C. xi + 1-210 p.
- . 1962. The beetles of the United States (A manual for identification). Part III. The Catholic University of America Press, Washington, D.C. 369-526 p.
- BARR, C. B. 1981. The aquatic Dryopoidea of Louisiana (Coleoptera: Psephenidae, Dryopidae, Elmidae). M.S. Thesis. Louisiana State University, Baton Rouge, Louisiana. 207 p.
- . 1984. *Dubiraphia harleyi*, a new species of riffle beetle from Louisiana (Coleoptera: Dryopoidea: Elmidae). J. Kans. Entomol. Soc. 57(2):336-339.
- BERTRAND, H. 1939. Les premiers états des *Eubria*. Latt. Bull. Mus. Hist. Nat., 2e ser. 11: 129-136, 291-299.
- . 1955. Notes sur les premiers états des Dryopides d'Amérique (Col.). Ann. de la Soc. Entomol. de France 124: 97-139.
- . 1965. Notes sur les premiers états des Dryopides d'Amérique (Col.) (Addendum). Bull. de la Soc. Entomol. de France 70: 163-166.
- BICK, G. H. 1957. The Odonata of Louisiana. Tulane Studies in Zoology 5(5): 71-135.
- BORROR, D. J., D. M. DELONG, and C. A. TRIPLEHORN. 1981. An introduction to the study of insects. 5th Edition. Saunders College Publishing, Philadelphia, Pennsylvania. 827 p.
- BRIGHAM, W. U. 1981. *Ectopria leechi*, a new false water penny from the United States (Coleoptera: Eubriidae). Pan-Pacific Entomol. 57(1): 313-320.
- . 1982. Aquatic Coleoptera, p. 10.1-10.136. In: A. R. Brigham, W. U. Brigham, and A. Gnika (eds.), Aquatic insects and oligochaetes of North and South Carolina. Midwest Aquatic Enterprises, Mahomet, Illinois. 822 p.
- BROWN, H. P. 1956. Riffle beetles in Oklahoma. Proc. Okla. Acad. Sci. 36: 38.
- . 1960. Oklahoma riffle beetles (Coleoptera: Dryopoidea). II. Additional county records. Proc. Okla. Acad. Sci. 40: 25-26.
- . 1966. Oklahoma riffle beetles (Coleoptera: Dryopoidea). V. New state and county records, with notes upon ecology. Proc. Okla. Acad. Sci. 46: 27-28.
- . 1970. A key to the dryopid genera of the New World (Coleoptera, Dryopoidea). Entomol. News 81: 171-175.
- . 1973. Survival records for elmids beetles, with notes on laboratory rearing of various dryopids (Coleoptera). Entomol. News 84: 278-284.
- . 1975a. A distributional checklist of North American genera of aquatic dryopoid and dascilloid beetles (Elmidae, Dryopidae, Limnichidae, Chelonariidae, Heteroceridae, Psephenidae, Ptilodactylidae, Cyphonidae, Georyssidae). Coleopterists Bull. 29(3): 149-160.
- . 1975b. Problems in identification of riffle beetles (Elmidae). Amer. Zool. 15(3): 815. Abstract.
- . 1976. Aquatic dryopoid beetles (Coleoptera) of the United States. Biota of Freshwater Ecosystems Identification Manual No. 6. Water Pollution Control Research Series, USEPA, Cincinnati, Ohio. 82 p.
- . 1980. A new genus and species of water beetle from Alabama (Psephenidae: Eubriinae). Trans. Amer. Micros. Soc. 99(2): 187-192.
- . 1981a. A distributional survey of the world genera of aquatic dryopoid beetles (Coleoptera: Dryopidae, Elmidae, and Psephenidae sens. lat.). Pan-Pacific Entomol. 57(1): 133-148.
- . 1981b. Updating the riffle beetle fauna of North America (Dryopoidea: Elmidae, Dryopidae, Psephenidae). Twentieth Annual Meeting, North American Benthological Society, Provo, Utah. April 27-30, 1981. Abstract.
- . 1983a. A catalog of the Coleoptera of America North of Mexico. Family: Psephenidae. U.S. Dept. of Agric. Handbook No. 529-41. 8 p.
- . 1983b. A catalog of the Coleoptera of America North of Mexico. Family: Dryopidae. U.S. Dept. of Agric. Handbook No. 529-49. 8 p.
- . 1983c. A catalog of the Coleoptera of America North of Mexico. Family: Elmidae. U.S. Dept. of Agric. Handbook No. 529-50. 23 p.
- . 1987a. Biology of riffle beetles. Ann. Rev. Entomol. 32:253-273.
- . 1987b. *Stenelmis cheryl*: new name for a well-known riffle beetle (Coleoptera: Elmidae). Entomol. News 98(3): 111-112.

- BROWN, H. P. and D. G. HUGGINS. 1977. Additions and corrections to the list of aquatic beetles of the families Dryopidae and Elmidae from Kansas. Tech. Publ. St. Biol. Surv. Kans. 4: 41-44.
- BROWN, H. P. and C. M. MURVOSH. 1974. A revision of the genus *Psephenus* (waterpenny beetles) of the United States and Canada (Coleoptera, Dryopoidea, Psephenidae). Trans. Amer. Entomol. Soc. 100: 289-340.
- BROWN, H. P. and C. M. SHOEMAKE. 1964a. Oklahoma riffle beetles (Coleoptera: Dryopoidea). III. Additional state and county records. Proc. Okla. Acad. Sci. 44: 42-43.
- . 1964b. Oklahoma riffle beetles (Coleoptera: Dryopoidea). IV. Ecology. Proc. Okla. Acad. Sci. 44: 44-46.
- BROWN, H. P. and D. S. WHITE. 1978. Notes on separation and identification of North American riffle beetles (Coleoptera: Dryopoidea: Elmidae). Entomol. News 89 (1&2): 1-13.
- BRUSVEN, M. A. 1970. Drift periodicity of some riffle beetles (Coleoptera: Elmidae). J. Kans. Entomol. Soc. 43(4): 364-371.
- BRYAN, C. F., D. J. DEMONT, D. S. SABINS, and J. P. NEWMAN, JR. 1976. Annual report: A limnological survey of the Atchafalaya Basin. Louisiana Cooperative Fishery Research Unit, Louisiana State University, Baton Rouge, Louisiana. 285 p.
- BURKE, H. R. 1963. Notes on Texas riffle beetles (Coleoptera, Elmidae). Southwest. Nat. 8(2): 111-114.
- COLLIER, J. E. 1969. A taxonomic revision of the genus *Optioservus* (Coleoptera: Elmidae) in the Nearctic region. Ph.D. Thesis. University of Minnesota, Minneapolis, Minnesota. University Microfilms, Inc., Ann Arbor, Michigan. 72 p.
- COWELL, B. C. and W. C. CAREW. 1976. Seasonal and diel periodicity in the drift of aquatic insects in a subtropical Florida stream. Freshwater Biology 6: 587-594.
- CROWSON, R. A. 1955. The natural classification of the families of Coleoptera. Nathaniel Lloyd, London. 187 p.
- . 1973. On a new superfamily Artematopoidea of polyphagan beetles, with definitions of two new fossil genera from the Baltic Amber. J. Nat. Hist. 7: 225-238.
- . 1978. Problems of phylogenetic relationships in Dryopoidea (Coleoptera). Entomol. Germ. 4(3/4): 250-257.
- DAVIS, C. 1942. Oxygen economy of *Coxelmis novemnotata* (King) (Coleoptera, Dryopidae). Proc. Linn. Soc. New South Wales 67: 1-8.
- DAVIS, M. M. and G. R. FINNI. 1974. Habitat preference of *Macronychus glabratus* Say (Coleoptera: Elmidae). Proc. Pa. Acad. Sci. 48: 95-97.
- DOYEN, J. T. and G. ULRICH. 1978. Aquatic Coleoptera, p. 203-231. In: R. W. Merritt and K. W. Cummins (eds.), An introduction to the aquatic insects of North America. Kendall/Hunt Publ. Co., Dubuque, Iowa. 441 p.
- EILAND, F. W., II. 1979. The Elmidae of Alabama. M.S. Thesis. Auburn University, Auburn, Alabama. 81 p.
- FINNI, G. R., E. C. MASTELLER, and R. L. HASSE. 1978. An annotated list of elmids, dryopids and psephenids from Pennsylvania (Coleoptera). Entomol. News 89(1&2): 17-26.
- FINNI, G. R. and B. A. SKINNER. 1975. The Elmidae and Dryopidae (Coleoptera: Dryopoidea) of Indiana. J. Kans. Entomol. Soc. 48(3): 388-395.
- GAUFIN, A. R. and C. M. TARZWELL. 1952. Aquatic invertebrates as indicators of stream pollution. Publ. Health Rep. 67(1): 57-64.
- . 1956. Aquatic macroinvertebrate communities as indicators of organic pollution in Lytle Creek. Sewage and Ind. Wastes 28(7): 906-924.
- GEAGAN, D. W. and T. D. ALLEN. 1960. An ecological survey of factors affecting fish production in Louisiana waters. Louisiana Wildlife and Fisheries Commission, Fisheries Section, Baton Rouge, Louisiana. 100 p.
- GOLDEN, M. F. 1972. Effects of a kraft paper mill effluent on benthic macroinvertebrate populations in Dugdemona River, Louisiana. M.S. Thesis. Louisiana Tech University, Ruston, Louisiana. 62 p.
- HARPSTER, H. T. 1941. An investigation of the gaseous plastron as a respiratory mechanism in *Helichus striatus* LeConte (Dryopidae). Trans. Amer. Micros. Soc. 60(3): 329-358.
- . 1944. The gaseous plastron as a respiratory mechanism in *Stenelmis quadrimaculata* Horn (Dryopidae). Trans. Amer. Micros. Soc. 63(1): 1-26.
- HILSENHOFF, W. L. 1973. Notes on *Dubiraphia* (Coleoptera: Elmidae) with descriptions of five new species. Ann. Entomol. Soc. Amer. 66(1): 55-61.
- . 1975. Aquatic insects of Wisconsin with generic keys and notes on biology, ecology, and distribution. Tech. Bull. 89, Department of Natural Resources, Madison, Wisconsin. 52 p.
- . 1977. Use of arthropods to evaluate water quality of streams. Tech. Bull. 100, Department of Natural Resources, Madison, Wisconsin. 15 p.
- HILSENHOFF, W. L., J. L. LONGRIDGE, R. P. NARF, K. J. TENNESSEN, and C. P. WALTON. 1972. Aquatic insects of the Pine-Popple River, Wisconsin. Tech. Bull. 54, Department of Natural Resources, Madison, Wisconsin. 44 p.
- HINTON, H. E. 1935a. New species of North American *Helichus* (Dryopidae, Coleoptera). Pan-Pacific Entomol. 11(2): 66-71.
- . 1935b. Notes on the Dryopoidea (Col.). Stylops 4(8): 169-179.
- . 1936. Descriptions of new genera

- and species of Dryopidae (Coleoptera). Trans. R. Entomol. Soc. London 85(18): 415-435.
- . 1937. *Helichus immsi*, sp. n. and notes on other North American species of the genus (Coleoptera, Dryopidae). Ann. Entomol. Soc. Amer. 30: 317-323.
- . 1939a. Notes on American Elmidae, with descriptions of new species (Coleoptera). Entomol. Monthly Mag. 75: 179-185.
- . 1939b. An inquiry into the natural classification of the Dryopoidea, based partly on a study of their internal anatomy (Col.). Trans. R. Entomol. Soc. London 89(7): 133-184.
- . 1940. A synopsis of the genus *Macronychus* Müller (Coleoptera, Elmidae). Proc. R. Entomol. Soc. London (B) 9(7): 113-119.
- . 1955. On the respiratory adaptations, biology, and taxonomy of Psephenidae. Proc. Zool. Soc. London 125: 543-568.
- HORN, G. H. 1870. Synopsis of the Parnidae of the United States. Trans. Amer. Entomol. Soc. 3: 29-42.
- HUGGINS, D. G., P. M. LIECHTI, and D. W. ROUBIK. 1976. Species accounts for certain aquatic macroinvertebrates from Kansas. In: J. Caldwell (ed.), New records of the fauna and flora of Kansas for 1975. Tech. Publ. St. Biol. Surv. Kans. 1: 13-77.
- LAGO, P. K. and D. F. STANFORD. 1979. New records for dryopid beetles in Mississippi. Entomol. News 90(1): 56.
- LECONTE, J. L. 1852. Synopsis of the Parnidae of the United States. Proc. Acad. Nat. Sci. Phila. 6: 41-45.
- . 1853. Synopsis of the Atopidae, Rhipiceridae and Cyphonidae of the United States. Proc. Acad. Nat. Sci. Phila. 6: 350-357.
- LEECH, H. B. and H. P. CHANDLER. 1956. Aquatic Coleoptera, p. 293-371. In: Robert L. Usinger (ed.), Aquatic insects of California. University of California Press, Berkeley, California. 508 p.
- LESAGE, L. and P. P. HARPER. 1975. Les dryopides aquatiques du Québec (Coléoptères). Ann. Soc. Entomol. Québec 20(3): 157-168.
- . 1976a. Cycles biologiques d'Elmidae (Coléoptères) de ruisseaux des Laurentides, Québec. Ann. de Limnologie 12(2): 139-174.
- . 1976b. Description de nymphes d'Elmidae néarctiques (Coléoptères). Can. J. Zool. 54(1): 65-73.
- . 1977. Description de cinq espèces de larves d'Elmidae néarctiques (Coléoptères). Ann. Soc. Entomol. Québec 22(1): 18-32.
- LODING, H. P. 1945. Catalogue of the beetles of Alabama. Geol. Surv. Ala. Mono. 11: 1-172.
- LOUISIANA DEPARTMENT OF NATURAL RESOURCES. 1974. Louisiana forest types. Map. Louisiana Department of Natural Resources, Office of Forestry, Baton Rouge, Louisiana. 1 p.
- . 1980. Louisiana water quality management plan. Louisiana Department of Natural Resources, Office of Environmental Affairs, Division of Water Pollution Control, Baton Rouge, Louisiana. 103 p.
- LOUTON, J. A. 1975. The Ephemeroptera of Louisiana. M.S. Thesis. Louisiana State University, Baton Rouge, Louisiana. 92 p.
- MASON, W. T., JR., P. A. LEWIS, and J. B. ANDERSON. 1971. Macroinvertebrate collections and water quality monitoring in the Ohio River Basin, 1963-1967. Coop. Report. Office of Technical Programs, Ohio Basin Region and Analytical Quality Control Laboratory, USEPA, Cincinnati, Ohio. 117 p.
- MINGO, T. M. 1979. Distribution of aquatic Dryopoidea in Maine. Entomol. News 90(4): 177-185.
- MORSE, J. C., J. W. CHAPIN, D. D. HERLONG, and R. S. HARVEY. 1980. Aquatic insects of Upper Three Runs Creek, Savannah River Plant, South Carolina. Part I: Orders other than Diptera. J. Ga. Entomol. Soc. 15(1):73-101.
- MURVOSH, C. M. 1970. Ecology of the water penny beetle *Psephenus herricki* (DeKay). Ecol. Mono. 41(1): 79-96.
- MUSGRAVE, P. N. 1933. New species of Helmidæ (Coleoptera). Proc. Entomol. Soc. Wash. 35(4): 54-57.
- . 1935a. Notes on collecting Dryopidae (Coleoptera). Can. Entomol. 67: 61-63.
- . 1935b. A synopsis of the genus *Helichus* Erichson in the United States and Canada, with description of a new species (Coleoptera: Dryopidae). Proc. Entomol. Soc. Wash. 37(7): 137-145.
- NELSON, H. G. 1981. Notes on Nearctic *Helichus* (Coleoptera: Dryopidae). Pan-Pacific Entomol. 57(1): 226-227.
- PATRICK, R., J. CAIRNS, JR., and S. S. ROBACK. 1966. An ecosystematic study of the fauna and flora of the Savannah River. Proc. Acad. Nat. Sci. Phila. 118(5): 109-407.
- PENNAK, R. W. 1971. Toward a classification of lotic habitats. Hydrobiologia 38(2): 321-334.
- . 1978. Fresh-water invertebrates of the United States. 2nd Edition. John Wiley & Sons, New York. 803 p.
- PETERSON, A. 1967. Larvae of insects. An introduction to Nearctic species. Part II. 6th Edition. Ohio State University, Columbus, Ohio. 416 p.
- REISEN, W. K. 1977. The ecology of Honey Creek, Oklahoma: The downstream drift of three species of aquatic dryopid beetles (Coleoptera: Dryopoidea). Entomol. News 88(7&8): 185-191.
- RODGERS, V. L. 1977. Comparison of physicochemical parameters and benthic macroinvertebrate diversity in Dugdemona River during pre-lime clarification and post-lime clarification of papermill effluent. M.S. Thesis.

- Louisiana Tech University, Ruston, Louisiana. 61 p.
- SANDERSON, M. W. 1938. A monographic revision of the North American species of *Stenelmis* (Dryopidae: Coleoptera). Univ. of Kans. Sci. Bull. 25(22): 635-717.
- . 1953. A revision of the Nearctic genera of Elmidae (Coleoptera). J. Kans. Entomol. Soc. 26(4): 148-163.
- . 1954. A revision of the Nearctic genera of Elmidae (Coleoptera). J. Kans. Entomol. Soc. 27(1): 1-13.
- SANDERSON, M. W. and H. P. BROWN. 1959. Records of Oklahoma riffle beetles and a description of the larva of *Hexacyclopeus* (Coleoptera: Dryopoidea). Proc. Okla. Acad. Sci. 37: 67-72.
- SCHAFER, K. A. 1950. Life history studies of *Psephenus lecontei* LeC. and *Ectopria nervosa* Melsh. (Coleoptera: Psephenidae; Dascillidae). M.S. Thesis. Ohio State University, Columbus, Ohio. 51 p.
- SEAGLE, H. H. 1980. Flight periodicity and emergence patterns in the Elmidae (Coleoptera: Dryopoidea). Ann. Entomol. Soc. Amer. 73(3): 300-306.
- SEAGLE, H. H. and A. C. HENDRICKS. 1978. Macrodistribution of the Dryopoidea of the South Fork of the Shenandoah River Basin, Virginia (Coleoptera: Elmidae). Bull. Assoc. of South-east. Biol. 25(2): 32-33. Abstract.
- . 1979. Dryopoid beetles of the South Fork of the Shenandoah River Basin, Virginia, with some biological notes. Coleopterists Bull. 33(2): 205-208.
- SHEPARD, W. D. 1980. A morphological study of larval forms of North American species of *Stenelmis* (Coleoptera: Elmidae). Ph.D. Dissertation. University of Oklahoma, Norman, Oklahoma. 133 p.
- SINCLAIR, R. M. 1964. Water quality requirements of the family Elmidae (Coleoptera), with keys to the larvae and adults of the eastern genera. Tenn. Stream Pollution Control Board, Tenn. Dept. of Public Health, Nashville, Tennessee. 14 p.
- SPANGLER, P. J. 1980. Chelonariid larvae, aquatic or not? (Coleoptera: Chelonariidae). Coleopterists Bull. 34(1): 105-114.
- STAATS, A. A. 1973. Effects of lime clarification of kraft paper mill effluent on benthic macroinvertebrate populations. M.S. Thesis. Louisiana Tech University, Ruston, Louisiana. 63 p.
- STEWART, K. W., B. P. STARK, and D. G. HUGGINS. 1976. The stoneflies (Plecoptera) of Louisiana. Great Basin Nat. 35(3): 366-384.
- SUMMERS, S. V. 1874. Catalogue of the Coleoptera from the region of Lake Pontchartrain, La. Bull. Buffalo Soc. Nat. Sci. 2: 78-99.
- THORNBURY, W. D. 1965. Regional geomorphology of the United States. John Wiley & Sons, New York. 609 p.
- THORPE, W. H. 1950. Plastron respiration in aquatic insects. Biol. Rev. (Cambridge) 25: 344-390.
- THORPE, W. H. and D. J. CRISP. 1949. Studies on plastron respiration IV. Plastron respiration in the Coleoptera. J. Exper. Biol. 26(3): 219-261.
- TWILLEY, C. E. 1972. Effects of kraft paper mill effluent on species diversity of benthic macroinvertebrates in Dugdemona River before and after initiation of a lime clarification process. M.S. Thesis. Louisiana Tech University, Ruston, Louisiana. 69 p.
- VIOSCA, P., Jr. 1926. Distributional problems of the cold-blooded vertebrates of the Gulf Coastal Plain. Ecology 8: 307-314.
- ULRICH, G. W. 1986. The larvae and pupae of *Helichus suturalis* LeConte and *Helichus productus* LeConte (Coleoptera: Dryopidae). Coleopterists Bull. 40(4): 325-334.
- WEBER, C. I., ed. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents: Macroinvertebrates. Program Element IBA027. National Environmental Research Center, Office of Research and Development, USEPA, Cincinnati, Ohio. 38 p.
- . 1976. Bio-store master species list. Aquatic Biology Section, Biological Methods Branch, Environmental Monitoring and Support Laboratory, USEPA, Cincinnati, Ohio. 150 p.
- WEST, L. S. 1929a. The behavior of *Macronychus glabratus* Say (Coleo.: Helmidae). Entomol. News 40: 171-173.
- . 1929b. A preliminary study of larval structure in Dryopidae. Ann. Entomol. Soc. Amer. 22(4): 691-727.
- WHITE, D. S. 1978. A revision of the Nearctic *Optioservus* (Coleoptera: Elmidae) with descriptions of new species. Syst. Entomol. 3: 59-74.
- . 1982. *Stenelmis morsei*, a new species of riffle beetle (Coleoptera: Dryopoidea: Elmidae) from South Carolina. Coleopterists Bull. 36(2): 170-174.
- WHITE, D. S. and H. P. BROWN. 1976. A new species of *Stenelmis* from North Carolina (Coleoptera: Elmidae). Coleopterists Bull. 30(2): 189-191.
- YOUNG, F. N. 1954. The water beetles of Florida. University of Florida Press, Gainesville, Florida. 238 p.
- . 1961. Effects of pollution on natural associations of water beetles. Purdue Univ. Engineering Series No. 106, Engineering Bull. 15(2): 373-380.

APPENDIX I

Locations of Collection Sites

Current Louisiana Department of
Transportation and Development

parish highway maps were used to determine the names of watercourses and the exact localities of sampling sites. If a name could not be found for a stream, it was referred to as a tributary (abbreviated "trib.") of a named watercourse. Major highway numbers and the nearest town are given from the Department of Transportation and Development 1979-1980 state road map. Compass direction of a site from the nearest town is straight line direction, not necessarily the direction on the highway given. Range (R), Township (T), and Section (Sec.) data are provided when the site was not on a numbered highway or was on a road not shown on the state road map. All collections were made by the senior author. Asterisks preceding stream or river names indicate that the site was unproductive. Numbers in parentheses—i.e., (1), (2), etc.—are given following the stream name when more than one site was sampled. This is necessary to clarify the species records presented in the Systematic Treatment. Boldfaced names refer to parishes.

ACADIA: Bayou Plaquemine Brule, N of Crowley on Hwy. 13; 10-VI-1980. Long Point Gully, S of Maxie on Hwy. 13; 10-VI-1980. **ALLEN:** Bayou Blue, N of Elton on Hwy. 26; 9-VIII-1979. Calcasieu River, NW of Oberlin on Hwy. 26; 30-VII-1980. Mitchell Creek, E of Oberlin E off US Hwy. 165, R3W T5S jct. Secs. 3 & 10; 9-VIII-1979. Soapstone Creek, W of Elizabeth, N off Hwy. 112 W jct. Hwy. 377, R6W T2S jct. Secs. 23 & 26; 30-VII-1980. Trib. of Calcasieu River, W of Kinder, N off US Hwy. 190 E of Calcasieu R., R5W T6S Sec. 29; 29-V-1979. *West Fork Caney Creek, S of Oakdale on Hwy. 372; 9-VIII-1979. **ASCENSION:** *New River, E of Gonzales on Hwy. 431 N jct. Hwy. 429; 6-XI-1980. **ASSUMPTION:** *Bayou Valerie, NE of Pierre Part on Hwy. 70; 18-VII-1980. **AVOUELLES:** Coulee des Grues, S of Marksville, W off Hwy. 115 just N Coulee des Grues bridge, R4E T2N Sec. 30; 4-IX-1980. **BEAUREGARD:** Bundick Creek (1), N of Dry Creek on Hwy. 113; 24-V-1979. Bundick Creek (2), E of DeRidder on Hwy. 112; 30-VII-1980. *Dry Creek, S of Dry Creek (town) on Hwy. 113; 24-V-1980. Hickory Branch, W of Longville on Hwy. 110; 31-VII-1980. Johns Gully, NE of Fields on Hwy. 109; 31-VII-1980. *Trout Creek, W of

DeRidder on US Hwy. 190; 30-VII-1980. **BIENVILLE:** Cypress Creek, 7 mi (11.2 km) N of Mt. Olive on Hwy. 147; 16-VIII-1979. Leatherman Creek, NW of Gibsland on I-20; 15-VI-1980. Redfield Branch of Toulon Bayou, SW of Ringgold on Hwy. 4; 16-VI-1980. Sixmile Creek, SW of Bienville, W off Hwy. 9, R6W jct. T15N Secs. 1 & 2 and T16N Secs. 35 & 36; 16-VI-1980. **BOSSIER:** *Cypress Creek, 1.5 mi (2.4 km) E of Plain Dealing on Hwy. 2; 15-VIII-1979. Flag Lake spillway, Fifi Bayou, E of Bossier City on East Reservation of Barksdale AFB, R12W T18N Sec. 34; 28-XII-1979. Martin Creek, W of Springhill on Hwy. 157; 15-VIII-1979. *Trib. of Foxskin Bayou, E of Bossier City on East Reservation of Barksdale AFB, R11W T18N Sec. 30; 28-XII-1979. Trib. of Little Cypress Bayou, W of Bolinger on the Dogwood Drive S off Hwy. 537, R13W T23N Sec. 33; 14-VI-1980. **CADDO:** Cypress Bayou, S of Spring Ridge on Hwy. 789; 17-VI-1980. Flag Branch of Kelly Bayou Canal, S of Ida on US Hwy. 71; 14-VI-1980. Myrtis Mill Creek, N of Vivian at Myrtis on Hwy. 1; 14-VI-1981. Paw Paw Bayou (Quapaw Bayou), N of Greenwood on Hwy. 169; 17-VIII-1979. Shettleworth Bayou, W of Blanchard in Walter B. Jacobs Nature Park, N off Parish Rd. 4; 17-VII-1979, 29-XII-1979. **CALCASIEU:** Buxton Creek, S of DeQuincy, W off Hwy. 27, R11W T8S jct. Secs. 23 & 24; 31-VII-1980. Indian Bayou, N of Westlake, E off Hwy. 378 Spur, R9W T8S Sec. 26; 31-VII-1980. **CALDWELL:** Castor Creek, W of Grayson on Hwy. 126; 26-VII-1980. Trib. of Flat Creek, NW of Olla on Hwy. 127 just E of Winn P. line; 26-VII-1980. **CATAHOULA:** Bushley Creek, E of Manifest on Hwy. 8 just W jct. Hwy. 126; 25-VII-1980. Haggerty Creek, S of Duty, S off Hwy. 124, R5E T10N Sec. 11; 26-VII-1980. Trib. of Birds Creek, E of Manifest on Hwy. 8, 1.5 mi (2.4 km) E jct. Hwy. 126; 25-VII-1980. *Trib. of Bushley Bayou, S of Harrisonburg on Hwy. 124; 13-VI-1979. *Trib. of Little River, N of Jonesville on Hwy. 124; 13-VI-1979. **CLAIBORNE:** *Buck Creek, SE of Blackburn on Hwy. 2; 15-VI-1980. *Crows Creek, NE of Minden on Hwy. 518 at Webster P. line; 1-I-1980. Middle Fork Bayou D'Arbonne, SW of Colquitt on Hwy. 520; 17-VI-1979. **CONCORDIA:** *Trib. of Boggy Bayou, 1 mi (1.6 km) N of Slocum on Hwy. 15; 25-VII-1980. **DE SOTO:** Bull Bayou, SE of Stanley on Hwy. 174; 17-VI-1980. Caney Bayou, S of Kingston on Hwy. 175; 18-VIII-1979. **EAST BATON ROUGE:** Beaver Bayou, NE of Baton Rouge, SE off Hwy. 409 on Frenchtown Rd.; 21-XI-1980. Beaver Pond Bayou, NE of Indian Mound, SE off Hwy. 409, R2E T5S jct. Secs. 37, 58, 59, & 70; 20-XI-1980. Comite River (1), E of Zachary on Hwy. 64; 2-VII-1979. Comite River (2), SE of Baker, W off Hwy. 410 on Comite Dr.; 2-VII-1979. *Cooper Bayou, W of Zachary, W off US Hwy. 61 on Parish Rd. 6; 14-V-1980. *Corporation Canal, Baton Rouge, on South Campus Dr. at Louisiana State Univ.; 9-X-1980. *University Lake spillway, Baton Rouge, on Stanford Ave.;

9-X-1980. **EAST CARROLL:** *Macon Bayou, W of Gassoway on Hwy. 585 at W. Carroll P. line; 14-VI-1979. **EAST FELICIANA:** Amite River, W of Darlington on Hwy. 10 at St. Helena P. line; 28-VI-1979. Foster Creek, S of Jackson on US Hwy. 61; 14-V-1980. Hurricane Creek, 4.5 mi (7.2 km) W of Norwood, W off Hwy. 19, R1W T1S Sec. 58; 19-II-1980. *Little Sandy Creek, S of Clinton, E off Hwy. 67 at S boundary of Idlewild Expt. Sta.; 19-II-1980. Redwood Creek, Ethel on Hwy. 19; 3-VI-1979. Sandy Creek (1), S of Clinton, E off Hwy. 67 just S of Idlewild Expt. Sta.; 28-VI-1980. Sandy Creek (2), S of Clinton, E off Hwy. 67 on Idlewild Expt. Sta.; 20-XI-1980. Woodland Creek, N of Woodland on Hwy. 67; 19-II-1980. **EVANGELINE:** Bayou des Cannes, NW of Chataignier on Hwy. 95; 22-VIII-1980. Bayou Grand Louis, SE of Ville Platte at US Hwy. 167 at St. Landry P. line; 22-VIII-1980. Bayou Nezpieque (1), W of Bayou Chicot on Hwy. 106; 9-VIII-1979. Bayou Nezpieque (2), W of Redell on Hwy. 376; 22-VIII-1980. **FRANKLIN:** *Pine Bayou Canal, Baskin on Hwy. 15; 27-VII-1980. **GRANT:** Big Creek, N of Pollock on US Hwy. 165; 9-VII-1980. Gray Branch of Fish Creek, NE of Dry Prong, S off Hwy. 123 on Forest Service Rd. 120; 9-VII-1980. Nantachie Creek, E of Montgomery on Hwy. 122; 20-VIII-1979. **IBERIA:** *Sandager Canal, SE of Olivier on Hwy. 182; 12-V-1981. **IBERVILLE:** *Bayou Tigre, SW of Bayou Goula on Hwy. 1; 12-V-1981. **JACKSON:** Trib. of Edwards Branch, 1 mi (1.6 km) W of Chatham on Hwy. 4; 16-VIII-1979. **JEFFERSON DAVIS:** Bayou Serpent and trib., N of Fenton on US Hwy. 165; 24-V-1979. Trib. of East Bayou Lacassine, 2.5 mi (4.0 km) N of Welsh on Hwy. 99; 24-V-1979. **LAFAYETTE:** *W trib. of Bayou Ile des Cannes, W of Scott on I-10; 10-VI-1980. **LAFOURCHE:** *Bayou Rond Pompon, W of Kraemer on Hwy. 307; 18-VII-1980. **LA SALLE:** Doyle Branch of Old River, 1.2 mi (1.9 km) W of Whitehall on Hwy. 460; 4-IX-1980. Hemphill Creek, E of Nebo on Hwy. 460; 4-IX-1980. Trout Creek, W of Jena on Hwy. 772; 9-VII-1980. **LINCOLN:** *Cypress Creek, NE of Vienna, E off US Hwy. 167 and S off Hwy. 822 on Parish Rd. 581; 17-VI-1979. Trib. of Choudrant Creek, NE of Choudrant on I-20 just E of Choudrant exit; 17-VI-1979. *Trib. of Cypress Creek, SW of Vienna, S off Hwy. 146, R3W T18N Sec. 9; 17-VI-1979. **LIVINGSTON:** Blood River, W of Albany on US Hwy. 190; 5-III-1980. Hog Branch, E of Livingston, S off US Hwy. 190 just E of Hog Branch bridge, R5E T6S Sec. 28; 2-VII-1979, 27-IX-1979. Little Collyell Creek, W of Frost, N off Hwy. 42, R4E T7S jct. Secs. 35 & 36; 6-XI-1980. *Little Natalbany River, N of Albany, W off Hwy. 1063, R6E jct. T5S Sec. 35 and T6S Sec. 2; 5-III-1980. Spillers Creek, NE of Watson on Hwy. 16 NE jct. Hwy. 1019; 13-VIII-1980. Trib. of Natalbany River, 0.8 mi (1.3 km) S of Springfield on Hwy. 22; 6-XI-1980. West Collyell Creek, NE of Denham Springs on Hwy. 1025; 20-

XI-1980. **MADISON:** *Roundaway Bayou, S of Tallulah on US Hwy. 65; 14-VI-1979. **MOREHOUSE:** *Chemin-a-Haut Bayou (1), NE of Beckman, E off Hwy. 139, R6E T22N Sec. 2; 15-VI-1979. Chemin-a-Haut Bayou (2), NE of Beckman, E off Hwy. 139 on Hwy. 590; 28-VII-1980. *Coffee Bayou, E of Jones on Hwy. 835; 14-VI-1979. *Trib. of Bayou Bartholomew, NE of Beekman at Chemin-a-Haut State Park; 15-VI-1979. *Trib. of Chemin-a-Haut Bayou, NE of Beekman, E off Hwy. 139 on Hwy. 590; 15-VI-1979. *Williamson Creek, trib. of Snake Creek, N of Beekman on Hwy. 142; 28-VII-1980. **NATCHITOCHE:** Antoine Creek, S of Ashland on Hwy. 153; 18-VIII-1979. Bayou Pierre, Gorum on Hwy. 119; 26-XII-1980. Kisatchie Bayou, NE of Kisatchie, W off Forest Service Rd. 366 at Kisatchie Bayou Primitive Camp, R7W T5N Sec. 4; 3-IX-1979. Little Bayou Pierre, E of Kisatchie on Hwy. 118; 3-IX-1979. Malaudos Creek, S of Goldonna on Hwy. 156; 18-VIII-1979. Santabarb Creek, SW of Provencal, W off Hwy. 478, R9W T7N jct. Secs. 21 & 28; 10-VII-1980. **ORLEANS:** *Drainage canal, New Orleans, Joe W. Brown Memorial Park; 30-I-1980. **OUACHITA:** *Cypress Creek, S of Luna, S off Hwy. 557, R2E T15N Sec. 12; 17-VI-1979. Guyton Creek, S of Cadeville, N off Hwy. 34 on Parish Rd. 7; 16-VIII-1979. *South Cheniere Creek, S of Cadeville on Hwy. 34; 16-VIII-1979. **POINTE COUPEE:** *Bayou Fordoche, Fordoche on Hwy. 77; 20-XII-1979. Bayou Grosse Tete, E of Livonia on US Hwy. 190, 1.4 mi (2.2 km) W jct. Hwy. 1; 19-XII-1979. Bayou Latenache Drainage Canal, E of Melville on Hwy. 10; 26-VIII-1980. *Trib. of Bayou Moreau, W of Lettsworth on Hwy. 1; 20-XII-1979. **RAPIDES:** Castor Creek, SW of Alexandria, S off Hwy. 488 on Forest Service Rd. 273; 2-IX-1979. Hemphill Creek, W of Gardner on Hwy. 28; 8-VII-1980. *Horsepen Creek, SE of Libuse, S off Hwy. 1205, R2E T4N Sec. 19; 4-IX-1980. Spring Creek, S of Melder, S off Hwy. 112, R3W T2N jct. Secs. 35 & 36; 7-VII-1980. **RED RIVER:** Trib. of Black Lake Bayou, S of Womack on Hwy. 507 just S jct. Hwy. 514; 16-VI-1980. Trib. of Brushy Creek, S of Martin, E off Hwy. 507 on Hwy. 787; 18-VIII-1979. **RICHLAND:** *Muddy Bayou, E of Alto on Hwy. 15; 27-VII-1980. **SABINE:** Bayou Scie, NE of Zwolle on Hwy. 120; 10-VII-1980. Lewing Creek, E of Florian on Hwy. 118; 3-IX-1979. **ST. CHARLES:** *Trib. of Lanaux Canal, E of Boutte on US Hwy. 90 3.1 mi (5.0 km) E jct. Hwy. 3060; 18-VII-1980. **ST. HELENA:** Darling Creek, E of Chipola on Hwy. 38; 28-VI-1979. East Hog Branch, W of Montpelier on Hwy. 16; 13-VIII-1980. Tickfaw River, E of Montpelier on Hwy. 16; 13-VIII-1980. Twelvemile Creek, SW of Greensburg on Hwy. 37; 31-V-1980. **ST. JAMES:** *Drainage canal, SE of Sorrento on I-10 at Ascension P. line; 30-I-1980. **ST. JOHN THE BAPTIST:** *Mississippi Bayou, N of Reserve on I-10 4 mi (6.4 km) E of St. James P. line; 30-I-1980. **ST. LANDRY:** *Bayou Little Teche, SE of Port Barre

on Hwy. 472; 19-XII-1979. Bayou Mallet, W of Lawtell on US Hwy. 190; 22-VIII-1980. Bayou Petite Prairie, SW of Melville, NE off US Hwy. 71, R6E T5S Sec. 2; 26-VIII-1980. Little Wauksa Bayou, E of Beggs on Hwy. 10; 19-XII-1979. **ST. MARTIN:** *Bayou Martin, SE of Parks, E off Hwy. 347, R7E T10S Sec. 5; 12-V-1981. **ST. MARY:** *Bayou Patterson, W of Patterson on US Hwy. 90; 12-V-1981. **ST. TAMMANY:** Abita Creek, Abita Springs on Hwy. 435; 29-IV-1981. *Bayou Lacombe, NE of St. Tammany (town) on Hwy. 36; 29-IV-1981. Bogue Falaya River, E of Folsom, N off Hwy. 40, R10E T5S Sec. 11; 29-V-1979. East Bedico Creek, W of Covington on I-12; 18-II-1980. East Fork Little Bogue Falaya River, NE of Covington, just N off Hwy. 21 on Hwy. 1082; 29-IV-1981. Gum Creek, Pearl River (town) on Hwy. 41; 18-II-1980. Mill Creek, trib. of Bogue Chitto River, W of Bush on Hwy. 40; 20-VI-1979. Talisheek Creek (1), W of Talisheek (town), N off Hwy. 435; R13E T6S Sec. 9; 18-II-1980. Talisheek Creek (2), N of Talisheek (town) on Hwy. 450 Spur; 2-VII-1980. Tchefuncte River, NW of Folsom, W off Hwy. 450, R9E T4S Sec. 42; 29-V-1979. **TANGIPAHOA:** Big Creek, SE of Tangipahoa, S off Hwy. 440 on Hwy. 1054; 7-VIII-1980. Chappepeela Creek (1), SE of Loranger on Hwy. 40; 29-V-1979. Chappepeela Creek (2), E of Holton on Hwy. 16; 31-V-1980. Natalbany River, W of Independence on Hwy. 16; 13-VIII-1980. Selzers Creek, E of Ponchatoula on Hwy. 22; 6-XI-1980. Tangipahoa River, SE of Osyka, MS, on Hwy. 1054; 31-V-1980. Terrys Creek, Kentwood on Hwy. 38; 28-VI-1979. **TENSAS:** *Clark Bayou, SW of Newellton on US Hwy. 65 S jct. Hwy. 4; 14-VI-1979. *Lake Bruin, N of St. Joseph at Lake Bruin State Park; 14-VI-1979. **TERREBONNE:** *Drainage canal, E of Chacahoula parallel to Hwy. 20; 18-VII-1980. **UNION:** Bayou de Loutre, E of Spearsville on Hwy. 550; 28-VII-1980. Cypress Creek, SE of Spearsville on Hwy. 15 just S jct. Hwy. 550; 27-VII-1980. Little Corney Bayou, E of Lillie on Hwy. 15; 16-VI-1979. Meridian Creek, W of Marion on Hwy. 348; 28-VII-1980. *Middle Fork Bayou D'Arbonne, SW of Bernice, W off US Hwy. 167 on Parish Rd. 4416; 16-VI-1979. **VERNON:** Calcasieu River, N of Slagle on Hwy. 8; 8-VII-1980. East Anacoco Creek, E of Anacoco on Hwy. 111; 10-VII-1980. Liberty Creek, E of Leesville, S off Hwy. 468 on Castor Lake Rd.; 8-VII-1980. Sixmile Creek, W of Pitkin on Hwy. 10; 2-IX-1979. **WASHINGTON:** Bogue Chitto River, W of Warnerton on Hwy. 438; 2-VIII-1979. Bogue Lusa Creek, Sheridan on Hwy. 10; 30-IV-1981. Bonner Creek, S of Franklinton on Hwy. 25; 7-VIII-1980. Crains Creek, S of State Line (town) on Hwy. 62; 2-VIII-1979. Foster Creek, E of Angie, E off Hwy. 21, R14E T1S Sec. 51; 30-IV-1981. Hays Creek, E of Clifton on Hwy. 38; 7-VIII-1980. Lawrence Creek, N of Enon on Hwy. 16; 20-V-1979. Mill Creek, E of Enon at jct. Hwys. 16 & 60; 2-VII-1980, 7-VIII-1980, 13-IV-1981. Muster Ground Creek, W of Varnado on

Hwy. 436; 30-IV-1981. North Carson Creek, W of Franklinton on Hwy. 450; 30-IV-1981. Pushepatapa Creek, W of Varnado, NE off Hwy. 436, R13E T2S Sec. 2; 2-VII-1980. Silver Creek, NE of Mt. Hermon on Hwy. 438; 2-VIII-1979. **WEBSTER:** Caney Creek below Caney Lakes, N of Minden, NW off US Hwy. 79/80 on Parish Rd. 1; 29-XII-1980. Cooley Branch, S of Minden on I-20; 16-VIII-1979. Holder Creek, E of Cotton Valley on Hwy. 3008; 29-XII-1980. Indian Creek, S of Shongaloo on Hwy. 2; 15-VIII-1979. *Trib. of Upper Caney Lake, N of Minden, R9W T19N Sec. 4; 1-I-1980. **WEST BATON ROUGE:** Bayou Poydras, W of Port Allen at jct. Hwys. 76 & 413; 26-VIII-1980. **WEST CARROLL:** *Little Colewa Bayou, W of Forest, N of jct. Hwys. 2 & 582; 28-VII-1980. *Trib. of Colewa Bayou, E of Jones on Hwy. 585; 14-VI-1979. **WEST FELICIANA:** Alexander Creek, St. Francisville on US Hwy. 61; 19-X-1980. Baker Creek, N of Weyanoke, NE off Hwy. 66, R4W T1S Sec. 73; 19-X-1980. Bayou Sara, NE of Weyanoke, R3W T1S jct. Secs. 69 & 71; 7-VIII-1979. *Sandy Creek, NE of Weyanoke, R3W T1S Sec. 61; 7-VIII-1979. Thompson Creek, W of Jackson on Hwy. 10; 14-V-1980. Tunica Bayou, N of Tunica on Hwy. 66; 7-VIII-1979. West Fork Thompson Creek, just E of Spillman on Hwy. 421; 3-VI-1979. **WINN:** E trib. of Kiesche Creek, NE of Winnfield on Hwy. 34; 13-VI-1980. Mill Creek, W of Calvin on Hwy. 156; 18-VIII-1979.

APPENDIX II

Additional Locality Records

Locality data (usually label data) are presented below for dryopoids collected outside of the study proper, i.e., before May 1979 or after May 1981, or collected by someone other than the authors. Records are from the Louisiana State University Insect Collection (LSUC), the University of Southwestern Louisiana (USL), and Harley P. Brown (HPB). Numbers in parentheses—i.e., (1), (2), etc.—following a location name are to clarify the species records presented in the Systematic Treatment. Boldfaced names refer to parishes.

ALLEN: Bundicks Cr. near Crosby L., 14-V-1977, K. T. Dupont (USL). **AVOYELLES:** Coulee des Grues, 3.2 km WSW of Marksville, 16-X-1981, C. B. Barr (LSUC). **BEAUREGARD:** Bundicks Lake, 19-IV-1973, J. Colley (Aq. In. Cl. 5) (USL). (Near Rosepine), 3-VI-1975 to 17-VI-1975, light

- trap (LSUC). Whiskey Chitto Cr. 2 mi N Wye, 14-IV-1973 (Aq. In. Cl. 5) (USL). **BIENVILLE:** SE Arcadia on Hwy 147, 76/6/5, H. P. Brown (HPB). NE Bienville, 76/6/5, H. P. Brown (HPB). **CALCASIEU:** Sam Houston Jones St. Pk., 21-V-1982, E. G. Riley, blk. lt. (LSUC). **CATAHOULA:** Bushley Cr., LA 8 just W jct. LA 126N, 16-X-1981, C. B. Barr (LSUC). **EAST BATON ROUGE:** Baton Rouge (1), 10-VI-1973, T. M. Andrews (LSUC). Baton Rouge (3), 6-28-1956, J. H. Roberts (LSUC). Baton Rouge (4), Burden Research Center, 11-IX-1974, 12-IX-1974, 13-IX-1974, light trap (LSUC). Beaver Pond Bayou, NE of Indian Mound, SE off Hwy. 409, R2E T5S jct. Secs. 37, 58, 59, & 70; 13-X-1981, C. B. Barr (LSUC). 1.2 mi S Central (1), E on LA 3034, 25-II-1978, Coll. C. B. Barr, swampy area (LSUC). 1.2 mi S Central (2), E of LA 3035, 28-V-1982, Coll. C. B. Barr, black light trap (LSUC). **EAST FELICIANA:** Idlewild Expt. Sta., 29-IV-1975 to 2-V-1975, 2-VI-1975 to 6-VI-1975, light trap (LSUC). Little Comite Cr., Hwy. 19, 16-IV-1983, T. W. Walker collector (LSUC). Sandy Cr. s Jackson, 76/6/26 (HPB). **EVANGELINE:** Bayou Cocodrie at dirt road below Glenmora and Turkey Creek, 18-III-1978, M. F. Vidrine (USL). **GRANT:** Big Creek, Pollock, 73/6/28, Bill Stark (HPB). 4-H Camp Grant Walker (E of Pollock), 28-VII-1982, C. B. Barr, blacklight (LSUC). Stuart Lake Rec. Area (Kisatchie Natl. Forest), 22-29-VII-1982, E. G. Riley, black light trap (LSUC). **IBERVILLE:** St. Gabriel Expt. Sta. (1), 18-VIII-1972, light trap (LSUC). St. Gabriel Exp. Sta. (2), 31-VII-1981, Coll. E. G. Riley, black light trap (LSUC). St. Gabriel Exp. Sta. (3), 2-VIII-1983, Coll. E. G. Riley, collected at blacklight (LSUC). **JEFFERSON:** Grand Isle, 6-24-42, 6-26-42, J. H. Roberts (LSUC). Grand Isle St. Pk., IX-5-1981, E. G. Riley, at light (LSUC). **LIVINGSTON:** Denham Springs, VII-11-1967, Liesel Klenk (LSUC). Hog Branch E of Livingston, 20-II-1983, T. W. Walker collector (LSUC). Little Natalbany River, Albany, 73/6/27, Bill Stark (HPB). Tickfaw River, Holden, 73/6/27, Bill Stark (HPB). Tickfaw R. W of Holden, 23-IV-1972 (Aq. In. Cl. 14) (USL). **MOREHOUSE:** Chemin-a-Haut St. Pk., 27-VII-1981, E. G. Riley & C. T. Robinson, collected at light (LSUC). **NATCHITOCHES:** Kisatchie Natl. Forest, Kisatchie Bayou Campgrd., 14-VI-1984, C. B. & J. E. Barr, mercury vapor & blk. lt. (LSUC). Little Bayou Pierre at LA Hwy. 118, 14-VI-1984, blacklight, Coll. C. B. & J. E. Barr (LSUC). Little Bayou Pierre 7 mi w Mora, 78/6/4, Jeff Witcosky (HPB). **RAPIDES:** Germany Branch, 70/11/30, Roy Rhame (HPB). Loving Cr. 2.8 mi SE of Castor Plunge, 21-III-1976, Tom Hardaway (USL). **SABINE:** 6 mi W Florien, V-22-82, E. G. Riley, blacklite (LSUC). **ST. HELENA:** Darling Creek at Hwy. 38 E of Chipola, 2-III-1979, J. T. Wassell (LSUC). **ST. MARTIN:** Parks, X-18-1962, Aithel McMahon (LSUC). **ST. TAMMANY:** Honey Island Nature Trail (Pearl R. Wildlife Mgt. Area), 17-VI-1982, black light, C. B. Barr & E. G. Riley (LSUC). 1-10 at Pearl River, 17-VI-1982, black light, C. B. Barr & E. G. Riley (LSUC). Mill Creek at Hwy. 40, 11-II-1979, J. T. Wassell (LSUC). Tchefuncte River between Tangipahoa & St. Tammany parishes at Hwy. 40, 11-II-1979, J. T. Wassell (LSUC). **TANGIPAHOA:** Big Cr. 3+ mi E of Amite, 17-III-1973, R. Montegut; 24-IV-1976 (Aq. In. Cl. 2) (USL). Hamilton Cr. at Hwy. 1061 N of Wilmer, 2-III-1979, J. T. Wassell (LSUC). Tangipahoa R. at La. 16, 15-IV-1972 (Aq. In. Cl. 6) (USL). Creek w of Hammond, 66/6/19, H. P. Brown (HPB). **VERNON:** Anacoco Bayou at Hawk Rd., 18-III-1978, L. Dugas (USL). **WASHINGTON:** Hays Creek N of Franklinton, 22-IV-1972 (Aq. In. Cl. 11); 24-IV-1976 (Aq. In. Cl. 5) (USL). Junction La. 16 & La. 60, 15 Apr. 1972 (Aq. In. Class 3) (USL). **WEST FELICIANA:** 28-VII-1981, Coll. A. Linsey, Student Collector (LSUC). Thompson Cr. s St. Francisville, 76/6/2 (HPB).