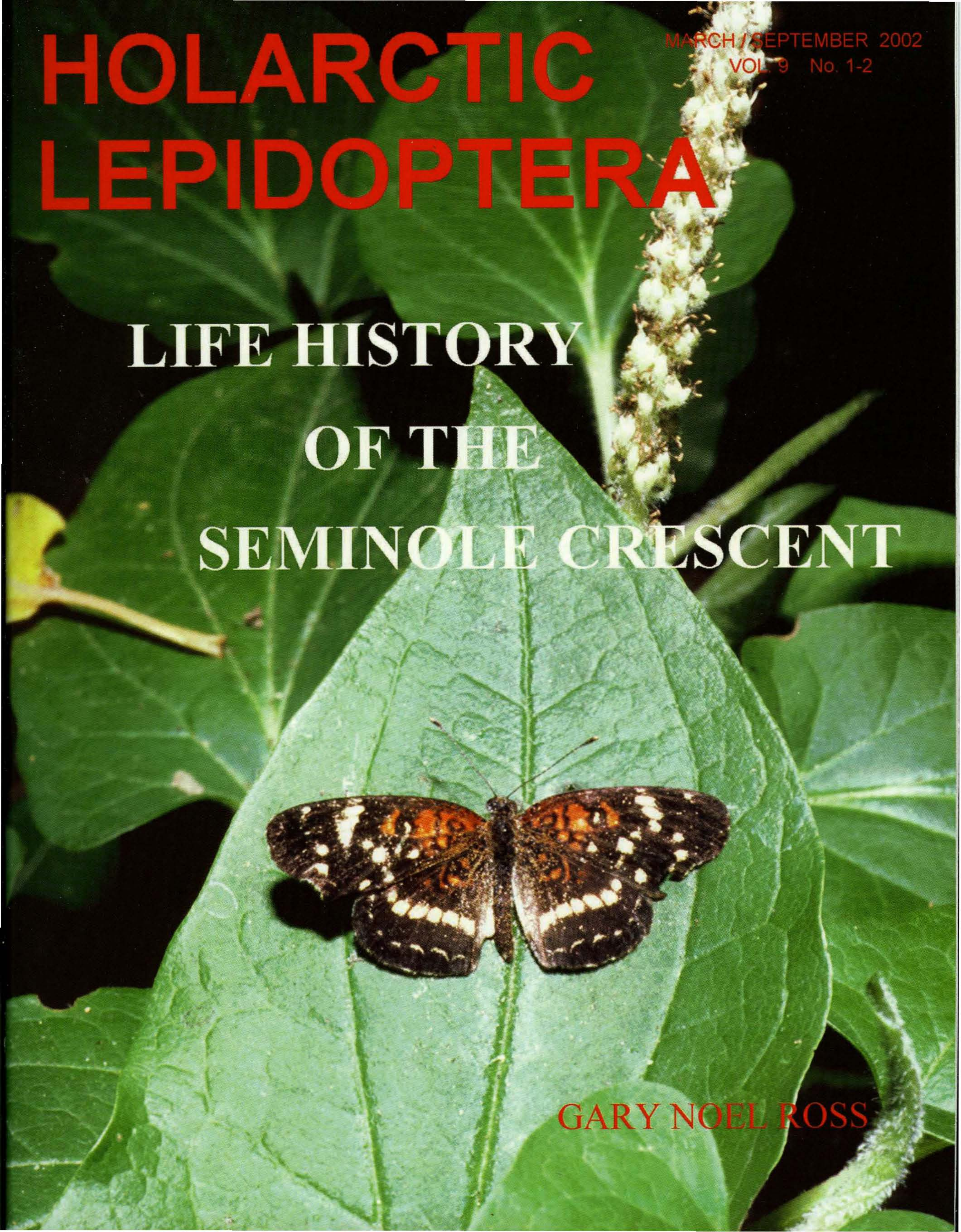
HOLARCTIC LEPIDOPTERA

MARCH / SEPTEMBER 2002
VOL. 9 No. 1-2

LIFE HISTORY OF THE SEMINOLE CRESCENT

GARY NOEL ROSS



HOLARCTIC LEPIDOPTERA

ASSOCIATION FOR TROPICAL LEPIDOPTERA

Editor: John B. Heppner
Assoc. Editor: Thomas C. Emmel

VOLUME 9 Number 1-2 MARCH / SEPTEMBER 2002

LIFE HISTORY OF THE SEMINOLE CRESCENT, *ANTHANASSA TEXANA SEMINOLE* (LEPIDOPTERA: NYMPHALIDAE)

by
GARY NOEL ROSS

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FRONT COVER (outside): Male Seminole crescent, *Anthanassa texana seminole* (Nymphalidae) resting on lizard's tail (*Saururus cernuus*) in Bluebonnet Swamp Nature Center, Baton Rouge, Louisiana. Detached deciduous body scales are obvious on wings of newly-eclosed specimen. (inside): Water reflections in Bluebonnet Swamp Nature Center, Baton Rouge, Louisiana, an urban mini sanctuary of 40.9 ha (101 ac) administered by the East Baton Rouge Recreation and Park Commission (BREC). Buttressed trees are bald cypress (*Taxodium distichum*) and tupelo gum/water tupelo (*Nyssa aquatica*). Protuberances are aerial roots ("knees") of bald cypress. Sanctuary is major habitat for *A. t. seminole*.

BACK COVER (outside): Female Seminole crescent (*Anthanassa texana seminole*) eclosing. Often several caterpillars will select adjacent sites to pupate. Pupae overwinter; adults emerge in late April or early May. In Louisiana, 3-5 generations each year are typical. (inside): Bluebonnet Swamp Nature Center, Baton Rouge, Louisiana during severe drought. Because of extreme land disturbances within watershed area, the swamp is often dry for extended periods throughout the summer. During floods, boardwalk can be submerged.

CENTERFOLD: Typical habitat for Seminole crescent, *Anthanassa texana seminole*, in southern Louisiana. Woodland ponds are often bordered by the native host, lance-leaved waterwillow (*Justicia ovata* var. *lanceolata*) (Acanthaceae), a low-growing, colonizing perennial that spreads by shallow root extensions. Photo: Burden Research Station, Louisiana State University Agricultural Center.

The Association for Tropical Lepidoptera, Inc., is a non-profit organization for the support of research on the biology, systematics, and conservation of tropical and subtropical Lepidoptera of the world. Funding for the Association helps to support research projects, field studies, and publications on tropical and subtropical Lepidoptera.

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HOLARCTIC LEPIDOPTERA (ISSN 1070-4140) is published semi-annually (March and September) by the Association for Tropical Lepidoptera, Inc. Membership is $90 per year ($110 per year outside the USA) (includes quarterly newsletter and all journals). Membership is open to all persons interested in Lepidoptera. Membership applications, dues, and other business should be sent to the Executive Director: Dr. John B. Heppner, Association for Tropical Lepidoptera, P. O. Box 141210, Gainesville, FL 32614-1210, USA. Tel: (352) 846-2000, ext. 234. FAX: (352) 373-3249.

 Home Page: http://www.troplep.org e-mail: troplep@aol.com 26 September 2005


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HOLARCTIC LEPIDOPTERA, 9 (1-2): 1-30 (2005)

LIFE HISTORY OF THE SEMINOLE CRESCENT, *ANTHANASSA TEXANA SEMINOLE* (LEPIDOPTERA: NYMPHALIDAE)

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ABSTRACT.– The Seminole crescent, *Anthanassa texana seminole* (Skinner), generally considered a distinct subspecies of the Texas crescent, *A. t. texana* (W. H. Edwards), is profiled from five insular populations in southern Louisiana. The immature stages and the natural history of the insect are documented. Larval frass appears to be resistant to microbial contamination. Late instar larvae regurgitate a green, mucilaginous fluid that probably acts as a physical and chemical deterrent to predation. In contrast to the nominate subspecies, *A. t. seminole* in Louisiana is a wetland multivoltine species found mainly along the borders of swamps, ponds, and creeks that support the host *Justicia ovata* (Walt.) Lindau var. *lanceolata* (Chapm.) R. W. Long (lance-leaved waterwillow) (Acanthaceae), a small, semi-aquatic, colonial, pioneer species, which is more common and widely distributed than the butterfly. Within the city limits of south Baton Rouge, adults often wander from their natural habitats into adjacent residential communities where they readily utilize as hosts various ornamental (exotic) species of acanthus, particularly *Dicliptera suberecta* (Andre') Bremek (King's crown). This propensity for invading urban neighborhoods affords butterfly gardeners the opportunity to attract the butterfly. In their natural habitats, adults feed readily on encrustations of cyanobacteria, common on drying swamp soil. Particularly during autumn, however, adults nectar on various herbaceous annuals and perennials in sunny locations adjacent to breeding sites. In urban settings, adults nectar on cultivated *Lantana camara* L. (Verbenaceae). *A. t. seminole* seems to be semi-tropical and greatly influenced by availability and reliability of its primary host—a pioneer species that is relatively stable in shaded or semi-shaded wetland habitats that also are relatively stable. A series of years featuring a relatively warm, dry winter followed by a relatively dry spring and summer encourages the spread of the host, which in turn, increases the population of the butterfly. Conversely, prolonged dry or wet years as well as excessive flooding of wetland habitats (especially during summer months) adversely affect the population densities of both host and butterfly.

KEY WORDS: Acanthaceae, biology, Bluebonnet Swamp Nature Center, conservation, cyanobacteria, ecology, hostplants, Louisiana, swamp, natural history, Nearctic, North America, Texas crescent, waterwillow, United States, wetlands.

"We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."
Aldo Leopold

On the morning of Saturday, 6 May 2000, Robert Sherman (RS), a close friend and avid butterflyer/birder, telephoned me to report that during the morning's birding field trip to Bluebonnet Swamp Nature Center, a newly opened facility in south Baton Rouge, Louisiana, he noticed several Seminole crescents flying in sunny patches along an elevated boardwalk. This piqued my curiosity because the species was documented from only a few insular localities in the state, and in 1998, RS and I had observed other specimens in a newly developing tract of land barely one mile from the preserve. Responding, on 7 May, RS and I visited the site. We quickly noticed approximately 25 individual Seminoles on the wing. Furthermore, we witnessed two females ovipositing on a low-growing plant that was in flower. A few days later RS telephoned to report that he had just observed at least one Seminole at his residence, approximately 3 km (2 miles) from my home. Within minutes I was accompanying RS in his extensive garden, designed to attract hummingbirds and butterflies. We soon spotted a female Seminole inspecting both a shrimp plant and King's crown (see Host Plants). She eventually deposited a clutch of eggs on the King's crown. Inspection of the garden revealed a cluster of small, spiny, dark caterpillars on a shrimp plant. Because the taxonomy of the Seminole crescent remains unresolved (subspecies? species?), the life history poorly reported, and I had a considerable amount of uncommitted time during the summer and fall, I decided I would endeavor to chronicle the natural history of the insect. Because of differences in weather patterns between 2000, 2001, and 2002, I extended field observations through December 2002. This paper is the product of that research.

Plant taxonomy follows Kartesz (1994) and IPNI (2001). Butterfly taxonomy follows Miller and Brown (1981) and NABA (2001), with some updates. Larval descriptions follow Peterson (1962).

CLASSIFICATION and ETYMOLOGY

The Seminole crescent, Seminole (Miller, 1992) or 'Seminole' Texan crescent (NABA, 2001) is designated as *Anthanassa texana seminole* (Skinner), 1911 (Miller and Brown, 1981), a subspecies of *A. texana texana* (W. H. Edwards), 1863, which is commonly referred to as the Texas (or Texan) crescent and Texan crescentspot (Miller and Brown, 1981) (front cover, Fig. 1). The species is placed within the subfamily Melitaeinae, Tribe Melitaeini (Miller and Brown, 1981). Throughout its history the species has been placed in the following genera: *Eresia*, *Melitaea* and *Phyciodes* (Miller and Brown, 1981) with *Anthanassa* Scudder (1875) reserved for subgeneric designation, e.g., *Phyciodes (Anthanassa) texana seminole* (Howe, 1975; Opler and Krizek, 1984). Neck (1996) considers *A. t. seminole* a separate species, designated as *Anthanassa seminole* (Skinner, 1911) (for distinguishing characteristics, see Oviposition Behavior and Developmental Stages: Adults).

The generic name is derived from the Greek *antha*, referring to "flower" or "brilliancy" (brightness) and *anassa*, referring to "a queen" (Borror, 1960). The designation probably has to do with the

Fig. 1. *Anthanassa texana*: A. Seminole crescent, *A. t. seminole*, female. B. Seminole crescent, *A. t. seminole*, male. C. Texas crescent, *A. t. texana*, male. "Texans" are the western subspecies; "Seminoles" represent the eastern subspecies. Note detached deciduous body scales on newly eclosed Seminoles.

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fact that many crescents are avid visitors of flowers and patches of sunlight. The species name, *texana*, is derived from the state of Texas; the subspecies name, *seminole*, is a Muskhogean Indian tribe of Florida, originally composed of immigrants from the Lower Creek villages of the Chattahoochee River (Opler and Krizek, 1984).

DISTRIBUTION

Historical

Anthanassa texana is a southern species: resident from coastal South Carolina and Georgia, central and northern Florida, then westward from southern Mississippi and Louisiana across the southern United States to southern California, and southward into tropical America through Mexico to Guatemala; strays are known to occur as far north as central Illinois, Minnesota, North Dakota, and central Nevada (Glassberg, 1999; Howe, 1975; Opler and Krizek, 1984; Opler, 1992; Scott, 1986). Pyle (1981) reports that spring broods (presumably in Texas) may wander "600 miles north, rivaling the long distance flights of the Dainty Sulphur and the Pygmy Blue." In general, populations of *A. texana* from central Texas westward are assigned to *A. t. texana* while eastern/southern populations extending from eastern Texas eastward are *A. t. seminole* (Opler and Krizek, 1984) (Fig. 1).

A. texana seminole is represented by several small, segregated populations (demes). The epicenter probably is the panhandle and central regions of Florida: Alachua Co. (Swengel and Opler, 2001; Swengel, 2002), Brevard Co. (Harris, 1972), Calhoun Co. (Kimball, 1965), Flagler Co. (Swengel, 2002), and Leon Co. (Kimball, 1965). No populations are known from southern Florida or the Keys (Opler and Krizek, 1984; Minno and Emmel, 1993). In Georgia, Harris (1972) records populations from the Coastal Region in Baker, Chatham, Decatur, Mitchell, and Thomas counties. Swengel and Swengel (2003) report five specimens from Francis Marion National Forest in South Carolina on 5 Jul 2002. There is but one record from Mississippi (southeastern): a single specimen collected in 1956 from Lamar Co. near Hattiesburg (Mather and Mather, 1958).

Within Louisiana, *A. texana* has been recorded from the northern parish of Caddo—a single male in November 1958, near Shreveport (Ross and Lambremont, 1963)—and in the south in the parishes of East Baton Rouge, Iberville, and St. Tammany between April and November (Lambremont and Ross, 1965; Ross and Lambremont, 1963). The single specimen from Caddo represents the subspecies *texana* (probably a stray from the west) while the other specimens are *seminole* (probably from distinct demes). Craig Marks (CM) (pers. comm.) states that in 2000 he observed Seminoles in the Atchafalaya Basin bordering the Atchafalaya River (a major distributary of the Mississippi River) near Butte La Rose, Indian Bayou Wildlife Management Area (Army Corps of Engineers) (St. Landry Parish): 6 specimens on 29 Apr and 5 specimens on 29 May. Additionally, CM states that before 1996 he had observed Seminoles in the same area as well as a locale within the city limits of Lafayette (Lafayette Parish) along the Vermilion River—a locale now urbanized. Kevin Cunningham (personal communication) observed large numbers (over 100) along a wide, open corridor flanked by a bayou (creek) and a cypress swamp on the outskirts of Houma (Lafourche Parish) in 1999.

Between 1975 and 2001, Seminoles have been documented from two locations during annual "Fourth of July Butterfly Counts—North American Butterfly Association": (1) "Lower East Pearl River, LA-MS" (Pearl River Wildlife Management Area ("Honey Island Swamp") (Louisiana Dept. of Wildlife and Fisheries) (St. Tammany Parish) = LEPR site, and (2) "Metro New Orleans, LA" (Orleans Parish) = MNO site. The data from LEPR (years 1975-2001) are: 1986 (10 individuals) (Opler and Powell, 1987), 1996 (7 individuals) (Swengel and Opler, 1997), 1999 (6 individuals) (Swengel and Opler, 2000), and 2000 (9 individuals) (Swengel and Opler, 2001). From this location in 1996 and 1999, Dorothea Munchow (personal communication), an annual participant in these counts, collected several female Seminoles for rearing and later release in the uptown New Orleans area. The single record from MNO (years 1993-2000) is: 1993 (3 individuals) (Swengel and Opler, 1994). Within the Baton Rouge area, RS (pers. comm.), Gale Strickland (pers. comm.), and I during the 1980s and 1990s periodically observed Seminoles within the southern sectors of the city, primarily in semi-shaded, moist sites within Bluebonnet Swamp Environmentally Sensitive Watershed intersected by Bluebonnet Boulevard and Highland Road. RS also reported a single male Seminole at Harb's Oasis, a nursery-landscape center in the eastern sector (Jones Creek) of the city (13827 Coursey Blvd., zip code 70817).

Howe (1975) indicates that a blend zone between *A. t. texana* and *A. t. seminole* may occur in central Kansas. Additionally, Charles Bordelon, Jr. (CB), and Edward Knudson (EK) (pers. comm.) state that the species is common within the Houston area. All specimens now taken are *A. t. texana*. In the past, a sizable population of *A. t. seminole* existed around Lake Houston in Eisenhower Park (Harris Co.). The data for *A. t. seminole* from CB and EK are: 18 Sep 1976, 3 Sep 1977; a single specimen representing a possible intergrade between *texana* and *seminole* was taken on 27 Aug 1994, Spring Valley (Harris Co.)

Currently, no populations of either subspecies of *A. texana* are known to occur between Houston (Texas) and the Atchafalaya Basin (Louisiana)—a straight-line distance of approximately 340 km (200 mi). Other than the single historic record from Mississippi (Mather and Mather, 1958), the closest populations of *A. t. seminole* east of Louisiana appear to be in the lowlands drained by the Apalachicola, Chattahoochee, Chipola, Flint, Little, and Ochloockonee Rivers and Lake Seminole in the panhandle of Florida and extreme southwest Georgia (see above for references). This is a straight-line distance of approximately 500 km (300 mi) from the most eastern deme in Louisiana. To my knowledge there are no recent published records from eastern Florida and southwestern Georgia.

Present Study

Five major breeding sites are identified, all within southeastern Louisiana. These are as follows:

(1) Pearl River Wildlife Management Area ("Honey Island Swamp") (Louisiana Department of Wildlife and Fisheries) (St. Tammany Parish);

(2) outskirts of southeastern Houma (Lafourche Parish);

(3) Baton Rouge (East Baton Rouge Parish-southern sector) including Bluebonnet Swamp Nature Center—administered by the East Baton Rouge Recreation and Park Commission (BREC)—and accessed from Bluebonnet Blvd. and N. Oak Hills Pkwy.; lands bordering or near the sanctuary—specifically, BREC Highland Road Park (zip code 70810) and accessed from Highland Road (State Highway 42), The Myrtles Subdivision (zip code 70810) and accessed from Highland Road, and The Estates at Worthington Lake (zip code 70810) and accessed from Staring Lane; Burden Research Station (Louisiana State University Agricultural Center), accessed from Essen Lane (State Highway 3064) (zip code 70809); Hilltop Arboretum (Louisiana State University), accessed from Highland Road (zip code 70884); the wetland behind the Louisiana Dept. of Wildlife and Fisheries (LDWF) building (2000 Quail Dr., zip code 70808); and various residential communities: College Town, Hundred Oaks Park, Kenilworth, Woodgate Crossing, Southdowns, Stratford Place (all zip code 70808 and all drained by Ward Creek,

Dawson Creek, Bayou Duplantier and Bayou Fountain), Goodwood (70806), and one community within the eastern sector of the parish, Jones Creek (70817);

(4) Baton Rouge-Community of Alsen (East Baton Rouge Parish-northern sector), Mississippi River floodplain at delta of Bayou Baton Rouge (a small distributary of the MR) adjacent to a restricted access site administered by the Environmental Protection Agency as the Petroprocessors, Inc. Superfund Cleanup Project, located at the end of Brooklawn Drive (70807) off U.S. Highway 61;

(5) Indian Bayou Wildlife Management Area (Army Corps of Engineers) (St. Landry Parish) within the Atchafalaya Basin. The various sites enclose a triangle with points 100-125 km (60-75 mi) apart.

Although I personally checked most locales during the summers of 2000, 2001, and 2002, the Bluebonnet Swamp, College Town and Hundred Oaks Park locations within the south Baton Rouge area were the primary sites for detailed life-history investigations during the summer of 2000. The Indian Bayou site was checked twice during 2001 (once by CM on 4 Jul and once by CM and myself on 29 Jul), and four times in 2002 (three times by CM—17 Apr, 25 May and 29 Jun—and once by CM and myself on 20 July). Because of its restricted designation, the north Baton Rouge (Alsen) site was checked exclusively by RS on multiple occasions during fall 2002.

Observations and Results (see Host Plants for complete notations of species):

(1) Pearl River: 21 Jun 2000, 8 Jul 2000, 10 Jun 2001, 22 Sep 2002: 1 male observed on 21 Jun and the host *Justicia ovata*, was noted on all visits.

(2) Houma: 20 Jul 2000, 18 Jul 2001: no adults seen although *J. ovata* was noted on both visits.

(3) Baton Rouge (south): Bluebonnet Swamp Nature Center: 2-3 times weekly — 7 May-15 Aug 2000, and twice weekly — 24 Aug-12 Sep; twice weekly — 4 Apr-2 Aug 2001, and once weekly between — 23 Aug-14 Sep. Hilltop Arboretum, Burden Research Station, and wetland behind LDWF: periodic surveys throughout the summer and fall months in 2000, 2001, and 2002; additionally, these sites were periodically monitored for habitat changes Sep-Dec 2002.

In 2000, *A. t. seminole* was most common at Bluebonnet Swamp; eggs and immatures were observed on *J. ovata;* 1 male was observed at either the Hilltop or Burden sites. Additionally, no butterfly was noted in the following residential cmmunities: College Town — (318 Stanford Ave.), 2 males, 3 females, 1 egg cluster and 12 larvae on the exotic host King's crown; Goodwood — (6966 Goodwood Ave.), 1 female, 2 egg clusters and 6 larvae on the exotic hosts Brazilian plume and yellow Jacobinia; Kenilworth — (7533 Blendon Dr. "Kenilworth Club, Inc." and "dead end" to 1600 block of Leycester Dr.), 1 male, evidence of larval feeding on *J. ovata* growing along a narrow drainage ditch behind the parking lot, swimming pool, and tennis courts. [NOTE: The two sites in Kenilworth, the one in Woodgate Crossing, and the one adjacent to the Louisiana Department of Wildlife and Fisheries building all border a natural, swampy sink containing *J. ovata*]; Hundred Oaks Park — (3128 So. Eugene St.), 3 egg clusters and 30 larvae on the exotics King's crown and shrimp plant — (2832 Zeeland Ave.), 2 larvae on King's crown; Woodgate Crossing — (6913 Chandler Dr.), 1 egg cluster, 5 larvae on *J. ovata* growing along the border of a large pond draining into a several ha swampy sink; Southdowns — (2235 Glasgow Ave.), 1 egg cluster on King's crown; and Stratford Place Subdivision — (6095 Stratford Ave.), 2 males, 2 egg clusters, one on King's crown, the other on the exotic Mexican honeysuckle; The Estates at Worthington Lake, rear of subdivision (High Worth Dr.) bordering Bluebonnet Swamp, 2 males, 1 egg cluster on *J. ovata*; The Myrtles Subdivision, rear of subdivision (Myrtle View Dr.) bordering Bluebonnet Swamp, 1 male, 1 female, 2 larvae on *J. ovata*. Observations in 2000 from these Baton Rouge locales form the basis for the Life Cycle section of this study.

In 2001, only 4 adults (probably males) were located, and all were within one residential neighborhood (residence of RS, 3128 So. Eugene St., Hundred Oaks Park).

In 2002, 9 males, 7 females were reared from fourth instar larvae found feeding on King's crown on 31 Jul in a garden at 318 Stanford Ave.

(4) Baton Rouge (north) — (Community of Alsen) (EPA-Petroprocessors, Inc. site): RS (an employee of TetraTech EM, Inc. — company contracted by EPA) began work at the site on 14 Oct 2002. On 16 Oct he noticed several Seminoles flying within sunny openings within the narrow swamp forest bordering the Mississippi River where Bayou Baton Rouge descends the Prairie Terraces, Pleistocene bluffs (Louisiana Geological Survey, 1989). Within a few days the number of individual butterflies increased to 3 to 4 dozen. Many of the butterflies would feed leisurely on herbaceous perennials (see Adults: *Feeding*). No Seminoles were ever observed on the higher ground of the bluff. RS continued to monitor the population casually during his professional outdoor duties through 30 Dec 2002. He observed adults throughout the period, although by mid November numbers were very much reduced, with the last individual recorded on 21 Nov (see Adults: *Phenology and Behavior*). *J. ovata* was identified in low abundance throughout the site, but no immature Seminoles were observed.

(5) Indian Bayou: Craig Marks surveyed the area on 4 Jul 2001 and both CM and I on 29 Jul 2001; in 2001, CM visited on 17 Apr, 25 May, and 29 Jun, and both CM and I on 20 Jul: no adults were observed on any occasion. According to CM the line cuts (electrical, oil and gas) that normally provide open areas immediately adjacent to the bottomland forest were very overgrown in 2001 and 2002. In fact, during our visit on 29 Jul 2001 and 20 Jul 2002 we had a difficult time walking to search for butterflies and host plants. Since many of these areas seemed ideal for *J. ovata*, I am of the opinion that if present, the species was severely limited in 2001 and 2002. However, *Diclipera brachiata* (branching foldwing), a documented host for *A. t. texana* in Texas, has been recorded from the vicinity.

LIFE CYCLE

In his popular field guide, Pyle (1992) states that the immature stages of the Texan crescent are "not reported." [An earlier guide by Klots (1951) omitted any reference to immatures.] Yet, Ajilvsgi (1990) includes brief descriptions of the egg and larva, repeated by Tveten and Tveten (1996) who also includes a photograph of a mature larva. These descriptions refer to the nominate subspecies, *A. t. texana*. This work is the first to document the immature stages of the *seminole* taxon.

Host Plants

Ajilvsgi (1990), Glassberg (1999), Howe (1975), Kendall (1959, 1964), Neck (1996), Opler and Krizek (1984), Pyle (1981), Scott (1986), and Tweten and Tveten (1996), record the following species as hosts for *A. texana* (presumably, *A. t. texana*: *Aniscanthus quadrifidus* (Vahl) Nees (flame acanthus), *Beloperone guttata* T.S. Brandegee (shrimp plant/bush) (Fig. 2B), *Dicliptera brachiata* (Pursh) Spreng. (branching foldwing/perennial dicliptera) (Fig. 3C), *D. sexangujlaris* (L.) Juss. (Rio Grande dicliptera), *Dyschoriste linearis* (Torr. & Gray) Kuntze (snakeherb), *Jacobinia carnea* (Lindl.) Nicholson (Brazilian plume/flamingo plant) (Fig. 3B),


A


B

Justicia americana (L.) Vahl (water-willow), *J. runyonii* Small (Runyon water-willow), *J. warnockii* B. L. Turner (Warnock water-willow), *Ruellia brittoniana* Leonard (Mexican petunia/doorstep flower) (Fig. 3D), *Ruellia caroliniensis* (J. F. Gmel.) Steud (Carolina ruellia/wild petunia), *R. davisiorum* Tharp & Barkl. R. *drummondiana* (Nees) Gray (Drummond ruellia), *R. occidentalis* (Gray) Tharp & Barkl. (ruellia), *Siphonoglossum pilosella* (Nees) Torr. (hairy tube-tongue), and *S. longiflora* (Torr.) Gray (long-flowered tube-tongue). Gerberg and Arnett (1989) record "water willow, *Justicia* sp." as the host for *A. t. seminole* in Florida. Charles Bordelon (personal communication) has documented that *A. t. texana* within the Houston area utilizes at least three species of *Diclipera* and *Beloperone*. All before-mentioned species belong to the family Acanthaceae (Acanthus family). Ajilvsgi (1990) also lists the shrub *Bernardia myricifolia* (Scheele) S. Wats. (southwest bernardia) as a host; this seems unlikely since *B. myricifolia* belongs to the family Euphorbiaceae. [Incidentally, *B. myricifolia* is the recorded host for *Strymon alea* (Godman & Salvin) (Lycaenidae), the alea hairstreak, tarugo hairstreak or Lacey's scrub-hairstreak.]

According to Bailey (1924), the acanthus family is primarily tropical with expansions into temperate regions. Approximately 2000 species are distributed between 170-180 genera. Within North America, 28 genera comprised of 110 species are recognized (Kartesz, 1994). Because of their tropical nature, many species are included as ornamentals within conservatories housed in temperate climates. Common examples include *Aphelandra* (zebra plant), *Hypoestes* (polka-dot plant), *Pseuderanthemum* (chocolate plant) and *Strobilanthes* (velvet plant). Other more cold tolerant species are often used in urban landscapes, such as *Beloperone guttata*, *Ruellia brittoniana* (Mexican petunia/doorstep flower), *Jacobinia carnea* and *J. velutina* (Nees) Voss (Brazilian plume/flamingo plant), and *Thunbergia alata* Bojer ex Sims (black-eyed Susan). Fernald (1950) describes the family as "chiefly herbs with opposite simple leaves, . . . Mucilageous and slightly bitter, but not noxious . . . . A large family in the warmer parts of the world." Schultes (1990) indicates that some species of *Justicia* in South America are known to be hallucinogenic. USDA (1961) lists 18 species within the Acanthaceae known to contain alkaloids. Of these species, 3 belong to the genus *Justicia*: *J. adhatoda* L., *J. gandarussa* L. f. and *J. hygropiloides* F. Muell. The alkalod vasicine (peganine) is cited for *J. adhatoda* whereas the alkaloids within the other two species are unidentified.

This study adds the following hosts (see Ross, 2000 for initial/partial report): *Justicia ovata* (Walt.) Lindau var. *lanceolata* (Chapm.) R. W. Long. (ovate waterwillow/lance-leaved waterwillow/looseflower waterwillow) (Fig. 4), *Justicia spicigera* Schlecht (Mexican honeysuckle) (Fig. 3C), *Jacobinia aurea* (Schltdl.) Hemsl. (yellow Jacobinia) (Fig. 3A), and *Dicliptera suberecta* (Andre') Bremek (dicliptera/King's crown) (Fig. 2A). *Justicia ovata* is native; *Justicia spicigera* and *Dicliptera suberecta* are exotic ornamentals with orange, tubular flowers. The leaves of *D. suberecta* have a characteristic grayish pubescence giving them a velvety appearance and a popular designation as "petting plant." *Jacobina aurea* is a tall and leafy with large yellow inflorescences. All exotics are frost sensitive, although rootstocks are usually not killed by Louisiana's relatively mild winters. All species favor shaded or semi-shaded locations, although several can tolerate direct sun for several hours each day, and *D. suberecta* thrives in both full shade and full sun.

Fig. 2. Major exotic host plants (Acanthaceae) for *A. t. seminole* in Baton Rouge, La.: A. King's crown (*Dicliptera suberecta*); inset, inflorescence detail. B. Shrimp plant (*Beloperone guttata*); inset, inflorescence detail. Shrimp plant is an old favorite in southern gardens whereas King's crown is just becoming popular. Both are freeze-sensitive perennials that prefer partial shade, but can adapt to full sun or full shade.

Louisiana Natives: *Justicia ovata* is the preferred native host in Louisiana (Fig. 4). Synonyms include *Dianthera lanceolata* (Chapm.) Small and *Justicia lanceolata* (Chapm.) Small. Godfrey and Wooten (1981) describe *J. ovata* from "swamps, wet woodlands, cypress-gum ponds or depressions, cypress prairies, wet clearings, ditches. Coastal plain, s.e. Va. to s. Fla. westward to e. Texas; northward in the interior, s.e. Okla., Ark., Tenn., s.e. Mo. and w. Ky." Fernald (1950) includes southern Illinois. [Incidentally, *J. ovata* and the related *J. americana* have the northernmost distribution of all Acanthaceae in North America.] In Louisiana, *J. ovata* is documented from all 64 parishes except Beauregard in the southwest and St. Bernard in the southeast (Thomas and Allen, 1996).

I found *J. ovata* to be locally abundant within four of the five research sites described earlier, but the species is probably present in the fifth as well. Typically, *J. ovata* is a pioneer species, that is, one of the first species to appear on bare ground following water retraction and disappearing as ecological succession proceeds. Individual plants are relatively herbaceous, although lower stems may be quite woody. Typical maximum heights are between 13-18 cm (5-7 inches), but occasionally up to 20-26cm (8-10 inches). Reproduction appears to be primarily through perennial slender rootstocks forming small, circular colonies. From early May and throughout the summer months, plants sport single white to pale lavender flowers on a terminal spike. Plants are extremely shade tolerant; leaves are deep green and often evergreen during mild winters. In appearance and growth form, *J. ovata* resembles *Chimaphila maculata* (L.) (spotted wintergreen) (Phrolaceae), common in dry woodlands throughout southeastern Canada and the entire eastern United States, including Louisiana (Fernald, 1950). Although *J. ovata* is not easily damaged by frosts, severe freezes will severely burn most of the leaves and upper stems. [For example, during late Dec 2001 and Jan 2002 temperatures dipped below freezing on several nights within the Baton Rouge area; in fact, a record low of -12°C (18°F) was recorded on 4 Jan. By checking habitats at Bluebonnet Swamp and Burden Research Station I learned that the *Justicia* plants were leafless but retained most of their lower, woody stems. Those individuals that were submerged during the cold spell, however, remained undamaged.]

Justicia ovata is most frequently encountered along the margins of shaded/semi-shaded aquatic or semi-aquatic habitats, areas that are commonly submerged in winter and occasionally during flood periods in other seasons. While growing throughout the summer, the plants can tolerate complete submersion for short periods of a week or more; during winter months when vegetation grown is suspended, total submersion is tolerated for several months. The species is not characteristically found in areas that are not inundated for at least part of the year. In laboratory conditions, plants maintain themselves well for many months in only a water medium. In the wild, as with many aquatic or semi-aquatic species, propagation is much more evident during dry periods and dry years when standing water is minimal. Then, individual specimens can attain heights of nearly 30cm (12 in.). However, when uprooted, the plants wilt almost immediately. [Perhaps the mucilaginous sap attests to the high water content of tissue?] As with most pioneer species, *J. ovata* is easily crowded out by other more robust species during ecological succession (see Habitat).

Oddly, while my observations indicate that *J. ovata* is most stable in low light habitats (swamps), Llewellyn (1992), Llewellyn and Shaffer (1993), and Shaffer *et al.* (1992) report that *J. lanceolata* (synonym for *J. ovata*) is often common in full sun on mudflats south of Morgan City, LA in the Atchafalaya Delta complex (Atchafalaya Bay) (Everes *et al.*, 1998) located at the southern tips of St. Mary and Terrebonne Parishes. This deltaic complex repre-

Fig. 3. Additional host plants (Acanthaceae) for *A. texana seminole*: A. Yellow Jacobinia (*Jacobinia aurea*), exotic. B. Brazilian plume/ flamingo plant (*Jacobinia carnea*), exotic. C. Branching foldwing/perennial dicliptera (*Dicliptera brachiata*), native. D. Mexican petunia (*Ruellia brittoniana*), exotic. All are perennials (frost sensitive) that prefer partial shade but can tolerate both full sun and full shade.

Fig. 4 (next page). Lance-leaved waterwillow (*Justicia ovata* var. *lanceolata*), the native host in south Louisiana. A. Colony around base of cypress "knees" in Bluebonnet Swamp Nature Center, Baton Rouge, La. B. Host flowers sporadically throughout summer; inset, close up of flower. Waterwillow is a pioneer species that spreads by shallow root extensions. The plants are easily outcompeted by more robust vegetation.


A
B

sents the most recent episode of a long history of river-mouth delta building in the northwest sector of the Gulf of Mexico (Roberts and Heerden, 1982).

The delta is in an extremely dynamic early successional phase driven by geomorphic forces, e.g., sedimentation and subsidence, beginning about 1952 (Shlemon, 1975). The natural subaerial growth of the delta began during the near-record spring flood of 1973 (Roberts *et al.*, 1980). Since then, intertidal land, which appears as small islands or mudflats, has increased at the rate of approximately 260 ha (642 ac) per year. Growth is not continuous since lands expand during severe spring floods and retreat in non-flood years (Everes *et al.*, 1998). At low tide, these mudflats can occupy as much as 5500 ha (13,585 ac) (Evers *et al.*, 1998). At high tide, most or all of the area is submerged. *J. lanceolata* acts as a pioneer species, colonizing the sunny mudflats that emerge during low tide. The plants occur at intermediate elevations as monospecific stands or islets of vegetation ranging in diameter from approximately 30cm (12 in.) to as great as 7m (22 ft) (C. Sasser, pers. comm.). Within these islets, individual plants attain heights of 30-45cm (12-18 in.).

The *Justicia* stands are very effective in trapping sediments; the roots of *Justicia* create a mat substantial enough to support the weight of an average human (Sasser, personal communication). But as islets increase in size, other marsh species invade. In time, the islets are invaded by more robust marsh vegetation such as *Colocasia esculenta* (L.) Schott (Araceae), *Echinochloa walteri* (Pursh) Nash (Poaceae), *Leersia oryzoides* (L.) Sw. (Poaceae), *Polygonum punctatum* Ell. (Polygonaceae), *Sagittaria lancifolia* L., *S. latifolia* Willd. and *S. platyphylla* Engelm. J. G. Sm. (Alismataceae). Since *Justicia* is a pioneer species, it cannot compete, being eventually replaced by succession species.

Llewellyn and Shaffer (1993) summarize their findings as: "(1) *J. lanceolata* is effective at trapping sediments and raising marsh elevations. (2) Once it is established and islet elevations are built up, *J. lanceolata* is readily out-competed by other species of wetland vegetation. (3) Thousands of propagules can be obtained from a single *J. lanceolata* islet without mortality to the adult plants. (4) It is resistant to nutria (*Myocastor coypus* Molina) herbivory, perhaps to the extent of serving as a herbivore repellent. (5) *J. lanceolata* is resilient with respect to saline storm surges, especially if followed by a freshwater flushing event. (6) It is well-adapted to flooded conditions." The authors conclude that *J. lanceolata* is a serious candidate for use in freshwater marsh restoration in the Louisiana coastal region, including areas that occasionally are inundated by saline water. I conclude that *J. ovata* manifestly has extremely broad tolerances to light.

It is pertinent to note that the authors report that nutria exhibit a strong and dramatic aversion to *Justicia.* D. Llewellyn and D. Evers (personal communication) indicate that an excellent way to survey for *Justicia* is to aerial photograph with infrared film (see Evers *et al.*, 1998). Since in most circumstances, nutria herbivory is so destructive to other vegetatio that the only images that register are those produced by the distinctive islets of *Justicia.* Also, herbivory by nutria on other wetland vegetation actually clears ground for the spread of *Justicia* (Evers *et al.*, 1998; Llewellyn, 1992; Llewellyn *et al.*, 1992; Shaffer *et al.*, 1992).

It is unclear why nutria avoid *Justicia.* As stated earlier, Schultes (1990) and USDA (1961) report that several species contain hallucinogens. A reasonable hypothesis is that the tissues of *J. lanceolata* contain phytochemicals that render the vegetation repellent to at least some mammalian herbivores. D. Llewellyn (personal communication) states that the only herbivory he noted on *Justicia* resulted from an unidentified leafhopper (Class Insecta, Order Homoptera). However, the authors did not observe lepidopterous larvae—an expected condition since it is difficult to imagine immature insects on a host confined to a habitat that is flooded daily.

Although *Hygrophila lacustris* (Schlecht. & Cham.) Nees (lake hygrophila) (Acanthaceae) is sympatric with and usually much more abundant and more robust than *J. ovata* in swampy locations, I failed to observe females of *A. texana seminole* ovipositing on it, although in the laboratory larvae did feed on the leaves when nothing else was available. [The vegetative portions of *H. lacustris* are more succulent and less tolerant to subfreezing temperatures than those of *J. ovata. H. lacustris* resumes growth in the spring earlier than *J. ovata* so that by the end of the growing season, *J. ovata* is often choked out.] Similarly, female Seminoles avoided *Ruellia caroliniensis* (Walt.) Steud.) (Carolina ruellia/wild petunia) (Acanthaceae), common on higher ground within all three research sites, and captive first instar larvae refused this large-flowered acanthus although older larvae did feed when leaves were offered in isolation. Close observation indicated that the highly pubescent leaves of *R. caroliniensis* probably physically preclude the mandibles of early instar larvae from penetrating leaf tissues.

Louisiana Exotics: *A. texana* adapts easily to many exotic species within the Acanthaceae (see Host Plants). Within the Baton Rouge area, I found females of *A. t. seminole* ovipositing on *Beloperone guttata, Jacobinia carnea* and *Dicliptera suberecta* (Ross and Welden, 2003), as well as *Justicia spicigera*, *Jacobinia aunea*, and *Dicliptera brachiata* (Fig. 2-3). *B. guttata* has been incorporated into gardens throughout southern Louisiana for scores of years (recently, the ornamental has become even more popular because of its attractiveness to hummingbirds); *J. carnea* has been cultivated for at least two decades. *D. suberecta* is the favored exotic host for *A. t. seminole* within urban settings, however. Although *D. suberecta* is a relative newcomer to the Baton Rouge Area, it is becoming increasingly popular. The species sports silvery, green leaves with bright orange tubular flowers grouped loosely in terminal flowerheads. As far as I can ascertain, *D. suberecta* was introduced to the region in the mid 1980s by a plant connoisseur living at 208 Stanford Ave. (College Town area). The homeowner obtained the species from a mail-order catalogue featuring exotic species. The introduction was successful. Shortly thereafter, a neighbor and avid gardener, Dr. June Tuma (JT), living at 318 Stanford Ave., secured cuttings and began propagation. Her success enabled her to share the attractive species with admiring friends. In 2000, I personally delivered cuttings to a major wholesale plant grower who now includes the species as part of the company's annual offerings. So, today *D. suberecta* is available in both the retail and wholesale nursery trade in and around Baton Rouge. Since the species now has proven to be a good "hummer" plant, I suspect that cultivation will become even more widespread. [Interestingly, JT commented to me that the summer of 2000 was the first year she ever noticed caterpillars (*A. t. seminole*) on her plants. And even though her extensive garden usually contains as many as 7 species of acanthus, only *D. suberecta* was utilized, and only those bushes within shaded, relatively undisturbed locations.]

Methods of Rearing

Egg clusters, larvae, and native host plant (*Justicia ovata*) were collected in the field (Bluebonnet Nature Center) and then transported to my personal makeshift laboratory — a large, well-lighted bathroom that had proven copacetic in the past. For transport of the host, I discovered that I achieved best results when individual plants were carefully uprooted and then transferred immediately to a water-filled container (jar or can) housed in an ice-packed cooler.

Fig. 5. Oviposition: A. Female *A. t. seminole* depositing eggs on underside of native host, *Justicia ovata* var. *lanceolata*. B. A typical clutch of eggs. Number of individual eggs varies between 1 and 145, and oviposition time can extend to 31 minutes. First row of eggs is always close to the midrib of the leaf.

Otherwise, specimens wilted within minutes. Once within my laboratory, the plants survived best if they were not transferred from their original containers, but maintained within their collection vesicles (chilled temperatures were no longer necessary). In fact, *J. ovata* can thrive in indoor conditions if contained within a water medium and exposed to strong natural light, e.g., a nearby window. Consequently, my rearing setup consisted of a large glass terrarium for housing hosts and egg masses. The terrarium was placed adjacent to four pairs of French doors for natural light. Because my observations indicated that both hosts and larvae thrived best if the relative humidity within the terrarium was elevated, I misted the interior of the terrarium on a daily basis and placed a layer of plastic atop it to retard evaporation.

Because larvae of *A. t. seminole* demonstrate a pronounced tendency to dislodge upon even the slightest disturbance of their host (see First Instar below), the terrarium arrangement proved cumbersome for periodically removing larvae for detailed observations. To resolve this problem, I transferred dislodged larvae into small plastic "Rubbermaid" storage containers lined with paper towels (Fig. 11). Larvae were then accessible for daily measurements and the lids helped maintain an interior high relative humidity. Each day I cut fresh leaves from my terrarium stock in order to replenish food. When mature larvae appeared to be at the end of their feeding cycle, I transferred them to small plastic "Critter Cages," usually marketed in pet shops as "carrying cages" (Fig. 7D). I placed an assortment of twigs and dried leaves into the cages to serve as substrates for larval attachment. After eclosion, adults were returned to the original site of collection — but in several cases, to a new site for introduction (see Attempt at Introduction).

Samples of all immature stages were preserved in 70% ethyl alcohol. These samples remain in my personal collection.

Courting and Mating

After basking for an hour or so, in mid-morning males begin to prowl for virgin females. When encountering another butterfly, a male will circle. If the prospective mate is another male or perhaps even a mated female, the two will spiral in an upward motion until they clear all vegetation. They continue to interact until one tires, flying away and downward. On the other hand, if the individual is a receptive virgin, the two will briefly spiral about each other before the female alights on the upper surface of a nearby leaf. The male responds by looping approximately 10cm (4 in) behind and above her, a behavior that is similar to that of *Charidryas nycteis* (Doubleday & Hewitson) (silvery checkerspot) and *A. t. texana* (Scott, 1986). If the female looses interest, she will flutter her wings for a

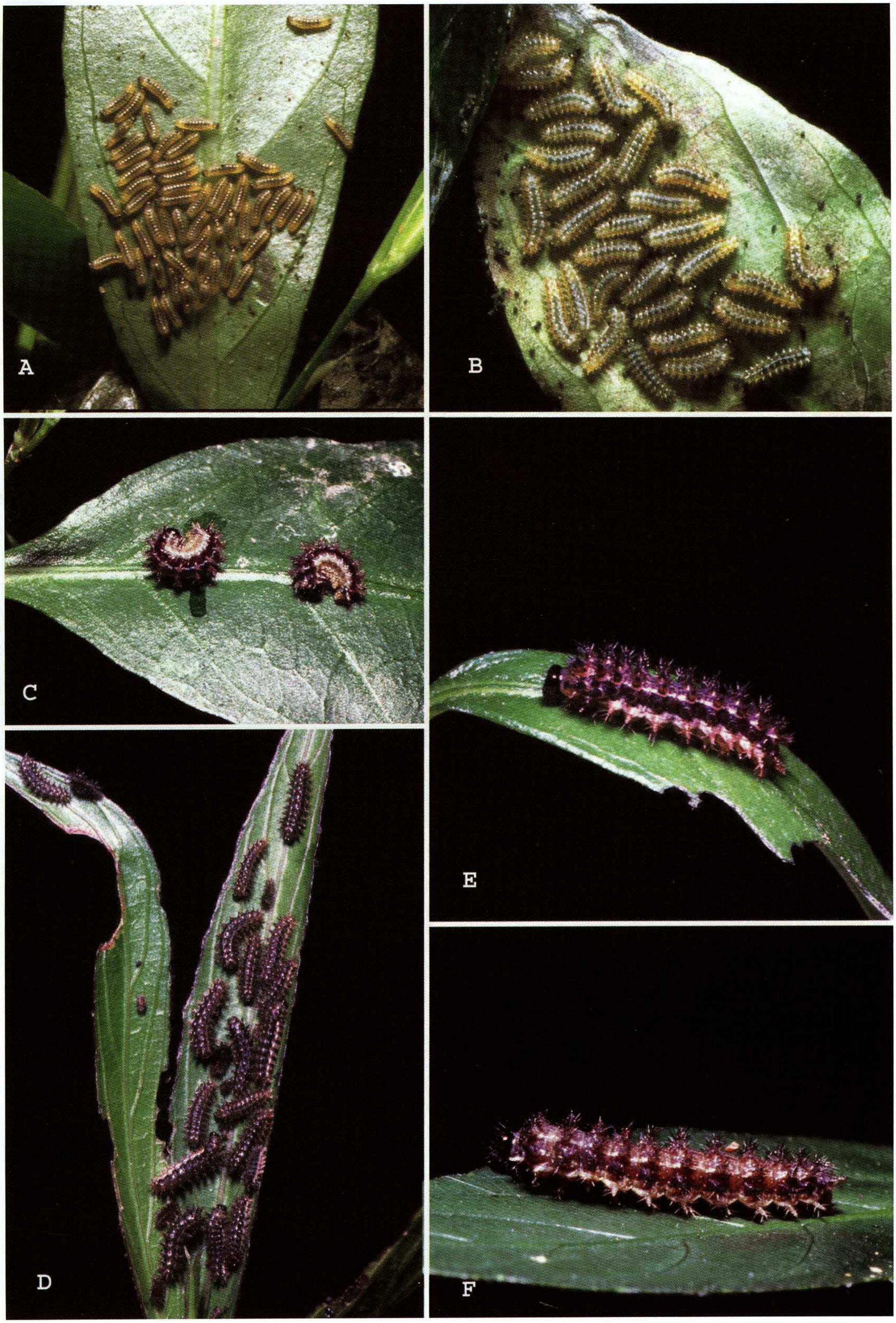
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Fig. 7. A. Prepupa on stem of sapling in swamp. B. Fresh pupa. C. Group of pupae in natural setting. D. Group of pupae in "critter cage" in laboratory. Pre-pupae larvae tend to concentrate before pupating.

Fig. 6 (previous page). Larval stages of *A. t. seminole*: A. First instar. B. Second instar. C. Late third instar. D. Newly molted third instar. E. Fourth instar prior to molting. F. Fifth instar. First and second instars feed on ventral surfaces of new leaves. Other instars feed on dorsal surfaces. When disturbed, larvae curl and excrete a droplet of green mucilage (C).

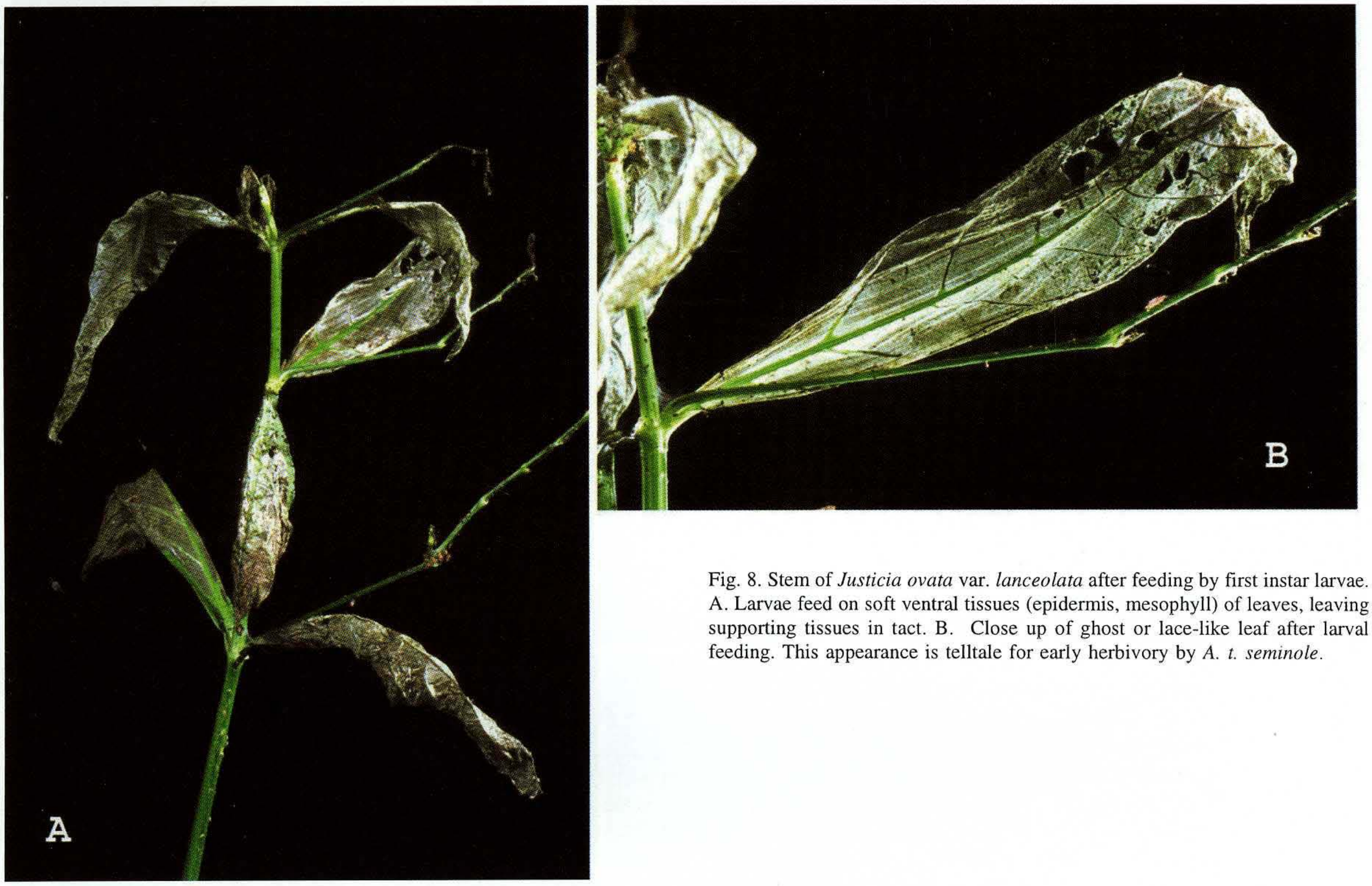

Fig. 8. Stem of *Justicia ovata* var. *lanceolata* after feeding by first instar larvae. A. Larvae feed on soft ventral tissues (epidermis, mesophyll) of leaves, leaving supporting tissues in tact. B. Close up of ghost or lace-like leaf after larval feeding. This appearance is telltale for early herbivory by *A. t. seminole*.

few seconds before departing upward with the male tailing in pursuit. The pair may again descend, repeating the procedure. But if the female continues to be receptive, she spreads her wings, vibrates them, and arches her abdomen upward. With this cue, the male alights along side and parallel to the female, closes his wings, and nudges the female by contorting his abdomen. He then backs up for a rear-to-rear coupling, after which both individuals close their wings, and remain quietly in tandem for 1-2 hours. If disturbed, the pair will take off to search for another perch; the female flies, while the male remains recumbent.

Oviposition Behavior and Developmental Stages

Native Swamp Habitat: n=9, time = 1100-0230 h CDT, ambient temperature 22°C (80°F) or higher. A female will fly slowly and close to the ground, briefly pausing to sample *J. ovata*. Usually, the individual selected will be no more than 20cm (8 in) tall, will be growing in a dry area (plants partially inundated are avoided), and will be adjacent to one already hosting a clutch of eggs or larvae. By selecting individuals that grow on dry ground and adjacent to others presently hosting clutches, females reduce the risk of depositing on hosts that are commonly submerged during heavy rainfalls or flood waters. Also, the choice of a "dry" site provides leaf litter for concealment and high relative humidity following dislodgment due to disturbance (see First and Fourth Instar).

Females deposit eggs in clusters, characteristic for crescents and checkerspots (Tribe Melitaeini) (Scott, 1986; Williams, 2002) (Fig. 5B). Oviposition begins with a female circling the selected plant between 4-6 times. After alighting on a mature leaf, she extends her wings horizontally while backing up to the leaf's margin. Then, she positions herself with mesothoracic legs extended in front and metathoracic legs extended horizontally and grasping the margins of the leaf. The abdomen is curled under the leaf and extended as far as possible along the leaf's midrib (Fig. 5A). Once positioned, the wings close and egg deposition commences. First eggs are oriented along the midrib. The abdomen is then slightly contracted and moved in a side-to-side arc. By continually contracting and arcing the abdomen, ever widening rows are created. Eventually the abdomen becomes so retracted that the sweeps cover less area. A female will remain in the same position until all free space available to her abdomen is utilized. The final product is a cluster of eggs that is more or less concentric, the area of which is determined by the degree of flexibility of the female's abdomen.

Rate of deposition is 4-5 eggs per minute; maximum number of eggs per cluster is usually between 110 and 125 with a cluster diameter of approximately 1.0cm, although I did observe a single cluster of 145 with a diameter of 1.4cm and deposited over an uninterrupted 31 minutes. If a female is interrupted while laying — usually caused by wandering ground-dwelling inverte-brates, e.g., grasshoppers and millipedes, and perhaps even vertebrates, e.g., frogs and snakes — she usually departs to search for another host in a less disturbed venue, or else to rest temporarily on any low-growing vegetation. Also, on occasion the area of a leaf is simply too small to accommodate a maximum cluster. Then the female will depart to search for a more appropriate site. This behavior accounts for the difference in number of eggs per cluster (between 1 and 145). With egg-laying completed, the female begins fanning her wings, and after a few seconds, flies off to bask for the remainder of the day. A female will continue to oviposit intermittently for 8-10 days producing as many as 4-6 clusters with a cumulative total of 250-300 eggs.

Urban Habitat: n=4, time = 1000-0200 h CDST. Female Seminoles in urban settings involving non-native hosts, usually select leaves as close to the ground as possible — as with native hosts. But because most exotic hosts are taller and more robust than natives, egg clusters usually are at least 15cm (12 in) above the ground. As in natural habitats, any disturbance during egg deposition will cause a female to interrupt her activity and temporarily flee. On two occasions I observed females depositing eggs in urban settings with considerable traffic. One location was an elaborate garden worked daily by an avid gardener; the other a fenced backyard containing two pet dogs. In both cases, all larvae disappeared during an early instar leading me to conclude that the periodic disturbances to the plants caused the larvae to drop to the ground so frequently (see First and Fourth Instar) that they eventually became victims of common terrestrial invertebrate predators, including the infamous red imported fire ant (*Solenopsis invicta* Buren) (Hymenoptera). Consequently, I theorize that a female Seminole's choice of a host growing in a relatively quiet location is an important survival adaptation.

Egg. (developmental time = 5 days, 6-7 days if night temperatures drop below 15°C (60°F); n=455). Individual eggs are globular and unsculptured, 0.4mm in diameter. Color is limy-yellow with a glossy, unsculptured texture (Fig. 5B). Deposited approximately 2 per mm with slight space between each egg, forming a circular cluster (see above). Depending upon number of eggs deposited, diameter of the cluster ranges from just over 1mm to 1.4cm (Ross, 2003). Color changes to a light green one day prior to eclosion, which is more or less synchronous for the clutch.

First Instar (duration = 3 days; n=366). Begin: L = 1.10 mm, W = 0.15mm, head capsule = 0.3-0.4mm in diameter. End: 2.5mm in length, 0.40mm in width (Fig. 6A). Cylindrical in shape, translucent limy-yellow in color with glossy black head (clypeus tan) and dorsum of prothorax. Head with well developed chaetotaxy. Thorax and abdomen glossy and translucent with numerous chalaza and scoli bearing simple, translucent setae (0.10mm in length except on T1 where they reach 0.15mm): T1 with crown of six more or less fused, black chalaza, each bearing a seta; T2 with one pair subdorsal scoli, one pair subdorsal chalaza, one pair spiracular scoli, two pair subspiracular scoli (very short); T3 with one pair subdorsal scoli, one pair subdorsal chalaza, one pair spiracular scoli, one pair subspiracular scoli; A1-8 with one dorsal scolus, one pair subdorsal scoli, one pair supraspiracular scoli, two pairs of subspiracular scoli (more ventral one slightly bifurcate); A9-10 with only one pair supraspiracular scoli, but individual chalaza elsewhere. Scoli range in height from mere nubs to 0.10mm. Prolegs with uniserial, biordinal crochets.

Hatchlings partially consume egg case, remaining in a tight cluster on the undersurface of the leaf. Larvae feed on lower epidermis and mesophyll leaf tissues, avoiding tougher supporting structures, e.g., vascular bundles. When undersurface is completely consumed, larvae relocate to dorsal surface to feed on upper edpidermis, producing a skeletonized leaf that appears lacelike—a telltale sign for the presence of *A. t. seminole* (Fig. 8, 10A). Frass often accumulates in the silken threads produced by mobile larvae, but I never observed contaminating fungal growth (see Fourth Instar below.) Larvae are nocturnal feeders during which they maintain their clustered organization. After feeding, larvae take on a dark green appearance that remains relatively transparent (the color is due to the green mash visible through the integument). An individual resembles a miniscule "Gummy Bears" candy, and the cluster, a slice of kiwi fruit. If disturbed, larvae immediately drop to the ground where they are almost impossible to spot. While this behavior is probably an adaptation to escape predators, the condition is extremely disadvantageous if the habitat becomes flooded. At such times, larvae are able to float because their dense setae trap air and create buoyancy. However, now vulnerable to hungry aquatic predators such as minnows and aquatic arthropods, they often are quickly eaten. Within a dry habitat, dislodged larvae easily relocate to their original host within 30 minutes.

Second instar (duration = 3 days; n=350). Begin: L = 3.0mm, W = 1.0mm, head capsule = 0.40-0.50mm in diameter. End: L = 4.5mm, W = 1.2mm (Fig. 6B). Head glossy black. Body cylindrical, still limy-yellow in color but dark green mash in gut now more prominent, giving the larva a more-or-less dark appearance. Although cuticle of body is still glossy, the scoli, now more developed; with their lime-yellow color they partially obscure the surface of the body. By the end of the second (sometimes third) stadium, the leaves of the native host are usually completely skeletonized, rendering them a ghost-like appearance (Fig. 8). Larvae then crawl along the ground searching for another available host.

One day I noticed that a clutch of larvae in my laboratory had exhausted edible leaf tissue on a small waterwillow and that the water in the containment vessel had evaporated to the point that the root system of the host was partially uncovered. To my surprise, all Seminole larvae were clustered together on these exposed roots (Fig. 9). (Older roots are medium brown in color, new growth is tan.) Under magnification, I noticed that the larvae were scraping and ingesting the outer layer, which appeared soft and easily removed, leaving behind a hard, cream-colored core. By maintaining this setup for several days, I learned that the larvae could thrive, at least for a while, by ingesting the roots' epidermal tissues. I conclude that such behavior probably is exhibited in natural habitats when leaves of a host are exhausted and other hosts are in short supply. This behavior buys time for the host to begin releafing. As well, by feeding close to the ground, larvae are exposed to higher relative humidity than otherwise, thereby reducing the potential for desiccation during a stressful period. (Incidentally, I noticed this same behavior with mature larvae).

Fig. 9. A root of *Justicia ovata* var. *lanceolata* with early (second/third) instar larvae. The laboratory setup included plants growing in glass jars filled with water. The sample in the photograph had dried and the larvae, having depleted the leaf stock, were feeding on the soft epidermal tissue of the exposed root.

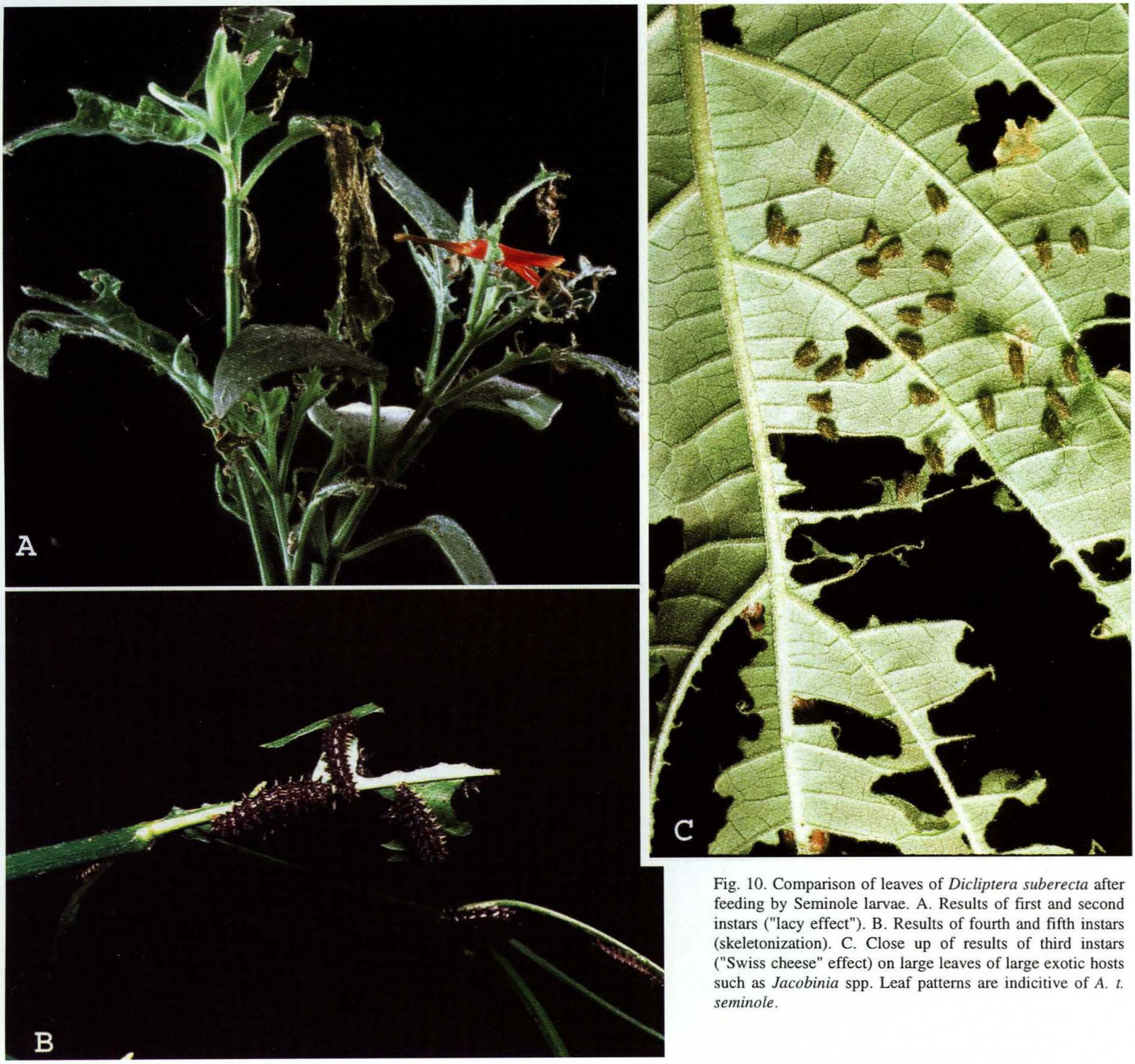

Fig. 10. Comparison of leaves of *Dicliptera suberecta* after feeding by Seminole larvae. A. Results of first and second instars ("lacy effect"). B. Results of fourth and fifth instars (skeletonization). C. Close up of results of third instars ("Swiss cheese" effect) on large leaves of large exotic hosts such as *Jacobinia* spp. Leaf patterns are indicitive of *A. t. seminole*.

Third instar (duration = 3 days; n=302). Begin: L = 5.5mm, W = 1.1mm, head capsule = 0.80mm in diameter. End: L = 9.5mm, W = 1.2mm (Fig. 6C,D). Head glossy black. Dorsum of body light brown, supraspiracular area dark brown, subspiracular area cream, ventrum cream. Scoli more developed with color consistent with body region.

After molting, larvae usually abandon their original host and disperse en masse to locate others. Although some individuals continue to remain closely associated with each other, most become solitary—allowing multiple samples to be utilized in much the same manner as the larger larvae of *Charidryas harrisii* (Scudder) (Harris' checkerspot) (Williams, 2002). Leaves of are now entirely eaten, except for midribs and some secondary veins (Fig. 10B). The feeding pattern on larger exotic species produces only large round holes or notches in the leaves for a Swiss cheese effect (Fig. 10C). (When offered various native and exotic hosts, larvae preferred *Dicliptera suberecta*).

Fourth instar (duration = 3-4 days; n=300). Begin: L = 10.0 mm, W = 1.5mm, head capsule = 1.0mm in diameter. End: L = 11.9-12.1mm, W = 1.9-2.0mm (Fig. 6E). Head glossy black. Dorsum of body dark brown with slight grayish mottling, supraspiracular area dark brown forming a distinct stripe, spiracular-subspiracular area light cream in color forming a distinct stripe, ventrum light cream. Most scoli now very distinct: T1 with crown of six fused scolia (short and almost chalaza-like), each with several setae and an adjacent chalaza-bearing seta; one pair supraspiracular chalaza, one pair spiracular chalaza with seata, two pairs subspiracular scoli; T2 with one pair subdorsal scoli, one pair subdorsal chalazae, one pair spiracular scoli; 2 pairs subspiracular scoli; T3 with one pair subdorsal scoli; one pair subdorsal chalazae; one pair spiracular scoli; one pair subspiracular scoli; A1-2 with one dorsal scolus, one pair subdorsal scoli, one pair supraspiracular scoli, two pairs subspiracular scoli, one pair very short ventral scoli; A3-6 with one dorsal scolus, one pair subdorsal scoli, one pair supraspiracular scoli, two pairs subspiracular scoli (more ventral one with anter ior/posterior bifurcations), one pair very short ventral scoli; A7 with

Fig. 11. Plexiglas box housing early instar larvae. Frass contains large quantities of sap from the native host, *Justicia ovata* var. *lanceolata*. In addition, when disturbed larvae regurgitate a drop of green mucilage. The author hypothesizes that the sap of the host contains toxic phytochemicals that are used by the larvae of *A. t. seminole* to deter potential predators and possibly even microbes.

one dorsal scolus, one pair subdorsal scoli, one pair supraspiracular scoli, two pairs subspiracular scoli (none birfurcate), one pair very short ventral scoli; A8 with two dorsal scoli (anterior/posterior), one pair subdorsal scoli, one pair subspiracular scoli (none bifurcate), one pair very short ventral scoli; A9-10 with only one pair subdorsal scoli, one pair very short ventral scoli. Anal plate with numerous chalazae with setae of slightly various lengths. Segments A2-8 each with one pair of heavily sclerotized chalazae near posterior basal portion of most dorsal subspiracular scoli. Scoli have dense setae and resemble "Christmas trees" (see below); color is consistent with the color of their placement.

In appearance, fourth (and fifth) instar larvae are similar to those of *Charidryas nycteis* (Doubleday and Hewitson) (silvery checkerspot). Host plants between the two species, nevertheless, are very different: *A. texana* feeds exclusively on members of the Acanthaceae and *C. nycteis* feeds within the Asteraceae (Ross, 2000, 2001b).

Fourth (and fifth) instar larvae often disburse from their smaller clusters, although often 2-3 larvae will remain within close proximity of each other. During the day, larvae often remain off their hosts, resting in dried leaf litter on the ground. This behavior probably reduces predation but also keeps moisture levels high in their microhabitats, thereby avoiding desiccation.

Fourth (and fifth) instar larvae feed on all leaf tisues except major suporting veins. In the end, leaves are skeletonized (Fig. 10B). When disturbed, larvae share a tendency to regurgitate droplets of green, mucilaginous liquid. This gooey substance produces an enduring stain on absorbent media (Fig. 11). The exudate probably consists of excess mucilage from the liquid-filled tissues of the host, and probably acts as a physical deterrent to potential predators. Then too, the same phytochemicals that likely are responsible for deterring nutria herbivory (Llewellyn, 1992; Llewellyn and Shaffer, 1993) (see Host Plants: Louisiana Natives) may serve as chemical repellents. A detailed analysis of this substance certainly would be prudent.

Fourth (and fifth) instar larvae excrete moisture-laden frass that appears to be relatively resistant to fungus. This was very evident in my laboratory stock. Unlike most artificial rearing chambers, which have to be cleaned every day or so because of fungal contaminations, my chambers remained remarkably free of contaminants, even thought the containers were kept moist to accommodate the swamp-based larvae. As with the green regurgitated exudates, perhaps the excreted frass contains phytochemicals from the host, *J. ovata*, with antimicrobial properties? This certainly would be an advantage to a species that is relatively communal, particularly during early instars when frass is often trapped by silken threads spun during locomotion (see Second Instar above). This hypothesis is fertile ground for future experimentation.

Fourth (and fifth) instar larvae frequently encounter problems during ecdysis. Because the scoli have such dense setae, a larva often encounters difficulties during separation of the two exoskeletons. In an attempt to free itself from its previous exoskeleton, a molting larva will actively wriggle for several minutes. Not infrequently, the separation proves unsuccessful, and the entrapped specimen eventually dies. At least in laboratory conditions, death from unsuccessful molts accounts for a considerable percentage of the mortality experienced by mature larvae.

Fifth instar (duration = 4-5 days; n=205). Begin: L = 13.0mm, W = 3.0mm, head capsule = 1.4-1.5mm. End: L = 18-21mm, W = 3.5-3.6mm (Fig. 6F). Head glossy black. In color, body is similar to fourth instar except darker brown in color with dorsum more noticeable gray speckling. A slight, interupped cream subdorsal stripe separating dorsum from dark supraspiracular stripe. Spiracular-subspiracular cream-colored stripe now very prominent, and made even more evident by the now darker (tannish) ventrum. The "Christmas tree-like" scoli reach maximum heights of 0.35-0.50mm with a base of 0.20mm. Individual setae are thick and spine-like, ranging up to 0.30-0.50mm in length, although those on T1 reach 0.51mm, the longest of all. Chalazae with individual, simple setae are scattered about, including on prolegs.

Pre-pupa (duration = 15-16 hours; n=190). (Fig. 7A.) Each larva attaches its posterior by means of a silken pad to any nearby substrate, but usually within 30cm (12 in) and 100cm (39 in) of the ground — probably an adaptation for reducing inundation by typical floodwaters. On occasion, I observed pupae anchored onto shorter stems of *J. ovata,* positions that presumably would be flooded by heavy rains.

Pupa (duration = 5-6 days—males, 6-8 days—females; n=143). Male: L = 10-12mm, W = 3-4mm (at widest point = anterior abdomen). Female: L = 13-14mm, W = 4-5mm (at widest point, anterior abdomen). (Fig. 7B,C,D.) Color is uniform light brown in male, medium brown in female; cryptic, resembling a curled, dried leaf. As typical for nymphalids, suspended by cremaster (0.50-0.55 mm). Segments A4-10 compressed ventrally so that pupa hangs at a 35-45 degree angle to perpendicular. Surface of pupa "bumpy": T2-3 each with one pair subdorsal cones, larger on T2. A2-7 each with one row of mid-dorsal cones, one pair of subdorsal cones, one pair supraspiracular cones, one pair subspiracular cones, and singularly scattered on wing covers. Largest cones on A4 (0.30-0.35mm in height), smallest (barely visible), subspiracular. One pair of small subventral protrusions on A8. Cones slightly darker than ground color. Eclosion in the laboratory is between pre-dawn and 0700h CDST (back cover). Males emerge a day or two before females. Late fall pupae hibernate through the winter.

Adults. *Description.* (front and back covers, Fig. 1.) My measurements coincide with those of Opler and Krizek (1984): male forewing length ranges between 1.6-1.8cm; female forewing, 1.9-2.1cm. Dorsally, the butterflies are basically black to dark brown, accented with squares, circles and crescents cream in color. The bases of the wings are orangy-red with small black circles and lines. Ventrally, the wings are buff to gray in color and accented with squares, crescents, circles, and lines — some dark brown others cream; the basal suffusion of orangy-red is more prominent, but often concealed by the hindwings when the individual is at rest. In general, the undersurface has the appearance of a fragmented leaf, presumably for camouflage. The most complete account of the differences between *Anthanassa texana seminole* and *A. t. texana* can be found in Howe (1975): "The upper surface of the wings (*A. t. seminole*) has the same pattern as in *texana texana*, but all white or cream colored spots are larger, tending more to form bands; the basal orange-red areas are brighter, clearer and slightly larger. [Simply, the bases of the dorsal forewings in Seminoles tend to be much more orange than those in typical Texans.] The under surface of the wings is almost identical to *texana texana*. A blend zone may occur in central Kansas."

Phenology and Behavior. A. t. seminole in Louisiana is multivoltine, with 3-4 (possibly 5) generations each year. Following a relatively mild winter, first generation adults emerge in late April (early to mid May after a relatively cold, lengthy winter), a time when daytime temperatures are approximately 30°C (85°F) and nighttime temperatures approximately 20°C (68°F) — although cold fronts do occasionally make it as far south as Baton Rouge and drop temperatures during the night to 13°C (55°F). During late April and early May the native host *J. ovata* and *Saururus cernuus* (lizard's tail) begin to flower (front cover and Fig. 4). The second generation of Seminoles usually emerges in late May and early June, followed by a third in mid to late July, and a fourth in late August to mid-September. At the Bluebonnet Swamp site in 2000, numbers of individuals were greatest for the first and second generations (approximately 50-75 each). By contrast, third and fourth generations were reduced to fewer than 35 individuals each. RS noted that in 2002, the late fall generation (possibly number 5) in October was significant, consisting of at least three-dozen individuals. The butterflies were never observed in their swamp habitat, but in adjacent, flower-filled fields; obviously, no breeding activity was observed. By mid November, when nighttime temperatures dropped to 5-7°C (low 40s°F), and even on one occasion to 4°C (39°F) with a slight frost, the butterflies gradually became less common; the last Seminoles were seen on 21 Nov. [During early December several nighttime temperatures dipped to −1°C (30°F) but were followed on several following days by temperatures 20-24°C (68-75°F). Even though several nectar sources were still available (See Adults: *Feeding*), no adult Seminoles were observed. Therefore, I conclude that adults are not cold tolerant.]

Within a colony of *A. t. seminole,* males are more commonly observed than females. Individuals usually fly low to the ground, usually within 30-60cm (1-2 ft). In urban environments where houses present large, broad obstacles, I have noticed that individuals usually fly over the obstruction rather than circle around it. In so doing, butterflies ascend to heights of 9–10m (28-33 ft). In native habitats, I have observed that when two males encounter one another, they often spiral upward and disappear above the tops of smaller trees, achieving heights of 10-12m (33-38 ft). Males are consummate baskers, frequently perching in small patches of sunlight hitting the swamp floor after approximately 0900h. Preferred perches are leaves within 60cm (2 ft) of the ground. Within the Bluebonnet Swamp location, males frequently rested on the wooden boardwalks and limestone paths. Although sunny locations were immediately adjacent to the Bluebonnet site, individual butterflies seemed to avoid these bright areas, preferring to remain within the dappled light of the swamp. When basking, males spread their wings but will occasionally slowly fan. Butterflies usually remain at a single perch for 30-60 minutes before departing. When disturbed, a butterfly will fly a short distance, but quickly take up another perch. When clouds obscure the sun, adults quickly alight on the top surfaces of vegetation and close their wings. Upon the return of sunlight, the perched butterflies spread their wings, and after a few minuets, fly to a nearby sunny patch. (Apparently, although the subspecies is well adapted to the subdued light of swamp habitats, sunrays are necessary for initiating flight.)

Fig. 12. Worn female *A. t. seminole* feeding on dried biotic crusts on swamp bottomland; inset, detail. Within swamp habitats, adult Seminoles feed exclusively on these crusts, blue-green algae or cyanobacteria. This feeding behavior seems to be a specialization that the butterfly species has made to its unique flower-poor habitat.

At night, Seminoles perch, wings vertical, in the open on the top surfaces of leaves, not undersides and not on stems. During light rainy periods, butterflies make no effort to crawl beneath leaves for protection. At rest, a butterfly partially tucks its forewings inside its hindwings, allowing the relatively loose scales on the butterflies to serve as water repellants as well as protection from ensnarement in spider webs (see Parasitism and Predation).

*Feeding***.** From the etymology of the taxon, one would suppose *A. texana* to be an avid flower feeder. Indeed, Ajilvsgi (1990) indicates that the nominate subspecies nectars on at least 7 different plants: "Texas Kidneywood, Thoroughwort, Engelmann Daisy (*Engelmania pinnatifida*), Golden-eye, Indian Blanket, New England Aster, and the Wild Onions." However, my observations in Louisiana indicate that the subspecies *seminole* is rarely attracted to flowers in its native habitats during its breeding season. In fact, within the swamp communities of south Baton Rouge, I observed no adults feeding on flowers even though the surrounding areas of higher ground had an abundance of *Verbena brasiliensis* Vellozo (Brazilian vervain (Verbenaceae), *Sambucus canadensis* L. (elderberry) (Caprifoliaceae), and *Sida spinosa* L. (prickly mallow) (Malvaceae) — all in bloom during peak flight periods for *A. t. seminole,* and species often visited by other lepidopterans. Because of urban encroachment upon the Bluebonnet Swamp site, several buildings bordering the swamp are landscaped with ornamental cultivars such as "New Gold" lantana and various verbenas, favorite nectar sources for many butterflies in Louisiana (Ross, 1994; Ross and Welden, 2003). Some flowers actually are venues for social gatherings for local butterflies (see Ross, 2004). But never did I notice Seminoles nectaring there. However, in late fall of 2002, a relatively wet year and apparently, during a non-breeding time (see Adults: *Phenology and Behavior*), RS noted that adults were not within their typical swamp habitat but in adjacent fields nectaring on *Aster prealtus* Poir. (aster), *Eupatorium coelestinum* L. (mist-flower/wild ageratum), *Acmella oppositifolia* (Lam.) R. K. Jansen var. *repens* (Walter) R. K. Jansen (creeping spotflower) (all three Asteraceae), and *Polygonum punctatum* Elliott (dotted smartweed) (Polygonaceae) — most of which persisted through several frosts. And, within urban settings in south Baton Rouge, both RS and I observed on several occasions, a lone male Seminole nectaring on a large specimen of *Lantana camara* L. [Incidentally, adults hold their wings in a vertical position when nectaring.]

So, what do Seminole adults feed on in swamp habitats during their breeding season?

During the spring and summer of 2000, study period, spring and summer experienced a significant drought (see Table 1), causing most swamp habitats to dry. As the previously inundated soils dried, they cracked into polygons and began cultivating microbiotic crusts composed of cryptobiotic organisms, probably blue-green algae (cyanobacteria). During several late afternoons, I noticed adults (predominately females) spending a considerable amount of time perched on these organic encrustations or biofilms that were drying and becoming rather flaky with curly edges (Fig. 12). When perched on the ground, the butterflies could be easily approached. In fact, I was able to actually touch an individual before it became alarmed. At first, I suspected that these observations were of basking behavior. However, the butterflies had the wings positioned vertically, and the venues were totally shaded. Next, I considered puddling (see Arms *et al.*, 1974; Boggs, 1998; Downes, 1973; Opler and Krizek, 1984; Ross, 1995b, 1998, 2001a, 2005a,b), a behavior in which male butterflies congregate at damp locations to imbibe water from which they extract nutrients used in sperm and pheromone production, and which are often transferred to females during the mating process. Yet, the majority of adult *A. t. seminole* encountered on the drying biofilm were individual females, not aggregates of males. Upon extremely close inspection, I observed that each butterfly had its proboscis extended as if feeding. My conclusion? The butterflies were siphoning nutrients from the cyanobacteria in much the same fashion as other butterfly species habitually imbibe fluids from fermenting fruit, plant tissues, fungi, insect secretions, bird droppings, and carrion (DeVries, 1987; Opler and Krizek, 1984; Ross, 1995a, 1995d; Scott, 1986).

While a diet of cyanobacteria may be unconventional for butterflies, such should not be unexpected. After all, these prokaryotic organisms are an ancient, morphologically diverse group with a photosynthetic life cycle, and many are able to fix N-2 (Rai *et al.*, 2000). While many species are the basis for many aquatic food chains, others occur on dry land including deserts (Zaady *et al.*, 2001) where they form crusts that bind soil particles together, and thus significantly increase soil surface stability, resistance to erosion, and water availability (Evans and Johansen, 1999; Hawkes and Flechtner, 2002). Gold *et al.* (2001) state that microbial crusts also increase soil organic matter and soil nitrogen and phosophorus. A few species are known to form biofilms on rock, including archeological monuments, and cause extensive degradation to their substrates (Gaylarde *et al.*, 2001). Several marine varieties degrade crude oil, thus having the potential for mitigating oil pollution on seashores (Raghukumar *et al.*, 2001), and one variety, *Microcystis aeruginosa* Kuetzing emend. Elenkin strain CCAP 1450/4, has appreciable toxicity to insects, including larvae of the butterfly *Pieris rapae* (L.) (cabbage white) (Delaney and Wilkins, 1995). Perhaps the most important species of cyanobacteria for humans belong to the genus *Spirulina*, noted for their richness in proteins, vitamins, amino acids, minerals, etc. (Chamorro *et al.*, 2002). As such, *Spirulina* is grown in various countries as food for human and animal consumption, used to derive additives for pharmaceuticals and foods, and for pharmacological properties effective in the treatment of allergies, anemia, cancer, hepatotoxicity, viral and cardiovascular diseases, hyperglycemia, hyperlipidemia, immunodeficiency, and inflammatory processes (Allnutt, 1996; Chamorro *et al.*, 2002; Hashem, 2001).

Although cyanobacteria form the basis for many food chains, only a few higher organisms have been reported to feed directly on them: a roach (*Rutilus* sp.) (Kamjunke *et al.*, 2002); collembola (Birkemoe and Liengen, 2002); epilithic trichopterans (Becker, 1990); and shore flies (Diptera: Ephydridae: *Hyadina albovenosa* Coquillett) (Foote, 1993, 1995). To my knowledge, this work constitutes the first record of an adult lepidopteran utilizing cyanobacteria as food. The exact mechanism for extracting nutrients remains unknown. For *A. t. seminole*, feeding on microbiotic crusts appears to be an adaptation for breeding in a swamp habitat where good butterfly nectar sources are usually minimal.

In conclusion, evidence indicates that *A. t. seminole* is an opportunistic feeder, taking advantage of both flower nectars and microbiotic crusts.

Parasitism and Predation

Six of the 143 larvae reared were parasitized by the larvae of an unidentified species of tachnid fly (Family Tachinidae). On one occasion I observed an unidentified dragonfly (Odonata) snatch from the air an adult (female) Seminole. But while spider webs are extremely common within the swamp habitat of Bluebonnet Swamp Nature Center, I did not observe ensnared Seminole butterflies (I did observe one partially "packaged" male *Hermeuptychia hermes* (Fabricius) (Carolina satyr) (Satyridae). Though on two occasions I did observe a newly emerged adult *A .t. seminole* fly into spider webs. Each time, the insect simply catapulted back like a child on a trampoline. My observations of freshly emerged adults indicate that some wing and body scales seem to dislodge freely, indicating they are poorly attached (front cover and Fig. 1). Such "deciduous" scales are known within the lepidioptera: Lycaenidae and Riodinidae (DeVries, 1991; Dodd, 1912; Johnson and Valentine, 1986) and Satyridae (Sourakov, 1999). The assorted species possess deciduous scales on their legs and bodies, presumably aiding the butterflies with a safe escape from the nests of ants or other potential predators within their particular microenvironments. Although my observations are limited, I hypothesize that the loose (deciduous) scales of adult *A. t. seminole* are an adaptation for escaping from the myriad spider webs or possibly even rain within their swamp habitat. (see Adults: Phenology and Behavior).

HABITAT

Natural

General. Most information on the ecology of *A. texana* refers to the nominate subspecies (see COMPARISON OF HABITATS BETWEEN *A. t. texana* and *A. t. seminole*). C. Bordelon and E. Knudson (personal communication) report that the historic population of *A. t. seminole* in the Lake Houston area was associated with riparian habitats. In Louisiana, I (and others) have observed the subspecies *seminole* only within the "Alluvial Flood Plain" Natural Region and the "Bottom Land Hardwoods and Cypress" Vegetation Region (Brown, 1965; Buchanan, 1959; Johnson and Yodis, 1998). These locations are typical south Louisiana wetland habitats — areas where drainage is slow, with much standing water for considerable periods after heavy rains (inside front cover and inside back cover). Those areas that are submerged at least part of each year are dominated by *Taxodium distichum* (L.) L. C. Rich. (bald cypress) (Pinaceae), *Nyssa aquatica* L. (tupelo gum/water tupelo) (Nyssaceae) in association with *Acer rubra* var. drummondii (Hook. & Arn. Ex Nutt.) Sarg. (Drummond red maple) (Aceraceae), *Fraxinus tomentosa* Michx. f. (pumpkin ash) and *Fraxinus caroliniana* Mill. (water ash) (Oleaceae). Marginal areas often contain *Cephalanthus occidentalis* L. (common buttonbush) (Rubiaceae) and *Salix nigra* Marsh (black willow) (Salicaceae). Higher, dryer ground bordering the wetlands is usually dominated by *Celtis laevigata* Willd. (hackberry), *Ulmus americana* L. (American elm), *U. alata* Michx. (winged elm) (all Ulmaceae), *Acer negundo* L. (box elder) (Aceraceae), *Magnolia grandiflora* L. (southern magnolia) (Magnoliaceae), *Quercus nigra* L. (water oak), *Q. prinus* L. (cow oak), *Q. falcate* Michx. var. *pagodaefolia* Ell. (cherrybark oak/southern red oak), *Q. shumardii* Buckl.) (Shumard red oak) (all Fagaceae), *Myrica cerifera* L. (southern wax myrtle) (Myriacaceae), and *Sabal minor* (Jacq.) Pers. (palmetto) (Aracaceae). Often single, large specimens of *Quercus virginiana* Mill. (live oak) (Fagaceae) stand as majestic monoliths. Naturalized exotics such as *Ligustrum sinense* Lour. (Chinese privet/common privet) (Oleaceae), *Sapium sebiferum* (L.) Roxb. (Chinese tallowtree) (Euphorbiaceae), and *Lonicera japonica* Thunb. (Japanese honeysuckle) (Caprifoliaceae) are usually well established. Mature *Taxodium distichum*, *Nyssa aquatica,* and *Fraxinus tomentosa* are buttressed and encrusted with various lichens, mosses, selaginella, and *Polypodium polypodioides* (L.) Watt (resurrection fern) (Polypodiaceae). *Tillandsia usneoides* L. (Spanish moss) (Bromeliaceae) may or may not be present.

The specific swamp microhabitats hosting *J. ovata* are relatively shady and stable (except for periodic water fluctuations). The following herbaceous plants are characteristic: Acanthaceae – *Hygrophila lacustris* (Schlecht. & Cham.) Nees (lake hygrophila), Anacardiaceae – *Toxicodendron radicans* (L.) Kuntze) (poison ivy), Apiaceae – *Hydrocotyle umbellate* L. (water-pennywort), Bigoniaceae – *Campsis radicans* (L.) Seem. ex Bureau (trumpet vine), Liliaceae – *Hymenocallis caroliniana* (L.) Herbert (spider lily), Poaceae – *Panicum* spp. (panic grass), Rosaceae – *Rubus flagellaris* Willd. (dewberry) and *Fragaria virginiana* Duchn. (wild strawberry), and Saururaceae – *Saururus cernuus* L. (lizard's tail).

In relatively dry habitats, *Viola* spp. (violets) (Violaceae) and *Tradescantia* spp. (spiderwort) (Commelinaceae) are often common.

In wet habitats with considerable sunshine, *Alternanthera philoxeroides* Griseb. (alligator weed) (Amaranthaceae), a common, naturalized exotic, and the native *Polygonum coccineum* Muhl. (water-pennywort) (Polygonaceae) are often sympatric with *J. ovata*. Once established, these two robust and highly invasive species quickly overpower *J. ovata*, which soon disappears.

Although *J. ovata* is often common within the Atchafalaya Delta (see Host Plants: Louisiana Natives), *A. t. seminole* is not likely to occur in that habitat because of the intense sun and daily inundations. And because *J. ovata* in these habitats is truly a pioneer species, the plant rapidly succumbs to ecological succession.

Butterfly species typical of the Louisiana swamp habitats include: *Hermeuptychia hermes*, *Asterocampa celtis* Boisduval and Leconte (hackberry butterfly) (Nymphalidae), *Phyciodes tharos* (Drury) (pearl crescent) (Nymphalidae), *Junonia coenia* Hubner (common buckeye) (Nymphalidae), *Vanessa atalanta* (L.) (red admiral) (Nymphalidae), *Polygonia interrogationis* (Fabricius) (question mark) (Nymphalidae), *Calycopis cecrops* (Fabricius) (red-banded hairstreak) (Lycaenidae) and *Pyrgus communis* (Grote) (common checkered skipper) (Hesperiidae).

Bluebonnet Swamp Environmentally Sensitive Watershed **(BSESW).** Located in the southern part of East Baton Rouge Parish and now incorporated within the city limits of Baton Rouge, this area of 418.2 ha (1033 ac) consists of a checkerboard of terraced (bluff) upland hardwood forest and lowland wetland forest created by the interface between the Pleistocene Prairie Terrace and the Recent Mississippi Flood Plain (Buchanan, 1959; Johnson and Yodis, 1998). The unique bluff is an escarpment that forms the natural eastern edge of the modern Mississippi River floodplain. It is the last elevated region before reaching the Gulf of Mexico (BREC, 1996). This Pleistocene escarpment has always escaped annual flooding by the Mississippi River and is the site for the city of Baton Rouge — the first highland settlement north of the mouth of the Mississippi River. Historically, most of the wetlands within this region were considered "wastelands" and avoided by developers. [Bluff Swamp, a small but ancient, cypress-dominated swamp located only a few km south of Bluebonnet (but in Ascension Parish) is considered to occupy the lowest point on the natural floodplain of the Mississippi (Reese and Liu, 2001).] Most of these lands are drained by Bayou Manchac, a small distributary of the Mississippi River during periods of high water (usually March-May). During low water, Bayou Manchac is approximately 5m (15 ft) higher than the Mississippi (Bartram, 1775/1958; Reese and Liu, 2001). Then the watercourse acts as a tributary, draining back into the Mississippi River (Johnson and Yodis, 1998; Kniffen, 1935; Reese and Liu, 2001). The upland areas, particularly those along Highland Road, were originally settled as far back as 12,000 years (BREC, 1996) by Native American cultures: Boula, Chitamacha, Choctaw, Houma (Reese and Liu, 2001) and Muskhogean (Johnson and Yodis, 1998). Huguet (1976) quotes from Bartram (1956) that the first inhabitants of the specific Bluebonnet region belonged to a "tribe of the Alibamons who had moved into the region from the eastern branch of the Mobile River, whence they had been driven by the Creeks and Muscogulges."

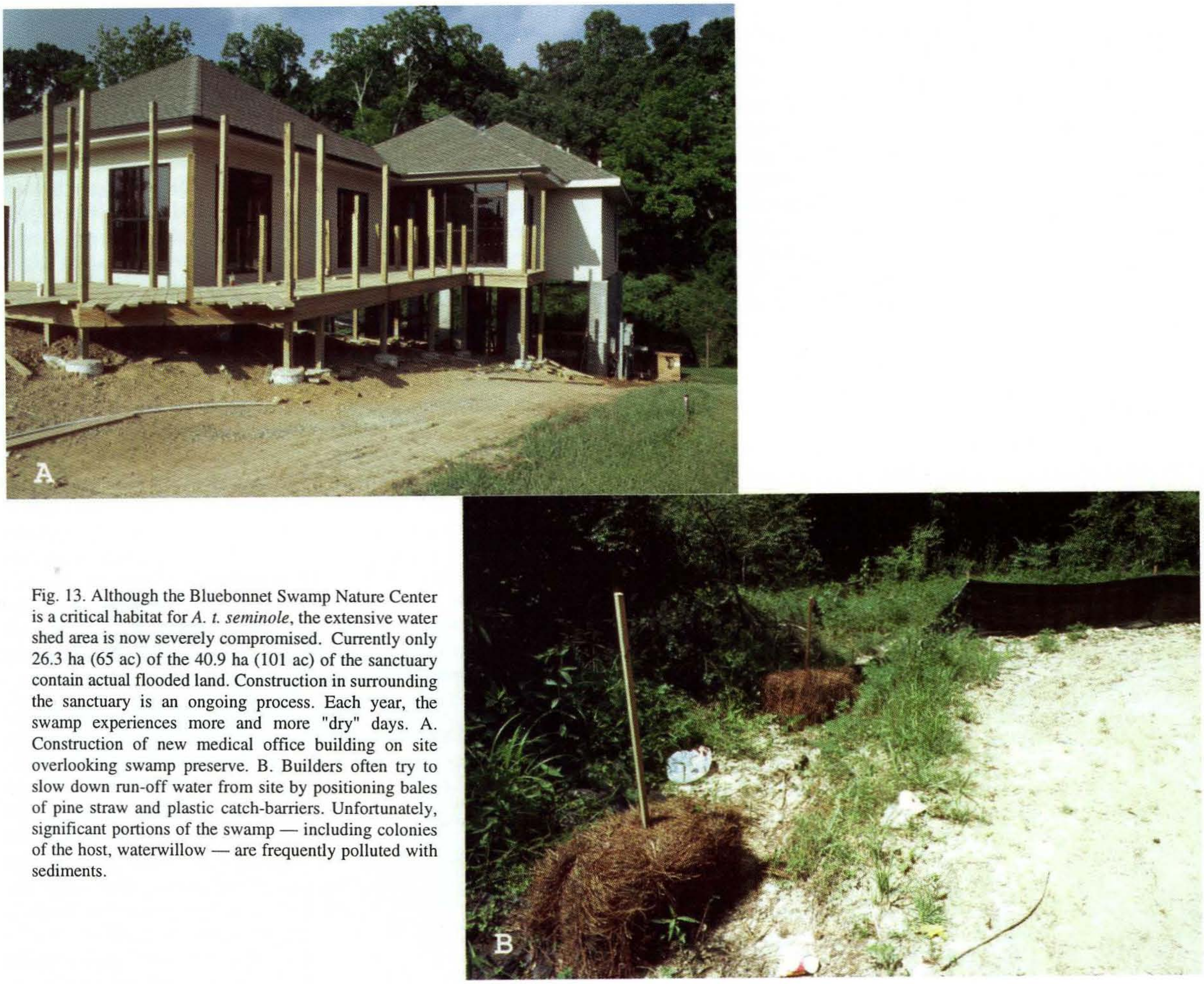

Fig. 13. Although the Bluebonnet Swamp Nature Center is a critical habitat for *A. t. seminole*, the extensive water shed area is now severely compromised. Currently only 26.3 ha (65 ac) of the 40.9 ha (101 ac) of the sanctuary contain actual flooded land. Construction in surrounding the sanctuary is an ongoing process. Each year, the swamp experiences more and more "dry" days. A. Construction of new medical office building on site overlooking swamp preserve. B. Builders often try to slow down run-off water from site by positioning bales of pine straw and plastic catch-barriers. Unfortunately, significant portions of the swamp — including colonies of the host, waterwillow — are frequently polluted with sediments.

Early explorers referred to this escarpment along the Mississippi as "the Hill of the Fountains" because of the clear springs that trickled down the hillsides into meandering Bayou Fountain and Ward Creek. As early as 1700 the region was suggested as the best place for a city because the area escaped the annual floods of the Mississippi River and its distributaries. About 1784, a small party of German (Deutsch) families from Pennsylvania and Maryland located to the area prompting the designation of "Dutch Highlands" and the "Highlands of Manchac." The current Highland Road soon became an inland communication route between the various small communities. The first commercial crop was indigo (Ross, 1995c, 1996, 1997). This was later abandoned for cotton and later still, sugarcane. In 1953, the Bluebonnet drainage basin was still largely a rural agricultural area. The construction of housing developments began in 1957, peaking in the 1970s. Bluebonnet Road (Boulevard) was completed in 1980 and suburban development intensified once again. By the late 1900s Highland Road had developed into a smattering of small business establishments and single middle-class residences interspaced with second growth hardwood upland and lowland forests. But in spite of all the human activity, historic Highland Road remains an attractive narrow, winding thoroughfare flanked by old, specimen-type live oak trees.

Today virtually all non-inundated lands within BSESW are under development (Fig. 13). According to BREC (1996) only 27.5 ha (68 ac) of swamp and small portions of the surrounding highland have escaped development. BREC's 1993 survey indicated that land use in the swamp's 418.2 ha (1033 ac) watershed was broken down into four main groups: Residential—254.7 ha (629 ac) (61%); Open Space — 129.5 ha (320 ac) (31%); Commercial — 29.1 ha (72 ac) (7%); and Institutional — 4.9 ha (12 ac) (1%). [See Comments on the Distribution and Future of *Anthanassa texana seminole* in Louisiana.]

The BSESW is showcased by Bluebonnet Swamp Nature Center, a public facility administered by East Baton Rouge Recreation and Park Commission (BREC) featuring an urban swamp (inside front cover and inside back cover). The center is located 8.5 km (5.1 mi) south of Louisiana State University and enclosed by Highland Road (an extension of State Highway 42) on the southwest, Perkins Road (State Highway 427) on the northeast, Staring Lane — an extension of Essen Lane (State Highway 3064) on the northwest and Siegan Lane (State Highway 3246) on the southeast. Bluebonnet Boulevard (State Highway 1248), running southwest to northeast dissects the watershed. The nature center is accessed from Bluebonnet Blvd. and N. Oak Hills Pkwy.

Bluebonnet Swamp Nature Center boasts a modern facility (dedicated on 17 May 1997) that encompasses the heart of the larger watershed (inside front and back covers). The center totals 40.9 ha (101 ac) that are divided between two major plant communities: 26.3 ha (65 ac) are occupied by cypress-tupelo swamp (characteristic of the low wetlands of the Mississippi River Delta), and 14.6 ha (36 ac) are dominated by magnolia-beech upland hardwood forest (the most southern portion of the upland hardwoods originating far to the north). Common dominant species within the swamp include *Nyssia aquatica*, *Taxodium distichum*, and *Acer rubrum* var. *drummondii*. Common dominant species within the upland hardwood forest on the escarpment include *Magnolia grandiflora, Fagus grandifolia* Ehrh. (Fagaceae) (American beech), *Liquidam-bar styraciflua* L. (American sweet gum) (Hamamelidaceae), *Celtis laevigata*, *Quercus nigra*, *Q. virginiana*, *Q. falcate*, *Ulmus alata*, *Gleditsia triacanthos* L. (honeylocust) (Fabaceae), *Liriodendron tulipifera* L. (tuliptree/yellow-poplar) (Magnoliaceae), *Acer negundo, Sassafras albidum* (Nutt.) Nees (sassafras) (Lauraceae), *Cornus drummondii* Meyer (roughleaf dogwood) (Cornaceae), *Sambucus canadensis*, and the exotics *Lonicera japonica*, *Sapium sebiferum*, *Ligustrum sinense*, and *L. lucidum* Ait. f. (tree ligustrum) (Oleaceae) are common in the buffer zone. The hardwood forest encircles the swamp and is characterized by relatively steep, deep-soil ravines. [NOTE: One of these ravines within the northernmost sector of the preserve features a healthy stand of native *Asimina triloba* (L.) Dunal (pawpaw), which each year host several broods of *Eurytides marcellus* (Cramer) (zebra swallowtail) (Papilionidae). This butterfly population represents the southern limit for the species within Louisiana.]

The true swamp is 5m (15 ft) above sea level and is surrounded by an escarpment 6.5m (20 ft) higher. Standing in the swamp one can walk 66m (200 ft) and have a greater change in elevation than walking 160 km (100 mi) south to the Gulf of Mexico (BREC, 1996).

The nature center features a large, modern wooden and glass exhibit building along with a combination of handicap accessible boardwalks and trails circling and linking the wet and dry ecosystems. The facility is dedicated to conservation, education, recreation, and tourism. According to their website: "Wildlife is plentiful at Bluebonnet Swamp. Many bird species make their homes in the swamp, including Yellow-crowned Night Herons, Prothonatory [sic] Warblers and a variety of owls and hawks. Raccoons, foxes, bobcats, snakes, turtles and alligators are also known to inhabit the site. The Nature Center building is home to Louisiana's largest duck hunting decoy collection and also houses a magnificent collection of carved wooden animals. The facility also holds temporary exhibits on history, ecology and culture." The center receives approximately 40,000 visitors each year.

Bluebonnet Swamp has a complex history (BREC, 1996). Aerial photography from 1941 shows the swamp surrounded by agrarian land use. All flat areas are open, the only forests showing are on the escarpment and within the swamp proper. Scattered homes are discernable. After 1953, urban development began with Magnolia Heights Subdivision on the far western edge of the watershed. In 1979 construction began on Bluebonnet Road; the first commercial building was completed in 1981.

Several commissioned studies for hydrology and pollen/diatom analysis from within the swamp offer clues to the origin of the swamp (BREC, 1996; Fearn, 1989; Lee, 1993; Liu *et al.*, 1995; Winston, 1996). The studies indicate that the region encompassing Bluebonnet Swamp can be divided into five horizons.

(1) A pre-swamp phase prior to 1770 represented by pollen from *Salix* (willow). In this phase a small bayou probably existed at the site before the swamp was formed. The swamp was formed by a rise in water table, possibly by natural processes such as a log-jam or beaver activities or even drainage disruption due to traffic or other human activities along the precursory Highland Road.

(2) A pre-settlement phase, 1770-1800 dominated by *Taxodium* pollen. At this time, the swamp probably was a pristine environment: water quality was good and the swamp supported an acidophilous diatom assemblage consisting of *Eunotia maior* (W. Sm.) Rabh., *E. pectinalis* (O. F. Mull.) Rabh., *E. opectinalis* var. *minor* (Kutz.) Rabh, *Pinnularia maior* Kutz., and *Navicula americana* Her.

(3) A settlement and early agricultural phase, 1800-1860, marked by Malvaceae (cotton) pollen. Early settlers probably selectively cut some bald cypress trees for timber and cleared the dry forest on the uplands for cultivation.

(4) An agricultural phase, 1860-1960, represented by *Ambrosia* (ragweed) pollen and the diatom *Pinnularia braunii* (Grun.) Cl. Cotton was gradually replaced or augmented with corn and sugarcane. The creation of open ground favored the spread of heliophytic shrubs and herbs like willow and ragweed. Forest clearance probably promoted increased runoff, and as a result, the water in the swamp rose promoting the expansion of water tupelo trees. Water conditions began gradually to change due to increased soil erosion, forest disturbance, and water level fluctuations.

(5) A suburban phase, post 1960, marked by the presence of pollen from the exotic *Sapium* and the diatoms *Amphora ovalis* (Kutz.) Kutz., *Nitzschia obtuse* W. Smith and *N. scalaris* W. Smith. At this time the pace of land clearance and agricultural expansion slowed as most available land around the swamp had been cultivated. Native trees probably recolonized various places around the swamp and on the surrounding uplands. New residents planted rapid-growing trees such as slash pine (*Pinus elliottii* Engelm. (Pinaceae), pecan (*Carya illinoensis* (Wang.) Koch.) (Juglandaceae) and *Sapium*. Also, lawns and gardens increased. Such activities contributed to a significant change in water quality. For example, increased surface water runoff and an increase in chemical fertilizers promoted eutrophication in the swamp. Now the water within the swamp changed from acid to neutral to alkaline conditions.

Today, water depth within the swamp is relatively shallow, rarely more than 60cm (2 ft). The swamp has a base flow recession constant ranging from 0.2-0.5 days, indicating a relatively rapid flow of water through the swamp. In summary, the analyses indicate that Bluebonnet Swamp is a relatively young swamp (250 years) with permanent water impoundment related to hydrologic changes caused by European settlement.

Bluebonnet Swamp Nature Center has a slow but ongoing program for the removal of exotic plant species. The labor-intensive strategy centers on manual extraction. Too, the Center is slowly reintroducing native species, particularly along the perimeter of the swamp adjacent to the commercial construction accessed from Bluebonnet Blvd. The principal plant for reintroduction is *Myrica cerifera,* which incidentally, is the primary host for the butterfly *Calycopis cecrops* (Fabricius) (Lycaenidae).

J. ovata is not distributed randomly throughout the center's swampy habitat (Fig. 4). The plant is concentrated only on the swamp's margin in the extreme southwestern sector of the nature center — close to the entrance/exit of the Bluebonnet Regional Library boardwalk.

Residential. Within southern Louisiana, *A. t. seminole* is not restricted to natural habitats. During the summer of 2000, I (and others) observed Seminoles throughout a widespread portion of southern and eastern sectors of the city of Baton Rouge (see Observations and Results). (In 2001 and 2002, sightings were very

Fig. 14. Burden Research Station, Louisiana State University Agricultural Center, has many habitats favorable for *A. t. seminole*. In 2002, the author released 21 virgin male and female Seminoles. However, a few days later, maintenance personnel mowed and sprayed herbicide to the borders of the ponds and creeks (note yellowing vegetation), effectively destroying the butterfly's abundant host, waterwillow. Within two weeks, all butterflies had dispersed. However, in the future, the Burden site could be important for maintaining an urban population of Seminoles.

much reduced.) Within the city, adults and immature stages occupied neighborhoods that (1) contained wetlands or bordered wetlands, and (2) were well drained. The latter is understandable when one considers that manmade landscapes within southern Louisiana and the semi-tropical Gulf South in general are often shaded or semi-shaded because of the canopies of mature live oak and water oak trees. Beneath these canopies, landscapes often consist of elaborate flower gardens, usually lush and containing a wide variety of annual and perennial ornamentals that provide showy displays of both foliage and flowers throughout the relatively long growing season each year. Usually artificial water systems are employed to supplement natural precipitation. As such, many residential communities are not that dissimilar to the shaded environments provided by natural wetlands. Moreover, within the last decade or so, there has been an increasing use of a number of plants within the acanthus family to accent shaded or semi-shaded gardens within the Gulf South. Many of these species have attractive flowers and foliage, most seem to be drought and disease resistant, and many produce inflorescences that are attractive to hummingbirds — and hence, a delight for homeowners into gardening for wildlife (see Ross, 1994; Ross and Welden, 2003).

Because of the South's increasingly mild winters, many acanthus species are proving to be dependable perennials, even though occasional winter subfreezing temperatures may burn vegetative growth. While some species such as *Beloperone guttata*, and *Ruellia brittoniana* are old favorites, other species are rapidly entering the wholesale and retail plant markets. For example, *Dicliptera suberecta* has extremely wide ecological tolerances (sun/shade, moist/dry) and is rapidly becoming a popular landscape choice because of both its attractiveness and propensity for attracting hummingbirds. Because this species is a favorite exotic host for the Seminole crescent, I actively educate the wholesale and retail nursery professions to advertise the plant as a "butterfly plant." In summary, many Gulf South gardens can serve as acceptable habitat for *A. t. seminole*.

ATTEMPTS AT INTRODUCTION

Burden Research Station

The Burden Research Station is a working field station owned and operated by Louisiana State University Agricultural Center (centerfold and Fig. 14). The station consists of 170.0 ha (420 ac) of land donated between 1966 and 1992 by Mr. Steele Burden, former landscaper for the LSU Campus, his sister Miss Ione Burden, former Assistant Dean of Women at LSU and Mrs. Jeanette Burden, widow of Mr. Pike Burden, brother of Steele and Ione. Originally, the site was located on the outskirts of the city of Baton Rouge. Today the property has been encircled by one of the busier sections of the city. Burden Research Station serves as a working outdoor laboratory for university faculty/student agrono-mists and horticulturists. Research focus is on fruit and vegetable crops, ornamentals and nursery production, and turfgrass. Because of Mr.

Burden's love of nature and education, the station features formal gardens and plant collections, informal gardens containing native and exotic species ("Windrush Gardens"), the Ione Burden Conference Center, the Steele Burden Memorial Orangerie, an All-American rose display garden, and the Rural Life Museum. Nature trails, gazebos, ponds, creeks, and sculpture accent these shaded park-like landscapes. Today, 6.1 ha (15 ac) are devoted to formal/informal gardens and 60.7 ha (150 ac) remain forested. Approximately 60,000 people visit annually.

My visit to the research station in May 2000 indicated that several of the ponds and creeks within the Windrush Gardens sector were bordered by *Justicia ovata* and *Hygrophila lacustris*; still I observed no adults or larvae of *A. t. seminole*. Equally important, the site is only 3 km (2 mi) from Bluebonnet Swamp and connected to the latter by natural bayou (creek) corridors. Since the locale seemed perfect habitat for the butterfly species, I decided to attempt an introduction. On 10 Aug, I released a total of 21 virgin male and female Seminoles that I had reared from eggs collected at the Bluebonnet Swamp locale. During revisits on subsequent days I noticed several adults on the wing, but no oviposition behavior. And then disaster! The recent prolonged drought caused the ponds and creeks to dry. Border vegetation expanded and became taller — especially *H. lacustris,* but *J. ovata* as well. To reestablish a more controlled cosmetic appearance to accommodate tourists, in early August plantation personnel mowed and sprayed herbicide to all "offensive" areas (Fig. 14). This, of course, effectively destroyed most border vegetation — including *J. ovata.* After two weeks, my periodic visits to the area to check for the butterfly proved unproductive.

The following summer (2001) I revisited the area on several occasions. Although water levels were back to normal and small colonies of *J. ovata* and *H. lacustris* were once again evident, I observed no Seminoles. Therefore, I conclude that although Burden Research Station is both ecologically suitable and accessible to *A. t. seminole*, current landscape practices (reliance on herbicides and frequent mowing for weed control) most likely are detrimental for long term sustainability of the butterfly species. Of course, education of personnel could alter this.

Residential

In an attempt to establish a breeding colony of Seminoles in my neighborhood (Stratford Place) I decided in early July 2000 to augment my extensive butterfly garden with a 3 m² section devoted exclusively to species of acanthus: *Beloperone guttata, Dicliptera brachiata, D. suberecta, Jacobinia carnea, Justicia spicigera, Ruellia brittoniana* and *Ruttya fruticosa* Lindau. On 4 Jul, I observed a single male basking on the leaf of *B. guttata*. On 10 Aug, I released 5 male and 5 female Seminoles from my rearing chambers into the garden. On 20 Aug, I discovered two small clutches of eggs (36 and 24), one on a leaf of *D. suberecta,* the other, a leaf of *J. spicigera.* (The leaves were removed and taken into my home laboratory for rearing.) Thirty-four individuals (22 males, 12 females) eclosed in mid-Sep; all were taken to the Bluebonnet Swamp sanctuary and released. On 18 Sep, I observed one male Seminole within the swamp, but no egg clusters.

In 2001 I attempted no introductions. I discovered no immatures. On 12 Jul 2002 I released 8 males and 6 females (from larvae relocated from the Stanford Ave. garden site) within my personal garden. The butterflies remained within the garden setting for 24-36 hours; most of the time, the individuals basked. Occasionally, though, I observed an individual nectaring on the yellow flowers of *Lantana camara* (variety "New Gold"). I detected no egg masses on any of my acanthus. Perhaps introductions involving larvae protected under netting, e.g., as documented for *Eumaeus atala* Poey (Lycaenidae) (Ellen, 2002), would be more productive?

COMPARISON OF HABITATS BETWEEN *A. T. TEXANA* and *A. T. SEMINOLE*

Anthanassa texana seminole in Louisiana seems to occupy a very different ecological niche than does the nominate species, *A. t. texana,* in Texas. Ajilvsgi (1990) reports that the nominate form "is a denizen of low, open, shrubby-type areas, such as along the edges of thin, rocky woodlands or along open, chaparral or thorn-shrub trails." Scott (1975) states that the Texas crescent is found "mainly in gulches and dry stream beds (southern Arizona)." Kendall (1964) describes the species feeding on *Diclipera brachiata* growing on an open knoll surrounded by woods in Memorial Park in Houston. Tveten and Tveten (1996), restating Kendall (1964), reports that *A. texana* (subspecies unspecified, but probably *texana*) "occurs frequently in Houston throughout much of the year" and feeds on a variety of flowers. *A. t. texana* prefers more open habitats but includes shady lanes and arroyos in open woods. Except for the metropolitan Houston locales, the reported natural habitats for *A. t. texana* are relatively dry.

In contrast, the habitats for *A. t. seminole* are relatively wet. "In the Southeast the species is found close to the banks of streams and rivers" (Opler and Krizek, 1984). Harris (1972) states that in Georgia, *A. t. seminole* flies along the banks of streams and rivers. It is worth noting that CB and EK (pers. comm.) report that the historic population of *A. t. seminole* in the Lake Houston area was associated with riparian habitats. However, CB (pers. comm.) indicates that his attempt to introduce *A. t. texana* to the relatively humid Beaumont area where there is an abundance of *Dicliptera brachiata*, an appropriate food plant for the species, failed.

To collect additional data on the differences in habitat between the two subspecies, on 5 Aug 2000 RS and I visited Zilker Botanical Garden in Austin, Texas, a lovely facility featuring the Doug Blachly Butterfly Trail noted for its relatively high concentrations of butterflies, including *A. texana*. As with most of the southeastern United States, central Texas at the time was experiencing a significant drought. In fact, on the day of our visit the temperature reached 37°C (99°F) with a relative humidity of 32 percent. Although personnel were attempting to irrigate the gardens, most plants appeared stressed — including the large concentrations of several species of native *Ruellia.* During our visit we encountered only one male *A. texana*, definitely the nominate subspecies. The individual was flying low to the ground along the trail, stopping occasionally to bask with wings outstretched. We found no evidence of larval feeding on any *Ruellia.* However, the gardens included a sizable sampling of *Beloperone guttata* and two specimens of *Justicia suberecta.* Only the latter exhibited the characteristic signs of former feeding by larval *A. texana;* but no larvae were present. (NOTE: RS revisited the gardens in June and Aug 2001, but failed to notice *A. texana.*)

Evidence to date indicates that in general, *A. t. texana* prefers much drier and more open, sunny habitats than does *A. t. seminole.* I conclude that the two taxa are differentiated by not only morphological traits and geography but by ecological differences as well. In fact, I conclude that *A. t. texana* can be described as a taxon favoring relatively dry (xerophytic) areas whereas *A. t. seminole* prefers more riverine and hydrophytic habitats, i.e., basically swamps (a blend zone probably occurs in the Houston area). In the future, comparisons of DNA from the distinct populations would be helpful in determining if each of the two subspecies should be elevated to species rank.

COMMENTS ON THE DISTRIBUTION AND FUTURE OF *ANTHANASSA TEXANA SEMINOLE* IN LOUISIANA

From both historical and current data, I conclude that the Seminole crescent is established, albeit tenuously, within several locations throughout south-central and southeastern Louisiana. These small demes are for the most part isolated from one another, although their climate and geography are similar: semitropical (relatively short cool winters, long hot summers, moderate rainfall) and shaded, semi-aquatic habitats such as swamps, bayous (creeks), and ponds. In addition, several semi-shaded urban neighborhoods within the southern and eastern sectors of Baton Rouge periodically support small populations of the butterfly. All areas are adjacent to and share common, natural wetland ecosystems hosting *J. ovata*, the butterfly's preferred native host. Floristic analyses of the natural sites throughout the state indicate that plant composition within each is similar. *Justicia ovata* is present in all with the possible exception of one: Indian Bayou. However, *Dicliptera brachiata* (an alternate known host for the nominate subspecies) as well as *J. ovata* probably are present there, too. Within these shaded and semi-shaded habitats, *J. ovata* is relatively stable, i.e., not out-competed by other more robust species. Within urban environments, the butterfly utilizes a variety of exotic acanthus species that are commonly used as landscape ornamentals, particularly *Dicliptera suberecta*. At present, all factors regulating the butterfly's distribution and population sizes cannot be identified.

This study offers the following partial paradigm:

(1) The distribution of *A. t. seminole* does not accurately match that of its primary host, *J. ovata*, i.e., the plant species has a much wider distribution (see Host Plants) than does the butterfly.

(2) There is a positive relationship between the size of the specific deme of the butterfly and the relative abundance of its primary host, i.e., abundance of *J. ovata* indicates an abundance of *A. t. seminole*.

(3) There is a correlation between population size of *J. ovata* and abundance of spring/summer rainfall, i.e., reduced precipitation fosters expansion of plants. Louisiana is one of the wettest of the forty-eight contiguous states with total annual rainfall at 1477mm (57.66 in). (Mississippi is the wettest with 1482mm (57.78 in) (Johnson and Yodis, 1998). When the state experiences a series of years marked by reduced rainfall, e.g., between 1998-2000 (see Table), *J. ovata* spreads into habitats that during years with normal rainfall are usually submerged for long periods.

TABLE. Annual Rainfall in Baton Rouge
Ave. = 1561mm (60.89 in)

YEAR	1997	1998	1999	2000	2001	2002
AVERAGE RAINFALL						
mm	1751	1448	1258	977	1598	1538
inches	68.27	56.49	49.06	38.10	62.32	59.98

During abnormally dry years, the host proliferates and *A. t. seminole* undergoes population and ecological expansions-often spreading into residential communities containing exotic hosts. Conversely, relatively wet years have negative affects upon the expansion of the colonial *J. ovata*. For example, in Baton Rouge in 2001 the prolonged assault by Tropical Storm Allison released nearly 590mm (23 in) of rainfall during 6 days, and in 2002, both Tropical Storm Isidore and Hurricane Lili in September and October brought rainfall during what is normally the state's driest two months to a whopping 397mm (15.49 in), bringing the year's total to 1538mm (59.98 in). And of course, areas both west and east of Baton Rouge, hit directly by "Isidore" and "Lili," respectively, received even greater precipitation. Innundated lands are hostile to all immature stages of *A. t. seminole* (floodwaters drown egg masses and pupae and dislodge larvae, which become easy prey for aquatic predators). Consequently, during relatively monsoon years, e.g., 2001, 2002, population sizes of *A. t. seminole* are significantly reduced.

(4) There is a correlation between the spring and summer population size of *J. ovata* and the severity of the previous winter, i.e., mild winters followed by early, dry springs encourage the early growth and proliferation of the host *J. ovata*. In fact, during mild winters, the plant does not experience dieback, and is therefore primed to begin vegetative growth considerably earlier than in years plagued by cold winters and wet springs. This early growth of the host provides additional oviposition sites for female Seminoles.

(5) Densities of demes of *A. t. seminole* are highest in spring and summers that follow a mild winter, i.e., relatively warm winters produce early springs and late autumns, both of which encourage an extended flight and breeding period for Seminoles. Consequently, *A. t. seminole* is able to fit in extra (fourth or fifth) generations following a mild winter.

(6) While urban populations of the butterfly species can be common due to the abundance of exotic acanthus hosts, these populations are usually unstable because the species requires reproductive sites that are relatively undisturbed to decrease the frequency of larvae dislodging from their hosts, which in turn, decreases potential for ground predation. Because of the highly volatile nature of urban sites, demes there are probably regulated each year more by the butterfly's densities in natural habitats, which in essence act as refugia for both butterfly and its native host. In effect, dense populations of butterflies in natural areas generally spark high numbers of butterfly sightings in urban areas.

The future of *A. t. seminole* in south Louisiana is far from certain. As with the vast majority of threatened species, destruction of habitat of the butterfly is the primary culprit (see Heppner, 2001 for excellent discussion). Both Pearl River Wildlife Management Area (St. Tammany Parish), Indian Bayou Wildlife Management Area (St. Landry Parish), and the swampy delta of Bayou Baton Rouge in north East Baton Rouge Parish (Alsen community) are probably reasonably secure from development; thus populations of the butterfly species are presumably safe in those locations, providing drainage patterns are not significantly altered by either man or climate. On the other hand, the wetlands bordering Houma (La Fourche Parish) and in East Baton Rouge Parish, the Bluebonnet Swamp Environmentally Sensitive Watershed and adjacent areas, are in jeopardy. For example, the Houma wetlands are being drained for development, and several residential communities now extend to the breeding sites for the butterfly.

More alarming, the Bluebonnet Swamp Sensitive Watershed ecosystem (including Ward Creek drainage area) in Baton Rouge, possibly the largest refugium and even epicenter for *A. t. seminole* within the state, is rapidly being assaulted by developers. The lands surrounding the Nature Center are now prime real estate to accommodate the parishes' rapidly expanding population (Fig. 13). Consider: East Baton Rouge Parish, comprising 1221.1 ha (471.81 sq mi), includes three major cities: Baton Rouge, with an area of 194.5 ha (75 sq mi.), Baker, with an area of 10.3 ha (4 sq m), and Zachary, with an area of 52.0 ha (20 sq mi). In 2000, the reported population for Baton was 227,818, an increase of 3.8 percent above the 219,531 reported in the 1990 census (U.S. Census Bureau). Much of that population increase occurred within the southern sector of the city-south of Louisiana State University, primarily along Highland Road and Bluebonnet Boulevard, both busy thoroughfares within the officially designated Bluebonnet Swamp Sensitive Watershed.

Within the three years of this study, I have noticed drastic changes in the Bluebonnet ecosystem. Other than the fact that many of the stately live oak trees still exist, the official designation of "environmentally sensitive" seems to be having little or no impact on developers or city officials. Drainage canals and ditches have been deepened and widened; construction projects have tripled; and traffic has at least doubled. Already a large, modern regional library, several banks, upscale commercial boutiques, restaurants, and a myriad of office buildings for physicians, dentists and lawyers occupy prominent positions on the boulevard; many of these encroach to the very edge of the Nature Center to provide "good visibility" for clientele (Fig. 13A). Nearby residential communities such as The Estates at Worthington Lake and The Myrtles subdivision (two areas that in the 1990s hosted small demes of Seminoles) have developed to exclude virtually all remnants of "wildness." Unless residents are immediately apprised of the situation and encouraged to include exotic acanthus species in their landscapes, there is little chance of ever observing Seminoles there ever again. [Of course, I suspect that I am unaware of a number of small demes of Seminoles in small pockets in the Bluebonnet Swamp Watershed and adjacent wetlands (particularly along the escarpment traversed by Highland Road). Perhaps some of these undisturbed areas will survive longer into the future? I hope so!]

Many local environmentalists and organizations are sounding alarms predicting that the Bluebonnet Swamp Sensitive Watershed cannot survive the current onslaught of human activity. Even though the swamp within the actual Nature Center is permanently secure from development, the alteration of drainage patterns surrounding the sanctuary could deny the swamp a reliable source of water; as a result, the swamp could completely dry. In fact, in 2000, and for a lesser time in 2001, such did occur (inside back cover). A local newspaper article (Dunne, 2000) during the early summer of 2000, a year in which Baton Rouge was experiencing a 100-year drought, stated that the swamp was "having an identity crisis" and "thirsting for water." As a result, foliage wilted and many tree species shed their leaves. Animals began to move out of the area in search of water causing several surrounding residential communities to witness an increase in the number of small animal road-kills.

My discussions with personnel at the Bluebonnet Nature Center indicate they already have noticed a high degree of fluctuation in the water level of the swamp. For example, following a rain the swamp fills rapidly. Then within a day or two, the level drops drastically, indicating that water flow from the swamp is much more rapid than in the not too distant past when the swamp was a reliable water basin. This change in amount of water retention seems to have come about from two sources: (1) the enhancement of the regions drainage canals and (2) the deforestation and paving of areas immediately adjacent to the swamp.

It is now clear that the water within the swamp is delicately balanced by both surface and subsurface drainages. The situation is even more alarming when one considers that there is an increased runoff into the swamp because of extensive areas of concrete that funnel large volumes of water into the swamp. This high-speed runoff not only raises water levels but also tends to "flush" the swamp. To complicate matters, the quality of water is now compromised because of the heavy load of chemical fertilizers resulting from landscape personnel servicing the various residential and commercial establishments. Then, too, there is an increased load of silt from construction sites (Fig. 13B). All in all, eutrophication of the swamp is on the increase. During this study, heavy thundershowers and tropical cyclones in 2001 and 2002 led to significant coatings of silt on many low-growing plants—including *J. ovata* —along the southern periphery of the swamp. Whereas the silt did not smother the plants, it did significantly damage many of the plants, evidenced by yellow/black blotches on leaves. Furthermore, the nutrients caused an abnormally rapid growth of surrounding, competing vegetation thereby jeopardizing the long-term viability of the Seminoles' host species.

While the drying of Bluebonnet Swamp sanctuary might be viewed as advantageous for *J. ovata* and *A. t. seminole* (recall that both plant and butterfly species experience population increases in relatively dry years), this positive response for both species is only short-term. *J. ovata* is undeniably a pioneer species, meaning that it is easily out-competed by other species during ecological succession; as such, the plant is dependent upon water and shaded or semi-shaded habitats for its long-term survival. I conclude that within the Bluebonnet Swamp Sensitive Watershed, the delicate balance between water, the plant *J. ovata*, and the butterfly *A. t. seminole* is being negatively and irrevocably altered.

But there is reason for optimism, albeit guarded. Both Burden Research Station and Hilltop Arboretum have wetlands that theoretically could host *A. t. seminole*. In fact, the Burden site already has substantial colonies of *J. ovata*. If personnel at the two sites were educated to the plight of the species they could initiate programs to champion the butterfly. For example, by simply curtailing the use of herbicide along ponds and bayous at the Burden site, habitat for *J. ovata* (and presumably *A. t. seminole*) would be greatly expanded. In addition, expanded incorporation of exotic acanthus species throughout the garden areas would furnish additional sites for butterfly reproduction. At Hilltop Arboretum, personnel could transplant *J. ovata* into wet areas and amend existing gardens with exotic acanthus. In effect, the two tourist-oriented facilities could easily become stable reservoirs for the butterfly. As spin-offs, both facilities would generate substantial positive publicity and witness an increase in tourism.

Perhaps the best hope for *A. t. seminole* in southern Louisiana lies in the fact that the butterfly is able to adapt well to urban environments hosting exotic species of acanthus. I find it reasonable to assume that the butterfly could be "managed." Within the Baton Rouge area, the juxtaposition between natural habitat and urban development affords an excellent opportunity to engage in modern-day butterfly stewardship. Bluebonnet Swamp Nature Center is uniquely positioned to recommend a course of action that could rally the public to the plight of what could become the center's "poster child." Garden clubs, school groups, civic organizations and even business establishments could initiate grassroot campaigns. In fact, Bluebonnet Regional Library, which borders the swamp, would be an ideal venue for disseminating information to the public. The mantra would be clear and simple: create landscapes that attract Seminoles for reproduction and nectaring by planting attractive exotic species of acanthus and various cultivars of lantana. Such undertakings would have to include education on the necessity for locating host plants in relatively undisturbed locations to minimize trauma to larvae. If such programs were carried out in locations that support even small natural populations of Seminoles, butterflies could actually be enticed to take up permanent residency within the artificial landscapes. Then, if natural populations were extirpated, urban-based ones would exist as viable, sustainable replacements.

In January 2002, I consulted with administrators of BREC and the Bluebonnet Swamp Nature Center. My suggestion for a media blitz for Seminoles was greeted with wholehearted enthusiasm. I was told that within the very near future, and with consultation from myself, they would launch a campaign to champion their beleaguered "swamp critter." After all, many attempts at wildlife management involving vertebrates, e.g., bison, deer, and turkey, in the past have proven remarkably successful once the public is fully apprised of the situation. And because insects share a reproductive biology that is far more efficient and far more responsive to artificial manipulation, conservation programs for insects can be highly successful [See Emmel and Kenney, 1997; Heppner, 2001; Smith, 2002 for *Eumaeus atala*]. Coupled with good PR from local environmental organizations such as Audubon Society, Sierra Club, The Nature Conservancy, such a strategy could create a powerful incentive for further action by civic and commercial organizations. Only time will tell.

> *"Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed it's the only thing that ever has."*
>
> Margaret Mead

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Burden Research Station (Louisiana St. Univ. Agricultural Center)
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Hours: Daily, 7 am-5 pm. Free.

Rural Life Museum
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Internet: www.rurallife.lsu.edu. Hours: Daily, 8:30 am-5 pm. (Closed New Year's Day, Easter Sunday, Thanksgiving Day, Christmas Eve, and Christmas Day). Fees: Ages 5-11 years, $4; Ages 12 years and older, $7; Senior Citizens, $6.

Hilltop Arboretum (Louisiana State University)
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ACKNOWLEDGEMENTS

A considerable number of people assisted me with various aspects of research and final manuscript preparation. I thank all, but in particular: Mr. Robert Sherman (Baton Rouge) for his extensive field observations, assistance with field work, and continued enthusiasm for Louisiana's butterflies; Miss Dorothea Munchow (New Orleans) for providing me with data on Seminole crescents in Pearl River Wildlife Management Area and for a specimen of *Dicliptera brachiata* for my garden; Mrs. Frances Welden (New Orleans) for sharing her back issues of Annual Report of NABA Fourth Of July Butterfly Counts with me; Dr. Rick Schoellhorn (Milton, FL) for confirming my identification of *D. suberecta*; the personnel at Bluebonnet Swamp Sanctuary and Burden Research Plantation-Louisiana State University (Baton Rouge) for accommodating my numerous visitations; Mr. Craig Marks (Lafayette, LA) for providing data on Seminoles in the Atchafalaya Basin; Mr. Charles Bordelon, Jr. and Dr. Edward C. Knudson (Houston, TX) for graciously providing distributional and host plant information for *A. texana* throughout Texas and the southeastern United States; Mr. Gayle T. Strickland (Baton Rouge) and Mr. Kevin Cunningham (Houma, LA) for sharing their observations on Seminole crescents; Dr. and Mrs. William Dore Binder (Baton Rouge) for hosting me on their property on Chandler Dr.; Dr. June Tuma (Baton Rouge) for sharing her knowledge of the history of *D. suberecta* in Baton Rouge, and her observations in her personal garden; Mr. Bill Palmer (Director, Planning and Engineering Department, East Baton Rouge Recreation and Park Commission), Ms. Claire Coco (Director, Bluebonnet Swamp Nature Center, Baton Rouge), and Mr. Greg Grandy (Coastal Restoration Division, Louisiana Department of Natural Resources, Baton Rouge) for discussions and making preliminary studies and maps of Bluebonnet Swamp available to me; Mr. Dan Llewellyn (Coastal Restoration Division, Louisiana Department of Natural Resources, Baton Rouge), Dr. Charles Sasser and Ms. D. Elaine Evers (LSU, Coastal Ecology Institute) for discussions about *J. lanceolata* and their research with marsh restoration; Dr. Lowell E. Urbatsch, Dr. Diane M. Ferguson, and Ms. Vesna Karaman-Castro (LSU, Department of Biological Sciences, Herbarium) for permitting me access to the herbarium collection and library; Dr. Meredith Blackwell, LSU, Department of Biological Sciences, for assistance with LSU's "ISI Web of Science"; Ms. Victoria L. Mosley (Curator, Louisiana State Arthropod Museum, LSU) for permitting me access to laboratory facilities for morphological descriptions; Mr. F. Randy Wright (LSU, Central Stations) for technical assistance with the internet and printing; Dr. John Heppner, Mr. James Schlachta and Dr. Andrei Sourakov (Gainesville, FL) for assistance with the electronic preparation of the photographic plates and overall design; and Mr. Frank Zachariah (Baton Rouge) for alerting me to a wetland in a residential landscape (Chandler Dr.). This study was personally funded.

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