Research Article

An Annotated List of Auchenorrhyncha and Heteroptera Collected in the Coastal Salt Marshes of the Mississippi Delta in Louisiana

I. M. Sokolov, X. Chen, R. M. Strecker, and L. M. Hooper-Bùi

Department of Environmental Sciences, LSU College of the Coast & Environment, 1002-Q Energy, Coast & Environment Building, Baton Rouge, LA 70803, USA

Correspondence should be addressed to I. M. Sokolov; isokolov1@lsu.edu

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Insects that live in the saltwater and brackish marshes, which fringe the northern coast of the Gulf of Mexico, are largely unstudied. During 2011–2013, a survey of insect fauna of the coastal salt marshes of the Mississippi Delta in Louisiana was conducted. We present the species of terrestrial representatives of Heteroptera and Auchenorrhyncha collected during that study. The Auchenorrhyncha are represented by 33 species in 6 families, with Cicadellidae (16 species) and Delphacidae (13 spp.), and are the most diverse. The terrestrial heteropterans are represented by 11 species in 5 families with the majority of species in Miridae (6 spp.). A list of species, annotated with numbers of specimens collected, ranges of collection dates (seasonality), and published information on their hosts, habitats, and ranges, is presented. Of 44 identified species, ten species (22.7%) are reported from Louisiana for the first time. The paper provides evidence of a diverse terrestrial arthropod community in brackish marshes; a community that is largely understudied.

1. Introduction

Louisiana’s coastal marshes are experiencing the highest rate of wetland loss in the US [1] mainly due to sea level rise and dynamic geomorphology, but also due to natural and human-induced disasters [2, 3]. Through the previous and 2017 Louisiana Coastal Master Plan, marsh restoration is ongoing to combat human-caused and natural land loss. As a consequence of the rising concern over loss of habitat, there is a focus on counteracting that loss via restoration and achieving a sustainable ecosystem within the coastal Louisiana. Furthermore, there is a strong need for adequate and accurate assessment of natural processes in fragile and valuable Louisiana wetlands [4, 5]. Such studies are not only critical in designing effective reserve systems for potential ecosystem restoration, but also necessary in many conservation and ecological studies [6, 7]. Together with annelids, mollusks, and crustaceans, terrestrial arthropods are critical ecosystem components due to their high diversity and sensitivity to perturbations [8]. Within Louisiana coastal ecosystems, terrestrial arthropods represent a major component of multicellular biodiversity with dominating roles of representatives of Hemiptera and Diptera [9]. However, cataloged and published data on arthropod fauna of the coastal Louisiana salt marshes are still scarce and hard to find. Information on the arthropod representatives of this ecosystem is scattered across many literature sources and is practically hidden from research.

During the years 2011–2013 thousands of insects were collected by the Hooper-Bùi research team (LSU, Baton Rouge) as a part of a project dedicated to assessing the ecological impact of hurricanes and oil spill contamination on salt marsh ecosystems in the Mississippi Delta. This paper presents the result of taxonomic treatment of the collected representatives of Auchenorrhyncha and Heteroptera, main suborders of the order Hemiptera. This is the first annotated list of leaf- and planthoppers and true bugs, inhabiting coastal salt marshes in Louisiana. Host and range analyses were completed to compare peculiarities of difference in species
relative abundance between Louisiana coastal salt marshes and other coastal regions of the USA.

2. Material and Methods

2.1. Study Area. The modern Mississippi Delta configuration is a result of the Holocene major shifts in the river’s course and associated land building and land loss ended in formation of five delta complexes [10]. In this study, we investigated marsh systems formed in the modern Balize delta lobe (active ~1000 yr BP to present) [10]. Field studies were conducted in Spartina marshes at sites established within Barataria Bay (13 sites; 29.43’N 89.83’W) and Breton Sound (5 sites; 29.52’N 89.61’W) areas (Plaquemines Parish, Louisiana). Currently both Barataria Bay and Breton Sound are in a similar state of deterioration via subsidence and land loss, and their land areas are represented by a number of flat islands occupied by marshes some of which are converted to open-water [11].

2.2. Site Descriptions. All sites were established in saline to brackish Spartina marshes. In Barataria Bay saltmarshes predominate, which has a low vertical tidal range (<50 cm). Dominant vegetation at these sites was represented by Spartina alterniflora Loisel., Distichlis spicata (L.) Greene, and Avicennia germinans (L.) L. [12]. Breton Sound is a brackish marsh with low vertical tidal range and freshwater inputs from the Mississippi River. Sometimes, during summer, water levels drop below the elevation of the marshes and marshes are dry. Dominant vegetation at Breton Sound sites was represented by Spartina patens (Aiton) Muhl., S. alterniflora, Juncus roemerianus Scheele, and Bolboschoenus robustus (Pursh) Soják [12].

2.3. Sample Collections. The arthropod community was collected during 2011, 2012, and 2013. Sites were marked using vertical PVC pipes at each end of the transect for repeated sampling at the same plots. Insects were collected between 6:30 am and 12:00 pm when the temperature ranged from 22°C to 34°C. Sites in Barataria Bay and Breton Sound were visited on consecutive days. Sweep net collections were conducted using a 38.1 cm (15 in) diameter collapsible insect collection net (140.1 cm², Bioquip Products Inc., Rancho Dominguez, CA). One collection consisting of two, 20 m transects was made by sweeping with a standard net through the upper two-thirds of Spartina along each transect at each of the sites. Collection transects ran perpendicular to the edge of the marsh starting at the edge and walking inland to reduce possible edge-effects. Collected terrestrial arthropods were transferred from the net into plastic ziplock bags filled with 95% ethanol and then transported to the lab at Louisiana State University and stored in vials with 95% ethanol.

2.4. Species Identification. The insects were identified using appropriate taxonomic keys and resources: to the genus level using Bartlett et al. [13] for Fulgoroidea, Dietrich [14] for Cicadomorpha, DeLong [15] for Cicadellidae, and Blatchley [16] for Heteroptera and to species level using corresponding taxonomic keys found in the taxonomic revisions of each genera, for example, in Beamer [17], in Kelton [18], and in Bartlett and Webb [19], or regional reviews of fauna, for example, for Illinois [15], Florida [20], and Cuba [21]. Most species identifications were based on male genitalia; in a case of male absence from the material, species identifications were based on the shape of female ovipositor when it gives reliable characters. Due to taxonomic difficulty, preimaginal stages were not identified. Voucher specimens are deposited partially in the Insect Collection of the Illinois Natural History Survey (INHS, Champaign, IL), where specialists kindly confirmed our identifications, and partially in the LSU Arthropod Museum (LSAM, Baton Rouge, LA).

2.5. Presentation of the Material. To characterize examined material, we divided all identified species into four abundance classes. Dominant species were those with a total number of collected specimens \( n > 1000 \); subdominant species were those with total number of collected specimens \( 1000 \geq n \geq 100 \); regular species were those with total number of collected species \( 100 \leq n \geq 10 \); rare species were those with total number of collected species \( n < 10 \). Within each classification, insect abundance-host (plant or insect) and insect abundance-range patterns were analyzed. Practically, in the case of the abundance-host pattern, we compared changes in proportions between herbivores and predators, between grass feeders and polyphagous species, and between specialized salt marsh sap-feeders and grass generalists; in the case of the abundance-range pattern, we compared changes in proportion between coastal species and noncoastal species of different origin among above-mentioned categories of abundance. Under the term “coastal species,” we consider species whose ranges include Atlantic and/or Gulf Coast States; under the term “noncoastal species,” we consider species distributed in coastal states and also in the eastern and/or midwestern states, or characterized by transtemporal distribution (from Atlantic to Pacific Coasts).

In the list, the dates are presented without regard to the year of collection; in a case of several collection dates the dates are presented as a range; in a case if one or two dates are available, dates are listed as they are.

3. Results

More than 20,000 specimens of all stages of insects belonging to the suborders Auchenorrhyncha and Heteroptera from almost 300 samples were examined during this study. Examined material included 4052 adult specimens of Auchenorrhyncha, represented by 33 species within 6 families, and 13403 specimens of Heteroptera, represented by 11 species within 5 families. The majority of identified species belonged to three families: Cicadellidae (16 species), Delphacidae (13 species), and Miridae (6 species).

3.1. Auchenorrhyncha

3.1.1. Fulgoroidea

Delphacidae

(1) *Keyflana hasta* Beamer, 1950

Relative abundance: 6 specimens (in INHS, LSAM).
Collection dates: 1 September–16 October.

Hosts: Denno et al. reported insects feeding on black needlerush (*Juncus roemerianus* Scheele) [22].

Habitat: it inhabits salt coastal marshes [22].

Regional distribution: described from Cedar Keys, Florida [23]. Distributed in the eastern USA from Maryland southward to Florida Peninsula [13, 24].

It is a new state record, which extends the known range of the species approximately 400 miles in westward direction.

(2) *Megamelus lobatus* Beamer, 1955

Relative abundance: one male (in INHS).

Collection dates: 13 September.

Hosts: this species feeds on saltmeadow cordgrass (*Spartina patens*) [25].

Habitat: it occurs in coastal habitats.

Regional distribution: described from Cedar Keys, Florida, and Slidell, Louisiana [17]. The range of species extends from New Hampshire southward to Florida and along the Gulf States to Texas [13].

(3) *Megamelus longicornis* (Doozier, 1922)

Relative abundance: 26 specimens (in INHS, LSAM).

Collection dates: 15 August–13 September.

Hosts: they are unknown.

Habitat: it is unknown, presumably coastal species.

Regional distribution: endemic of the western Gulf States. Type specimen of this species was collected in Ocean Springs, Mississippi [26], but has been lost. Neotype was designated on the basis of specimens originated from Covington, Louisiana [17]. As far as known, the species is limited in its distribution to three western Gulf States: Mississippi, Louisiana, and Texas [13, 24].

(4) *Metadelphax propinqua* (Fieber, 1866)

Relative abundance: 17 specimens (in INHS, LSAM).

Collection dates: 14 August–4 February.

Hosts: polyphagous species, feeding is reported on about 15 grass species, including agricultural crops like sugarcane (*Saccharum officinarum* L.), barley (*Hordeum vulgare* L.), Bermuda grass (*Cynodon dactylon* (L.) Pers.), maize (*Zea mays* L.), rice (*Oryza sativa* L.), and coastal graminoids like chairmaker's bulrush (*Schoenoplectus americanus* (Pers.) Volkart), and seashore saltgrass (*Distichlis spicata*) [28].

Habitat: coastal areas and agricultural landscapes.

Regional distribution: cosmopolitan species, described from Southern and Central Europe [27] and known from warm temperate and tropical zones of all continents: Africa, Asia, Australia, Europe, North, and South America; in North America it belongs to a transcontinental species reaching northward into Canada [13].

Economic importance: on agricultural crops *M. propinqua* is known as a vector of few viruses like cynodon chlorotic streak virus in corn and bermudagrass and maize rough dwarf virus [29].

(5) *Neomegamelus elongatus* (Ball, 1905)

Relative abundance: 22 specimens (in INHS, LSAM).

Collection dates: 14 August–4 February.

Hosts: presumably feeds on *Spartina patens* [31].

Habitat: inhabits coastal marshes.

Regional distribution: this species was described from Biscayne Bay, Florida [30], and is widely distributed along the Atlantic and Gulf Coasts northwards to Massachusetts and westward to Louisiana [13, 24].

(6) *Neomegamelus spartini* (Osborn, 1905)

Relative abundance: one male and one female (in INHS, LSAM).

Collection dates: 13 September.

Hosts: Wilson recorded *Spartina patens* [25] as the host plant.

Habitat: inhabits coastal marshes.

Regional distribution: described from New York [32] and is widely distributed along the Atlantic Coast from Maine southward to Florida and along the Gulf Coast westward to Louisiana [13].

(7) *Perkinsiella saccharicida* Kirkaldy, 1903

Relative abundance: one male (in INHS).

Collection dates: 6 September.

Hosts: sugarcane is reported as the preferred host plant for this species and also it was recorded from corn [33].

Habitat: agricultural landscapes.

Regional distribution: cosmopolitan species, described from the Hawaiian Islands [34] and distributed across the tropical parts of Asia, Australia, Africa, the Middle East, and both Americas in regions where sugarcane is grown [13]. *P. saccharicida* was firstly introduced into continental USA in Florida in the early 1980s [35]; in Louisiana the pest was firstly recorded in 1994 [36]; modern distribution in the USA is limited to Gulf States [13].

Economic importance: the species is an important pest of sugarcane and it is a vector of sugarcane *fiji* disease virus, which causes severe yield losses [37].

(8) *Prokelisiacrocea* (Van Duzee, 1897)

Relative abundance: three specimens (in INHS, LSAM).

Collection dates: 14 September.

Hosts: Holder and Wilson reported the prairie cording grass *Spartina pectinata* Link. as the host plant [39].

Habitat: inhabits grasslands.
Regional distribution: described from Iowa [38]. Widespread across the eastern and midwestern states of the USA, westward to North Dakota, Colorado, New Mexico, and Louisiana and northward to southern Canada [40].

(9) Prokelisia dolus Wilson, 1982
Relative abundance: 1560 specimens (in INHS, LSAM).
Collection dates: 1 April–4 February.
Hosts: Wilson reported Spartina alterniflora as the main host of the species [25]
Habitat: coastal species and one of the most abundant herbivorous insects in Spartina marshes [41].
Regional distribution: described from Maryland rather recently [40] and widely distributed along the Atlantic and Gulf Coasts, reaching northward into the southern Canada and southward into Mexico [13]; also, unintentionally, this species was introduced into California [40].

(10) Prokelisia marginata (Van Duzee, 1897)
Relative abundance: 1180 specimens (in INHS, LSAM).
Collection dates: 1 April–19 October.
Hosts: this species is recorded on different species of Spartina: S. alterniflora, S. patens, S. foliosa Trin., S. maritima (Curtis), S. anglica C. E. Hubb. [25, 42].
Habitat: it is primarily a coastal species and one of the most abundant herbivorous insects in Spartina marshes [41].
Regional distribution: this species was described from New Jersey and New York [38] and is widespread across the eastern and southern states of Atlantic and Gulf Coast [40] and also was introduced into California [13] and Western Europe [42].
Economic importance: together with P. dolus this species was considered to be a potential biological agent for control invasive Spartina species [43]. Also, both species are being used extensively as an ecological models over nearly 30 years by Denno and colleagues (see Eubanks et al. [44]), particularly as models for tritrophic ecological interactions between habitat and life history parameters.

(II) Sogatella molina (Fennah, 1963)
Relative abundance: one female (in INHS).
Collection dates: 14 August.
Hosts: native host plants for this species are unknown, but they were collected from invasive California grass Panicum purpurascens Raddi (=Urochloa mutica (Forsk.) T. Q. Nguyen) [45]. Congeners of this species are important pests of many agricultural cereals, like rice, wheat, and corn [46–48].
Habitat: they are agricultural and urbanized landscapes.

Regional distribution: this species was described from Mexico [45]. It is distributed in Central America and West Indies reaching into the southern United States northward to South Carolina and westward to Mississippi [13].

It is a new state record, representing the most western locality of the species in the USA.

(12) Spartidelphax detectus (Van Duzee, 1897)
Relative abundance: 1012 specimens (in INHS, LSAM).
Collection dates: 1 April–4 February.
Hosts: Bartlett and Webb reported this species from Spartina alterniflora and S. patens; also it was collected from Distichlis spicata [19].
Habitat: it is coastal species.
Regional distribution: this species was described from New York [38] and widespread across Atlantic and Gulf Coast states [19] and also in West Indies [13]. Very often it appears in great numbers and together with representatives of Prokelisia shapes a major portion of all herbivores in Spartina salt marshes [49].

(13) Saccharosydne saccharivora (Westwood, 1833)
Relative abundance: one male (in INHS).
Collection dates: 6 September.
Hosts: the species is a major pest of sugarcane, but its original host plants are considered to be Andropogon bicornis L. and A. glomeratus (Walter) Britton [51]; also the species is recorded on Sorghum sudanense (Piper) Stapf. (=Sorghum × drummondii (Nees ex Steud.) Millsp. & Chase) [52].
Habitat: it is agricultural landscapes.
Regional distribution: it is new World species described from West Indies [50] and is distributed across the historical and modern range of sugarcane cultivation: northern South America, Central America, and West Indies, reaching into the Atlantic and Gulf Coast states of USA, including Louisiana, northward to Maryland [13].
Economic importance: this planthopper is a vector of sugarcane yellow leaf phytoplasma, a dangerous disease, causing vegetation losses from 30% to over 60% of susceptible varieties [53].

Dictyopharidae

(14) Rhynchomitra curvata (Metcalf, 1923)
Relative abundance: one male and one female (in INHS, LSAM).
Collection dates: 1 July, 1 September.
Hosts: native host plants for this species are unknown, but it was recorded on an introduced weeping lovegrass (Eragrostis curvula (Schrad.) Nees) [55].
Habitat: it is unknown.

Regional distribution: this species was described from North Carolina [54]. It is native to the southern-eastern North America ranging from Texas and Louisiana northward to North Carolina [13].

Flatidae

(15) Metcalfa pruinosa (Say, 1830)
Relative abundance: one female (in INHS).
Collection dates: 15 August.

Hosts: the species has common name “citrus flatid planthopper” and was reported from only cultivated Citrus trees [57], but it feeds on many trees, shrubs, and some herbs. In Illinois, host plants were recorded as 85 species in 45 families [58]. During a survey of tidal marshlands in Mississippi M. pruinosa was swept from Baccharis halimifolia [59].

Habitat: it is wooded natural and agricultural landscapes.

Regional distribution: transcontinental species is described from “United States” in 1830 [56] and is widely distributed in North America reaching northward into southern Canada; also it is adventive in southern Europe and Korea [13].

Economic importance: the species is of limited economic importance in North America, is a nonvector, and ordinarily does very little damage to hosts [57].

Cicadellidae

(16) Agallia nielsoni Freytag, 2003
Relative abundance: one female (in INHS).
Collection dates: 14 August.

Hosts: host plant is unknown, but representatives of the genus feed on a wide variety of plants, mostly legumes. In a case of high abundance, Ag. nielsoni may also affect cereal, forage, and truck crops [60].

Habitat: it is unknown.

Regional distribution: this subtropical species was described from Honduras [61] and widely distributed across northern South America, Central America, Mexico, and south Texas [61], as Ag. lingula Van Duzee was recorded for Natchitoches Parish, Louisiana [60], but without subsequent confirmation [61]. The discovery of Ag. nielsoni in Plaquemines Parish indicates the presence of this species in Louisiana and represents the most north-eastern locality of the species in the USA.

(17) Amplicephalus (Amplicephalus) littoralis (Ball, 1905)
Relative abundance: 120 specimens (in INHS, LSAM).
Collection dates: 1 April–19 October.

Hosts: saltmeadow cordgrass Spartina patens is reported to be a host plant [62]; also the species was collected from Distichlis spicata [63].

Habitat: it is coastal species.

Regional distribution: the species was described from New Jersey [30] and occurs in the Atlantic and Gulf Coast states from Quebec in the north to Mississippi in the south-east [33].

It is a new state record, representing the most western locality of the species in the USA.

(18) Balclutha frontalis (Ferrari, 1882)
Relative abundance: 12 specimens (in INHS, LSAM).
Collection dates: 6 September–19 October.

Hosts: this species feeds on sugarcane, Sorghum sp., Panicum barbinode Trin. (=Urochloa mutica (Forsk.) T. Q. Nguyen), and Setaria viridis (L.) P. Beauv. (as Balclutha rosea [65]).

Habitat: it is grasslands.

Regional distribution: cosmopolitan species is described from Italy [64] and is widely distributed in the tropical and adjacent temperate zones of all continents [33]. In North America B. frontalis occurs in states along the Gulf of Mexico and Atlantic Coasts northward to Virginia and also in California and Nevada (as Agellus guajanae [66]).

(19) Balclutha neglecta (DeLong & Davidson, 1935)
Relative abundance: one male and one female (in INHS, LSAM).
Collection dates: 12 and 20 September.

Hosts: the species was collected from sugarcane in Texas [67].

Habitat: it is grasslands.

Regional distribution: transcontinental species described from Colorado (as Agellus neglectus [66]) and is widespread in North America ranging from Canada southward to Guatemala in Central America and Puerto Rico in West Indies [33].

(20) Balclutha sp.
Relative abundance: one female (in INHS).
Collection dates: 15 August.

(21) Draeculacephala floridana Ball, 1900
Relative abundance: 54 specimens (in INHS, LSAM).
Collection dates: 1 April–29 September.

Hosts: Rossi and Strong reported Spartina alterniflora the host plant, also the species was reported from Salicornia virginica L., Batis maritima L., Distichlis spicata, and Borrichia frutescens (L.) de Candolle [68].

Habitat: it is coastal marshes.

Regional distribution: it was described from Florida [69] and until now was known for Florida and Texas only [70].
It is a new state record. This locality is situated within the known species range.

(22) Draeculacephala portola Ball, 1927

Relative abundance: 7 specimens (in INHS, LSAM).
Collection dates: 9 April–1 July.
Hosts: they are unknown.
Habitat: it is coastal marshes.
Regional distribution: this species was described from Florida [71]. Previously, it was considered to be a widespread central and eastern species common on agricultural crops [67, 72]. After a genus revision and species reclassification it turned out that D. portola is a species from coastal habitats of the Atlantic Coast [73]. Until present, the species was known from southern Delaware to northern Florida [70].

(23) Empoasca (Empoasca) solana DeLong, 1931

Relative abundance: 12 specimens (in INHS, LSAM).
Collection dates: 15 August.
Hosts: it is a polyphagous species; feeding is recorded on a wide variety of trees, shrubs, and herbs, including many agricultural crops like cotton, potato, alfalfa, and spinach [33].
Habitat: it is eurytopic.
Regional distribution: this species was described from Baton Rouge, Louisiana [74]. It belongs to the species with transcontinental distribution ranging in North America from southern Canada southward into Central America and northern South America [75, 76].

(24) Exitianus exitiosus (Uhler, 1880)

Relative abundance: one male (in INHS).
Collection dates: 14 August.
Hosts: this species feeds on bermudagrass Cynodon dactylon (L.) Pers. and green foxtail Setaria viridis (L.) Beauv. and also is reported from small grains, like spring wheat, barley, and oat [78].
Habitat: it is grasslands and agricultural landscapes.
Regional distribution: transcontinental species is described from Maryland [77] and is widespread in North America reaching northward into Canada and southward into Mexico and West Indies [33, 79].

It is a new state record. This locality is situated within the known species range.

(25) Graminella nigrifrons (Forbes, 1885)

Relative abundance: three specimens (in INHS, LSAM).
Collection dates: 6 and 20 September.
Hosts: feeding is recorded on a wide variety of graminoids, including such agricultural crops as oats, barley, maize, sugarcane, and others [81].
Habitat: it is grasslands.
Regional distribution: transcontinental species is described from Illinois [80] and is widespread in North America ranging from Canada southward to Mexico and West Indies [33, 82].
Economic importance: the species is a vector of maize chlorotic dwarf virus and maize bushy stunt phytoplasma [83].

(26) Graminella sonora (Ball, 1900)

Relative abundance: one male (in INHS).
Collection dates: 6 September.
Hosts: the species is a grass generalist and was reported from约翰songrass Sorghum halepense (L.) Pers., wild cane S. bicolor (L.) Moench., sudangrass S. sudanense (Piper) Stapf., corn, oat, wheat [85], bermuda grass [86], and sugarcane [67].
Habitat: it is grasslands.
Regional distribution: transcontinental species is described from Arizona [84] and is widespread in North America ranging from the northern USA (Minnesota) southward to Costa Rica in Central America and Puerto Rico in West Indies [33].
Economic importance: the sorghum stunt mosaic rhabdovirus may be transmitted [85].

(27) Haldorus (Eohaldorus) australis (DeLong, 1926)

Relative abundance: one male (in INHS).
Collection dates: 14 August.
Hosts: they are unknown.
Habitat: it is grasslands.
Regional distribution: this species was described from Florida [87] and in the continental USA is recorded also for Louisiana and Mississippi; outside it is known from Puerto Rico in West Indies [33].

(28) Negosiana miliaris (Stål, 1864)

Relative abundance: one female (in INHS).
Collection dates: 28 September.
Hosts: they are unknown.
Habitat: it is unknown.
Regional distribution: the species was described from Mexico [88]. Records on this species are scattered along the coastal states: Connecticut, Virginia, North Carolina, Florida, Georgia, and Texas [33], but also the species is known on one male from Illinois (as Gypona (Prairiana) miliaris [89]).

It is a new state record. This locality is situated within the known species range.

(29) Sanctanus fusconotatus (Osborn, 1922)

Relative abundance: 8 specimens (in INHS, LSAM).
Collection dates: 14 August–3 October.

Hosts: the host plant for this leafhopper is not known. The closest in genitalia morphology and allopatric S. aequatorium (DeLong and Sleesman) is recorded on the cordgrass (Spartina sp.) [91], while more distant S. fasciatus (Osborn) and S. sanctus (Say) were recorded on Cyperus rotundus L. and C. esculentus L., respectively [92].

Habitat: it is coastal species.

Regional distribution: the species was described from Cameron Parish, Louisiana [90]. So far it is known from Louisiana only and may be considered as a local coastal endemic species [33, 93].

(30) Spangbergiella vulnerata (Uhler, 1877)

Relative abundance: 16 specimens (in INHS, LSAM).

Collection dates: 9 April–1 September.

Hosts: this species was recorded from St. Augustine grass (Stenotaphrum secundatum (Walter) Kuntze) [95].

Habitat: it is grasslands.

Regional distribution: this species was described from Central Texas [94] and is widely distributed across the midwestern and eastern states in the USA, Mexico, West Indies, and South America [33, 96].

(31) Xyphon reticulatum (Signoret, 1854)

Relative abundance: one male and one female (in INHS, LSAM).

Collection dates: 1 July and 14 October.

Hosts: this is a polyphagous species recorded on many herbaceous hosts including cordgrass, bermudagrass, cane, alfalfa, and potato [33, 98].

Habitat: it is grasslands and agricultural landscapes.

Regional distribution: transcontinental species is described from Cuba [97] and is widespread in New World ranging from the northern states in the USA south through Central America and West Indies to Brazil and Chile [33].

3.1.3. Membracoidea

Membracidae

(33) Spissistilus festinus (Say, 1830)

Relative abundance: two females (in INHS, LSAM).

Collection dates: 14 September.

Hosts: Dietrich et al. reported as host plants a wide variety of plants, mostly legumes and grasses, like peanuts Arachis hypogaea L., alfalfa Medicago sativa L., bushclovers Lespedeza spp., common beans Phaseolus vulgaris L., and soybeans Glycine max (L.) Merr. [103].

Habitat: it is grasslands and agricultural landscapes.

Regional distribution: transcontinental species was described from Florida [56] and is widely distributed throughout North and Central Americas from Canada to Mexico [104] reaching southward into Panama [105].

3.2. Heteroptera

3.2.1. Cimicoidea

Anthocoridae

(1) Orius insidiosus (Say, 1832)

Relative abundance: 55 specimens (in LSAM).

Collection dates: 15 August.

Hosts: both the nymph and adult stages of this species are well-known generalist predators of phytophagous mites [107] and different stages of soft bodied insects, like thrips and aphids [108, 109]. Field researches demonstrated the ability of this predatory species to suppress population of their prey items under natural conditions [110, 111].

Habitat: it is eurytopic.

Regional distribution: this species was described from Pennsylvania and “Carolina” [101] and is widespread in the eastern and midwestern states of the USA reaching in southwest direction into Arizona and also is recorded from Mexico [102].

3.1.2. Cercopoidea

Clastopteridae

(32) Clastoptera xanthocephala Germar, 1839

Relative abundance: one female (in INHS).

Collection dates: 15 August.

Hosts: this spittlebug feeds on the aerial parts of many trees, shrubs, and grasses [99], but favorite hosts are considered to be sunflower (Helianthus spp.) and ragweed (Ambrosia sp.) [100]. During survey of tidal marshlands in Mississippi it was swept from Baccharis halimifolia [59].

Habitat: it is eurytopic.

Regional distribution: this species was described from Pennsylvania and “Carolina” [101] and is widespread in the eastern and midwestern states of the USA reaching in southwest direction into Arizona and also is recorded from Mexico [102].
(2) *Orius pumilio* (Champion, 1900)

*Relative abundance:* 62 specimens (in LSAM).

*Collection dates:* 15 August.

*Hosts:* predator of mites, thrips, and aphids is considered to be a useful biocontrol agent against flower thrips in green houses and can be used for mass rearing [117].

*Habitat:* it is eurytopic.

*Regional distribution:* central-American species was described from Guatemala [116], reaching northward in the southern United States, from where it was recorded from Florida only [112, 118].

It is a *new state record*, which extends the known range of species approximately 400 miles in westward direction.

**Nabidae**

(3) *Nabis* (*Tropiconabis*) *latior* Kerzhner and Henry, 2008

*Relative abundance:* one female (in LSAM).

*Collection dates:* 10 April.

*Hosts:* similar to the other representatives of the family, it is supposed to be a generalist predator, feeding on a vast spectrum of small invertebrates, chiefly insects [119]. Its closest relative, *N. (*Tropiconabis*) *capsiformis* Germar, is considered to be an important biological control agent in soybean fields in Louisiana [120].

*Habitat:* it is unknown.

*Regional distribution:* this species has been missed by researchers for a long time and was described from Louisiana less than 10 years ago [121]. Species range occupies all the Gulf States (from Texas eastwards to Florida) and Bahamas [121].

3.2.2. Lygaeoidea

**Blissidae**

(4) *Ischnodemus conicus* Van Duzee, 1909

*Relative abundance:* 437 specimens (in LSAM).

*Collection dates:* 1 April–14 September.

*Hosts:* this species feeds on *Spartina alterniflora* [20, 122].

*Habitat:* it is coastal species.

*Regional distribution:* the species was described from Galveston, Texas [123], and reported from Louisiana and other Gulf and Atlantic Coastal States north to Virginia and North Carolina [20].

**Cymidae**

(5) *Cymodema breviceps* (Stål, 1873)

*Relative abundance:* one female (in LSAM).

It is a *new state record*, which extends the known range of species approximately 400 miles in westward direction.

(6) *Dagbertus fasciatus* (Reuter, 1876)

*Relative abundance:* 66 specimens (in LSAM).

*Collection dates:* 15 August.

*Hosts:* polyphagous species is recorded on different woody plants, such as *Cordia nitida* Vahl (= *Cordia laevigata* Lam., Boraginaceae) and *Tecoma stans* (L.) Juss. (Bignoniaceae) in Cuba [127] or avocado in Florida [128], as well on herbs like *Portulaca oleracea* L. [129].

*Habitat:* it is eurytopic.

*Regional distribution:* the species was described from South Carolina [126] and is widespread in the southern Atlantic and Gulf Coastal States, including Florida, Georgia, Louisiana, Mississippi, and Texas [130].

(7) *Rhinacloa clavicorns* (Reuter, 1905)

*Relative abundance:* 6 specimens (in LSAM).

*Collection dates:* 15 August.

*Hosts:* this species was recorded from a wide range of hosts, including such agricultural crops as corn, cotton, potato, and bean; also adults are reported from *Crotalaria juncea* L. (Fabaceae), *Ambrosia artemisioides* Meyen and Walpers (Asteraceae) [132], and *Buddleja wrightii* Robbins (= *B. sessiliflora* Kunth, Buddlejaceae) [21].

*Habitat:* it is eurytopic.

*Regional distribution:* this is a tropical species, described from Venezuela [131], and ranging from Argentina to Mexico, West Indies, and Florida [133].

It is a *new state record*, which extends the known range of species approximately 400 miles in westward direction.

(8) *Trigonotylus tenuis* Reuter, 1893

*Relative abundance:* 6 specimens (in LSAM).

*Collection dates:* 4 May–1 September.
Psyche

Hosts: this species feeds on grasses and sedges Bromus arvensis L. (= B. japonicus Thunb.), Digitaria ciliaris (Retz.) Koeler, Hordeum psilum Nutt., Cyperus rotundus L. (as T. doddi (Distant) in [129]). Also it was reported from invasive grasses Cynodon dactylon (L.) Pers., Eleusine indica (L.) Gaertn. [21], and some agricultural crops like rice [134].

Habitat: it is grasslands.

Regional distribution: cosmopolitan species is originally described from Seychelles Islands [135] and is characterized by pantropical distribution [136], including tropical or subtropical regions of West Indies and Central and South America [137]. In North America, its range occupies Louisiana and other Gulf States and extends northward into Maryland in the east, Nebraska in the midwest, and California in the west [18].

(9) Trigonotylus saileri Carvalho, 1957

Relative abundance: 137 specimens (in LSAM).
Collection dates: 16 March–14 September.
Hosts: Seashore saltgrass Distichlis spicata was recorded as the host plant of this species [136].
Habitat: it is saline wetlands.

Regional distribution: the holotype of this species originates from Maryland [137]; the taxon is native to the coastal states of the eastern and southern North America, including Louisiana and reaching westward Arizona [18]. In the Maritime Provinces, adults were collected on grasses along the upper margins of tidal flats [18].

(10) Trigonotylus uhleri (Reuter, 1876)

Relative abundance: 12,583 specimens (in LSAM).
Collection dates: 16 March–19 September.
Hosts: Denno reported Spartina alterniflora as the host plant [49], on which it can reach very high densities up to 3000 specimens per square meter [138].
Habitat: it is salt coastal marshes.

Regional distribution: the origin of the type series of this species is cited as “Habitat Americam borealem” [126]. Its modern distribution is similar to that of T. saileri, but T. uhleri is strictly confined to the coastal states, ranging from Quebec in the north to Texas in the south [18, Texas record, http://bugguide.net/node/view/649297].

It is a new state record. Though a Louisiana locality of T. uhleri is situated within the known species range, this finding is worth noting, because the Texas record, most western among the Gulf States, is based on one image of the species in the BugGuide database.

(11) Tytthus vagus (Knight, 1923)

Relative abundance: 49 specimens (in LSAM).

Collection dates: 11 January–1 September.
Hosts: predaceous bug is specialized in its dietary habits, feeding primarily on the eggs and young nymphs of Delphacidae and Cicadellidae [140]. It is considered to be one of the most effective predators for delphacid Prokelisia dolus [141] and can kill up to 24 planthopper eggs per day [142].
Habitat: in coastal communities it has been recorded from Spartina alterniflora and S. bakeri Merr. [143].
Regional distribution: the species was described from the Long Island, New York [139], and is distributed across Atlantic and Gulf States from Newfoundland southward to Louisiana [143].

4. Discussion

The assemblage of the dominant and subdominant species in the examined material was represented by seven species, namely, leafhopper Amplicephalus littoralis (Ball) from Cicadellidae, planthoppers Prokelisia dolus Wilson, P. marginata (Van Duzee), and Spartidelphax detectus (Van Duzee) (all from Delphacidae), heteropterans Ischnodemus conicus Van Duzee from Blissidae, Trigonotylus uhleri (Reuter), and Tr. saileri Carvalho (both from Miridae). A group of the dominant species with the abundance over 1000 collected specimens was composed of four multivoltine species. Three multivoltine planthoppers P. dolus, P. marginata, and S. detectus comprised 91.9% of all collected adults of Auchenorrhyncha, and one multivoltine plant bug T. uhleri comprised 93.8% of all collected heteropterans. All species from the dominant and subdominant groups belonged to sucking herbivores associated with the salt marsh ecosystem with the dominant plants of the family Poaceae (Monocotyledones), either with cordgrass (Spartina alterniflora and/or S. patens) or with seashore saltgrass (Distichlis spicata) (Figure 1, green). In a biogeographical aspect, all species from the dominant and subdominant groups have similar geographical distribution and are native to the Atlantic and Gulf Coast States (Figure 2, dark blue). The group of common species comprised 11 species, sucking herbivores as well as predators (Figure 1, red). The predators were represented by three species, two minute pirate bugs Orius insidiosus and O. pumilio from Anthocoridae, and one plant bug Tytthus vagus from Miridae, that altogether comprised 42.5% of all specimens of this group. Relatively high abundance of these predators, their small size, and well-known specialization of T. vagus in egg-feeding [140] suggests that this complex of species feed on eggs and preimaginal stages of the species from the dominant and subdominant groups. Sucking herbivores of the group of common species included not only taxa associated with the dominant coastal plants, but also taxa with wider host preferences. So, the host pattern of the group was characterized by two fractions of polyphagous species and grass generalists absent from the dominant and subdominant groups. As is shown in Figure 1 (dark blue and grey), the fraction of polyphagous species encompassed 37.5%, and the fraction of grass generalists encompassed 25.0% of all herbivore species of the group.
The range pattern of the group of common species was also different from that of the dominant and subdominant groups. Here, the portion of the Atlantic and Gulf Coasts species started to decline and was replaced by species with different, often wide, and noncoastal types of ranges. It can be seen from the increased proportions of (1) the noncoastal species with either eastern, midwestern, or transcontinental distributions, and of (2) the southern coastal species, distributed in the USA along the Gulf Coast only and absent from the Atlantic Coast States (Figure 2, green and yellow, and light blue and red, resp.). The assemblage of southern coastal species was comprised mostly of the taxa with wide ranges, with either Caribbean or Neotropical distributions, but included also a couple of endemics (Figure 2, red), such as leafhopper *Draeculacephala floridana*, restricted to the Gulf States, and planthopper *Megamelus longicornis*, inhabiting the western Gulf States only.

From a total of 44 species, the group representing rare species embraced 25 species and contributed to shaping biodiversity of the examined material. In general, host and range patterns of the group were structurally similar to those of the group of common species but varied in details. Proportion of predators in the group of rare species was close to zero (just one species); thus nearly all diversity of the group was shaped by sucking herbivore species. Host pattern of the herbivores of common and rare species showed similar proportion of the polyphagous species (33–37%) and of the species associated with grasses (~50% of all herbivore species). However, within the latter assemblage the fraction of rare species associated with dominant plants of the salt marsh was noticeably smaller, and, respectively, grass generalists among rare species had a much greater presence (Figure 1, green versus grey) in comparison to the group of common species. It is worth mentioning that more than 50% of collected taxa of the rare species were represented by singletons, and many of these belonged to the species with unknown biology and with unknown hosts (Figure 1, yellow). A certain portion of species collected as singletons definitely belonged to adventive species, accidentally delivered to the salt marsh a small group of species potentially connected with regional agroindustry (Figure 1, blue). In this group, we place two pests of sugarcane, *Perkinsiella saccharicida* and *Saccharosydne saccharivora*, and citrus flatid planthopper *Metcalfa pruinosa*. The range patterns of the rare species were characterized by the dominance of noncoastal species (>50% of all taxa) with prevalence of taxa with the eastern-midwestern distributions (Figure 2, yellow). Among rare coastal species the fraction of taxa with Gulf Coast States distribution (Figure 2, light blue) similar to the common species was mostly represented by taxa with Neotropical or Caribbean distributions. Only few rare coastal species were represented by local endemics (Figure 2, red): leafhopper *Sanctanus fusconotatus* from this group is known from the coastal Louisiana only [33, 93].

Examined material allowed us to establish new state records for 10 species from which eight are native to the coastal salt marshes of Atlantic and Gulf Coast States. Five of newly recorded species are of Neotropical or Caribbean origin, which may reflect the last years’ tendency of the expansion of many species in northward direction possibly due to climate change [144, 145].

**Figure 1:** Stacked bar chart showing the host-abundance pattern of the members of Auchenorrhyncha and Heteroptera, collected in Louisiana salt marshes in the Mississippi Delta. X-axis represents classes of abundance with corresponding species group names and a number of collected specimens per species. Comments in the text.

**Figure 2:** Stacked bar chart showing the range-abundance pattern of the members of Auchenorrhyncha and Heteroptera, collected in Louisiana salt marshes in the Mississippi Delta. X-axis represents classes of abundance with corresponding species group names and a number of collected specimens per species. Comments in the text.
5. Conclusions

Summarizing the analyzed patterns of Auchenorrhyncha and Heteroptera coastal faunas, it can be stated that within Louisiana salt marsh the core assemblage of species is limited in number and consists of four sap-sucking species, which are tropically connected to the dominant plant of the marsh, Spartina alterniflora. All four are characterized by multivoltine biology and are widely distributed across the Atlantic and Gulf Coasts States. These features reflect successful adaptations of these species to the life in the coastal salt marsh ecosystem and allow them to reach very high densities. However, an actual biodiversity of the sampled material was provided by species with much lower densities, different biology, and biogeography. Among those, one can meet adventive and native coastal species, polyphages and grass specialists, cosmopolitan species, as well as local endemics.

In general, Louisiana salt marshes harbor the same assemblage of dominant species as salt marshes of New Jersey [49], North Carolina [125], South Carolina [146], Florida [147], Alabama [148], and Mississippi [59]. Conversely, the complex of species, belonging to the classes with lower abundancy, differs from other regions. For instance, according to our survey, neighboring Mississippi which possesses the most thoroughly completed checklist of the coastal fauna, has only 13 species of Auchenorrhyncha and six species of Heteroptera in common with Louisiana (cf. Lago and Testa III in [59]). The most striking feature of the examined material is the lack of planthoppers Spartidelphax penedectus (Beamer) and representatives of Tumidagina, characteristic elements of the salt marsh fauna of the Atlantic Coast [19, 25, 149–151]. The future investigations will show whether the recorded difference in hemipteran fauna between Louisiana and other regions is an artifact or points to unknown natural reasons. Nevertheless, for some groups of taxa the difference in faunistic lists can be explained by the following causes. Partly, it may be connected with the differences in collecting techniques: Louisiana material was obtained by sweep-net method only, while other researchers used light traps, Malaise traps, pitfalls, sticky plates, or hand picking in addition to net-sweeping techniques (cf. methods in [59, 146, 148]). For some genera, the incongruity is linked to the problems in recognizing species of taxonomically difficult groups (e.g., Balclutha), taxa of which in previous studies were not identified to the species level. Finally, natural and unpredictable fluctuations in the number of occasional and adventive species may also be a cause of certain deviations in faunistic lists of the community.

Conflicts of Interest

There are no conflicts of interest regarding this paper.

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