

THE ODONATA OF FLORIDA

An Identification Manual



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Department of Environmental Protection
Division of Environmental Assessment and Restoration
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An identification manual for the suborders and families
AESHNIDAE, GOMPHIDAE, PETALURIDAE, CORDULIGASTRIDAE,
MACROMIIDAE, CORDULIIDAE, LIBELLULIDAE, CALOPTERYGIDAE,
COENAGRIONIDAE, and LESTIDAE

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1. INTRODUCTION

Odonata, or dragonflies, are relatively large aquatic insects that are common in nearly all freshwater habitats throughout the state of Florida. They are predaceous throughout their life cycle, often as apex predators, affecting the ecological dynamics in both aquatic and terrestrial communities. As such, they are indicators of ecosystem health. Within the order, the ability of the immature stages to withstand environmental perturbation runs the gamut from sensitive to tolerant. Therefore, identifying Odonata is a vital step in aquatic habitat survey and assessment work. This manual is a means with which to accomplish identification of the aquatic, or nymph stage, of these beneficial insects.

The Odonata fauna of Florida comprises 172 species in 10 families. The two suborders, Anisoptera (dragonflies) and Zygoptera (damselflies) are unequally represented, as there are 125 species of Anisoptera and only 47 species of Zygoptera recorded in the state. In terms of species diversity, the numbers compare favorably with the neighboring states of Georgia (176) and Alabama (181), which have roughly the same disparity between Anisoptera and Zygoptera. The total number of Odonata species in the lower 48 states of the United States is 470 (332 Anisoptera, 138 Zygoptera); therefore, approximately 37% of the U.S. odonate fauna has been recorded in Florida.

The diversity of the Florida odonate fauna reflects the diversity of aquatic habitats in the state. Elevation ranges from 0 to 105 m, with a mean elevation of 30 m; on average, it is the flattest of the 50 states. Lack of high elevation and geographical gradient reduces the potential for aquatic habitat diversity. Nevertheless, Florida has an amazing variety of lake, pond, marsh, swamp, stream, seep, and fen habitats which vary greatly in size, substrate, and types of aquatic vegetation. In addition, the proximity of Florida to the Greater Antilles and Mexico probably has contributed significantly to its odonate diversity. Besides the diversity in available habitats and species numbers, there is diversity in structure and behavior among Florida's Odonata nymphs. Fortunately, morphological diversity provides a means to identify them. The main structures that are useful in identification of odonate nymphs are the labium (the main prey-catching organ), the antennae, abdominal shape and setal arrangement, and the caudal appendages.

Accordingly, identification of Odonata nymphs requires a detailed knowledge of morphological structures and terms. An entire chapter in this manual, Chapter 2, is devoted to describing and illustrating the characters necessary to use the keys provided in the main chapters of this manual. Also important is the ability to determine the stage and sex of nymphs under scrutiny, as discussed in Chapter 3. A list of all species of Odonata found in Florida to date is provided in Chapter 4. Chapters 5–15 provide the identification keys, first to the 10 families, then to genus and species level in each of the families. Included in the treatment of each genus are further diagnostic remarks, both at the genus and species levels; furthermore, notes on habitat, adult flight season (based mainly on Dunkle 1992 and Abbott 2006–2020) and life history are provided. Distribution maps are presented to show the county records for each species. The keys build on the works of Walker (1953), Huggins and Brigham (1982), Needham et al. (2014), Westfall and May (2006), Richardson (2010), and Tennessen (2019a, 2019b), plus individual species descriptions scattered in the literature. Users of previous keys will find that certain characters once regarded as reliable have been excluded and replaced with a number of new characters. And finally, a glossary of terms used in the keys and text is provided.

Florida has 67 counties (Fig. 1.1). For general discussion of species distributions, it is convenient to divide the state into four regions (Fig. 1.1 inset):

1. The Panhandle, a salient from Escambia County east to Madison and Taylor counties.
2. The Northern Peninsula, the portion from Hamilton County south to Marion County.
3. The Middle Peninsula, the portion from Citrus/Seminole counties to Lake Okeechobee.
4. The Southern Counties and The Keys, south of Lake Okeechobee.

North of Lake Okeechobee the climate is considered humid subtropical, whereas south of the big lake it is mostly tropical.



Figure 1.1. Map of Florida showing the 67 counties, with inset showing division into four regions.

As of 2020, an estimated 22 million people live in Florida, making it the third most populous state in the United States. The steady growth of the human population in Florida, together with the activity associated with human needs and expansion, result in ever-increasing environmental change. Forestry and agricultural practices, industrial waste, suburban expansion, and invasive species continue to put increasing pressure on aquatic resources. Rising temperatures and sea levels are potential effects of climate change. Odonata nymphs are useful indicators in monitoring such changes in freshwater habitats because they undergo their entire development in aquatic habitats. Thus there is critical need for their accurate identification.

The use of the term “nymph” instead of “larva” for pre-adult hemimetabolous insects such as Odonata follows a long-standing tradition of usage in North America. More in-depth arguments on usage of nymph, naiad, and larva were presented by Tennessen (2019a).

Maintaining a Reference Collection and Preservation Methods

Besides utilizing keys and other reference works to identify nymphs and exuviae, maintaining a handy reference collection is a good way to further one’s identification expertise. Keeping identified, preserved specimens allows comparisons with new material and a recheck of previous determinations. Specimens verified by experts are especially valuable for future comparisons. The condition, and thus the usefulness, of preserved Odonata specimens depends on collection methods and the treatment of specimens after collection.

Exuviae, which are the non-living cast skins of nymphs that have emerged to the adult stage, can be kept dry or put in alcohol. If kept dry, they are prone to breakage, especially when manipulating the labium and antennae to observe microscopic details. The preferred method is to put exuviae in alcohol (either 70% ethanol or isopropyl) while collecting in order to keep them pliable; after storing in alcohol, exuviae should not be dried again as their condition will badly deteriorate. The value of exuvia surveys has been stressed by Raebel et al. (2010).

Preservation methods recommended for live nymphs differ depending on suborder. Killing Anisoptera nymphs in alcohol leads to interior deterioration of tissues, distorting the shape and color of the nymphs. The most proven method for yielding excellent specimens of dragonflies is the par-boil method. Living nymphs are put in water that is near the boiling point; death is instantaneous. The nymphs should be left in the hot water for up to a minute then taken out and cooled. After dabbing them on a paper towel to remove excess water, they should be placed immediately in 80% ethanol; isopropyl can be used if ethanol is not available. Zygoptera (damselfly) nymphs, on the other hand, should not be placed in hot water because it distorts the caudal lamellae. Damselfly nymphs should be put individually in small vials containing 75–80% ethanol. Separating damselfly nymphs in the field is not always convenient, but because they are prone to losing the caudal lamellae, putting several together in one container can lead to lamellae autotomy which will cause confusion later in trying to match which lamellae came from which nymph. It is imperative not to put any other aquatic insects in containers with damselfly nymphs to prevent further loss of lamella and other structural damage.

Each container should be labelled with county, locality (including latitude and longitude), date of collection, and name of the collector. Vials should be evaporation proof; screw cap vials with poly-seal caps are recommended. The collection should be checked for evaporation at least once a year. Reference collections should be stored in dark, cool cabinets to help prevent evaporation and specimen bleaching, which is caused by prolonged exposure to light.

Adult dragonflies should be treated with acetone to retain color patterns (see Needham et al. 2014 for methods).

2. NYMPH MORPHOLOGY

External morphological structures of Odonata nymphs and the terms that apply to these structures are treated here. This knowledge is necessary to negotiate the identification keys in this manual. The following morphological treatment addresses North American Odonata exclusively. The discussion is based on Tillyard (1917), Snodgrass (1935, 1954), Asahina (1954) and Tennessen (2019a). Note: Odonata nymphs and exuviae are often covered with foreign materials such as sand and mud; a fine brush and needle can be used to clean key structures of any such materials, but care should be taken to prevent breaking off certain structures, especially antennae, spines, and setae.

Odonata have a body plan typical of most insects, with the body divided into three regions: **head**, **thorax**, and **abdomen** (Fig. 2.1). The head bears the antennae, eyes, and mouthparts. The thorax of Odonata differs from that of most insects in that it is divided into a **prothorax** and a **pterothorax** (the latter is composed of the fused mesothorax and metathorax). There are three pairs of segmented legs and two pairs of external wing sheaths, although wing sheaths do not appear until nymphs are about half grown. The **abdomen** is the largest part of the body, highly variable in shape, and terminating in **anal appendages** that are also highly variable in their morphology.

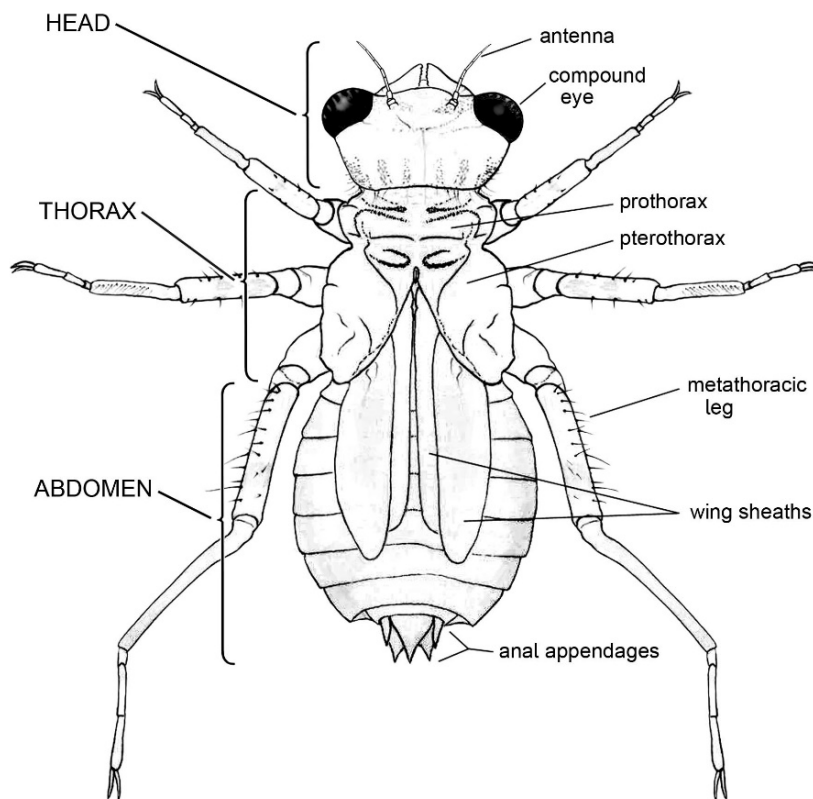


Figure 2.1. Dorsal view of a dragonfly nymph showing the major parts of the body and some basic morphological features.

Head

The head bears the mouthparts and numerous sensory organs. The **head capsule** is variable in shape throughout the order but in dorsal view it is usually subquadrate with rounded or square corners. The shape of the head capsule provides distinctive characters in some families, in both dorsal and lateral views. The gnathous condition of the odonate nymph head varies from prognathous (directed anteriorly, as in Fig. 2.2a) to almost hypognathous (directed anteroventrally, as in Fig. 2.2b).

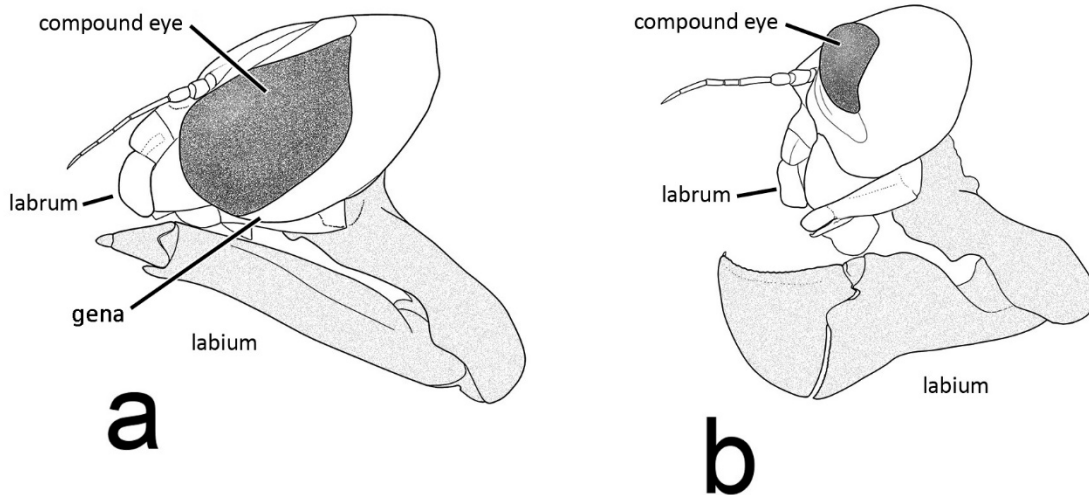


Figure 2.2. Head of an Aeshnidae nymph (a) and a Libellulidae nymph (b) showing gnathous condition of the head and position of the labrum and labium, lateral view; labium shaded entirely light gray.

The dorsum of the head capsule is divided into defined regions by sutures and minute fracture lines. The anterior, flap-like **labrum** serves as an upper lip (Fig. 2.2). The **clypeus** is a narrow sclerite immediately joined to the labrum (Fig. 2.3). The **frons** lies dorsoposteriorly to the clypeus; it is sometimes produced anteriorly as a distinct ridge, termed the **frontoclypeal ridge**. The degree to which the ridge protrudes and its shape are taxonomically useful. The frons is further divided into the antefrons and postfrons. The dorsum of the head is made up mostly of the **occiput** and **postocciput**; the **posterolateral corner** is sometimes called the **occipital corner** (Fig. 2.3). The **gena** (sort of like a cheek) makes up the ventrolateral part of the head capsule, below the compound eyes (Fig. 2.2a); it is rarely useful in taxonomy. The types and arrangements of setae found on the head capsule are useful in some groups.

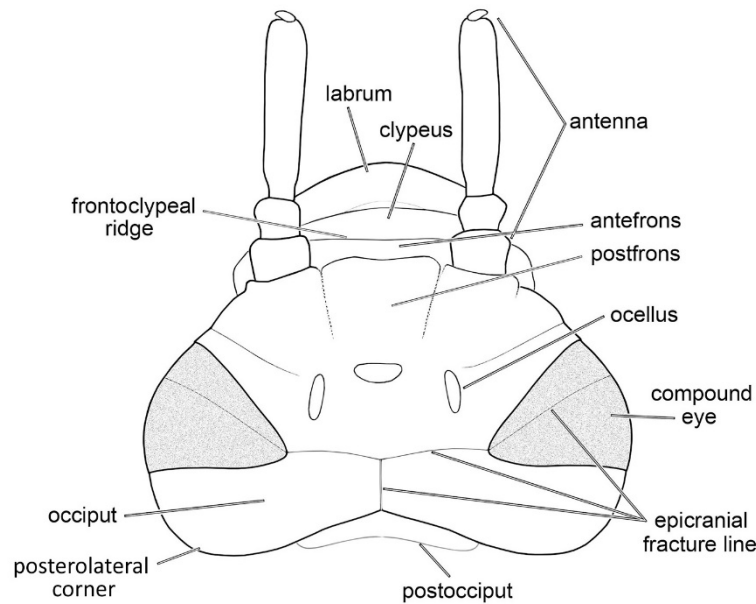


Figure 2.3. Head of a Gomphidae nymph showing major components of the head; dorsal view.

Eyes. The **compound eyes** are large and are situated on the anterolateral portion of the head; eye size and shape are useful in some groups. On top of the head are three small, inconspicuous light sensitive organs called **ocelli**; the ocelli have little taxonomic value.

Antennae. The antennae are paired, segmented, sensory structures situated on the dorsum of the head capsule in an anterior position. The basal-most segment has been termed the **scape**, the second segment the **pedicel**, and the remaining distal segments the **flagellum**. Antennae vary from four to seven segments (Fig. 2.4). The individual segments (also called antennomeres) are highly variable in dimensions, color, and setal arrangement. It is important to be aware that the number of segments increases as nymphs molt and grow: very early instars have only three segments, and the final number of antennal segments is not attained until nymphs are about three or four molts short of final instar. The antennae offer useful characters, including segment number, length, shape, and setal arrangement.

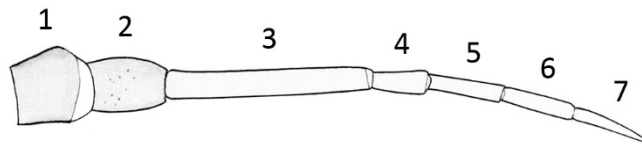


Figure 2.4. Antenna of an Aeshnidae nymph showing the segments (antennomeres).

An antennal character sometimes used to separate species is the relative lengths of the antennal segments. For example, consider the 7-segmented antenna of *Anax junius* with segment lengths (from basal segment to apical segment) of 0.32, 0.36, 0.85, 0.28, 0.40, 0.43, and 0.40 mm. These absolute lengths can be converted into ratios. The first, or basal, segment (scape) is given an arbitrary value such as 5, so the ratios in this example would be 5, 5.6, 13.3, 4.4, 6.3,

6.7 and 6.3. In this example, the 3rd segment is over twice as long as either of the first two segments. By using ratios, the relative lengths of the segments make it easier to compare closely related species. However, antennal segment length is highly variable within most species and is of limited usage for identification purposes.

Labrum. The labrum is the upper, or anterior “lip” that covers the other mouthparts both dorsally and anteriorly (Fig. 2.3). It is rarely used as a character in the nymph keys.

Mandibles. The mandibles are the major chewing and/or engulfing organs. Although there are differences in mandibles at the family level, there are few instances where the mandibles are helpful in separating genera and species. Also, the mandibles are difficult to expose and examine; therefore, I have not included them in the keys or diagnoses.

Maxillae. Like the mandibles, few characters are afforded by the maxillae and I have not included them in this discussion or in the keys.

Labium. The labium is the prey catching organ and is the largest of the mouthparts. Depending on the shape of the labium (flat or scoop-shaped), it either comes up to the ventral margin of the labrum (as in Fig. 2.2a, above) or it can partially or completely cover the labrum when fully retracted (Fig. 2.5b). Many characters for separating family, genus and species are found on the labium and therefore it is the most important taxonomic structure on the nymph head. The basal segment of the labium is the **postmentum**. The postmentum is attached to the venter of the head capsule; its length and the presence of setae vary within some groups, providing a few characters for separating genera and species. The distal segment of the labium is the **prementum** which articulates with the postmentum via a **hinge** (Fig. 2.5a,b). The prementum is tremendously important taxonomically, especially the relative dimensions of length, maximum width and basal width. The distal margin of the prementum is the **ligula**, which presents several important taxonomic characters. The lateral margin of the prementum is the **dorsolateral rim** (Fig. 2.6); the arrangement and stature of setae on the rim are sometimes important taxonomically. Conspicuous setae may be present or absent on the ental surface of the prementum; groups with a scoop-shaped prementum have prominent **premental setae** (Fig. 2.6) that flex at the base. Premental setae are highly variable in number and size. On each side of the prementum, the setae may be present as one set that decreases gradually in size toward the median, or they may be arranged in two distinct sets, a set of larger lateral setae and a set of smaller more medial setae. The ventral surface of the prementum may have a median **sulcus** or groove (Fig. 2.5a).

At the distal end of the prementum is a pair of **labial palps**. The palps oppose each other when closed so that the **distal margins** of the two palps meet. The palps are highly variable in size and shape. In families with a flat palp, the main portion is termed the **palpal blade**; typically there is an **end tooth** and a variable number of **palpal teeth** on the blade (Fig. 2.7a). In families with a curved palp, the basal portion is termed the **palpal lobe**. At the distal end of each palp is a **movable hook**, also highly variable within the order (Fig. 2.7). In some Zygoptera, the **palpal base**, from the articulation with the prementum out to the base of the movable hook, is an important character (Fig. 2.8c). As with the prementum, prominent setae may be absent (Fig. 2.7a) or present (Fig. 2.7b); in the latter case, these large setae are called **palpal setae**. The palpal setae are based on the inner aspect of the **dorsal rim of the palp**. In Anisoptera families with curved (scoop-shaped) palpal lobes, the distal margin is scalloped, with each small lobe called a **crenation**; the shape and height of the crenations plus any setae present are often distinct between taxa. In Zygoptera families, the distal margin is produced into a variable number of lobes, including an upper lobe (adjacent to the movable hook) which may be pointed, truncate or

have both pointed and truncate processes, and one or two lower lobes that are sharply pointed (Fig. 2.8); the morphology of the lobes is useful in separating the families and also valuable in differentiating some genera.

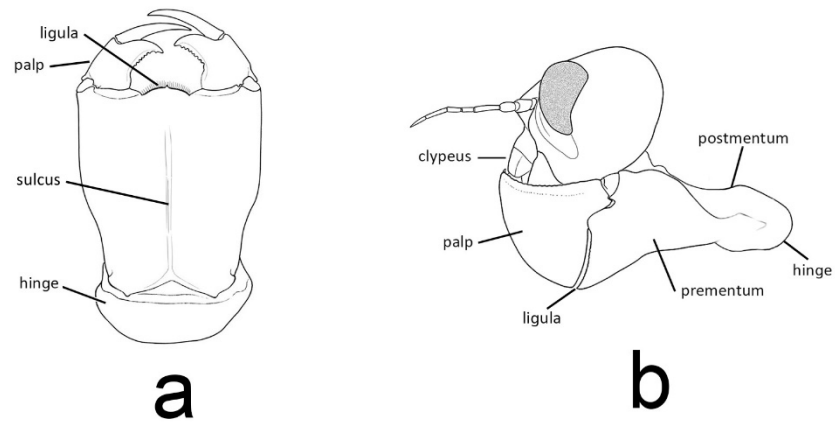


Figure 2.5. Anisoptera mouthparts: a) flat Gomphidae labium, ventral view; b) scoop-shaped Libellulidae labium, fully retracted, lateral view.

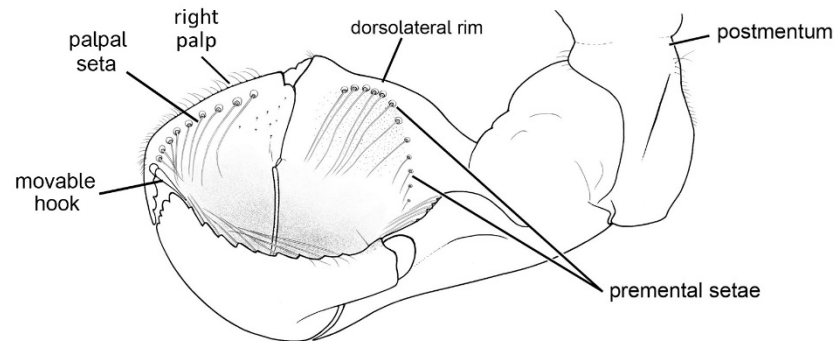


Figure 2.6. Labium, Libellulidae, dorsolateral view, showing scoop-shaped prementum and conspicuous premental and palpal setae.

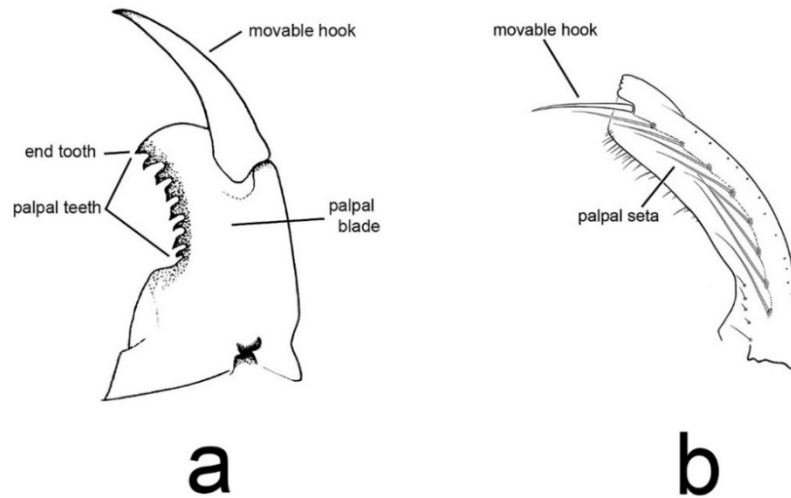


Figure 2.7. Right palp, Anisoptera, dorsal view: a) Gomphidae; b) Libellulidae.

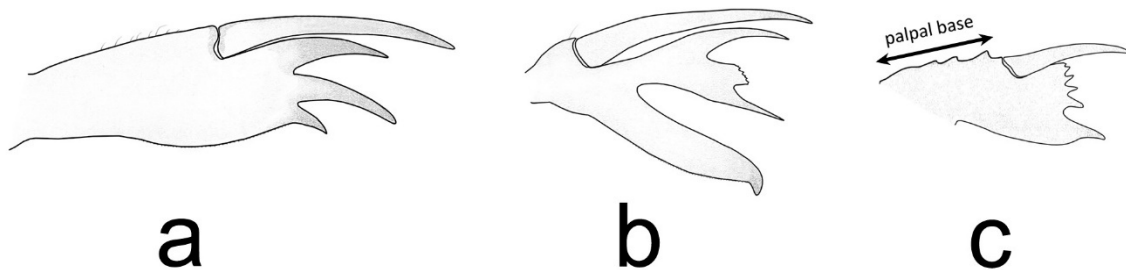


Figure 2.8. Right palp, Zygoptera, ectal view: a) Calopterygidae; b) Lestidae; c) Coenagrionidae.

Thorax

The thorax, as already mentioned, is divided into a small **prothorax** and a much larger **pterothorax**. The prothorax in most families is produced laterally into a shoulder-like projection called the **epaulet** (Fig. 2.9). Ventral to the epaulet there may be another projection (in the propleural region) called the **supracoxal process**. The pterothorax has several definable regions, notably the dorsal and dorsolateral portion called the **mesepisternum** (the two sides of the mesepisternum meet middorsally forming a **middorsal line**), and several sclerites that make up the lateral portion, the **mesepimeron**, **metepisternum** and **metepimeron** (Fig. 2.10). Few characters of taxonomic value are located on these sclerites. The venter of the pterothorax provides a few taxonomic characters, in both Anisoptera and Zygoptera, based on aspects of the **sternal plates**, the **furcal pits**, the **discriminal line**, and the **transverse suture** (Fig. 2.11).

The legs segments, from base to distal end, are **coxa**, **trochanter**, **femur**, **tibia**, and **tarsus**; the tarsal **claws** articulate at the distal end of the last segment, or tarsomere (Fig. 2.12). Numerous useful taxonomic characters are based on leg length and other features. The length of the **wing sheaths**, as measured by the abdominal segment to which they extend, is also important taxonomically. Wing sheath length is also used to determine instar, as is discussed in Chapter 3. The wing sheath pairs are usually parallel to each other although in some groups they are divergent.

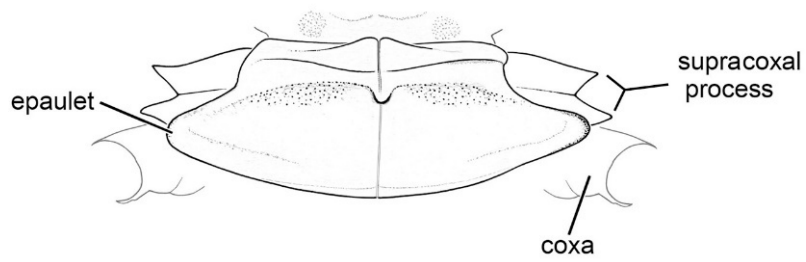


Figure 2.9. Prothorax, dorsal view, Aeshnidae.

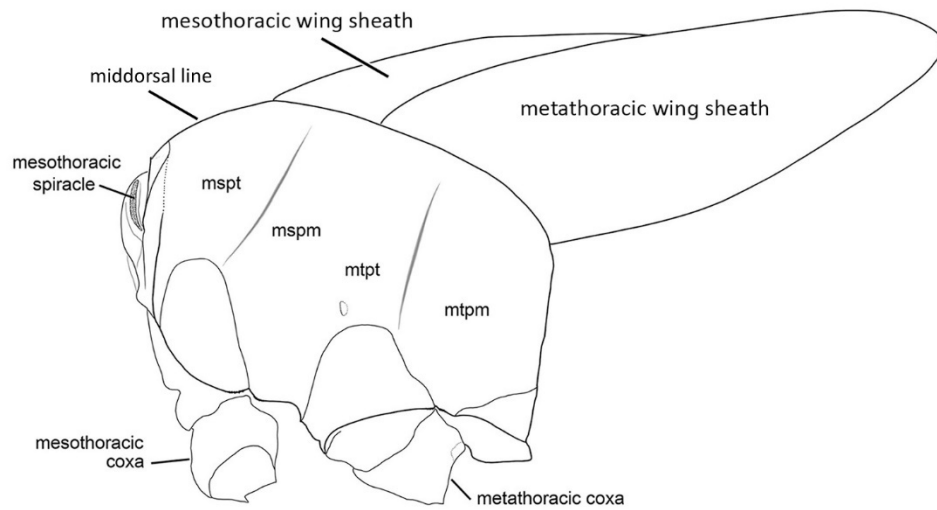


Figure 2.10. Pterothorax, lateral view, Aeshnidae; mspt = mesepisternum, mspm = mesepimeron, mtpt = metepisternum, mtpm = metepimeron.

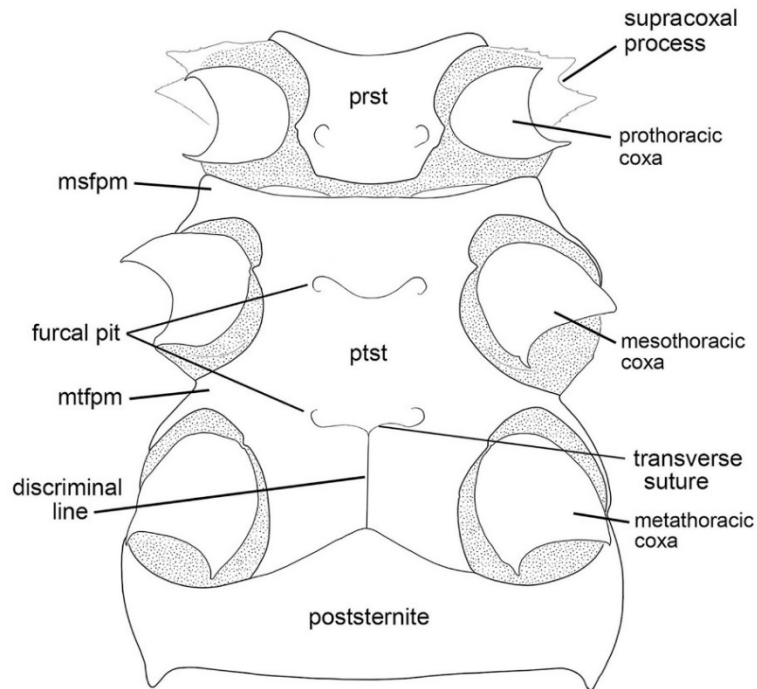


Figure 2.11. Pterothorax, ventral view, Aeshnidae; msfpm = mesinfracapitulum, mtfpm = metinfracapitulum, prst = prosternum, ptst = fused pterothoracic sternum; stippled areas are membranous cuticle.

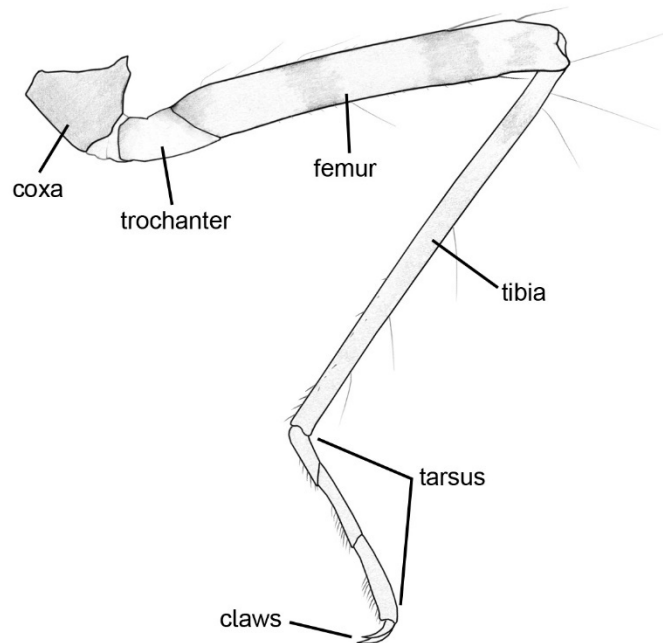


Figure 2.12. Left metathoracic leg, lateral view, Libellulidae, *Pachydiplax*.

Abdomen

The shape of the abdomen in dorsal view is highly variable within the order, from very slender and elongate to oval or nearly circular. In Anisoptera, it is fusiform (spindle-shaped) and variably tapered posteriorly compared to parallel-sided and truncate posteriorly in Zygoptera. In cross-section, the dorsum is convex to varying degrees. There are 10 segments; the easiest way to enumerate the segments is to locate the anal appendages and then count backwards from segment 10; this can be done in dorsal or ventral view (Figs. 2.13 and 2.14).

The venter of the abdomen is generally flat although it can be slightly convex and/or concave at certain points. Color pattern on the venter is usually uniform, although occasionally distinctive patterns are present. In Anisoptera, major longitudinal sutures on each side of the median separate segments 2–9 each into three major sections, a **median sclerite** and two **lateral sclerites** (Fig. 2.14); note that sutures are absent on the venter of segment 10. These sutures allow for flexibility, thus aiding in respiration. An additional anterolateral suture is sometimes present on certain segments, demarcating a small **anterolateral sclerite** (Fig. 2.15); the presence and dimensions of this sclerite are useful taxonomically in some groups.

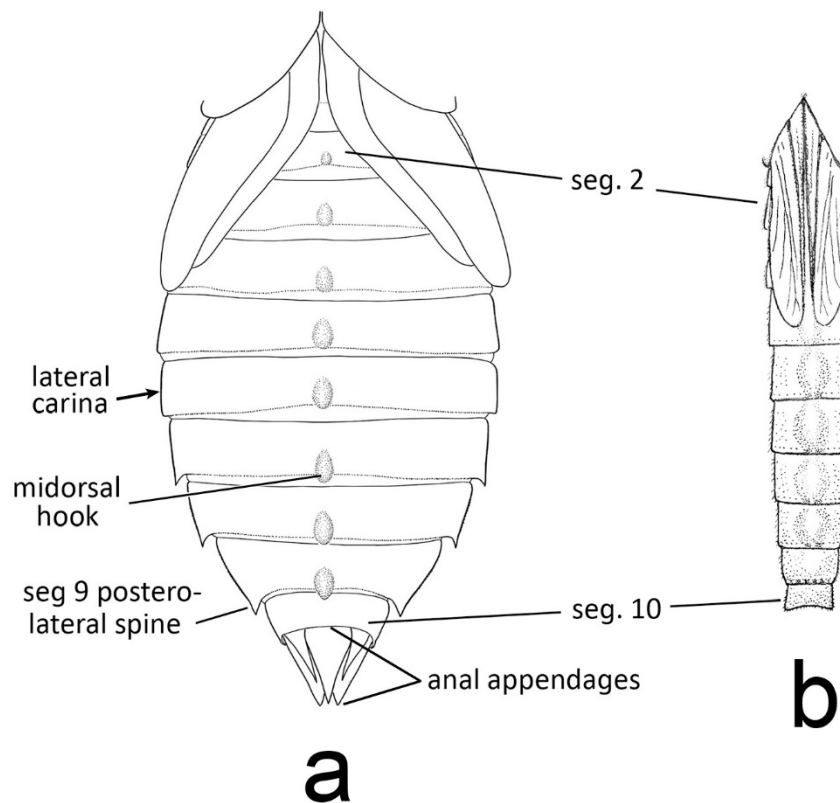


Figure 2.13. Abdomen, dorsal view: a) Anisoptera (Gomphidae); b) Zygoptera (Coenagrionidae), caudal lamellae omitted.

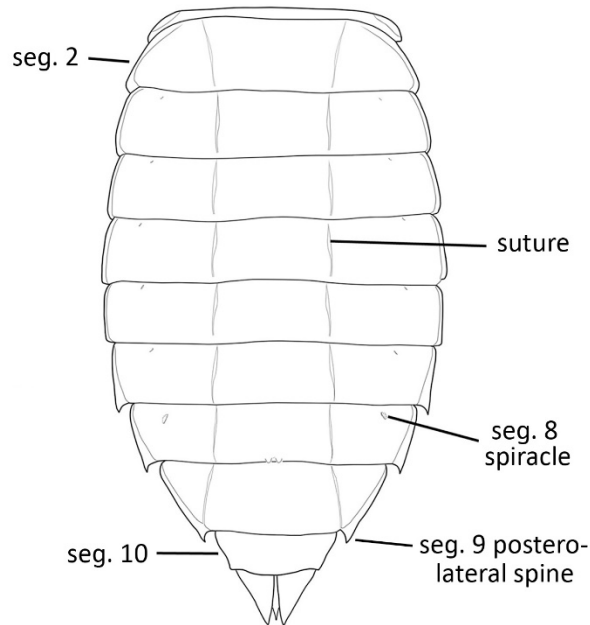


Figure 2.14. Abdomen, ventral view, Gomphidae.

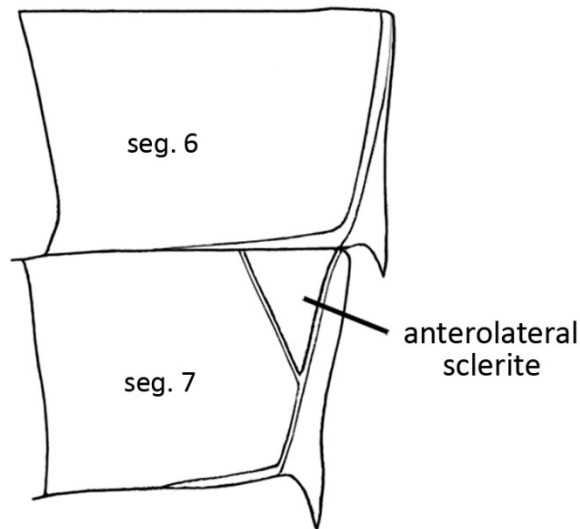


Figure 2.15. Abdominal segments 6 and 7, left side, ventral view, Gomphidae.

Many useful taxonomic characters are found on the abdomen, including the dimensions of various segments, the presence/absence of **middorsal hooks**, the size and shape of the **posterolateral spines**, and the shape and relative sizes of the **anal appendages** (Fig. 2.13). The **lateral carinae**, in addition to the posterolateral spines, often bear small **spinules** (Fig. 2.16) that are useful taxonomically in some groups.

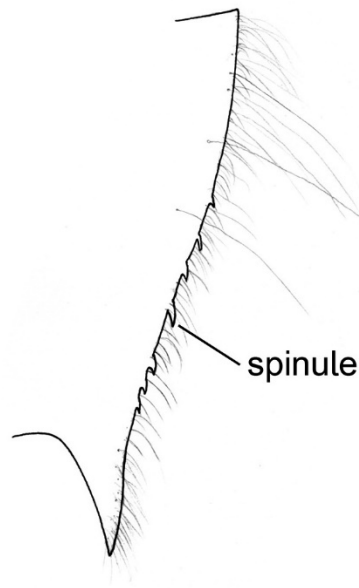


Figure 2.16. Abdominal segment, right side, dorsal view, Gomphidae, *Phanogomphus*.

Middorsal hooks (in most references, the term “dorsal hooks” is used) vary from small to prominent in the form of blunt protuberances (Fig. 2.13) or sharply-tipped straight or curved hook-like structures. Middorsal hooks are taxonomically useful structures in many Anisoptera groups but they are absent in North American Zygoptera. When the dorsum of the abdomen is viewed laterally, it is known as an **abdominal profile** (Fig. 2.17); this is usually the best view to determine the presence and shape of middorsal hooks, although a dorsal view can also help detect middorsal hooks when they are small, flat, and triangular.

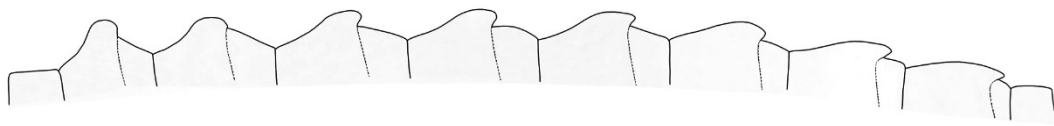


Figure 2.17. Abdominal profile, Gomphidae, *Ophiogomphus*.

Posterolateral spines (often called “lateral spines”) are present in most genera. These spines are usually more prominent on the posterior segments, and their presence/absence and relative size offer many useful characters. The spines can be quite small and hidden by setae and foreign materials such as silt, mud, and algae. In some Anisoptera genera, posterolateral spine length is dependent on whether the nymphs develop in fish or fishless habitats (e.g., Flenner et al. 2009). These environmental effects decrease the reliability of spine length as a character to separate certain species; further details on posterolateral spines in certain genera are discussed in this manual where applicable.

Both Anisoptera and Zygoptera have five anal appendages: a dorsomedial **epiproct**, two dorsolateral **cerci**, and two ventrolateral **paraprocts**. Despite striking differences in structure of the epiproct and the paraprocts of the two suborders, the appendages are homologous. In Anisoptera, the anal appendages (sometimes collectively called the **anal pyramid**) are stout and tapered to a point (Fig. 2.18a) although the tip of the epiproct is sometimes blunt or bifid; the five appendages can be closed tightly to protect the anal opening. In older references, the epiproct was called the superior appendage, the cerci were the lateral appendages, and the paired paraprocts were the inferior appendages. Zygoptera cerci are similar to those of Anisoptera, usually small with a rounded or pointed apex. The epiproct and the paired paraprocts of Zygoptera, however, terminate in elongated **caudal appendages**, here termed the **caudal lamellae** (Fig. 2.18b); these appendages have also been called caudal gills. The epiproct bears the median lamella and the paraprocts bear the lateral lamellae; the median lamella is usually differently shaped than the two lateral lamellae. The lamellae, especially the laterals, can be nearly as long as or longer than the abdomen. The lamellae, especially the laterals, can be nearly as long as or longer than the abdomen. The epiproct and paraprocts have a basal transverse suture that serves as a breaking point between the base and the lamellae (Fig. 2.19) — the lamellae can be easily shed if grabbed by a predator, a self-amputation called **autotomy**. Lamellae lost in instars before F-0 are regenerated in successive molts, although normally they do not regain the size, shape, and structure of typical lamellae; such gills can create problems in identification. Zygoptera lamellae differ in shape, marginal setae arrangement, color pattern, and tracheation, providing valuable taxonomic characters at all levels of classification, from family to species. In Coenagrionidae, the proximal portion of the lamellae is usually different than the distal portion; in such cases, the point at which the difference is apparent is called the **nodus**. The location of the nodus is an important taxonomic character in some coenagrionid genera, although its position can be difficult to determine. When present, the nodus varies from transverse to oblique. If the nodus is not readily apparent based on color change, it can sometimes be determined by locating the end of the row of small stout setae, called **spiniform setae**, located proximally on the margins (Fig. 2.20); in such lamellae, the series of spiniform setae is termed the antenodal series. Further details on and illustration of the nodus are presented in Chapter 15. The apical angle has been utilized in previous references, although it is variable and difficult to measure.

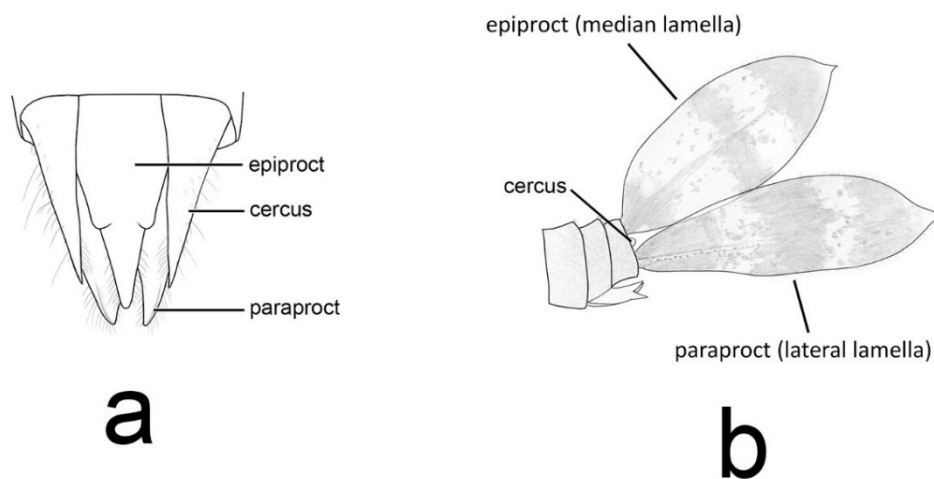


Figure 2.18. Anal abdominal appendages: a) Anisoptera, Gomphidae, *Dromogomphus*; b) Zygoptera, Coenagrionidae, *Argia*.

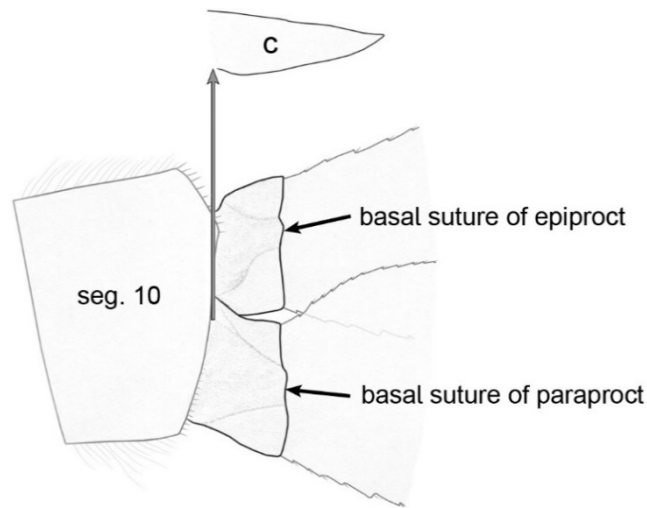


Figure 2.19. Bases of caudal lamellae of a zygopteran, *Lestes australis*, in lateral view, showing basal transverse sutures of epiproct and left paraproct. Cercus (c) moved upward digitally from its actual position, as indicated by arrow, to completely reveal bases of the appendages.

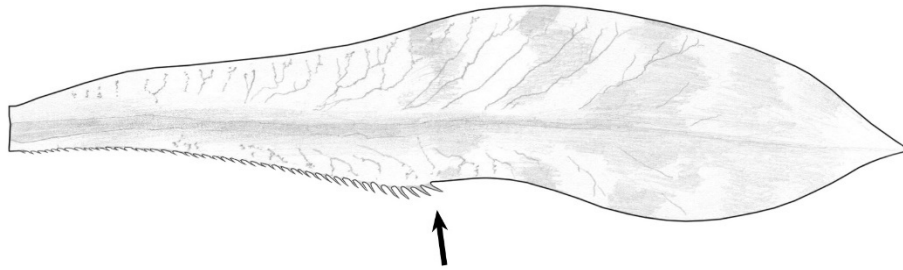


Figure 2.20. Lateral caudal lamellae of a coenagrionid, *Enallagma pollutum* (lateral view) with arrow showing location of indefinite nodus at end of series of small sharp setae (the antenodal series) on ventral margin.

Setae

Nymphal setae are highly variable in nature, from short to extremely long, hair-like to spiniform, straight to curved and wavy, flat and blade- or scale-like to branched (Fig. 2.21). In some groups, various types of setae are useful taxonomically.



Figure 2.21. Various types of setae on Odonata nymphs.

The cuticular area that immediately surrounds the alveolus (socket) of some types of setae can be raised; this is the **setal base**. The setal base varies from circular to irregularly-shaped. When raised and numerous, the bases give the body surface a maculose, or granulate, appearance which can be conspicuous under low magnification, especially if the bases differ in color from the surrounding flat surface of the cuticle (Fig. 2.22).



Figure 2.22. Abdominal segment 9, dorsal view, Gomphidae, showing maculose or “granulate” surface.

3. INSTAR DESIGNATION AND SEX DETERMINATION

1. Determining Instar

Knowing the instar of a specimen is a necessary step in identifying an Odonata nymph. Keys are usually based on the final instar; taking earlier instars through most keys can result in a dead end or an error. We know that the exuviae of emerging adults are final instar. But determining instars of nymphs is certainly challenging, even for odonatologists. The only definite way to determine instars exactly is to rear nymphs all the way from egg hatching to full-grown and preserve each exuvia. Obviously, rearing is not possible with preserved, field-collected specimens. Therefore, a method to determine instar of sample specimens is necessary. Fortunately, late instars can be determined by a method which counts backwards, from the last instar to instars in which wing sheaths are small. Wing sheath length and head width provide the data needed for this determination.

Wing sheaths usually first appear as small buds in the 6th or 7th instar (in instars earlier than those, wing buds simply have not yet developed). Relative instar is designated following Lutz (1968), where F-0 is the final instar, F-1 the penultimate instar, and so on. The following discussion is based mainly on Tennessen (2017). Relative instar designation (RID) is limited because it cannot determine instars before wing sheaths appear.

The RID method is based on measurements of head width and metathoracic wing sheath length (metathoracic wing sheaths are the outer ones). Head width is measured as maximum width in dorsal view, which is usually across the compound eyes; hind wing sheath length is measured in dorsal or dorsolateral view, from the base of the wing sheath at its medial juncture with the metepisternum to the apex of the wing sheath (Fig. 3.1).

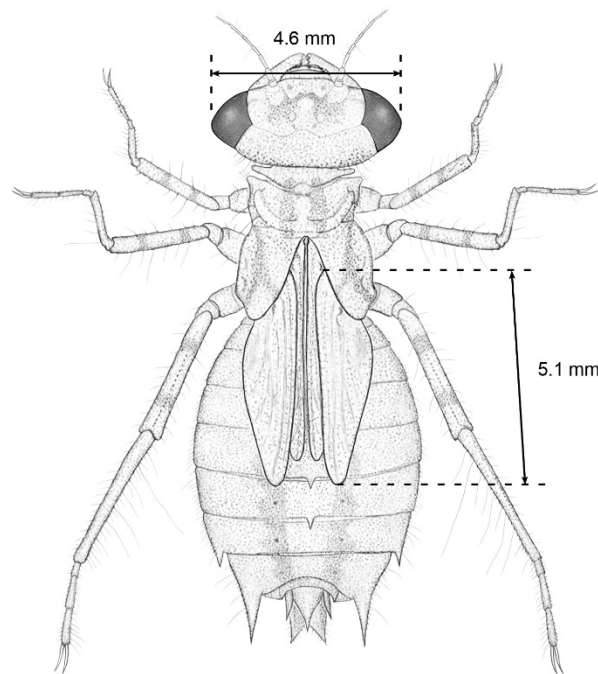


Fig. 3.1. Measurement of head width and hind wing sheath length of a full-grown libellulid nymph, *Celithemis elisa*.

Once head width and hind wing sheath length are determined, the ratio of wing sheath length to head width (HwL/HW) is calculated. HwL/HW ratios allow accurate determination of instars from F-0 back to F-4 (Table 3.1). Nearly all species I sampled had a ratio greater than 1.0 for F-0, although a few species in the families Aeshnidae and Corduliidae had ratios of 1.0 or slightly less (range from 0.9–1.2). By comparison, the highest ratio for any F-1 was 0.91; therefore, specimens with a ratio greater than 0.9 nearly always will be F-0. In the example using the libellulid in Fig. 3.1, hind wing length was 5.1 mm and head width was 4.6 mm, for a ratio of 1.11; with a ratio greater than 1, we see that this nymph is in the final instar (F-0).

Table. 3.1. Mean hind wing sheath length/head width ratios in the five latest instars of 22 species of Odonata. Dash indicates specimens unavailable; asterisk indicates a species that does not occur in Florida.

Species	F-4	F-3	F-2	F-1	F-0
<i>Tachopteryx thoreyi</i>	—	0.27	0.42	0.69	1.24
<i>Boyeria vinosa</i>	0.15	0.26	0.39	0.57	1.00
<i>Anax junius</i>	0.21	0.36	0.42	0.68	1.11
<i>Nasiaeschna pentacantha</i>	0.18	0.32	0.43	0.65	1.15
<i>Erpetogomphus designatus</i>	—	0.35	0.50	0.78	1.22
<i>Phanogomphus lividus</i>	0.23	0.32	0.49	0.71	1.18
<i>Ophiogomphus colubrinus</i> *	0.24	0.33	0.49	0.74	1.17
<i>Cordulegaster maculata</i>	0.26	0.35	0.49	0.63	1.14
<i>Didymops transversa</i>	0.29	0.39	0.50	0.82	1.27
<i>Macromia illinoiensis</i>	0.24	0.32	0.45	0.68	1.12
<i>Neurocordulia molesta</i>	0.18	0.26	0.38	0.60	0.99
<i>Somatochlora cingulata</i> *	0.24	0.32	0.47	0.70	1.12
<i>Erythemis simplicicollis</i>	0.19	0.28	0.43	0.67	1.17
<i>Plathemis lydia</i>	0.32	0.42	0.60	0.87	1.35
<i>Calopteryx maculata</i>	—	0.37	0.61	0.88	1.62
<i>Hetaerina titia</i>	—	—	0.73	0.91	1.43
<i>Lestes vigilax</i>	—	—	0.58	0.75	1.31
<i>Argia fumipennis</i>	—	—	0.45	0.63	1.13
<i>Enallagma signatum</i>	—	—	—	0.69	1.25
<i>Ischnura posita</i>	—	—	0.49	0.61	1.15
<i>Nehalennia integricollis</i>	—	—	—	0.61	1.06
<i>Telebasis byersi</i>	—	0.44	0.56	0.75	1.02
Low Range:	0.15	0.26	0.38	0.57	0.99
High Range:	0.32	0.42	0.73	0.91	1.62

Although the HwL/HW ratios varied among species and families, they do offer general guidelines for determining instar:

For F-0, the ratio is rarely slightly less than 1.0.

For F-1, the ratio ranged from about 0.6 to 0.9 (mean = 0.70)

For F-2 the ratio ranged from about 0.4 to 0.7 (mean = 0.50). Instar F-2 overlapped broadly with F-1 at values between 0.57 and 0.73.

F-3 overlapped slightly with F-2 at values between 0.38 and 0.42.

F-4 overlapped slightly with F-3 between 0.26 and 0.32.

As a general rule, the ratio for F-4 is about $\frac{1}{4}$, for F-3 about $\frac{1}{3}$, for F-2 about $\frac{1}{2}$, for F-1 about $\frac{2}{3}$, and for F-0 greater than one. However, it should be kept in mind that species differ quite widely in their ratios from instar to instar, and more data are needed to estimate variation and limits within each family.

2. Determining Sex

A few characters in the keys depend on the sex of the nymph in question. To determine sex of nymphs, several characters on the abdomen must be examined. The easiest nymphs to sex are the Aeshnidae, Petaluridae, Cordulegastridae, and the Zygoptera – females have outgrowths where the ovipositor will develop in the final phase of transformation to the adult stage (Fig. 3.2); the outgrowths are visible in instars as early as F-3. Female Gomphidae have a pair of triangular lobes at the base of segment 9 (Fig. 3.3), outgrowths where the female vulvar laminae develop; they are often hidden, tucked under the posterior part of segment 8.

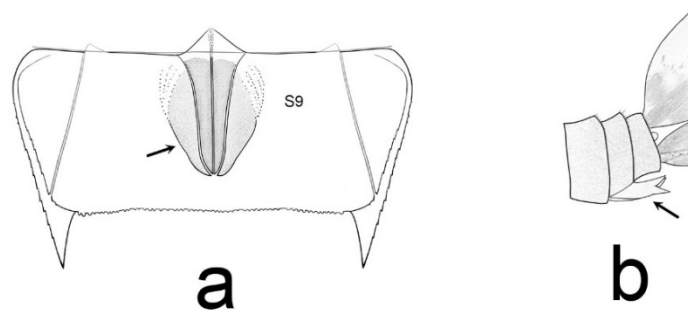


Fig. 3.2. Developing ovipositor of nymphs in two families: a) Aeshnidae, *Anax*, ventral view; b) Zygoptera, *Argia*, lateral view. Arrow indicates outgrowths of developing ovipositor.

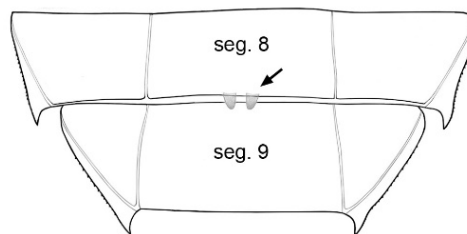


Fig. 3.3. Developing vulvar laminae of nymph in the family Gomphidae, *Ophiogomphus*, ventral view. Arrow indicates lobes of developing vulvar laminae.

The other Anisoptera families (Macromiidae, Corduliidae and Libellulidae) are more difficult to sex, and the most distinguishing features are on males. Males of these three families are similar to all Odonata in having medial, slightly raised and delineated areas on the venter of segments 2 and 3 (Fig. 3.4) that females lack. These areas can be slightly different in pigmentation and they lack setae compared to the surrounding integument. However, in some Libellulidae, the areas are pale and barely demarcated, and therefore difficult to discern.

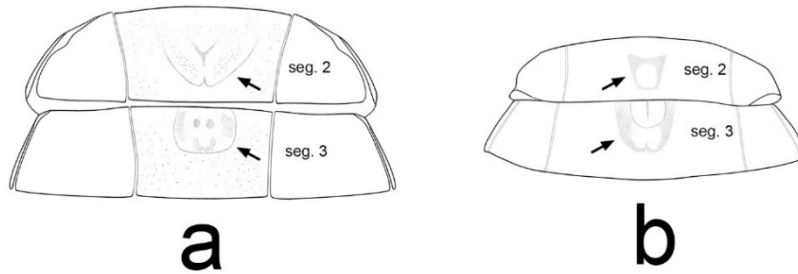


Fig. 3.4. Male abdominal segments 2 and 3, ventral view: a) Gomphidae, *Ophiogomphus*; b) Libellulidae, *Libellula*. Arrows indicates raised areas.

Another male characteristic in Anisoptera is the presence of a pair of tubercles on the dorsum of the epiproct (Fig. 3.5). Most genera have distinct male epiproctal tubercles except for some Libellulidae. In cases where the above male characteristics are not detectable, examining the venter of segment 9 may be helpful. Males have a single small gonopore whereas females have a pair of very small gonopores (Fig. 3.6); gonopores are sometimes difficult to detect, and they are usually present only in F-0.

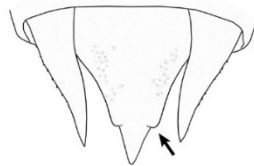


Fig. 3.5. Male abdominal appendages, dorsal view, Gomphidae, *Gomphurus*. Arrow indicates tubercle on epiproct.

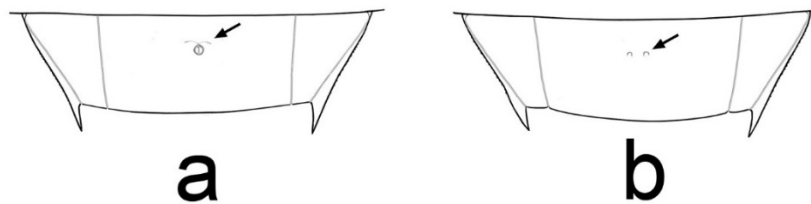


Fig. 3.6. Abdominal segment 9, ventral view, Libellulidae, *Libellula*: a) male; b) female. Arrow indicates gonopore.

4. FLORIDA ODONATA SPECIES LIST

AESHNIDAE (15)

Anax amazili (Burmeister, 1839)
Anax junius (Drury, 1773)
Anax longipes Hagen, 1861
Basiaeschna janata (Say, 1840)
Boyeria vinosa (Say, 1840)
Coryphaeschna adnexa (Hagen, 1861)
Coryphaeschna ingens (Rambur, 1842)
Coryphaeschna viriditas Calvert, 1952
Epiaeschna heros (Fabricius, 1798)
Gomphaeschna antilope (Hagen, 1874)
Gomphaeschna furcillata (Say, 1840)
Gynacantha nervosa Rambur, 1842
Nasiaeschna pentacantha (Rambur, 1842)
Triacanthagyna septima (Selys, 1857)
Triacanthagyna trifida (Rambur, 1842)

GOMPHIDAE (28)

Aphylla williamsoni (Gloyd, 1936)
Arigomphus maxwelli (Ferguson, 1950)
Arigomphus pallidus (Rambur, 1842)
Dromogomphus armatus Selys, 1854
Dromogomphus spinosus Selys, 1854
Erpetogomphus designatus Hagen, 1858
Gomphurus dilatatus (Rambur, 1842)
Gomphurus hybridus (Williamson, 1902)
Gomphurus modestus (Needham, 1942)
Gomphurus vastus (Walsh, 1862)
Hagenius brevistylus Selys, 1854
Hylogomphus geminatus (Carle, 1979)
Ophiogomphus australis Carle, 1992
Phanogomphus australis (Needham, 1897)
Phanogomphus cavillaris (Needham, 1902)
Phanogomphus exilis (Selys, 1854)
Phanogomphus hodgei (Needham, 1950)
Phanogomphus lividus (Selys, 1854)
Phanogomphus minutus (Rambur, 1842)
Phanogomphus westfalli (Carle & May, 1987)
Progomphus alachuensis Byers, 1939
Progomphus bellei Knopf & Tennessen, 1980
Progomphus obscurus (Rambur, 1842)
Stylurus ivae (Williamson, 1932)
Stylurus laurae (Williamson, 1932)
Stylurus plagiatus (Selys, 1854)
Stylurus potulentus (Needham, 1942)
Stylurus townesi (Gloyd, 1936)

PETALURIDAE (1)

Tachopteryx thoreyi (Hagen, 1858)

CORDULEGASTRIDAE (3)

Cordulegaster maculata Selys, 1854
Cordulegaster obliqua (Say, 1840)
Zoraena sayi (Selys, 1854)

MACROMIIDAE (5)

Didymops floridensis Davis, 1921
Didymops transversa (Say, 1840)
Macromia alleghaniensis Williamson, 1909
Macromia illinoiensis Walsh, 1862
Macromia taeniolata Rambur, 1842

CORDULIIDAE (18)

Epitheca costalis (Selys, 1871)
Epitheca cynosura (Say, 1840)
Epitheca princeps Hagen, 1861
Epitheca semiaquea (Burmeister, 1839)
Epitheca sepia (Gloyd, 1933)
Epitheca spinosa (Hagen, 1878)
Epitheca stella (Williamson, 1911)
Helocordulia selysii (Hagen, 1878)
Neurocordulia alabamensis Hodges, 1955
Neurocordulia molesta (Walsh, 1863)
Neurocordulia obsoleta (Say, 1840)
Neurocordulia virginiensis Davis, 1927
Somatochlora calverti Williamson & Gloyd, 1933
Somatochlora filosa (Hagen, 1861)
Somatochlora georgiana Walker, 1925
Somatochlora linearis (Hagen, 1861)
Somatochlora provocans Calvert, 1903
Somatochlora tenebrosa (Say, 1840)

LIBELLULIDAE (55)

Brachymesia furcata (Hagen, 1861)
Brachymesia gravida (Calvert, 1890)
Brachymesia herbida (Gundlach, 1889)
Celithemis amanda (Hagen, 1861)
Celithemis bertha Williamson, 1922
Celithemis elisa (Hagen, 1861)
Celithemis eponina (Drury, 1773)
Celithemis fasciata Kirby, 1889
Celithemis ornata (Rambur, 1842)
Celithemis verna Pritchard, 1935
Crocothemis servilia (Drury, 1773)
Dythemis velox Hagen, 1861
Erythemis plebeja (Burmeister, 1839)
Erythemis simplicicollis (Say, 1840)
Erythemis vesiculosa (Fabricius, 1775)

Erythrodiplax berenice (Drury, 1773)
Erythrodiplax minuscula (Rambur, 1842)
Erythrodiplax umbrata (Linnaeus, 1758)
Idiataphe cubensis (Scudder, 1866)
Ladona deplanata Rambur, 1842
Libellula auripennis Burmeister, 1839
Libellula axilena Westwood, 1837
Libellula flavida Rambur, 1842
Libellula incesta Hagen, 1861
Libellula jesseana Williamson, 1922
Libellula luctuosa Burmeister, 1839
Libellula needhami Westfall, 1943
Libellula pulchella Drury, 1773
Libellula semifasciata Burmeister, 1839
Libellula vibrans Fabricius, 1793
Macrodiplax balteata (Hagen, 1861)
Miathyria marcella (Selys, 1857)
Micrathyria aequalis (Hagen, 1861)
Micrathyria didyma (Selys, 1857)
Nannothemis bella (Uhler, 1857)
Orthemis ferruginea (Fabricius, 1775)
Orthemis sp. (cf. *schmidtii* Buchholz, 1950)
Pachydiplax longipennis (Burmeister, 1839)
Pantala flavescens (Fabricius, 1798)
Pantala hymenaea (Say, 1840)
Perithemis tenera (Say, 1840)
Plathemis lydia (Drury, 1773)
Sympetrum ambiguum (Rambur, 1842)
Sympetrum corruptum Hagen, 1861
Sympetrum vicinum (Hagen, 1861)
Tauriphila australis (Hagen, 1867)
Tauriphila azteca Calvert, 1906
Tholymis citrina Hagen, 1867
Tremea abdominalis (Rambur, 1842)
Tremea binotata (Rambur, 1842)
Tremea calverti Muttikowski, 1910
Tremea carolina (Linnaeus, 1763)
Tremea insularis Hagen, 1861
Tremea lacerata Hagen, 1861
Tremea onusta Hagen, 1861

CALOPTERYGIDAE (4)

Calopteryx dimidiata Burmeister, 1839
Calopteryx maculata (Palisot, 1805)
Hetaerina americana (Fabricius, 1798)
Hetaerina titia (Drury, 1773)

LESTIDAE (8)

Lestes australis Walker, 1952
Lestes forficula Rambur, 1842
Lestes inaequalis Walsh, 1862
Lestes rectangularis Say, 1840
Lestes spumarius Hagen in Selys, 1862
Lestes tenuatus Rambur, 1842
Lestes vidua Hagen, 1861
Lestes vigilax Hagen in Selys, 1862

COENAGRIONIDAE (35)

Argia apicalis (Say, 1840)
Argia bipunctulata (Hagen, 1861)
Argia fumipennis (Burmeister, 1839)
Argia moesta (Hagen, 1861)
Argia sedula (Hagen, 1861)
Argia tibialis (Rambur, 1842)
Enallagma basidens Calvert, 1902
Enallagma cardenium Hagen in Selys, 1876
Enallagma civile (Hagen, 1861)
Enallagma concisum Williamson, 1922
Enallagma daeckii (Calvert, 1903)
Enallagma davisii Westfall, 1943
Enallagma divagans Selys, 1876
Enallagma doubledayi (Selys, 1850)
Enallagma dubium Root, 1924
Enallagma durum (Hagen, 1861)
Enallagma geminatum Kellicott, 1895
Enallagma pallidum Root, 1923
Enallagma pollutum (Hagen, 1861)
Enallagma signatum (Hagen, 1861)
Enallagma sulcatum Williamson, 1922
Enallagma vesperum Calvert, 1919
Enallagma weewa Byers, 1927
Ischnura hastata (Say, 1840)
Ischnura kellicotti Williamson, 1898
Ischnura posita (Hagen, 1861)
Ischnura prognata (Hagen, 1861)
Ischnura ramburii (Selys, 1850)
Leptobasis lucifer (Donnelly, 1967)
Nehalennia gracilis Morse, 1895
Nehalennia integricollis Calvert, 1913
Nehalennia minuta (Selys in Sagra, 1857)
Nehalennia pallidula Calvert, 1913
Neoerythromma cultellatum (Hagen in Selys, 1876)
Telebasis byersi Westfall, 1957

Keys to the Odonata Nymphs of Florida

The Odonata of Florida comprises two suborders, the Anisoptera (dragonflies) and the Zygoptera (damselflies). The term dragonfly is used by some students for the entire order.

5. Key to the Suborders (all instars)

1. Body stout, head narrower than abdomen and usually narrower than thorax (Fig. 1a); abdomen in dorsal view fusiform (Fig. 5.1a); 3 short, stiff, tapered appendages at tip of abdomen, cerci prominent (Fig. 5.2a).....**Anisoptera**
- 1'. Body slender, head wider than thorax and abdomen (Fig. 1b); abdomen in dorsal view more or less parallel-sided (Fig. 5.1b); 3 long caudal lamellae at tip of abdomen, cerci extremely small (Fig. 5.2b).....**Zygoptera**

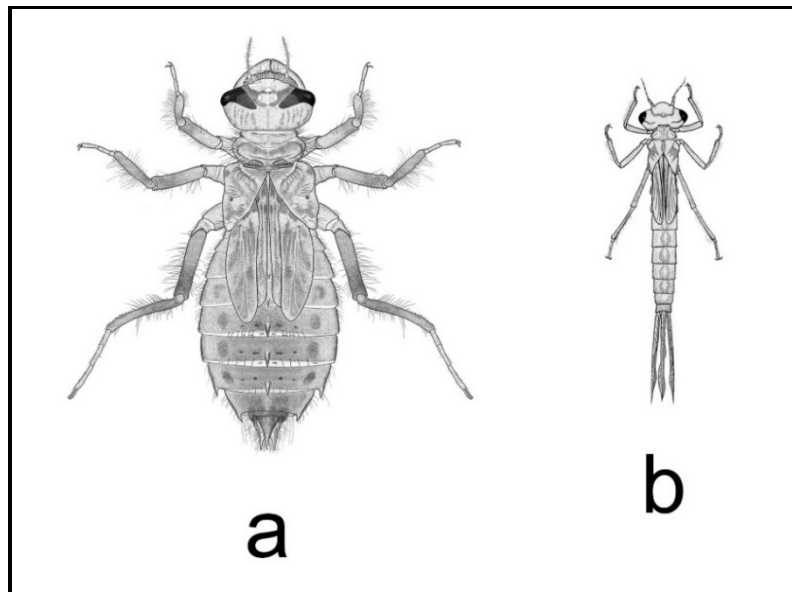


Figure 5.1. Nymph, dorsal view: a) Anisoptera (*Libellula*); b) Zygoptera (*Enallagma*).

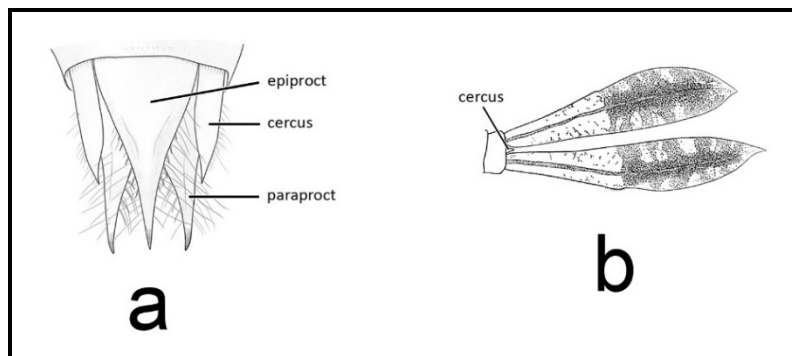


Figure 5.2. Anal appendages: a) Anisoptera (*Libellula*), dorsal view; b) Zygoptera (*Enallagma*), lateral view.

Note: Because of variability, be aware that some specimens you examine will not fit all character states or match exactly the illustrations in the following keys. All keys are constructed based on limited numbers of specimens. Structures such as size, antennal segments, number of palpal and premental setae, posterolateral spines, and anal appendages are especially variable. The caudal lamellae of Zygoptera are prone to breaking off and being lost. Some specimens have reduced or deformed lamellae, usually a result of regeneration after the lamellae were lost in an earlier instar. If all the lamellae are absent, rely on the other characters in the couplets to confirm your choice. Very small instars of Zygoptera have three caudal lamellae typically shaped more filamentous than lamellate; their lamellae are usually very thin and rod-like with sharply pointed tips and a few prominent stiff setae (rather than being plate-like or inflated as in later instars). In comparison, very small instars of Anisoptera have the short stout epiproct and paraprocts evident, but the cerci may not have yet developed depending on the instar.

Key to Families of the Anisoptera Nymphs of Florida

Seven families of Anisoptera occur in Florida. Instars earlier than F-0, at least those with detectable wing sheaths, can be keyed reliably to family except for some Corduliidae and Libellulidae. Instars before wing buds have formed present difficulty in some cases, although many of them can still be determined.

1. Labial palp with stout spine near base of movable hook (Fig. 5.3a); all tibiae with 4 apical, robust burrowing processes tipped with movable spurs, and most tarsomeres with 1 or 2 similar spines (Fig. 5.4a); dorsum of abdomen with two submedian rows of prominent setal tufts**Petaluridae** (page 124)
- 1'. Labial palp without spine proximal to movable hook (Fig. 5.3b); tibiae without burrowing processes (Fig. 5.4b) or pro- and mesothoracic tibiae with a blunt, spur-less burrowing lobe and all tarsi without robust spines (Fig. 5.4c); dorsum of abdomen with scattered setae, without submedian rows of setal tufts**2**

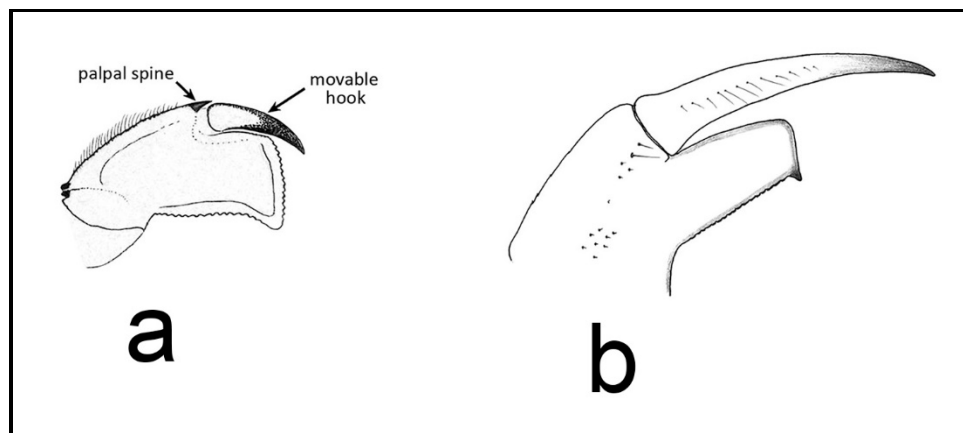


Figure 5.3. Labial palp, ental view: a) Petaluridae; b) Aeshnidae.

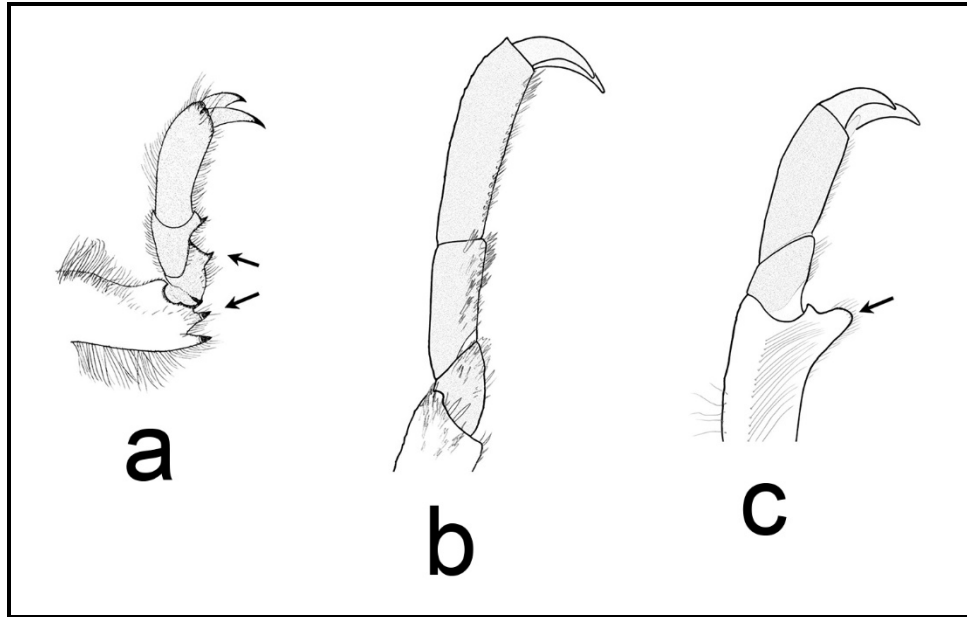


Figure 5.4. Distal portion of right prothoracic leg, showing apex of tibia plus tarsus and claws: a) Petaluridae (arrows indicate burrowing processes); b) Aeshnidae; c) Gomphidae (arrow indicates burrowing lobe on apex of tibia).

2. Prementum flat, broad axis of labial palpi in horizontal plane (Fig. 5.5a); labrum completely exposed when prementum and palpi are retracted (Figs. 5.6a,b); prementum without long setae on ental surface (Fig. 5.7a)3
- 2'. Prementum scoop-shaped, broad axis of labial palpi in vertical plane (Fig. 5.5b); labrum covered when prementum and palpi are retracted (Fig. 5.6c); prementum with long setae on ental surface, usually a row of prominent setae on each side (Fig. 5.7b)4

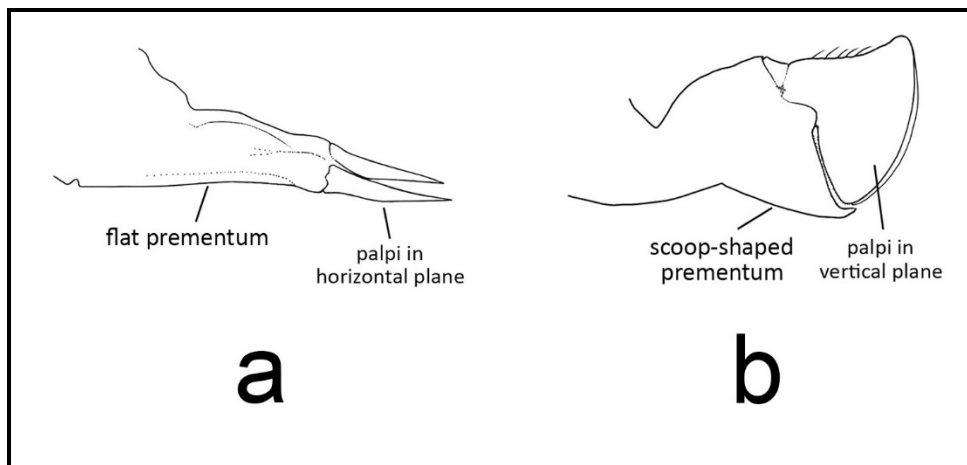


Figure 5.5. Labium, lateral view: a) Gomphidae; b) Libellulidae.

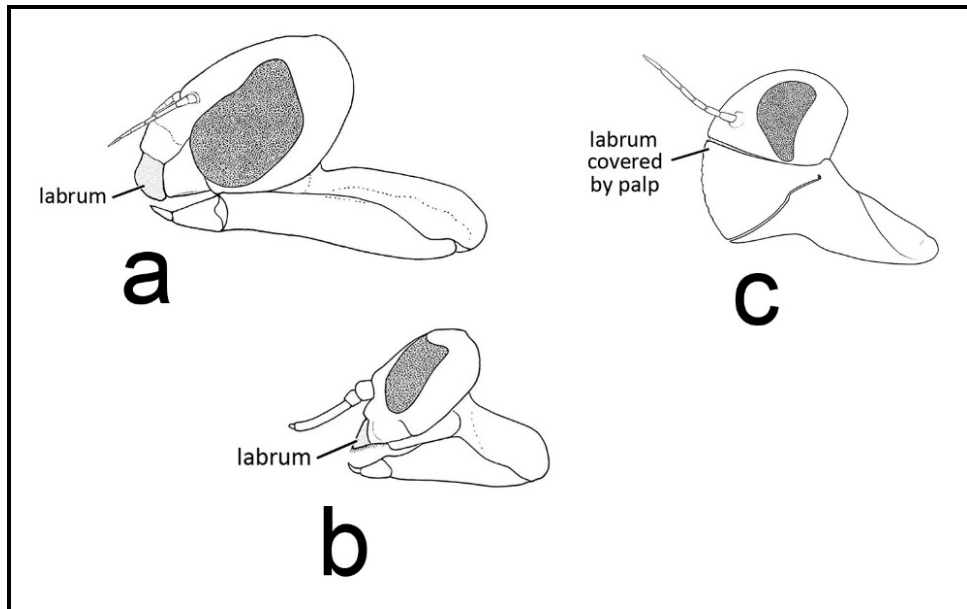


Figure 5.6. Head, lateral view: a) Aeshnidae; b) Gomphidae; c) Libellulidae.

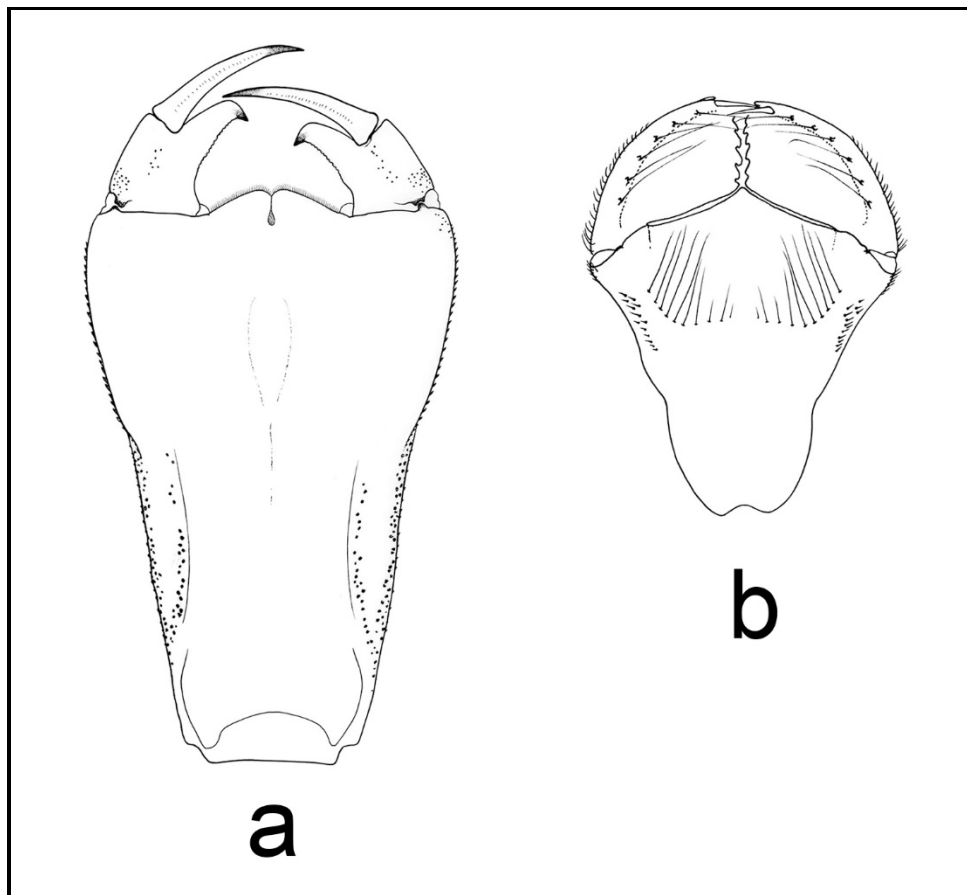


Figure 5.7. Prementum, ental (dorsal) view: a) Aeshnidae; b) Corduliidae.

3. Antenna with 6 or 7 antennomeres, apical antennomere nearly equal in length and basal width to preapical antennomere (Fig. 5.8a); pro- and mesothoracic tarsi 3-segmented (Fig. 5.9a); apex of epiproct usually blunt, often with a small lateral spine on each side (Fig. 5.10a), occasionally pointed **Aeshnidae** (page 41)
- 3'. Antenna with 4 antennomeres, apical antennomere distinctly shorter and/or narrower basally than preapical antennomere (Fig. 5.8b); pro- and mesothoracic tarsi 2-segmented (Fig. 5.9b); apex of epiproct acuminate (Fig. 5.10b) **Gomphidae** (page 75)

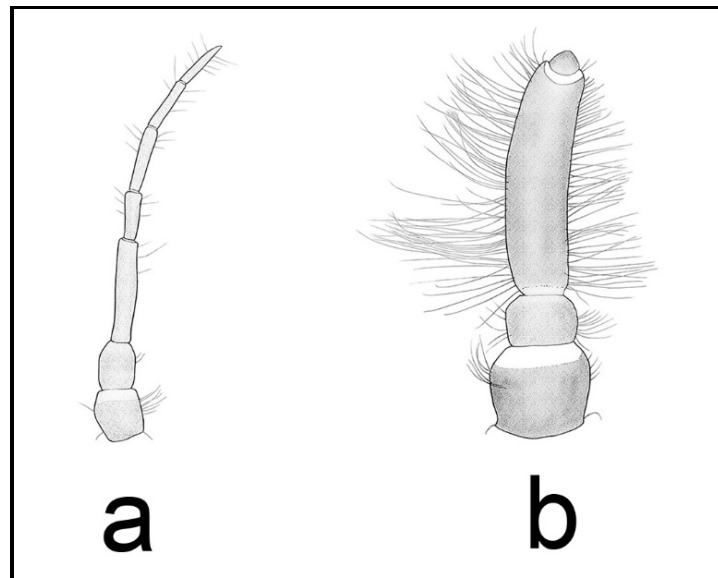


Figure 5.8. Antenna: a) Aeshnidae; b) Gomphidae.



Figure 5.9. Mesothoracic tarsus: a) Aeshnidae; b) Gomphidae.

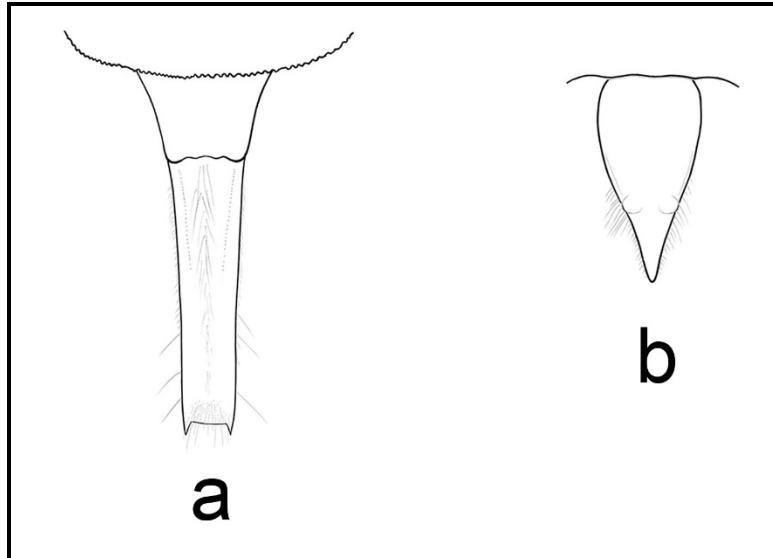


Figure 5.10. Epiproct, dorsal view: a) Aeshnidae; b) Gomphidae.

4. Distal margin of each palpal lobe with large, irregular teeth lacking stout setae (Fig. 5.11a); ligula with bifid median process, each side with an angular projection (Fig. 5.12a); metinfraepimeron with pale median sulcus, furcal pits situated well anterior of poststernum (Fig. 5.13a).....**Cordulegastridae** (page 127)
- 4'. Distal margin of each palpal lobe with rounded teeth (rarely angular) bearing stout apical setae (Fig. 5.11b); ligula with median portion entire, angular to rounded (Fig. 5.12b); metinfraepimeron without median sulcus, furcal pits situated near level of anterior point of poststernum (Fig. 5.13b)**5**

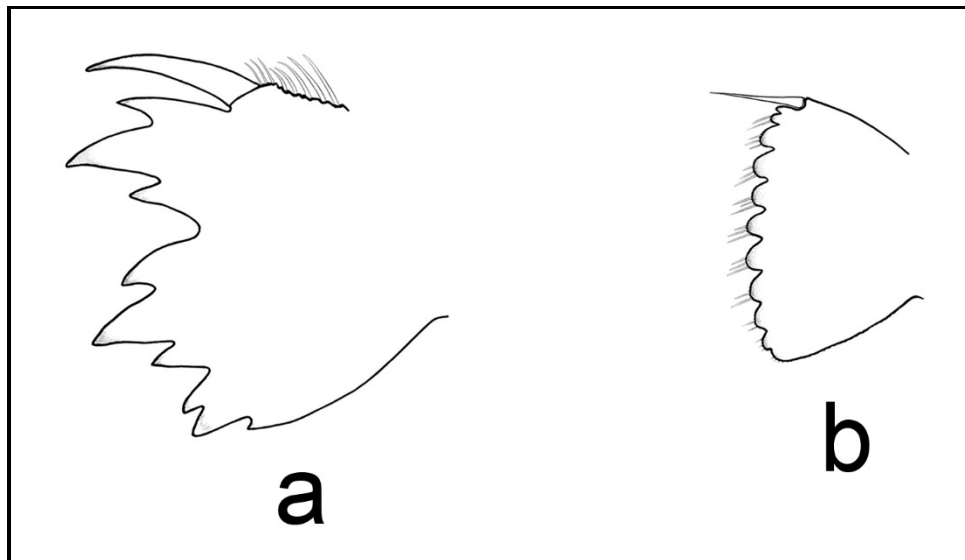


Figure 5.11. Palpal margin: a) Cordulegastridae; b) Corduliidae.

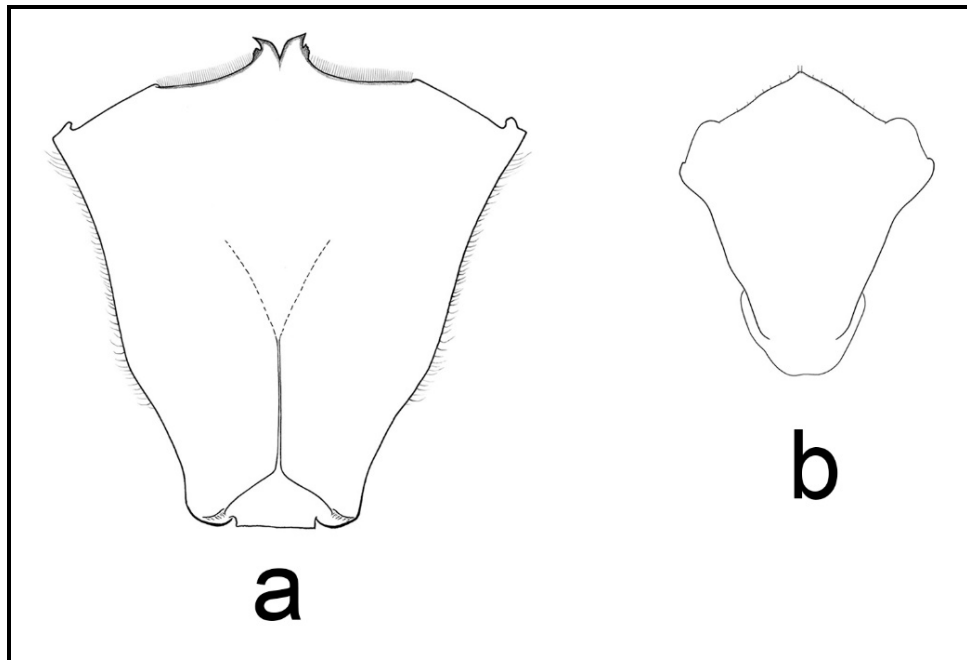


Figure 5.12. Ligula: a) Cordulegastridae; b) Libellulidae.

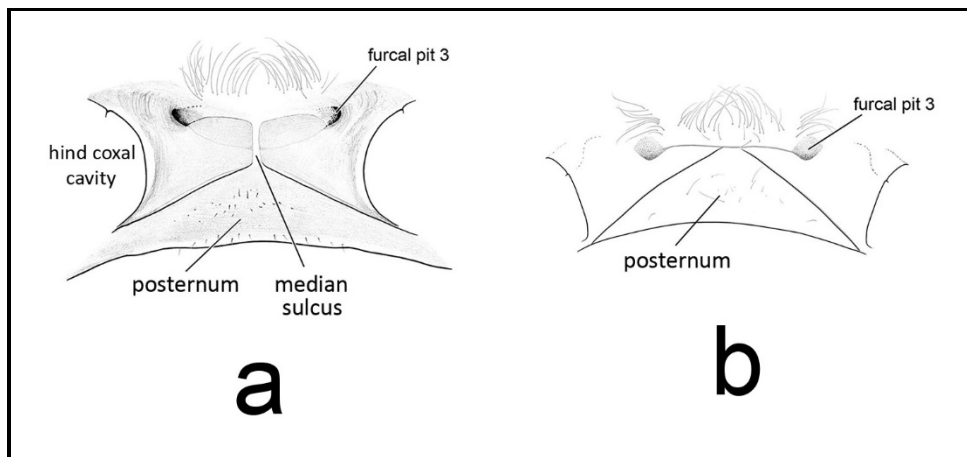


Figure 5.13 Metinfraepimeron: a) Cordulegastridae; b) Corduliidae.

5. Mesinfraepimeron with a triangular, anteriorly-directed lobe near each side of postmentum (Fig. 5.14a); poststernite with medial, transverse, setose tubercle (Fig. 5.14a); length of mesothoracic femur greater than head width; frons with triangular projection between bases of antennae (Fig. 5.15a) **Macromiidae** (page 135)
- 5'. Mesinfraepimeron without a triangular, anteriorly-directed lobe near each side of postmentum (Fig. 5.14b); poststernite without medial transverse tubercle (Fig. 5.14b); length of mesothoracic femur less than head width; frons almost always reduced, without a projection between bases of antennae* (Fig. 5.15b).....**6**

* an exception in Corduliidae is *Neurocordulia molesta*, which has a triangular frontal projection.

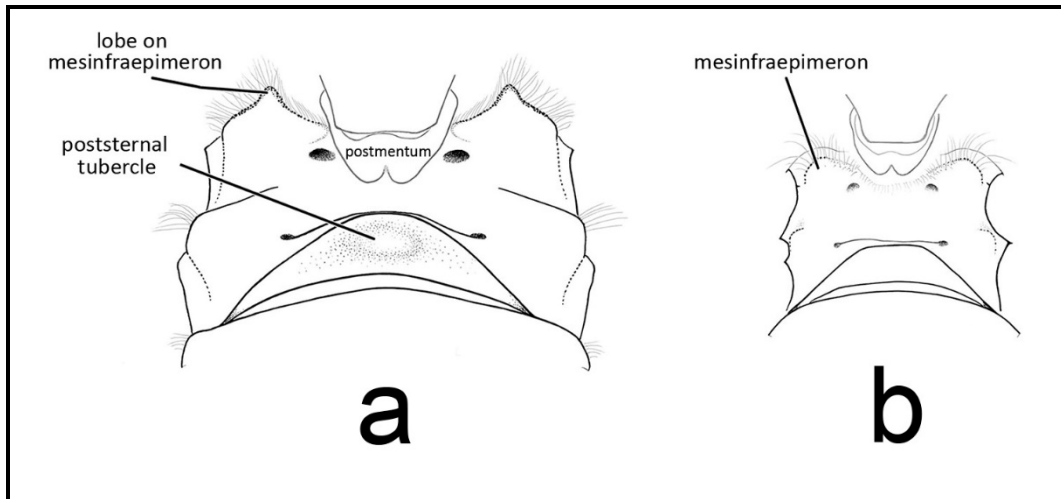


Figure 5.14. Pterothoracic sternum: a) Macromiidae; b) Corduliidae.

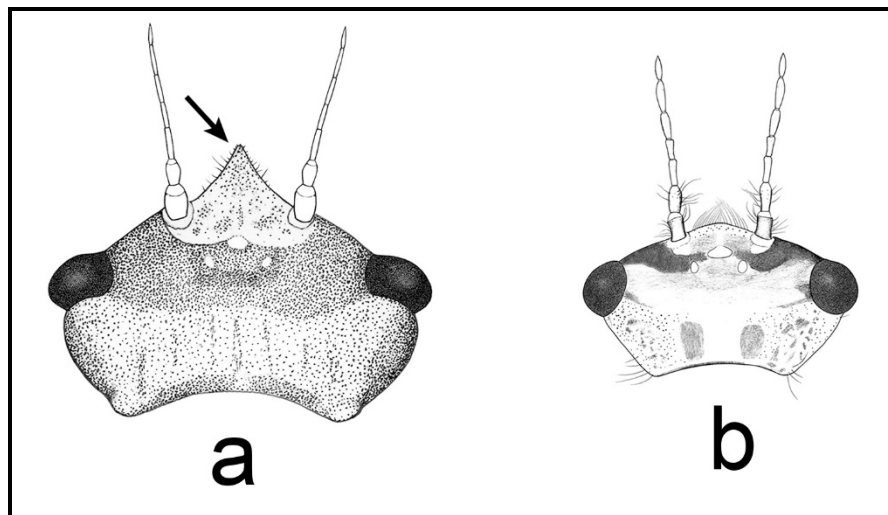


Figure 5.15. Head: a) Macromiidae; b) Corduliidae.

6. Prementum with a ventromedial groove (Fig. 5.16a); dorsal rim of labial palp with numerous pale, piliform setae complete from base to apex (Fig. 5.17a), plus ratio of palpal crenation #3 or 4 H:L usually >0.25 and cercus L:paraproct L 0.50–1.20.....**Corduliidae** (page 146)
- 6'. Prementum without a ventromedial groove (Fig. 5.16b); dorsal rim of labial palp without piliform setae or with few on basal half (Fig. 5.17b), sometimes setae scattered along entire length of rim in which case palpal crenation #3 or 4 H:L ratio usually <0.20 and cercus L:paraproct L usually <0.50**Libellulidae** (page 171)

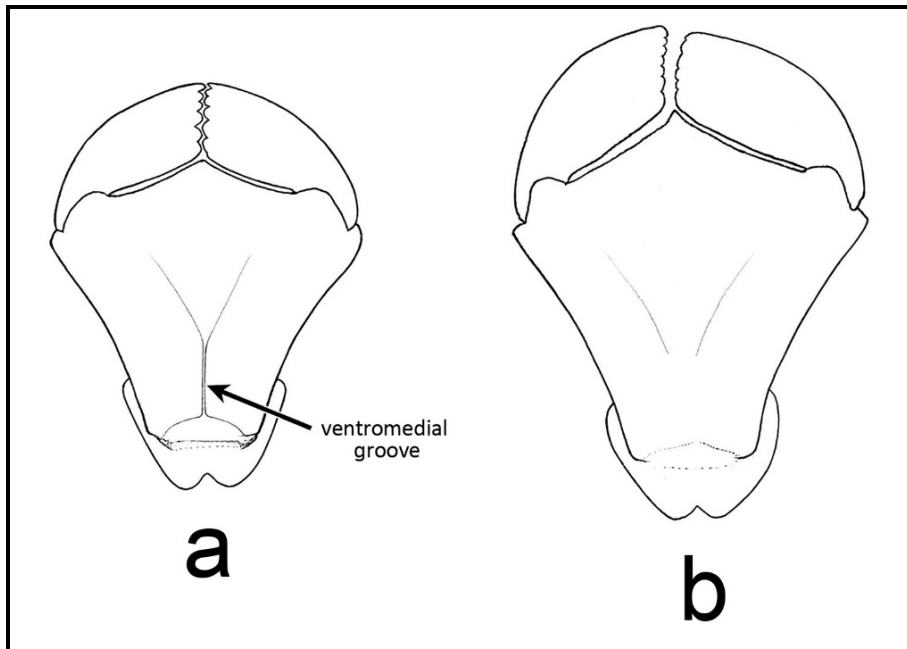


Figure 5.16. Labium, ventral view: a) Corduliidae; b) Libellulidae.

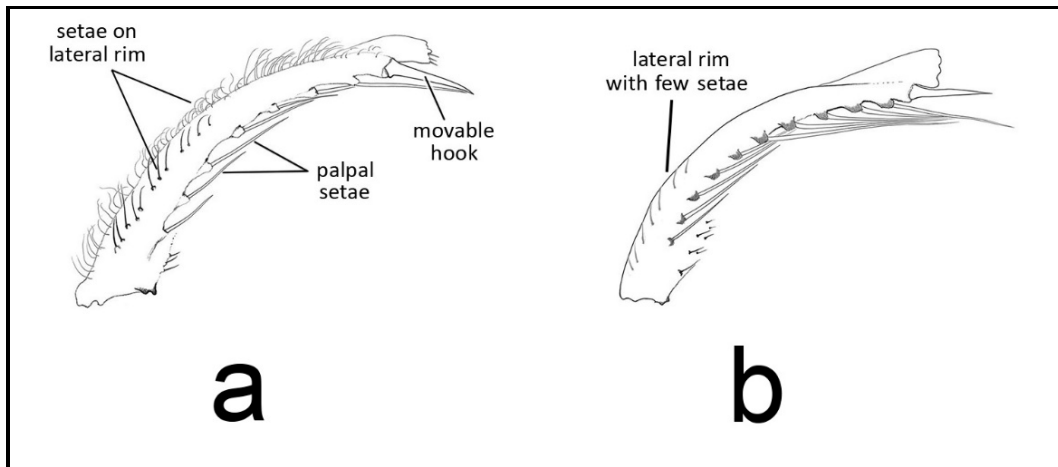
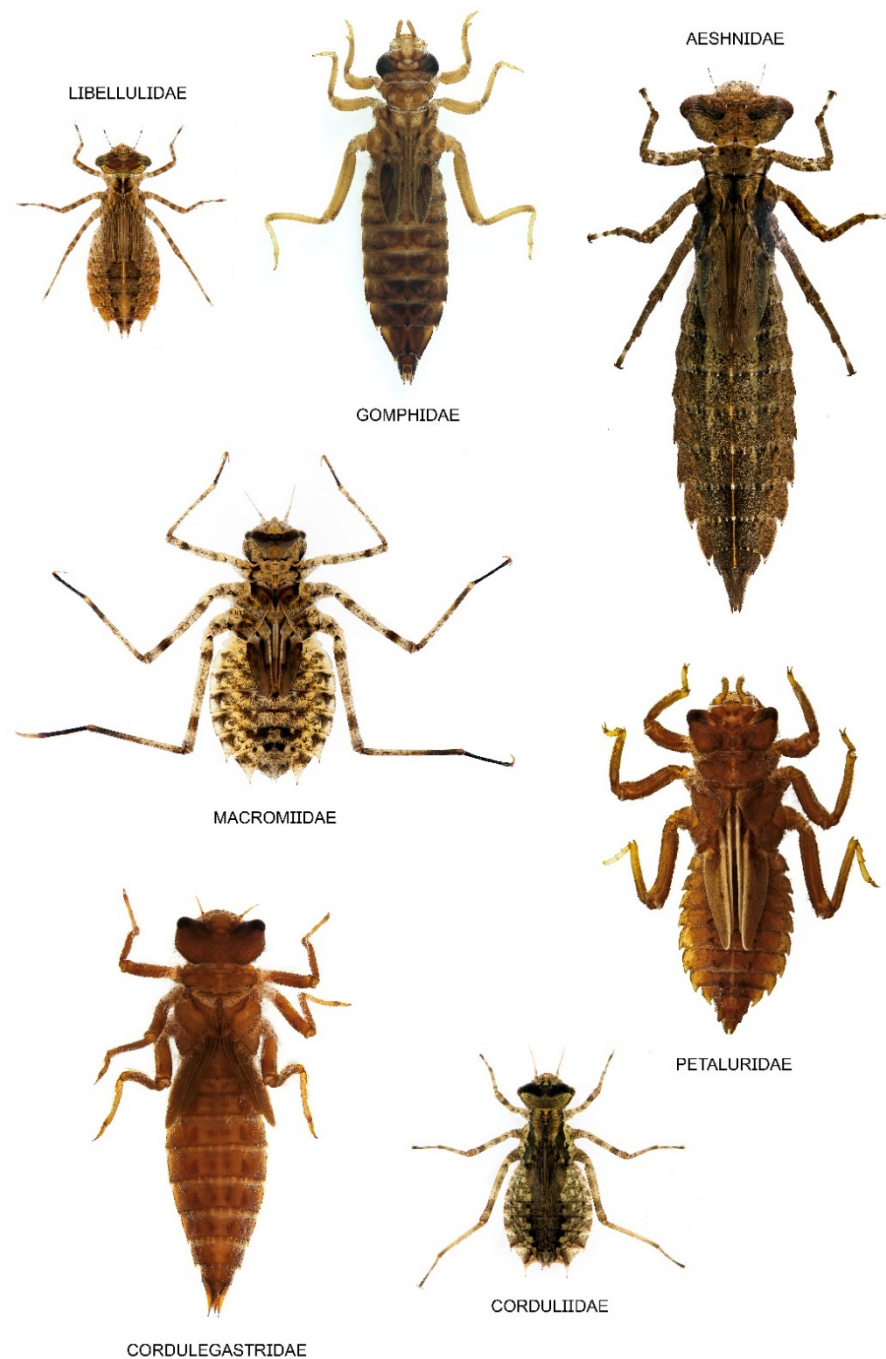


Figure 5.17. Dorsal rim of left palp, dorsal view: a) Corduliidae; b) Libellulidae.

The Anisoptera families of North America are easily distinguished except for Corduliidae and Libellulidae. Historically, these two families were difficult to determine with certainty; a combination of characters, most of which are highly variable, was needed to separate them. Oftentimes a specimen had to be taken through the keys to genera for both families before one could be sure to which family it belonged. The discovery of the ventromedial groove on the prementum of Corduliidae (Theischinger and Fleck 2003, Tennessen 2019a) provided a single, easily observed character to distinguish the two families. However, as reliable as the ventromedial groove appears to be, these families still can be confused. First, the ventromedial groove is relatively weak in a few species of Corduliidae (e.g., *Epitheca princeps*), and a few Libellulidae appear to have a rudimentary groove (e.g., *Perithemis tenera*). To compound the issue, there are often slight irregularities in the contours of the ventral surface of the prementum of Libellulidae

and/or slight color changes that mistakenly give the appearance of a possible groove. Also, the groove can be obscured by foreign materials such as silt and mud. I have added a second character in couplet 6 in the above key (the setal arrangement on the dorsal rim of the palpal lobe) which has proved helpful in determining doubtful specimens. Examining numerous specimens, especially in reference collections, can help one gain proficiency in recognizing the differences between these two families; there is no substitute for experience. For further evaluation and discussion of the differences and similarities between Corduliidae and Libellulidae, see Tennessen (2019a).

Plate 1. Representatives* of the seven families of Anisoptera that occur in Florida (photographs by Marla C. Garrison); relative size approximate.



* The species presented in Plate 1 are *Epiaeschna heros* (Aeshnidae), *Dromogomphus spinosus* (Gomphidae), *Tachopteryx thoreyi* (Petaluridae), *Cordulegaster maculata* (Cordulegastriidae), *Didymops transversa* (Macromiidae), *Epithea cynosura* (Corduliidae), and *Pachydiplax longipennis* (Libellulidae).

Key to Families of Zygoptera Nymphs of Florida

Three families of Zygoptera occur in Florida. Instars earlier than F-0 in which wing sheaths have developed can be keyed reliably to family. Instars before wing buds have formed present difficulty in some cases, although all except the earliest can usually be recognized. Several characters are presented in case specimens are missing the caudal lamellae.

1. Antennal segment 1 as long as distal segments combined (Fig. 5.18a); prementum with large, deep medial cleft (Fig. 5.19a); lateral caudal lamellae triquetral (Fig. 5.20a)..... **Calopterygidae** (page 259)
- 1'. Antennal segment 1 much shorter than distal segments combined (Fig. 5.18a); prementum uncleft (Fig. 5.19a) or with very short, narrow medial cleft; lateral caudal lamellae nearly flat (Fig. 5.20b), sometimes oval in cross-section.....**2**

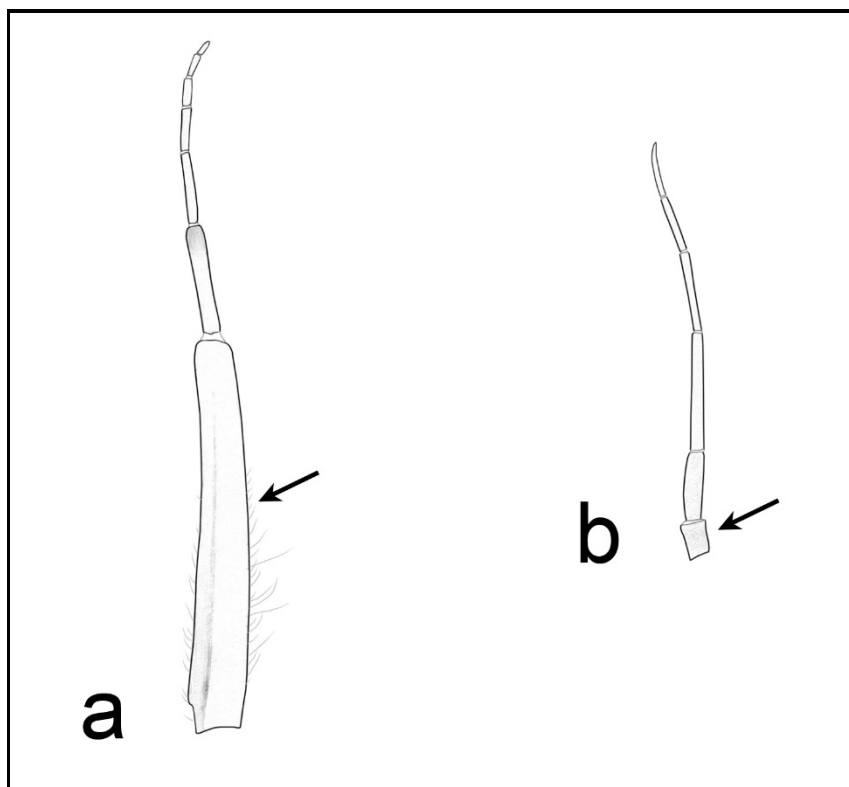


Figure 5.18. Left antenna, dorsal view: a) Calopterygidae; b) Coenagrionidae.

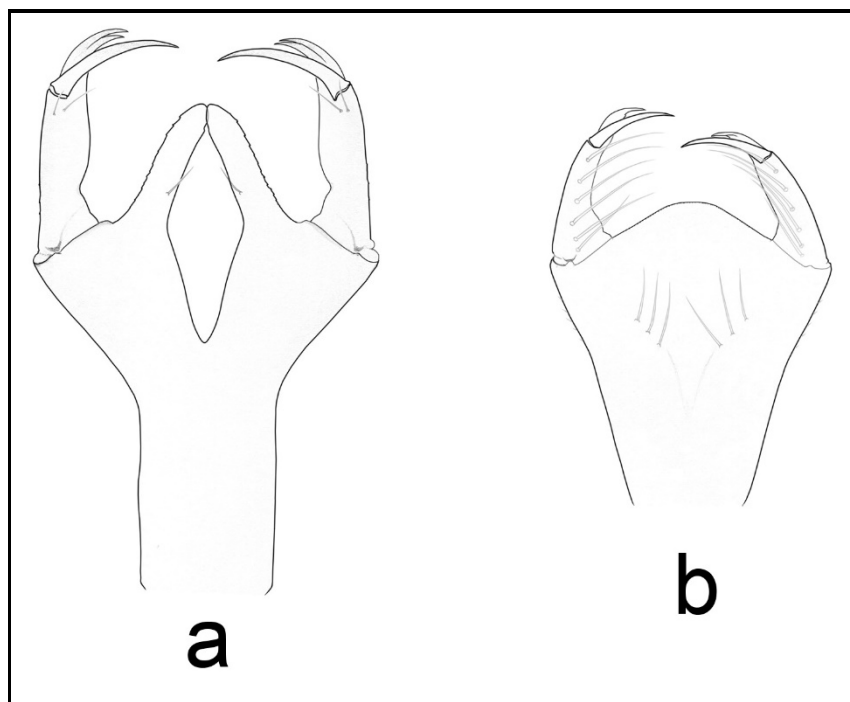


Figure 5.19. Prementum, ectal view: a) Calopterygidae; b) Coenagrionidae.

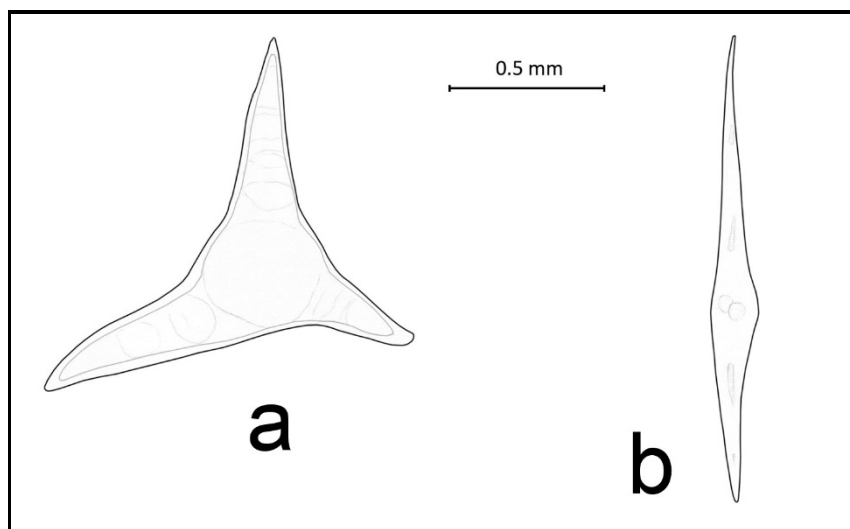


Figure 5.20. Lateral caudal lamella, cross section: a) Calopterygidae; b) Coenagrionidae.

2. Prementum trapezoidal to pentagonal, flat (Fig. 5.21a); movable hook without long setae (Fig. 5.22a); most secondary tracheal branches of caudal lamellae unequally branched and obliquely angled off median branch (Fig. 5.23a)..... **Coenagrionidae** (page 267)
- 2'. Prementum narrow proximally, wide and scoop-shaped apically (Fig. 5.21b); movable hook with 2 or 3 long setae (Fig. 5.22b); most secondary tracheal branches of caudal lamellae parallel and approximately perpendicular to median branch (Fig. 5.23b)..... **Lestidae** (page 323)

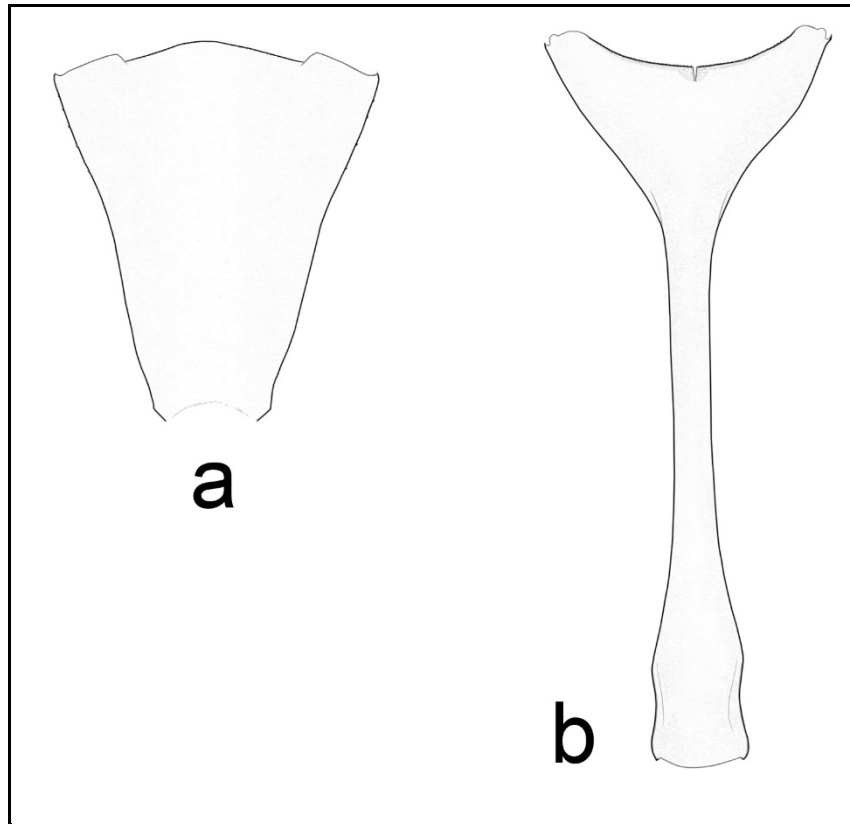


Figure 5.21. Prementum, ectal view: a) Coenagrionidae; b) Lestidae.

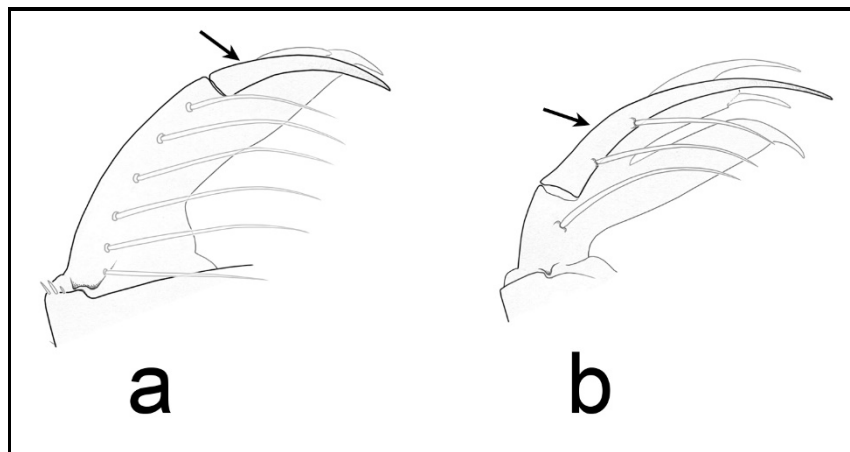


Figure 5.22. Movable hook of right palpal lobe, dorsal view: a) Coenagrionidae; b) Lestidae. Arrow indicates movable hook, without (a) or with (b) long setae.

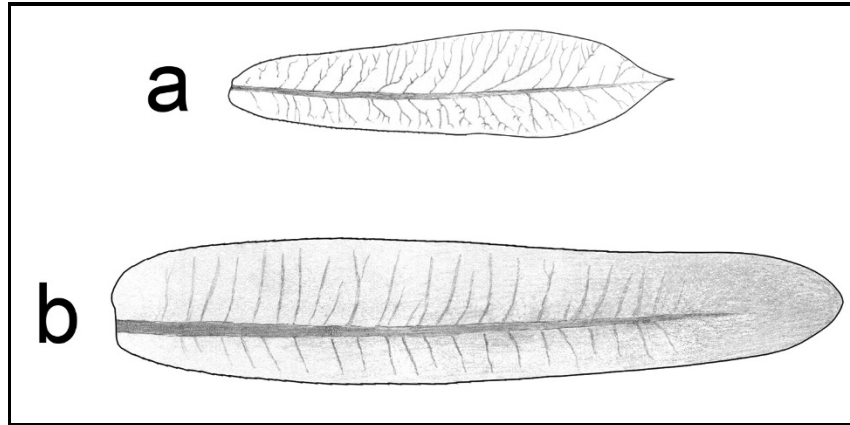


Figure 5.23. Tracheal pattern of lateral caudal lamellae (left lamella), lateral view: a) Coenagrionidae; b) Lestidae.

The Zygoptera families of Florida are unmistakable, even in early instars, especially in the shape of the prementum. The deep median cleft on the ligula and the triquetral lateral caudal lamellae of Calopterygidae are unparalleled. The petiolate prementum of Lestidae and the shape and tracheal pattern of the caudal lamellae (tracheae perpendicular to main median trachea) are unique in the Zygoptera. The subquadrate shape of the prementum of Coenagrionidae is distinct from Calopterygidae and Lestidae. The movable hook is generally shorter than the base of the palpal lobe in Coenagrionidae (Fig. 5.22a) whereas it is longer than the base in Lestidae (Fig. 5.22b). Coenagrionidae genera are variable in prementum shape but in Florida this family should not be mistaken with the other two families; in regions outside Florida, other families with a similarly shaped prementum exist.

Appendage Loss and Regeneration in Zygoptera

Appendages such as antennae, palpi, tarsi, and caudal lamellae can be injured or lost during a nymph's lifetime, mainly as a result of attacks by predators. Physical damage and subsequent regeneration can have a frequency as high as 40% of the individuals in a population. Regrowth of lost or injured appendages can occur in as few as two molts, but the regenerated structures may be incomplete. Antennae that have been injured are usually shorter than normal antennae, and they can have fewer segments that have unusual lengths. Regenerated tarsi usually have fewer segments and only one or two stunted claws. Unfortunately, regeneration of appendages, especially caudal lamellae, can have consequences for identification; experience and familiarity with normally developed appendages helps in recognizing regenerated appendages (Fig. 5.24); the latter should be disregarded when assessing key characteristics.

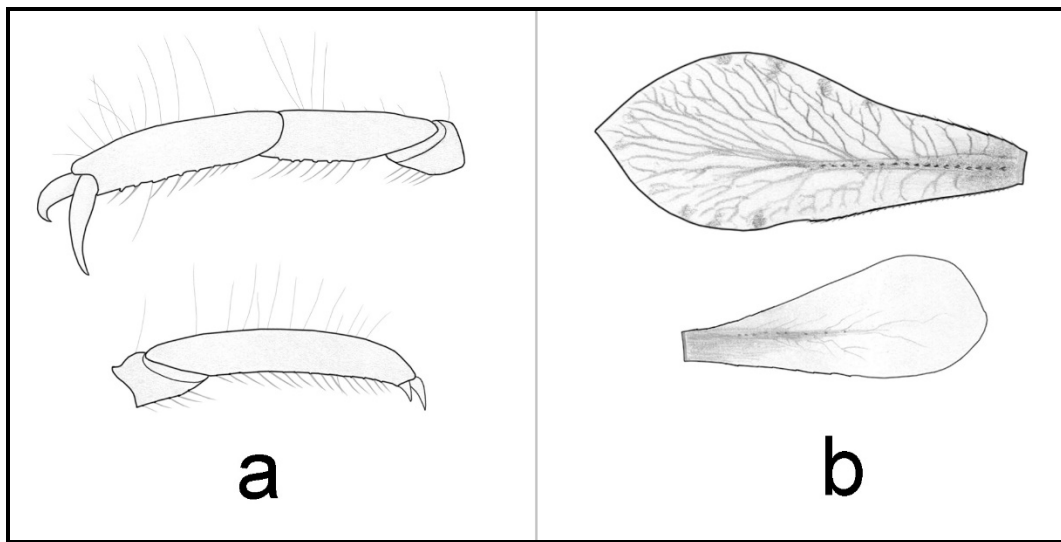
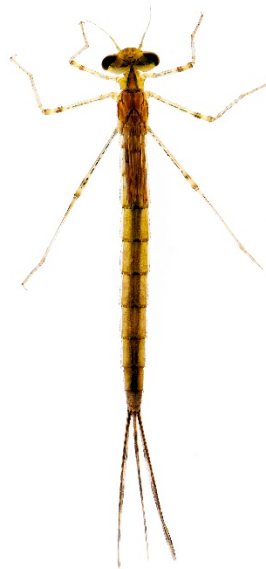


Figure 5.24. Examples of normal and regenerated appendages of Zygoptera: a) metathoracic tarsi of *Ischnura posita*, dorsolateral view (upper = normal right tarsus with 3-segmented and two full-sized claws; lower = regenerated 2-segmented left tarsus and reduced claws); b) lateral caudal lamellae of *Telebasis byersi* (upper = normally developed right lateral lamella, lower = regenerated left lateral lamella).

Plate 2. Representatives* of the three families of Zygoptera that occur in Florida (photographs by Marla C. Garrison); relative size approximate.



CALOPTERYGIDAE



LESTIDAE



COENAGRIONIDAE

* The species presented in Plate 2 are *Calopteryx dimidiata* (Calopterygidae), *Lestes vigilax* (Lestidae), and *Enallagma doubledayi* (Coenagrionidae).

6. AESHNIDAE

Aeshnid nymphs are adapted for clinging to and climbing on substrates such as plant stems, detritus, and sunken logs above or at the benthic layer. They have elongated bodies with a narrow abdomen that is subcylindrical in cross-section and tapered to a sharp apex. The legs of most species are long and relatively slender. There is little variability in general body shape within the family, although with experience aeshnid nymphs can usually be identified to genus in the field by examining the shape of the head and eyes.

The family is characterized by 1) mouthparts prognathous; 2) prementum flat, lacking prominent setae on the ental surface; 3) palpal lobes blade-like, usually without prominent setae (two genera are exceptions); 4) movable hook large and stout; 5) 6- or 7-segmented antennae; 6) all three pairs of legs with 3-segmented tarsus; 7) anal pyramid large and stout with sharp-tipped cerci and paraprocts; 8) body with relatively few long setae.

Nine genera of Aeshnidae are found in Florida, namely *Anax* Leach, *Basiaeschna* Selys, *Boyeria* McLachlan, *Coryphaeschna* Williamson, *Epiaeschna* Hagen, *Gomphaeschna* Selys, *Gynacantha* Rambur, *Nasiaeschna* Selys, and *Triacanthagyna* Selys. The following generic key was constructed solely for the aeshnid fauna of Florida. Measurements for each genus are summarized in Table 6.1 (p. 48).

Key to Genera of Aeshnidae

1. Antenna length greater than length of head from base of antenna to posterior margin (Fig. 6.1a); gena with a triangular projection (Fig. 6.1a); labrum as wide as distal portion of prementum ***Gomphaeschna***
- 1'. Antenna length less than length of head from base of antenna to posterior margin (Fig. 6.1b); gena without a triangular projection (Fig. 6.1b); labrum narrower than distal portion of prementum **2**

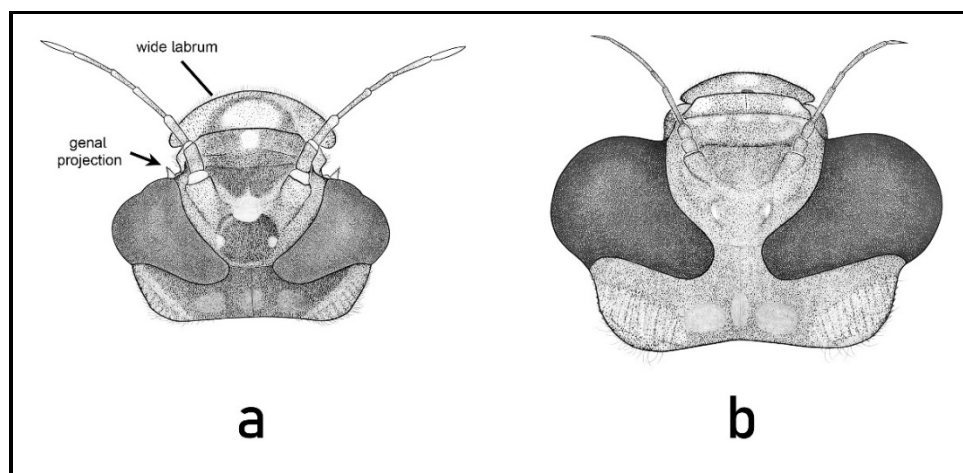


Fig. 6.1. Aeshnidae, head in dorsal view: a) *Gomphaeschna furcillata*; b) *Gynacantha nervosa*.

2. Posterolateral corner of head either angulate and without distinct tubercles (Fig. 6.2a) or obtuse-angulate with 1 or 2 low tubercles (Fig. 6.2b)3
- 2'. Posterolateral corner of head rounded, without tubercles (Fig. 6.2c).....7

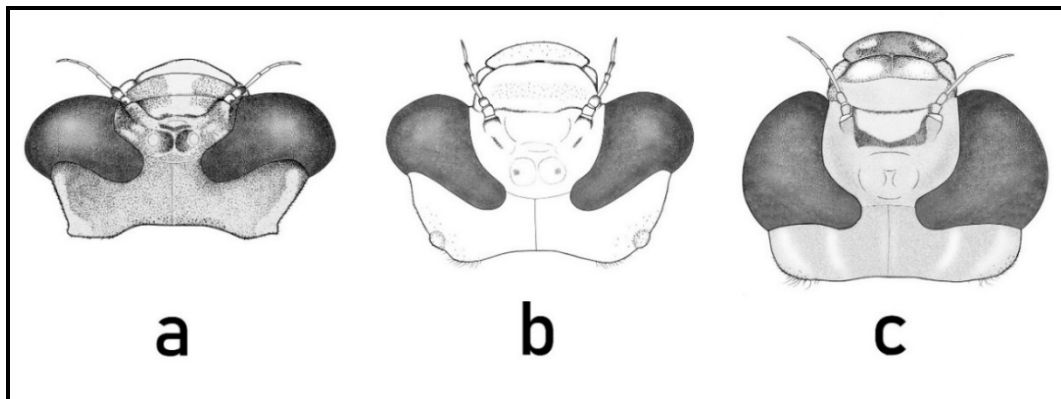


Fig. 6.2. Aeshnidae, head in dorsal view: a) *Boyeria vinosa*; b) *Epiaeschna heros*; c) *Anax junius*.

3. Posterolateral corner of head angulate without tubercles (Fig. 6.3a); dorsum of abdomen broadly rounded4
- 3'. Posterolateral corner of head obtuse-angulate with 1 or 2 tubercles (Fig. 6.3b); dorsum of abdominal segments 6–9 with low median ridge or blunt middorsal hooks.....6
4. Apex of epiproct truncate, cerci about as long as epiproct (Fig. 6.3a); abdomen with posterolateral spines on segments 6–9*Coryphaeschna* (in part)
- 4'. Apex of epiproct emarginate (Fig. 6.3b) or acuminate (Fig. 6.3c), cerci much shorter than epiproct; abdomen with posterolateral spines on segments 5–95

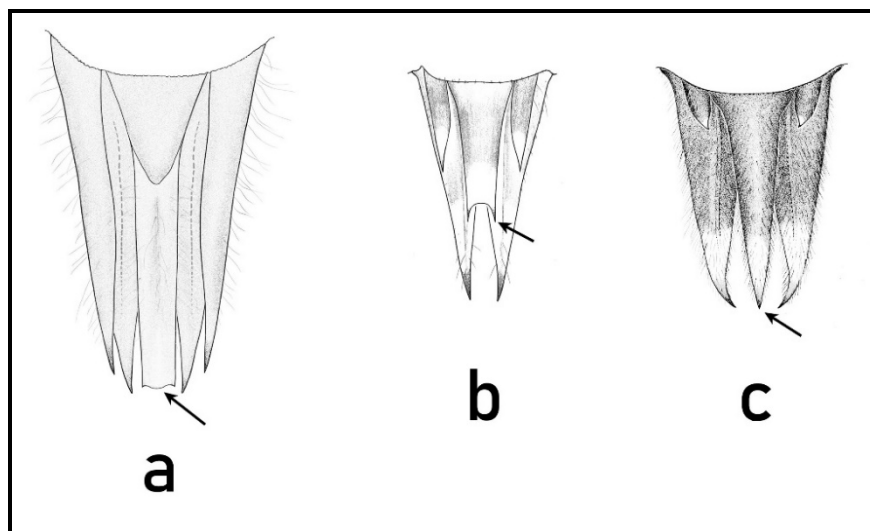


Fig. 6.3. Aeshnidae, anal appendages, dorsal view: a) *Coryphaeschna ingens*; b) *Basiaeschna janata*; c) *Boyeria vinosa* (arrow indicates apex of epiproct).

5. Palpal blade narrow distally (Fig. 6.4a); ratio of prementum length:max width < 1.25 (Fig. 6.4a); ligula with a low rounded tubercle, barely discernible, on each side of median cleft (Fig. 6.16b); abdominal dorsum with obscure pale medial spot on segments 5–7 ***Basiaeschna***
- 5'. Palpal blade truncate distally (Fig. 6.4b); ratio of prementum length:max width > 1.35 (Fig. 6.4b); ligula with a sharp point on each side of median cleft (Fig. 6.17b); abdominal dorsum with pale medial spot on segment 8 ***Boyeria***

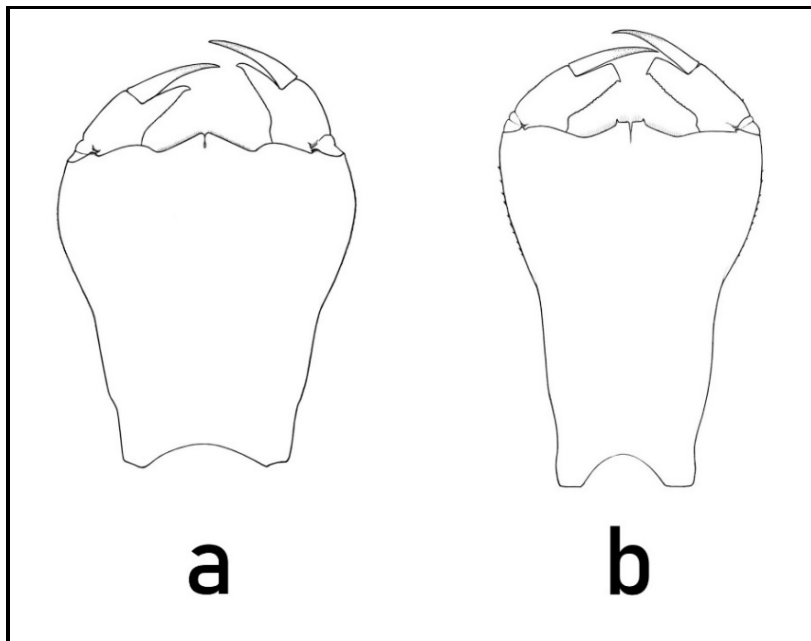


Fig. 6.4. Aeshnidae, prementum, ental view: a) *Basiaeschna janata*; b) *Boyeria vinosa*.

6. Median pair of tubercles between compound eyes low and without setae (Fig. 6.5a); low middorsal ridge on abdominal segments 5–9, middorsal hooks usually absent, sometimes a small hook present on segment 8 or 9; ratio of prementum length:max width > 1.3 , and ligula with a small tubercle on each side of median cleft (Fig. 6.6a) ***Epiaeschna***
- 6'. Median pair of tubercles between compound eyes raised and setose (Fig. 6.5b); middorsal hook on abdominal segments 7–9 produced; ratio of prementum length:max width < 1.3 , and ligula without a tubercle on each side of median cleft (Fig. 6.6b) ***Nasiaeschna***



Fig. 6.5. Aeshnidae, dorsum of head, lateral view: a) *Epiaeschna heros*; b) *Nasiaeschna pentacantha* (arrow indicates dorsomedial tubercle).

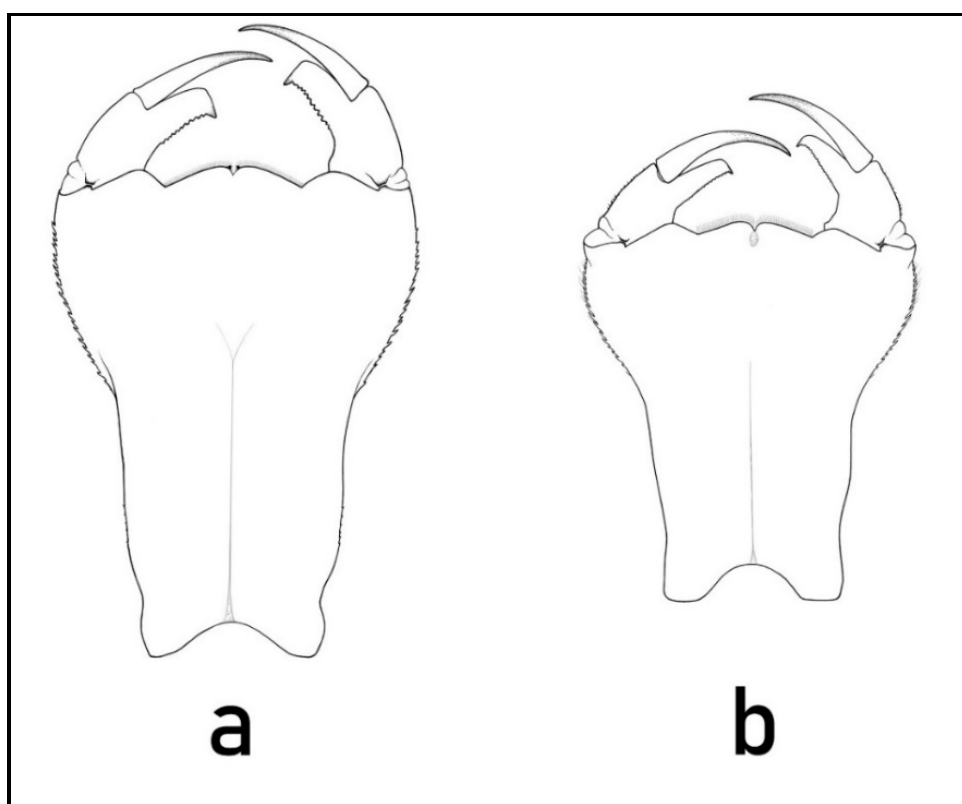


Fig. 6.6. Aeshnidae, prementum, ventral view: a) *Epiaeschna heros*; b) *Nasiaeschna pentacantha*.

- | | | |
|-----|--|---|
| 7. | Palpal blade with several long, prominent setae (Fig. 6.7a); paraproct serrate on entire ventrolateral margin (Fig. 6.8a) | 8 |
| 7'. | Palpal blade without long setae (Fig. 6.7b); paraproct smooth on ventrolateral margin except a few serrations in basal ¼ in some specimens (Fig. 6.8b) | 9 |

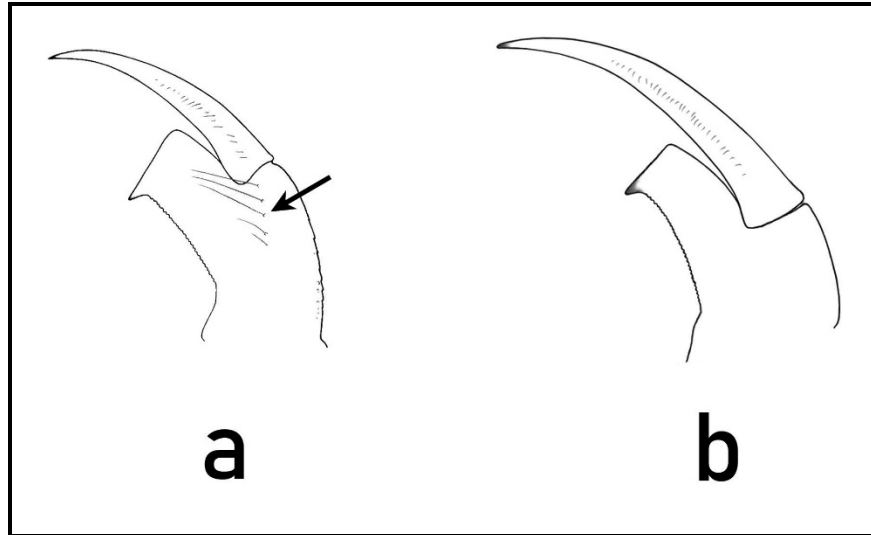


Fig. 6.7. Aeshnidae, right palpal blade, ental view: a) *Gynacantha nervosa*; b) *Anax longipes* (arrow indicates long setae on blade).

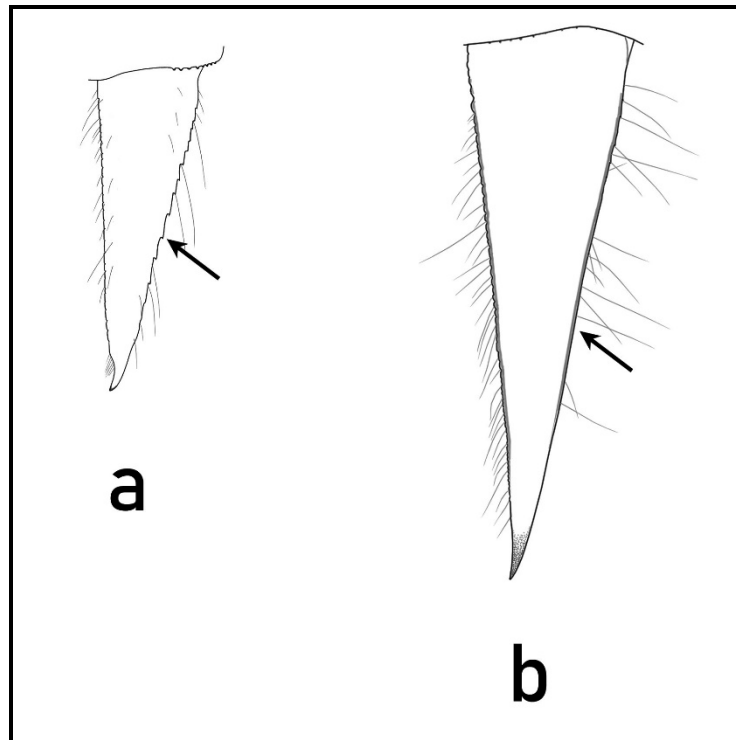


Fig. 6.8. Aeshnidae, left paraproct, ventral view: a) *Gynacantha nervosa*; b) *Anax longipes* (arrow indicates lateral margin).

- 8. Abdominal segment 5 without a posterolateral spine; palpal blade with large end tooth and long setae diminishing in length proximally (Fig. 6.9a)..... ***Gynacantha***
- 8'. Abdominal segment 5 with a posterolateral spine; palpal blade with very small end tooth and all long setae approximately equal in length (Fig. 6.9b)..... ***Triacanthagyna***

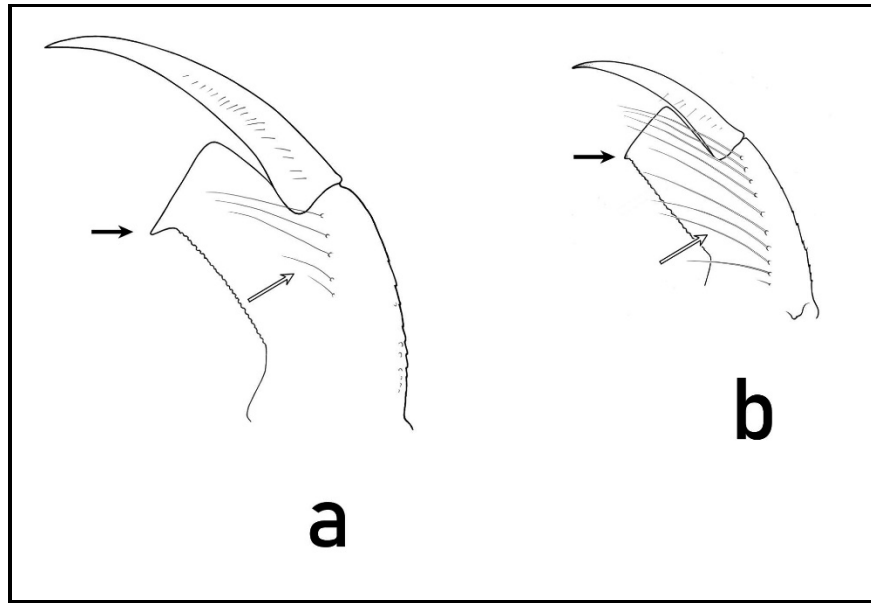


Fig. 6.9. Aeshnidae, right labial palp, ental view: a) *Gynacantha nervosa*; b) *Triacanthagyna trifida* (dark arrow indicates end tooth, light arrow indicates long setae).

- 9. Abdominal segment 6 without a posterolateral spine; cerci shorter than epiproct, apex of epiproct truncate with distinct, sharp lateral spines (Fig. 6.10a)*Anax*
- 9'. Abdominal segment 6 with a posterolateral spine; cerci subequal in length to epiproct, apex of epiproct with very small lateral spines often not visible in dorsal view (Fig. 6.10b)*Coryphaeschna* (in part)

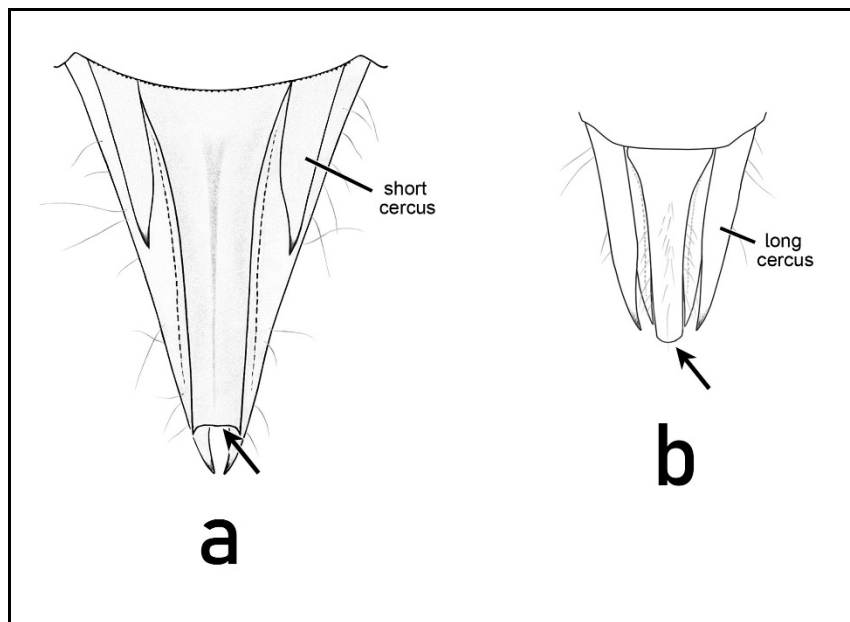


Fig. 6.10. Aeshnidae, anal appendages, dorsal view: a) *Anax junius*; b) *Coryphaeschna adnexa* (arrow indicates apex of epiproct).

Generic Notes:

Another aeshnid to be on the lookout for in Florida is *Hemianax* Selys. An Afrotropical member of this genus, *H. ephippiger* (Burmeister), has been recorded in the Lesser Antilles (Meurgey and Weber 2007); it is a known migrant that could occur in south Florida in shallow vegetated ponds (especially those with rushes and small woody shrubs) that hold water for only a few months. Nymphs of *Hemianax* closely resemble *Anax* but can be distinguished by the shorter prementum in the final instar (length 6.5–7.0 mm for *Hemianax*, 7.8–12.6 mm for *Anax*) and by the curvature of the lateral margin of the prementum: very slightly incurved in *Hemianax* (Fig. 6.11a) versus distinctly incurved in *Anax* (Fig. 6.11b). Also, the epiproct of male *Hemianax* nymphs has a single indistinct basal tubercle (Fig. 6.12a) compared to the distinctly raised double tubercles in *Anax* (Fig. 6.12b). Some references place *H. ephippiger* in *Anax* (Gentilini and Peters 1993) although other authorities regard *Hemianax* worthy of generic rank. For further comments on *Hemianax*, see Tennessen (2019a).

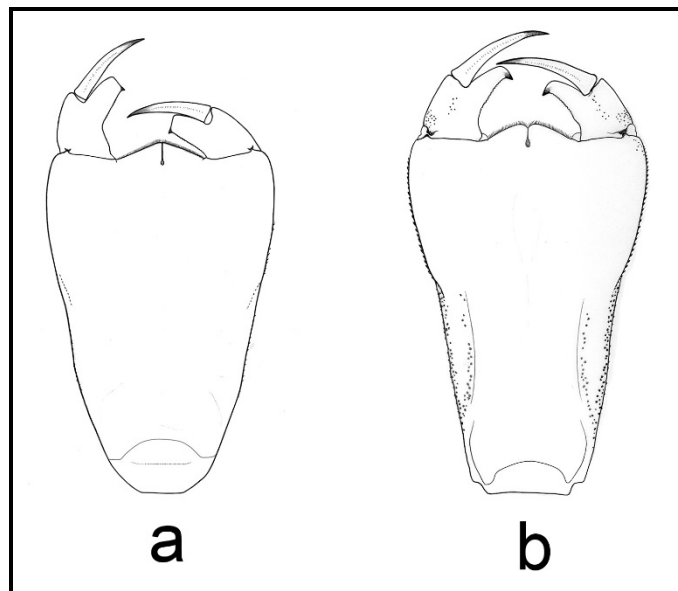


Fig. 6.11. Aeshnidae, prementum, ental view: a) *Hemianax ephippiger*; b) *Anax junius*.

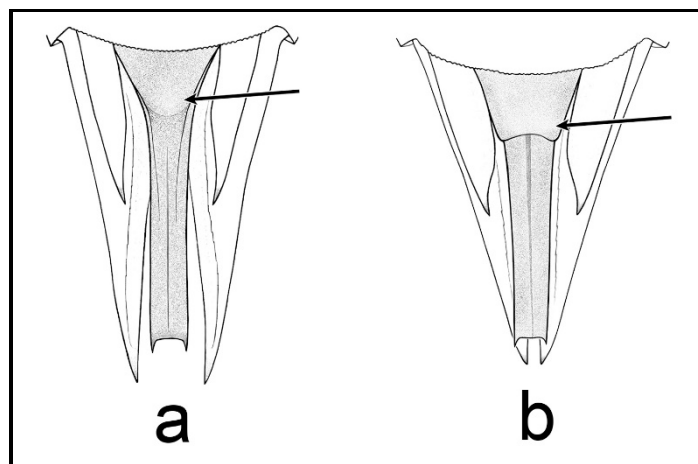


Fig. 6.12. Aeshnidae, anal appendages, dorsal view: a) *Hemianax ephippiger*; b) *Anax junius*. Arrow indicates basal tubercle on male epiproct.

Table 6.1. Summary of size measurements (mm) for the nine genera of Aeshnidae in Florida, for instar F-0.

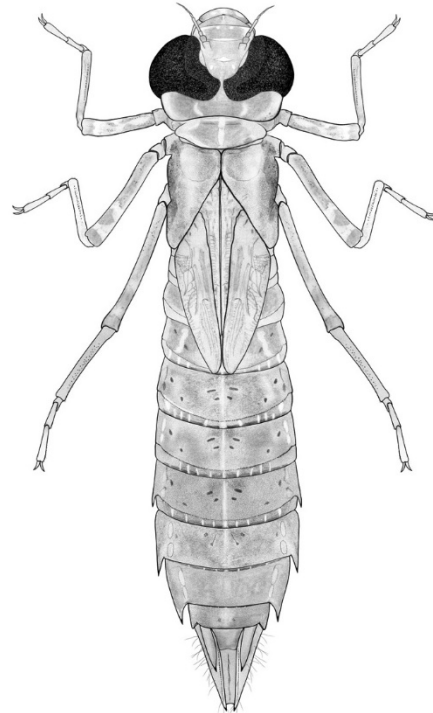
Genus	# Spp. in Florida	Total Length	Head Width	Premenum Length	Epiproct L	Ovipositor Length
<i>Anax</i>	3	36.5–59.3	8.30–9.80	7.85–12.60	4.55–6.75	2.10–2.85
<i>Basiaeschna</i>	1	29.5–36.4	7.50–8.15	4.35–5.25	2.65–3.30	1.95–2.35
<i>Boyeria</i>	1	31.2–37.5	7.30–8.10	5.15–6.35	3.10–3.70	2.60–2.90
<i>Coryphaeschna</i>	3	31.5–62.0	7.05–9.25	5.95–13.40	3.05–6.10	1.90–2.65
<i>Epiaeschna</i>	1	43.0–53.8	9.70–10.65	5.30–6.25	3.75–4.00	3.65–3.75
<i>Gomphaeschna</i>	2	27.7–32.0	5.20–6.10	3.20–3.60	2.30–2.70	2.20
<i>Gynacantha</i>	1	34.8–37.5	7.55–8.10	6.00–6.75	3.25–3.55	3.75–3.95
<i>Nasiaeschna</i>	1	38.2–48.5	8.45–8.85	4.80–5.40	3.20–3.50	2.70–3.00
<i>Triacanthagyna</i>	2	31.5–33.3	6.90–7.15	4.70–5.30	2.60–3.00	2.30–2.55

Aeshnidae Generic Treatments

A total of 15 species of Aeshnidae occur in Florida. Species identification in the three monotypic genera, *Basiaeschna*, *Epiaeschna* and *Nasiaeschna*, is, of course, directly derived once the genus is recognized. However, species determinations in genera with multiple species in Florida are relatively difficult and attention must be paid to microscopic details.

Anax

Elongate, sleek nymphs, variable in color (from green or tan to dark brown) and patterning; large eyes occupy 3/4 lateral margin of head; abdomen fusiform, posterolateral spines on segments 7–9, cerci short



Anax is a cosmopolitan genus with three species in Florida.

Key to *Anax* Species (F-0; see Diagnosis below for earlier instars)

1. Distal corner of palpal blades broadly rounded, distal margins divergent when palps opposed (Fig. 6.13a); prementum L < 9.7 mm; ovipositor L (from base of S9) 2.1–2.5 mm ***junius***
- 1'. Distal corner of palpal blades distinctly angulate (Fig. 6.13b), distal margins parallel when palps opposed; prementum L > 9.8 mm; ovipositor L 2.6–3.1 mm **2**

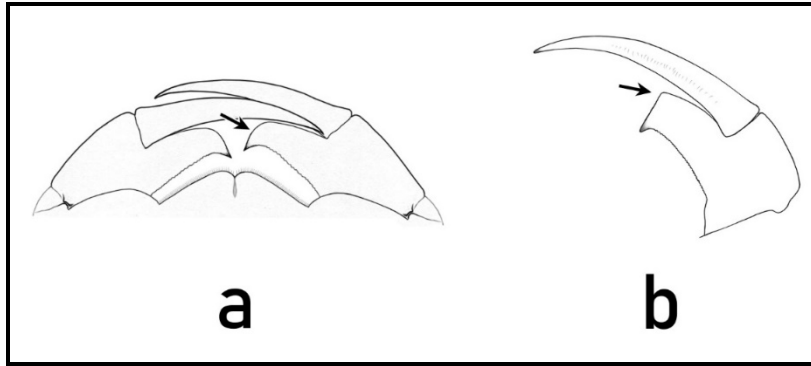


Fig. 6.13. *Anax* palpal lobes in retracted position: a) *A. junius*; b) *A. longipes*. Arrow indicates distal margin of palpal blade.

2. Ligula with median cleft narrow distally, shallow, not reaching level of chord (Fig. 6.14a); distal margin of palpal lobe concave (Fig. 6.15a); metathoracic femur L < 11.5 mm*amazili*
- 2'. Ligula with median cleft wide distally, deep, open nearly to level of chord (Fig. 6.14b); distal margin of palpal lobe straight (Fig. 6.15b); metathoracic femur L > 11.5 mm*longipes*

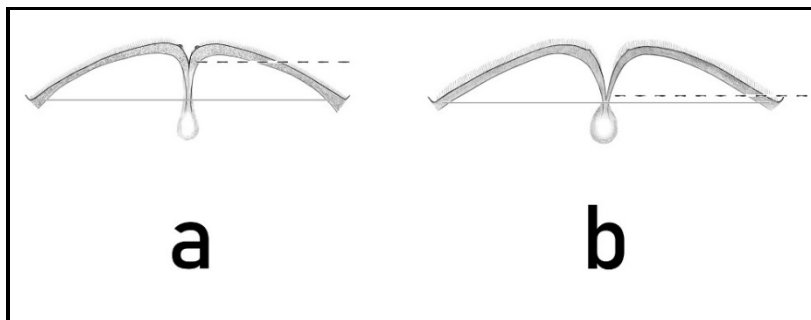


Fig. 6.14. *Anax* ligula, ental view: a) *A. amazili*; b) *A. longipes* (horizontal gray line represents imaginary chord of ligula; dashed line indicates depth of median cleft).

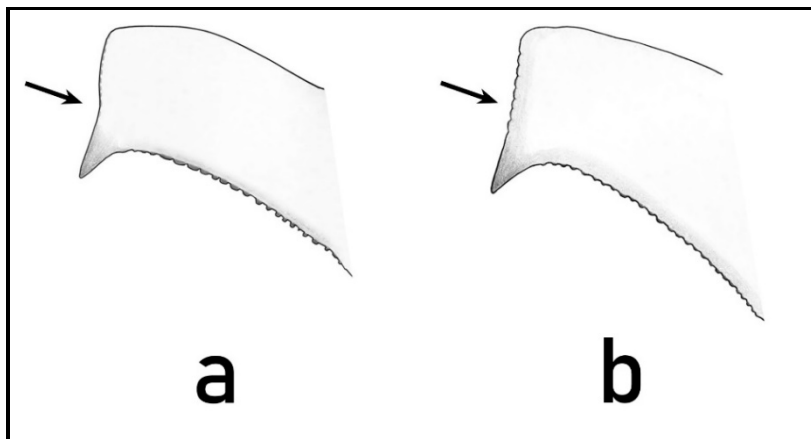


Fig. 6.15. *Anax*, distal margin of palpal lobe: a) *A. amazili*; b) *A. longipes* (arrow indicates distal margin of blade).

Diagnostic Remarks:

Although fully grown nymphs of North American *Anax* species are identifiable using the key characters presented above, younger instars present problems, especially because ontogenetic changes affect the morphology of *Anax junius*. As *A. junius* grows, the shape of the palpal blade changes slightly with each molt. In very early instars (2nd to 6th), the palpal blade is square, as wide distally as it is basally, and the distal corner is somewhat truncate. With successive molts thereafter, up to F-3, the shape of the blade gradually becomes slightly more elongate, but it is still nearly uniform in width from its base to the distal margin and the distal corner is still more or less truncate (Fig. 6.16a & 6.146b). In instar F-3, the distal corner becomes slightly more rounded, and in instars F-1 and F-2, the distal portion of the blade becomes narrower than the base and the distal corner is even more rounded (Fig. 6.16c). Therefore, the palpal blades of early instar *Anax junius*, especially those earlier than F-3, resemble those of *A. amazili* and *A. longipes* in being more truncate distally. Fortunately, these early instar *A. junius* can be distinguished from early instar *A. longipes* by checking the position of the labial hinge at rest: in *A. junius*, the hinge is usually between the mesothoracic coxae or slightly beyond, whereas in *A. longipes* the hinge lies beyond the metathoracic coxae, sometimes reaching the venter of abdominal segment 1. Distinguishing early instars of *A. amazili* from *A. junius* is uncertain as only F-0s of *A. amazili* were available for study.

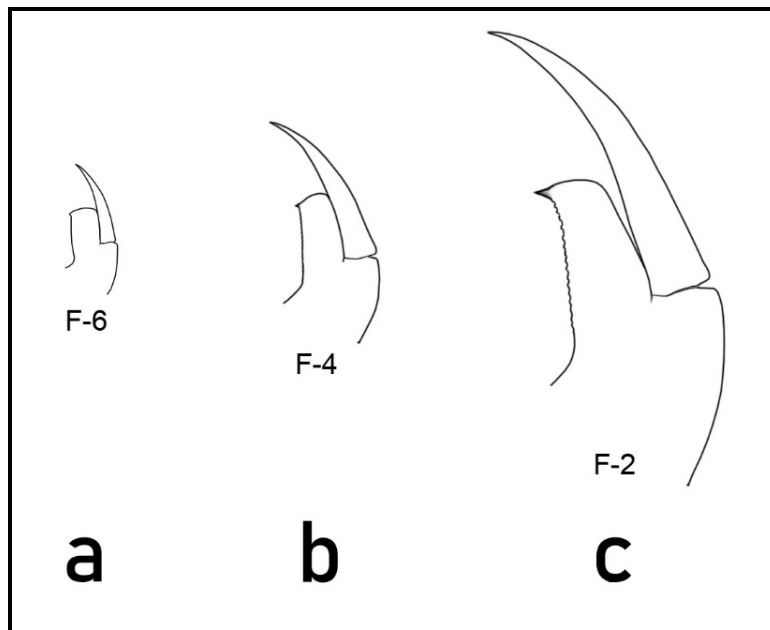


Fig. 6.16. Ontogenetic change in the distal margin of the palpal blade of early instar *Anax junius*.

Habitat, Distribution, Life Cycle:

Anax nymphs typically inhabit shallow lentic waters with floating and/or rooted aquatic vegetation, although they can be found occasionally in slow-flowing portions of some streams. Small lakes, ponds, marshes, and ditches, usually open but with emergent aquatic plants and surrounding forest or high grasses, are the most utilized habitats. They are found mainly in waters that lack insectivorous fish although at times *A. junius* has been found with fish present. Early instar *Anax*, prior to formation of wing sheaths, are often patterned (a condition called “piebald”)

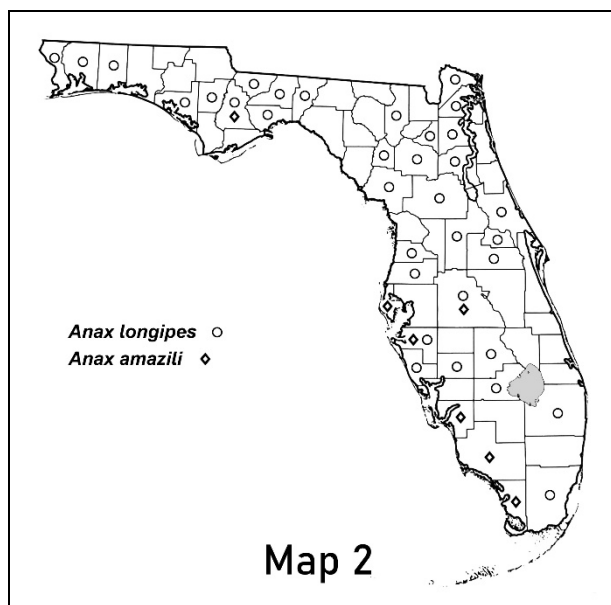
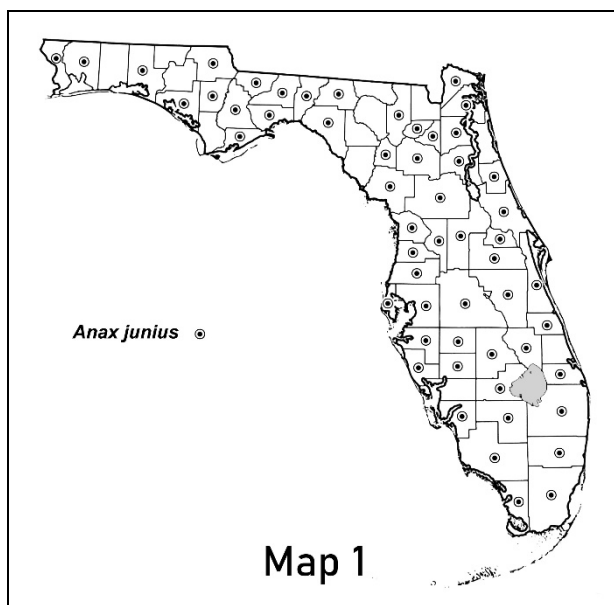
with alternating yellow and black transverse bands (Fig. 6.17), seemingly an adaption that helps small nymphs escape predation through protective coloration.



Fig. 6.17. Early instar (probably F-6) of *Anax junius* showing banded coloration.

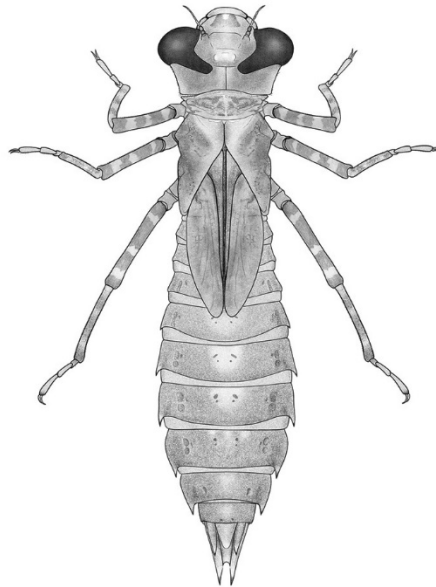
Anax junius is the most common and widely distributed species of the genus in Florida, as it has been recorded in 54 of the 67 counties (Map 1); it probably occurs in every county in the state. It is a strong migrant (May et al. 2017), flying north in early spring and giving rise to a second generation emerging in autumn which then migrates south late in the year. *Anax longipes* occurs statewide, having been recorded in 33 counties (Map 2) but it is less commonly encountered than *A. junius*. *Anax amazili* is rarely encountered in the state; all records are based on adult collections. As nymphs of this species have not as yet been collected in Florida, it is uncertain whether the species breeds in the state or whether adults periodically migrate from more southern or western areas. The preponderance of records along the Gulf Coast (Map 2) indicates that adults could be reaching Florida from Cuba and/or Mexico.

Anax junius is probably bivoltine throughout much of its expansive geographic range although in more northern populations there are individuals that require a year to complete their development. A wide range in nymph size in samples from single dates and localities indicate that there is continuous egg laying and hatching in Florida throughout the year. *Anax longipes* is probably univoltine in most of its range. The life cycle of *Anax amazili* in Florida is unknown. *Anax junius* probably emerges continually in southern Florida, as adults occur year-round. Adults of *A. longipes* are present in Florida from February 23 to November 23; *A. amazili* is infrequently recorded; flight dates range from June to October.



Basiaeschna

Elongate, somewhat compact, gray to dark brown, sometimes with reticulate pattern; head with square posterior corners; abdomen with posterolateral spines on segments 5–9, pale spot on segments 5–7



Basiaeschna is a monotypic, North American endemic. The only species, *B. janata*, is widely distributed in the eastern half of North America although its range in Florida is limited to the panhandle.

Diagnosis:

Basiaeschna nymphs most closely resemble *Boyeria* in shape of body and head. These two genera have similarly shaped heads in that the posterior corners are angulate. Other similarities include size, abdominal shape, posterolateral spines on segments 4 or 5 to 9, and pale medial spots on the abdomen. An easy, reliable character by which to differentiate them is the shape of the palpal blade. In *Basiaeschna*, the distal margin of the palp is tapered to a slender point (Fig. 6.18a); in *Boyeria*, the distal margin is truncate. Also, the ligula has a pair of very low, blunt, tubercles on each side of the median cleft (Fig. 6.18b) compared to the paired sharp points of *Boyeria*. The dorsal abdominal pattern of the two genera can also be used to distinguish them: in *Basiaeschna*, there is a median, diffuse pale spot on segments 5 to 7 and segment 8 is mostly dark; in *Boyeria*, there is a median pale spot on segment 8 and the other segments are dark. In some specimens, the dorsum of the abdomen is coated with mud or other foreign materials and must be brushed or scraped clean in order to see the pattern. The epiproct of F-0 and F-1 *Basiaeschna* is much shorter than the paraprocts compared to approximately as long in *Boyeria*.

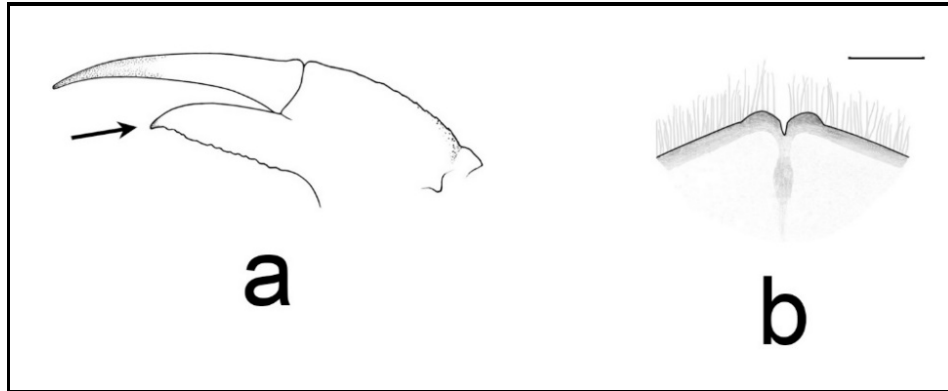


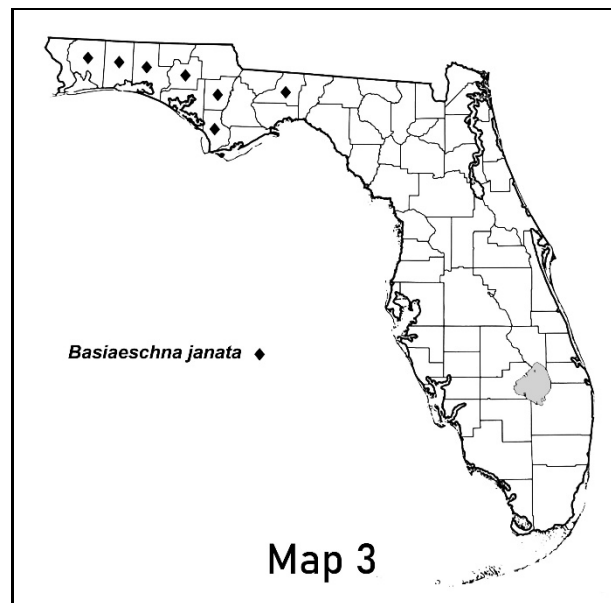
Fig. 6.18. *Basiaeschna janata*: a) palpal blade (arrow indicates tapered tip of blade); b) median portion of ligula (scale bar in upper right equals 0.1 mm).

Habitat, Distribution, Life Cycle:

Basiaeschna nymphs typically inhabit lotic waters with rooted aquatic vegetation; in regions north of Florida they can be found also in lakes. They coexist with insectivorous fish.

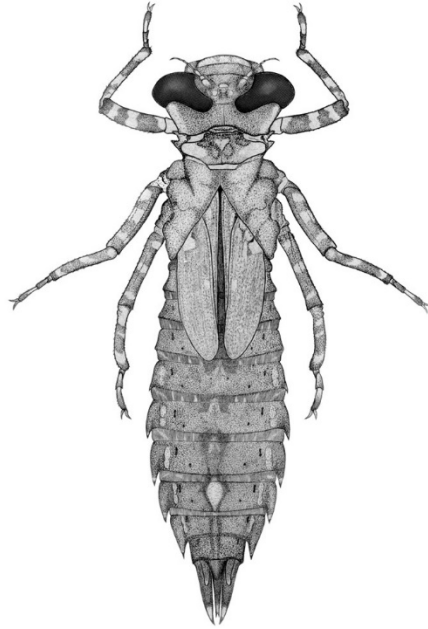
Basiaeschna janata is restricted to the northwestern part of the state where it has been recorded in only seven counties to date (Map 3). It emerges early in the year in Florida and is appropriately named Springtime Darner. Recorded flight season in the state ranges from March 7 to April 10.

Basiaeschna janata appears to be univoltine in Florida.



Boyeria

Elongate, relatively compact, dark brown; head with posterior corners angulate; abdomen with postero-lateral spines on segments 4–7, pale median spot on segment 8



Two species of *Boyeria* occur in North America, one of which, *B. vinosa*, is found in Florida.

Diagnosis:

Boyeria nymphs most closely resemble *Basiaeschna*. The distal margin of the palpal blade is truncate in *Boyeria* (Fig. 19a) versus tapered to a point in *Basiaeschna*. Also, the ligula of *Boyeria* has a pair of sharp points (Fig. 6.19b), unlike the low, almost indiscernible tubercles of *Basiaeschna*. The dorsal abdominal pattern also distinguishes the two genera: in *Boyeria*, the abdomen is dark except for a pale median spot on segment 8; in *Basiaeschna*, diffuse pale spots are present on segments 5 to 7 whereas segment 8 is mostly dark. The dorsal pattern of the abdomen is sometimes obscured with mud or other foreign materials; a brush or fine needle can be used to reveal the surface pattern. The epiproct of F-0 and F-1 *Boyeria* is about as long as the paraprocts versus epiproct much shorter than the paraprocts in *Basiaeschna*; however, the distinction breaks down in younger nymphs because the epiproct of *Boyeria vinosa* is distinctly shorter than the paraprocts in instars earlier than F-1.

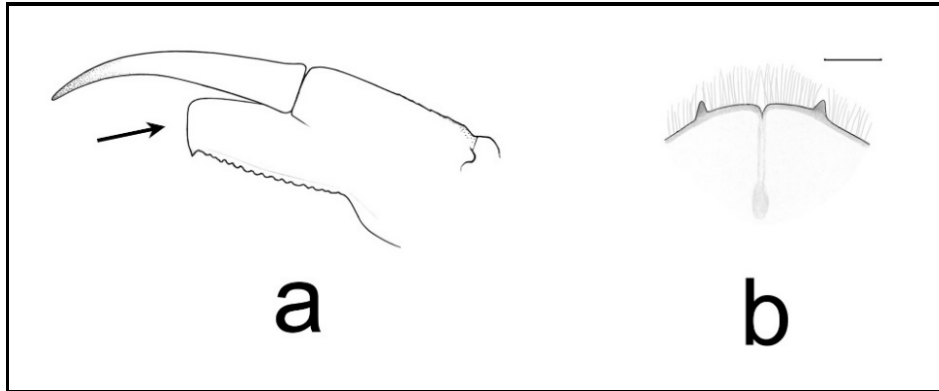


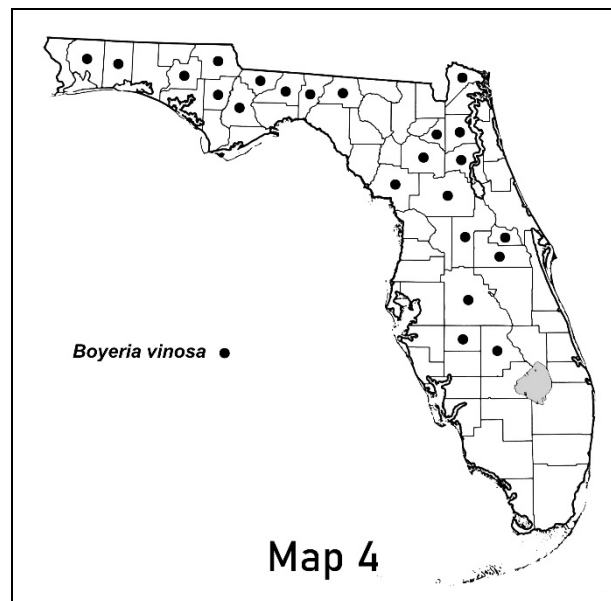
Fig. 6.19. *Boyeria vinosa*: a) palpal blade (arrow indicates truncate tip of blade); b) median portion of ligula (scale bar in upper right equals 0.1 mm).

Habitat, Distribution, Life Cycle:

Boyeria nymphs inhabit shady lotic waters with sunken wood and rooted bank vegetation; in northern regions, like *Basiaeschna*, they can be found also in lakes. They also coexist with insectivorous fish.

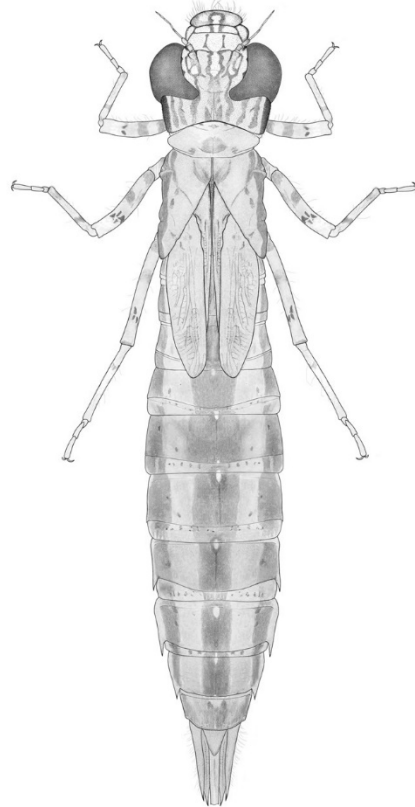
The range of *Boyeria vinosa* in Florida is mainly in the northern 1/3 of the state, there being very few records in the lower part of the peninsula (Map 4).

Boyeria vinosa appears to be semivoltine in Florida. It does not emerge as early in the year as *Basiaeschna janata* but flies much later; recorded flight season in the state ranges from May 11 to December 4.



Coryphaeschna

Very elongate, sleek,
green, tan or brown;
head squarish, flat,
striped; posterolateral
spines on abdominal
segments 6–9; cerci
nearly as long as
epiproct



Coryphaeschna is mainly a Neotropical genus; three species occur in Florida.

Generic Notes:

Coryphaeschna comes out in the generic key in two places as head shape is not consistent (see couplet 2) in the genus as it is currently constituted. The more rounded shape of the head and the morphology of the ligula in *C. adnexa* raises the possibility that this species is not congeneric with the other species of *Coryphaeschna*; however, there is currently no other group in which to conveniently place *C. adnexa*.

Key to *Coryphaeschna* Species

1. Ligula with a small round tubercle on each side of median cleft (Fig. 6.20a); distal margin of palpal blade truncate with small end tooth (Fig. 6.21a)***adnexa***
- 1'. Ligula with a large sharp spine on each side of median cleft (Fig. 6.20b); distal margin of palpal blade tapered with large end tooth (Fig. 6.21b)**2**

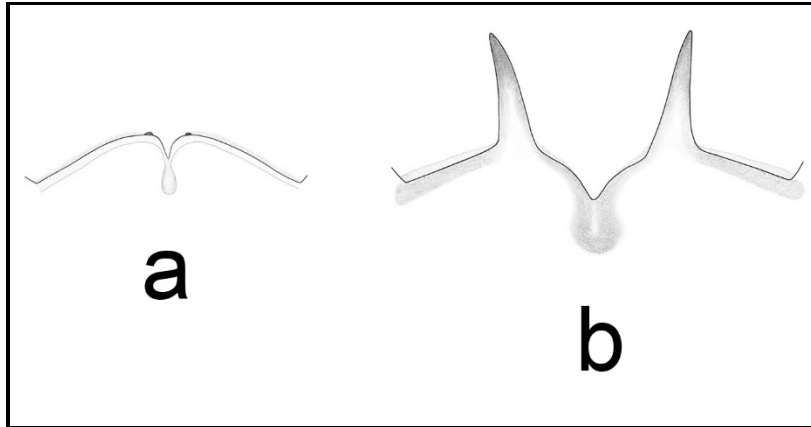


Fig. 6.20. *Coryphaeschna ligula*: a) *C. adnexa*; b) *C. ingens*.

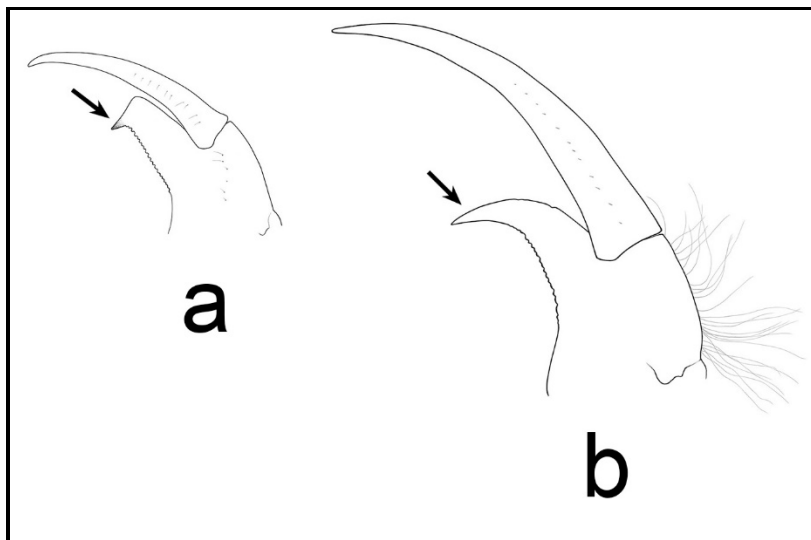


Fig. 6.21. *Coryphaeschna palpal blade*: a) *C. adnexa*; b) *C. ingens* (arrow indicates end tooth).

- 2. Distal margin of palpal blade smoothly contoured along entirety, corner broadly rounded (Fig. 6.22a); total length of final instar 52–62 mm, head width 8.80–9.25 mm.....***ingens***
- 2'. Distal margin of palpal blade straighter, corner abruptly rounded (Fig. 6.22b); total length of final instar 47–52 mm, head width 7.05–8.20 mm..... ***viriditas***

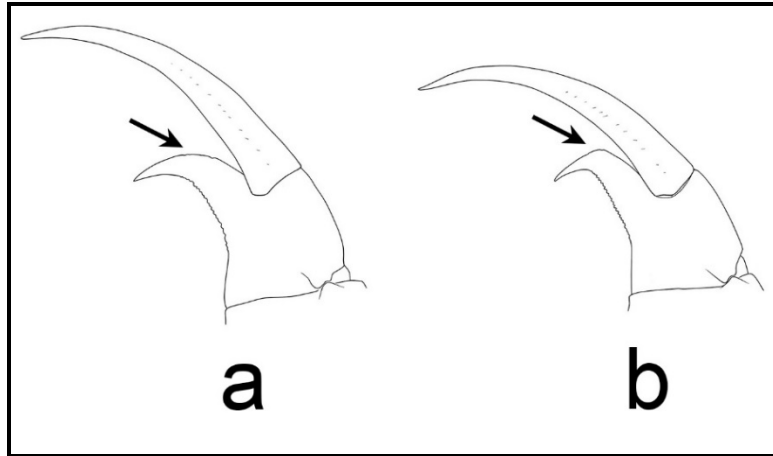


Fig. 6.22. *Coryphaeschna*, palpal blade: a) *C. ingens*; b) *C. viriditas* (arrow indicates distal corner of blade).

Diagnostic Remarks:

In addition to the characters in couplet 1, *C. adnexa* is distinct from the other two species in the more rounded posterior corners of the head and bulkier compound eyes (Fig. 23a) versus the square posterior corners and more elongate eyes (Fig. 23b); these differences are present in instars earlier than F-0.

Young instars of *C. ingens* may be indistinguishable from *C. viriditas*. The distal margin of the palpal blade of *C. ingens* changes shape slightly with each molt, becoming broadly rounded only in the last two instars (F-0 and F-1); in F-2 and earlier instars, the distal margin is straighter and somewhat truncate (Fig. 6.24), appearing similar to that of *C. viriditas*. It is not advised to use the key characters for F-2 and earlier instars of *Coryphaeschna* nymphs with ligula spines.

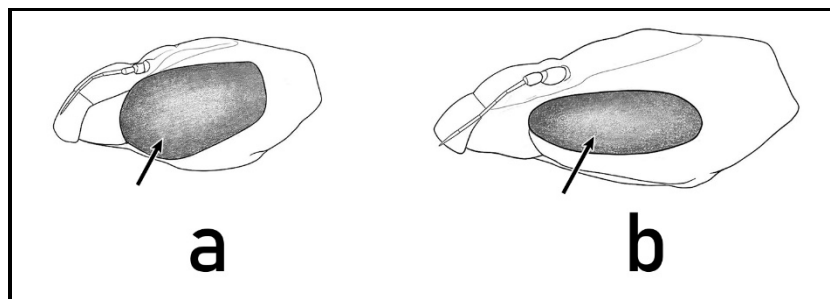


Fig. 6.23. *Coryphaeschna*, head shape: a) *C. adnexa*; b) *C. ingens*.

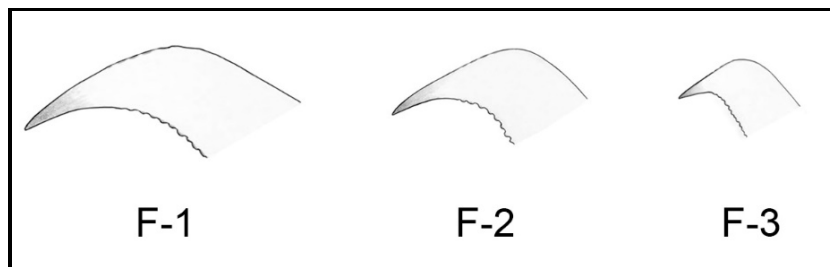


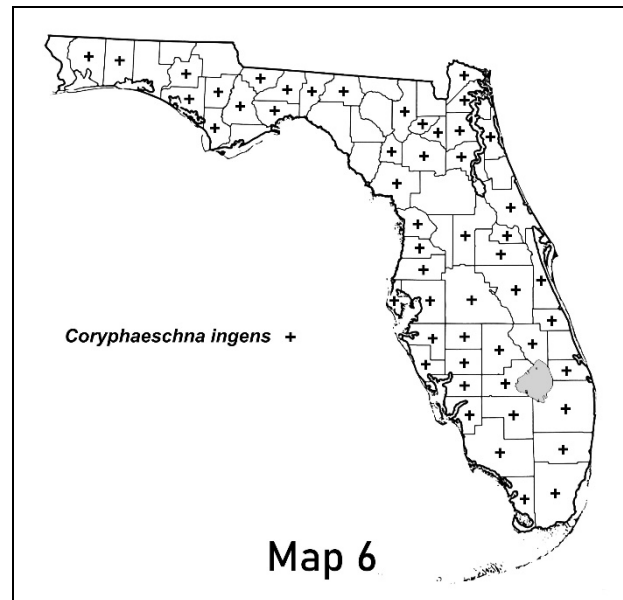
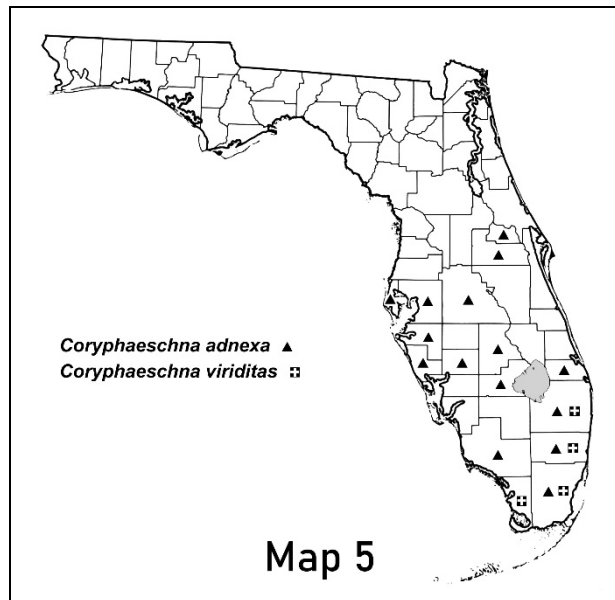
Fig. 6.24. Ontogenetic change in the distal margin of the palpal blade of *Coryphaeschna ingens*.

Habitat, Distribution, Life Cycle:

Coryphaeschna nymphs are typically lentic, occupying habitats such as ponds, lakes, and marshes with floating or rooted aquatic vegetation; they are found occasionally in slow-flowing canals.

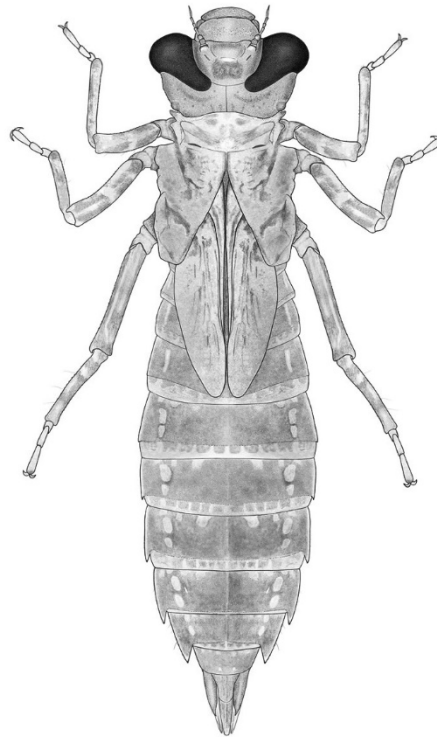
Coryphaeschna adnexa is recorded in Florida from the southern 3/4 of the peninsula, whereas *C. viriditas* has been found only in the southern 1/4 (Map 5). *Coryphaeschna ingens* is common and widely distributed in Florida, having been recorded in 50 counties to date (Map 6).

Coryphaeschna species are probably univoltine. Recorded flight seasons are long, apparently year-long for *C. adnexa* and ranging from February 6 to October 19 for *C. ingens*; the scant data for *C. viriditas* indicates it flies from March 19 to August 10.



Epiaeschna

Elongate but relatively stout, dark brown; low tubercle on posterior corner of head; abdomen with stout posterolateral spines on segments 6–9, low middorsal ridge on segments 5–9



Epiaeschna is a monotypic, North American endemic; the only species, *E. heros*, is widely distributed in eastern North America.

Diagnosis:

Epiaeschna nymphs are most likely to be confused with *Nasiaeschna*. The posterior corners of the head in *Epiaeschna* have a single low tubercle compared to two prominent tubercles in *Nasiaeschna*. *Nasiaeschna* also has a pair of prominent, closely-set tubercles between the compound eyes. The difference in the head tubercles between the two genera is even more pronounced in early instars. *Epiaeschna* has a low median ridge on abdominal segments 5–9 compared to the low, blunt middorsal hooks on segments 7–9 in *Nasiaeschna*; *Epiaeschna* occasionally has a small, rounded middorsal hook on segment 8. The palpal blade of *Epiaeschna* is of approximately equal width along its length (Fig. 6.25) versus tapered distally in *Nasiaeschna*; however, the palpal blade of *Nasiaeschna* instars earlier than F-1 are less tapered and the tips appear more truncate.

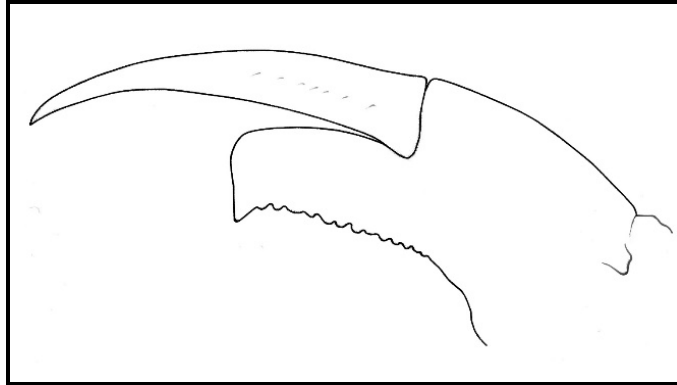


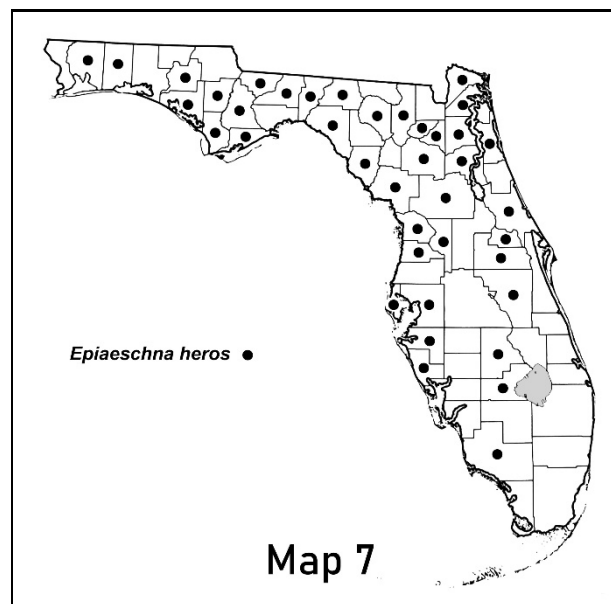
Fig. 6.25. Palpal blade of *Epiaeschna heros*.

Habitat, Distribution, Life Cycle:

Epiaeschna nymphs inhabit shaded lentic waters, especially swamps and shallow ditches with muddy bottoms and dead leaves and detritus; some habitats dry up temporarily (Boose 2014).

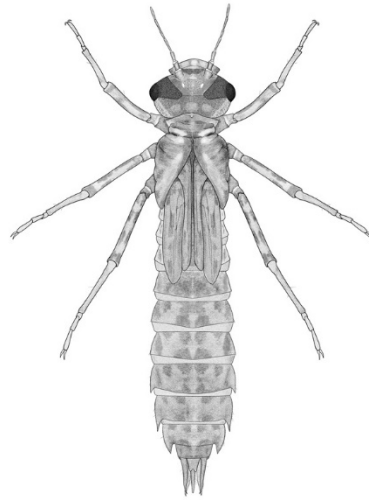
The range of *Epiaeschna heros* in Florida is nearly statewide, although there are few county records in the southern third of the peninsula (Map 7).

Epiaeschna heros appears to be univoltine in Florida. It flies nearly throughout the year; recorded flight season in the state ranges from February 27 to November 1. May (2012) included observations that indicate this species migrates.



Gomphaeschna

Elongate, slender;
antennae as long as
head; labrum wide;
genae each with sharp
triangular projection;
legs relatively long;
stout posterolateral
spines on segments
7–9



Gomphaeschna is endemic to eastern North America; only two species are known, both occurring in Florida.

Generic Notes:

Gomphaeschna is not closely related to any other North American genus of Aeshnidae. The long antennae (as long as or nearly as long as head), wide labrum (covering base of mandibles), and a sharp triangular projection on each gena are unique within our aeshnid fauna.

Key to *Gomphaeschna* Species

- 1. Antenna 7-segmented; tip of epiproct exceeding tips of paraprocts; palpal blade with alternating large and small teeth (Fig. 6.26a) *antelope*
- 1'. Antenna 6-segmented; tip of epiproct not reaching tips of paraprocts; palpal blade with approximately evenly sized teeth (Fig. 6.26b) *furcillata*

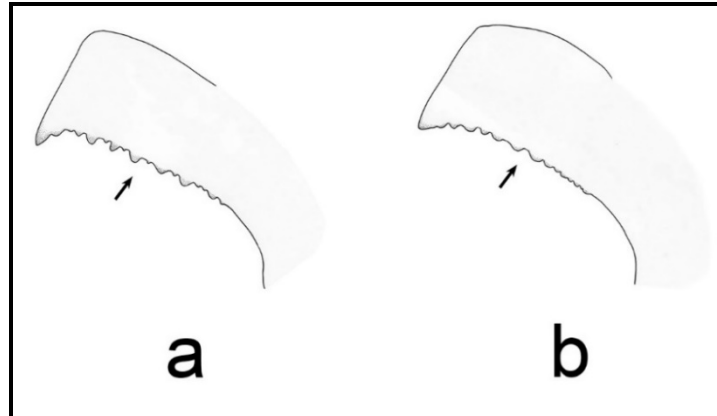


Fig. 6.26. *Gomphaeschna* palpal blade: a) *G. antilope*; b) *G. furcillata* (arrow indicates teeth on inner margin of blade).

Diagnostic Remarks:

The key to species is based on only three specimens of *G. antilope*; therefore, variation in the proposed characters may be greater than current data indicates. A note of caution: the few specimens of *G. antilope* available for study show that the antennae are clearly 7-segmented (Fig. 6.27a); however, the terminal antennal segment (segment 6) of *G. furcillata* has an encircling indentation slightly beyond mid-length, giving the impression of a seventh segment (Fig. 6.27b). In addition to the key characters, the thorax of *G. furcillata* has pale dorsal spots, whereas the thorax is dark in *G. antilope*, a difference noted by (Dunkle 1977); the pale spots are not evident in *G. furcillata* exuviae. There also appears to be a difference in the dimensions of the mesothoracic wing sheaths, the length:width ratio in *G. antilope* being less than 3.2 versus greater than 3.2 in *G. furcillata*.

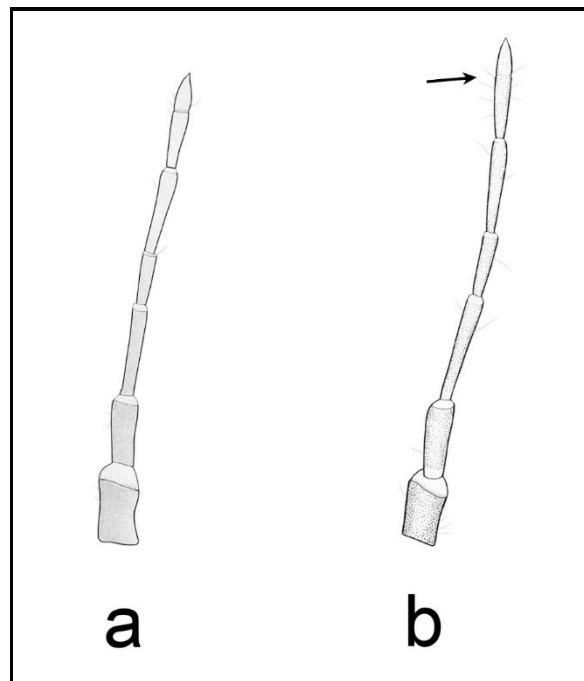


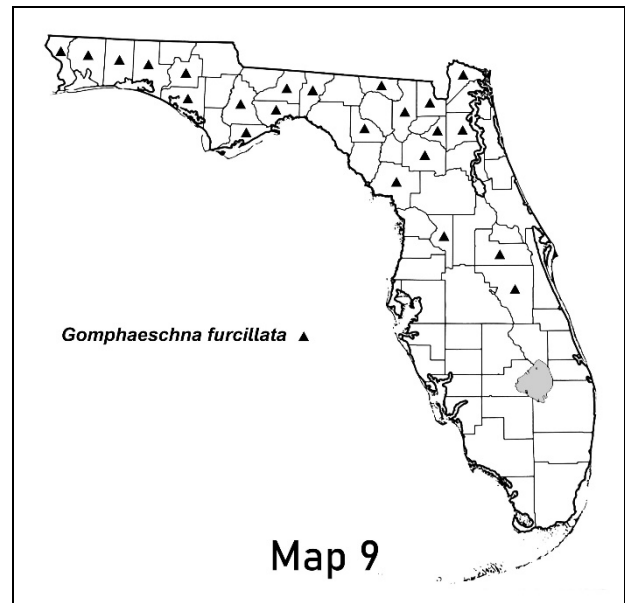
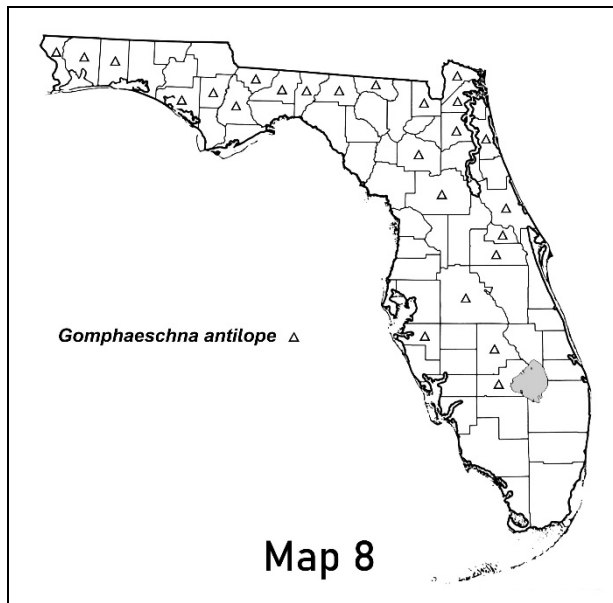
Fig. 6.27. *Gomphaeschna* antenna: a) *G. antilope*; b) *G. furcillata* (arrow indicates indentation at mid-length of segment 6).

Habitat, Distribution, Life Cycle:

Gomphaeschna nymphs inhabit shaded lentic waters, especially tupelo gum/cypress swamps with sunken logs. The nymphs are rarely obtained mainly because they are uncommon, and they cling to logs and tree roots making them difficult to dislodge and net.

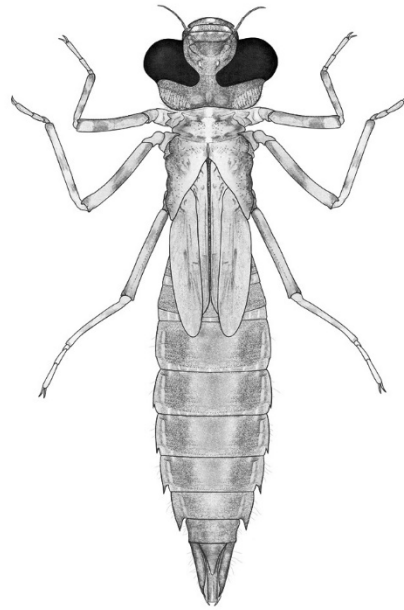
The range of both *Gomphaeschna* species in Florida is nearly statewide, although there are few county records in the southern third of the peninsula; *G. antilope* ranges slightly further south (Map 8) than *G. furcillata* (Map 9).

Voltinism in *Gomphaeschna* is unknown. Both species emerge early, and the flight seasons are rather short; recorded flight season in the state for *G. antilope* ranges from January 13 to June 9 and for *G. furcillata* from January 8 to April 22.



Gynacantha

Elongate, slender; head across eyes markedly wider than thorax; palpal blade with 3–4 long setae; posterolateral spines on segments 6–9 slender; cerci as long as epiproct; epiproct truncate at apex



Gynacantha is a cosmopolitan genus with high diversity in the Neotropics. Only two species are known to occur in the United States, one of which, ***G. nervosa***, is common in Florida.

Diagnosis:

Gynacantha nymphs most closely resemble *Triacanthagyna*. The long setae on the palpal blade of *Gynacantha* number 3–5 and they diminish in length and stature proximally (Fig. 6.28); comparatively, in *Triacanthagyna*, the palpal blade setae are more numerous and are of subequal length all along the blade. Also, the end tooth of *Gynacantha* is larger and more acute than in *Triacanthagyna*. Posterolateral spines are present only on abdominal segments 6–9 in *Gynacantha* versus on abdominal segments 5–9 in *Triacanthagyna*.

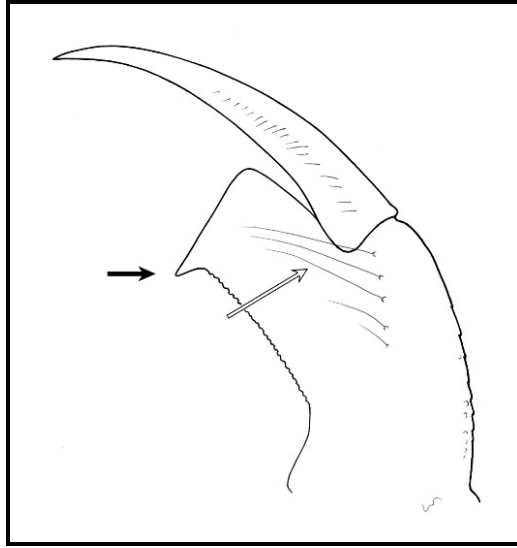


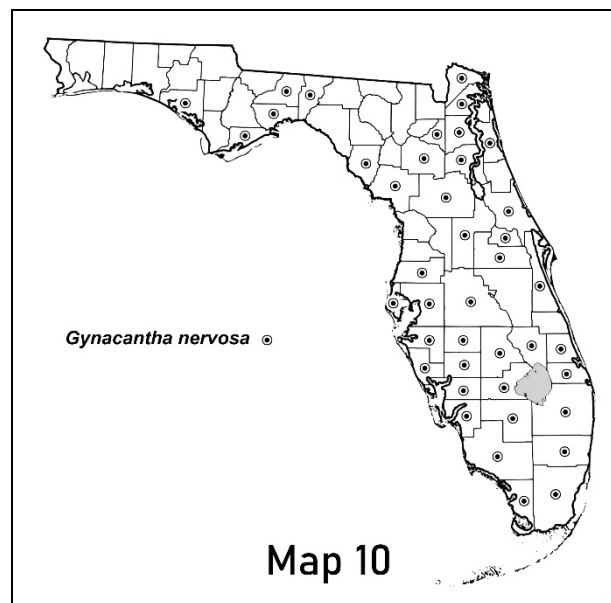
Fig. 6.28. Palpal blade of *Gynacantha* (solid arrow indicates prominent end tooth, open arrow indicates palpal setae).

Habitat, Distribution, Life Cycle:

Gynacantha nervosa nymphs occupy shallow, swampy lentic waters, particularly temporary woodland swales that fill after heavy seasonal rains. The crepuscular adults have been encountered in buildings where they get trapped; they typically hang from palm fronds and other woody species in shady areas during the daylight hours.

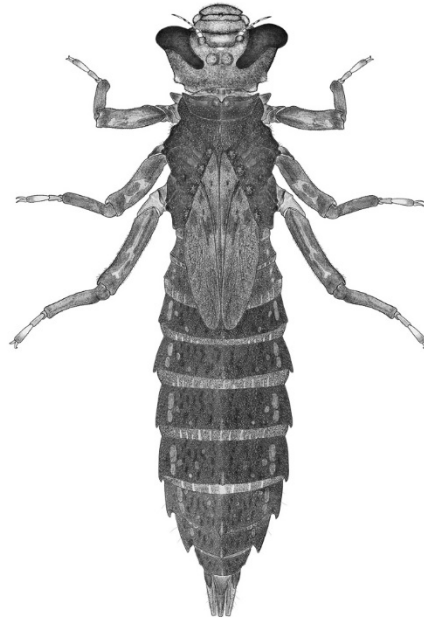
Gynacantha nervosa occurs nearly statewide, although there are no county records in the western part of the panhandle (Map 10). The nymphs are rarely found.

Most *Gynacantha* species are relatively fast growing, probably going from egg to adult in two or three months (Williams 1937); data on voltinism are scarce. Adults of *G. nervosa* are present in Florida year-round.



Nasiaeschna

Elongate, stocky; legs relatively stout; head with prominent tubercles; posterolateral spines on segments 5–9; middorsal hooks on segments 7–9; cerci less than half length of paraprocts



Nasiaeschna is a monotypic, North American endemic. The only species, *N. pentacantha*, occurs throughout Florida.

Diagnosis:

Nasiaeschna nymphs resemble *Epiaeschna* although the legs are stockier and they have more prominent, angular corners and edges, appearing much more stick-like. Also, *Nasiaeschna* has a pair of prominent, close-set tubercles between the compound eyes (posterior to the lateral ocelli) whereas *Epiaeschna* has remnants of these tubercles, low and barely detectable. The palpal blade of *Nasiaeschna* (Fig. 29) is more tapered than in *Epiaeschna* (Fig. 25). The abdomen of *Nasiaeschna* has apically blunt middorsal hooks on segments 7–9 (Fig. 6.30); *Epiaeschna* usually lacks middorsal hooks although some nymphs have a low hook on segment 8. The cerci are less than half the length of the ovipositor in *Nasiaeschna* but over half the length in *Epiaeschna*.

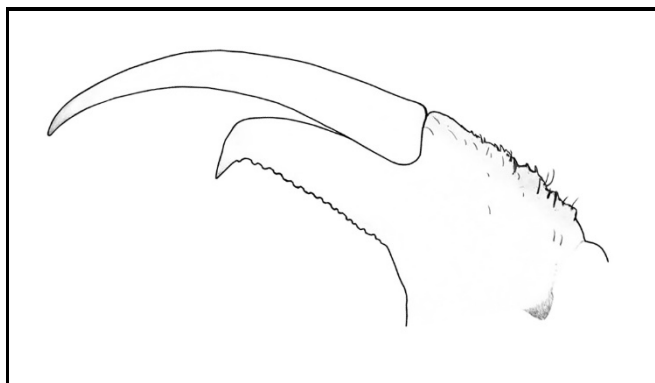


Fig. 6.29. Palpal blade of *Nasiaeschna pentacantha*.

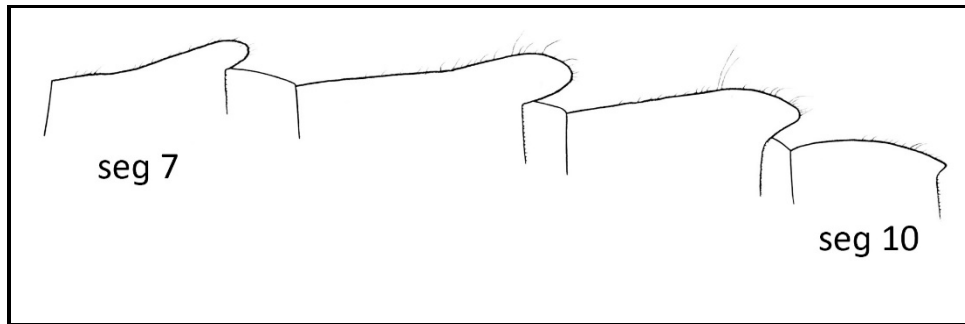


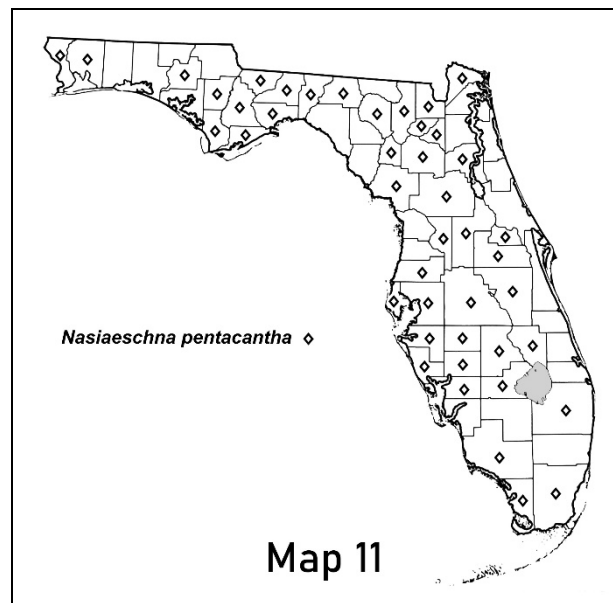
Fig. 6.30. Abdominal segments 7–10 of *Nasiaeschna pentacantha*, lateral view.

Habitat, Distribution, Life Cycle:

Nasiaeschna pentacantha nymphs are both lentic and lotic, occupying edges of wooded ponds and small lakes and slow streams with rooted aquatic plants. Nymphs have been seen passively floating with their legs tucked in, appearing twig-like.

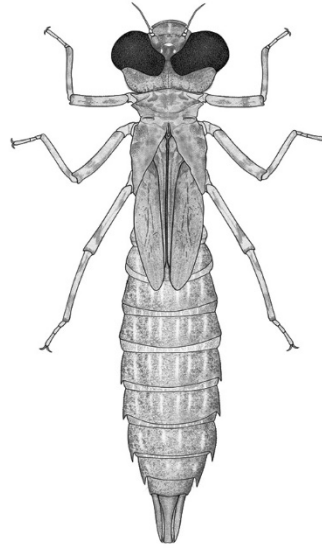
Nasiaeschna pentacantha occurs statewide (Map 11) but population size is usually relatively small.

Nasiaeschna is univoltine in Florida (Dunkle 1985); adults fly nearly year-round, the flight season extending from March 2 to December 28.



Triacanthagyna

Elongate, slender; head across eyes markedly wider than thorax; palpal blade with 8–9 long setae; posterolateral spines on segments 5–9 slender; cerci as long as epiproct; epiproct truncate at apex



Triacanthagyna is mainly a Neotropical genus with two species recorded in Florida.

Generic Notes:

Triacanthagyna nymphs closely resemble *Gynacantha*. The long setae on the palpal blade of *Triacanthagyna* number at least 7 to 9 and they are all approximately equal in length (as long as blade is wide) and stature (Fig. 6.31); in *Gynacantha* the long palpal blade setae are fewer (only 3–5 present) and the more proximal setae are much shorter than the width of the blade (Fig. 6.28). Also, the end tooth of the palpal blade of *Triacanthagyna* is small and obtuse (Fig. 6.31) whereas the end tooth of *Gynacantha* is larger and more acute (Fig. 6.28). Postero-lateral spines are present on abdominal segments 5–9 in *Triacanthagyna* versus only on abdominal segments 6–9 in *Gynacantha*.

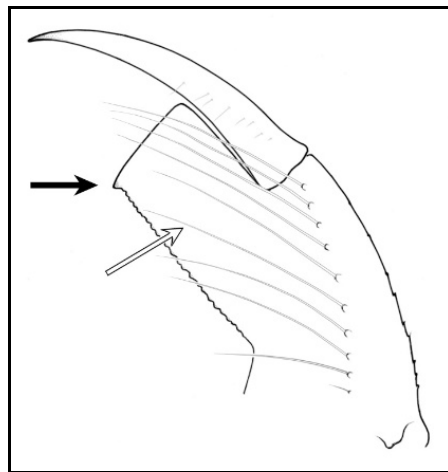


Fig. 6.31. Palpal blade of *Triacanthagyna* (solid arrow indicates small end tooth, open arrow indicates palpal setae).

Key to *Triacanthagyna* Species

1. Posterior arm of prothoracic supracoxal process obtuse (Fig. 6.32a); ratio of cercus length to epiproct length 0.8–0.9; paraproct length, in ventral view, less than combined length of abdominal segments 9 and 10 *septima*
- 1'. Posterior arm of prothoracic supracoxal process acute (Fig. 6.32b); ratio of cercus length to epiproct length at least 0.95; paraproct length, in ventral view, subequal to combined length of abdominal segments 9 and 10 *trifida*

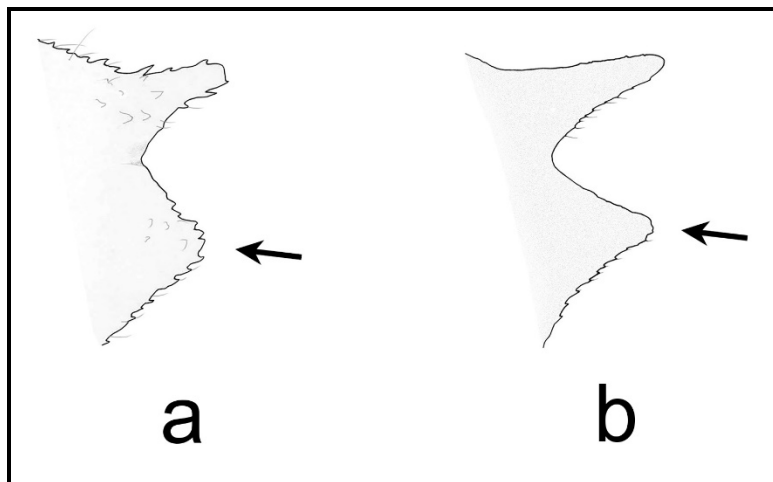


Fig. 6.32. *Triacanthagyna* supracoxal process, right side, dorsal view: a) *T. septima*; b) *T. trifida* (arrow indicates posterior arm).

Diagnostic Remarks:

The two species found in Florida differ only in minor details, as presented in the key. Although the prothoracic epaulet appears to be spinier in *T. septima* than in *T. trifida* (Fig. 30), too few specimens of the former species were available for study to be confident that the difference is reliable.

Habitat, Distribution, Life Cycle:

Triacanthagyna nymphs occupy shallow, swampy lentic waters, particularly temporary deciduous woodland swales that fill after heavy seasonal rains.

Triacanthagyna trifida occurs nearly statewide, although there are few county records in the western part of the panhandle (Map 12). *Triacanthagyna septima* has been recorded only in the southernmost counties and the Keys.

Most *Triacanthagyna* species are relatively fast growing, probably going from egg to adult in a couple of months, although precise data on voltinism are lacking. *Triacanthagyna* nymphs are rarely found as the habitat (temporary forested rainpools) is present only for a short time after heavy seasonal rains. Flight season of *T. trifida* in Florida ranges from July 10 to February 15 of the following year; the known flight season for *T. septima* is similar, from July 15 to January 5.

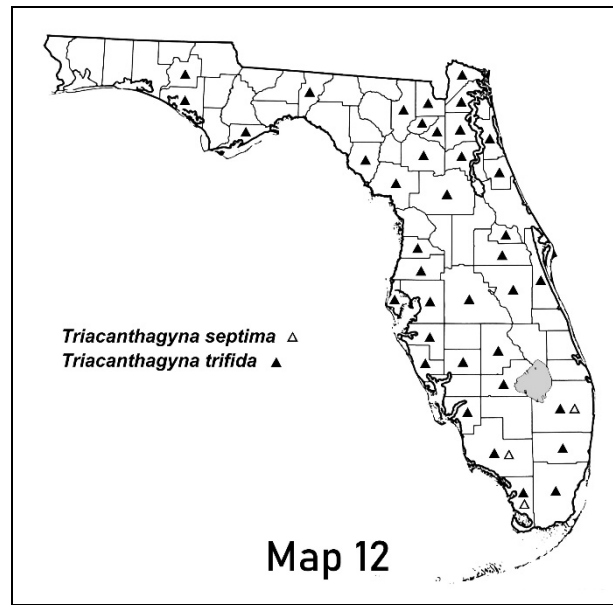
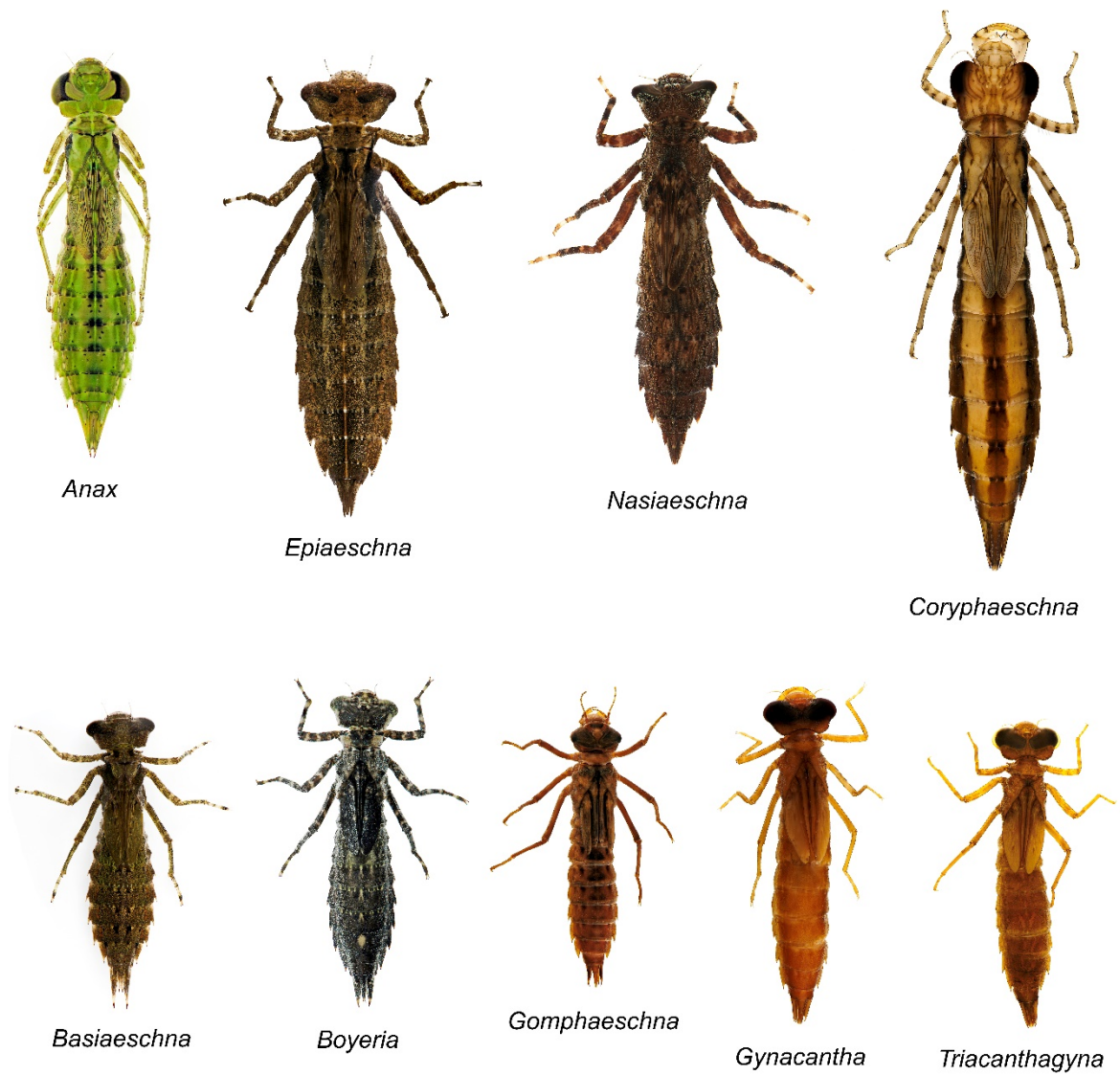


Plate 3. Representatives* of the nine Aeshnidae genera of Florida (photographs by Marla C. Garrison).



* The species represented in Plate 3 are *Anax junius*, *Epiaeschna heros*, *Nasiaeschna pentacantha*, *Coryphaeschna ingens*, *Basiaeschna janata*, *Boyeria vinosa*, *Gomphaeschna furcillata*, *Gynacantha nervosa*, and *Triacanthagyna trifida*.

7. GOMPHIDAE

Gomphid nymphs are adapted mainly for burrowing into substrates or less frequently hiding in detritus. They do not form open burrows, rather the substrate falls in around them as they dig into it. Most species have stout, flattened bodies, shortened antennae and labium, and short stout legs, adaptations for a sub-surface existence. There is a high degree of variability in body shape within the family, which often enables identification to genus in the field.

The family is characterized by 1) mouthparts prognathous; 2) prementum flat, lacking setae on the ental surface; 3) palpal lobes blade-like, without prominent setae; 4) movable hook stout; 5) antennae 4-segmented; 6) tarsus of pro- and mesothoracic legs 2-segmented; 7) anal pyramid short; 8) body especially setose, with a great variety of setae, from very long silky setae to short polyp-like setae.

Eleven genera of Gomphidae are found in Florida, namely *Aphylla* Selys, *Arigomphus* Needham, *Dromogomphus* Selys, *Erpetogomphus* Selys, *Gomphurus* Needham, *Hagenius* Selys, *Hylogomphus* Needham, Westfall & May, *Ophiogomphus* Selys, *Phanogomphus* Carle, *Progomphus* Selys, and *Stylurus* Needham. Measurements for each genus are summarized in Table 7.1 (p. 87).

Key to Genera of Gomphidae

1. Abdominal segment 10 tubular, longer than segments 8 and 9 combined (Fig. 7.1a); labial palp with only 3 or 4 inner teeth, these teeth nearly as large as end tooth (Fig. 7.2a).....*Aphylla*
- 1'. Abdominal segment 10 flat, shorter than segments 8 and 9 combined (Fig. 7.1b); labial palp usually with numerous inner teeth not nearly as large as end tooth (Fig. 7.2b)2

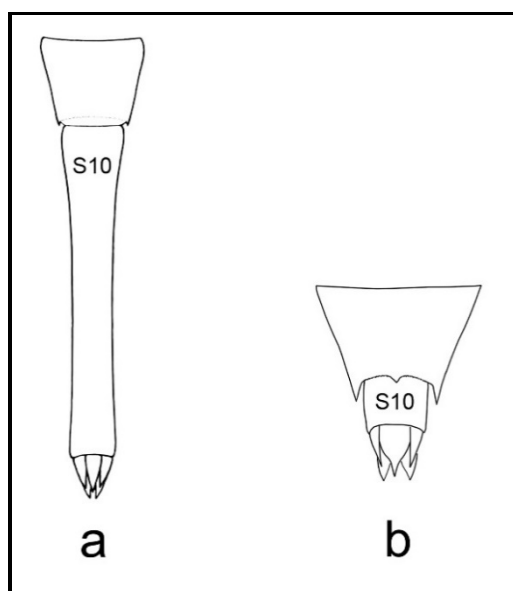


Fig. 7.1. Gomphidae, apex of abdomen, dorsal view: a) *Aphylla williamsoni*; b) *Phanogomphus lividus*.

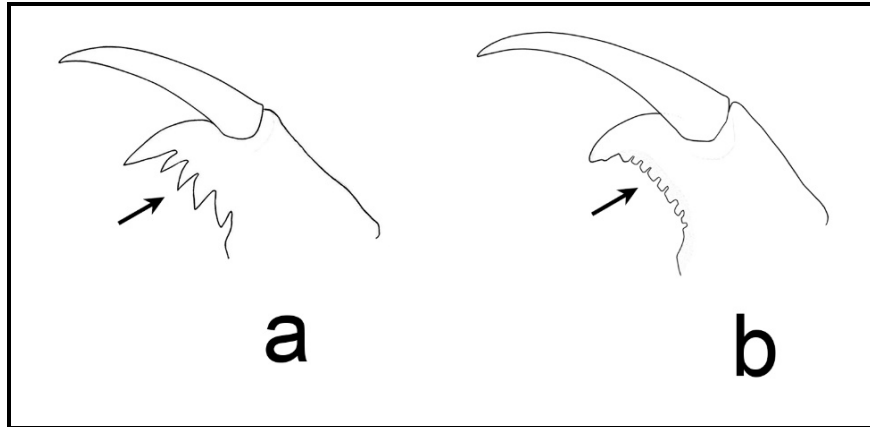


Fig. 7.2. Gomphidae, right labial palp, dorsal view: a) *Aphylla williamsoni*; b) *Phanogomphus lividus*.

2. Abdomen very broad, leaf-shaped (Fig. 7.3a), nearly as wide as long, width of segment 8 at least 6 times its median length; head with 4 dorsal tubercles (Fig. 7.4a); antennal segment 3 nearly as wide as long (Fig. 7.4a) ***Hagenius***
- 2'. Abdomen narrow, fusiform (Fig. 7.3b), longer than wide, width of segment 8 less than 4.5 times its median length; head without dorsal tubercles (Fig. 7.4b); antennal segment 3 only about 1/4 to 2/3 times as wide as long (Fig. 7.4b, 7.7b) **3**

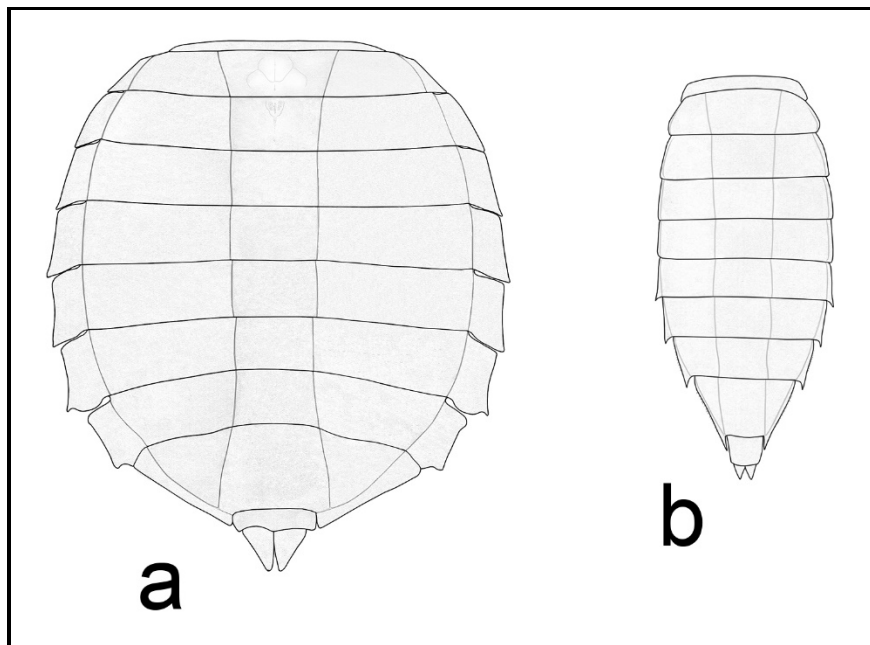


Fig. 7.3. Gomphidae, abdomen, ventral view: a) *Hagenius brevistylus*; b) *Dromogomphus spinosus*.

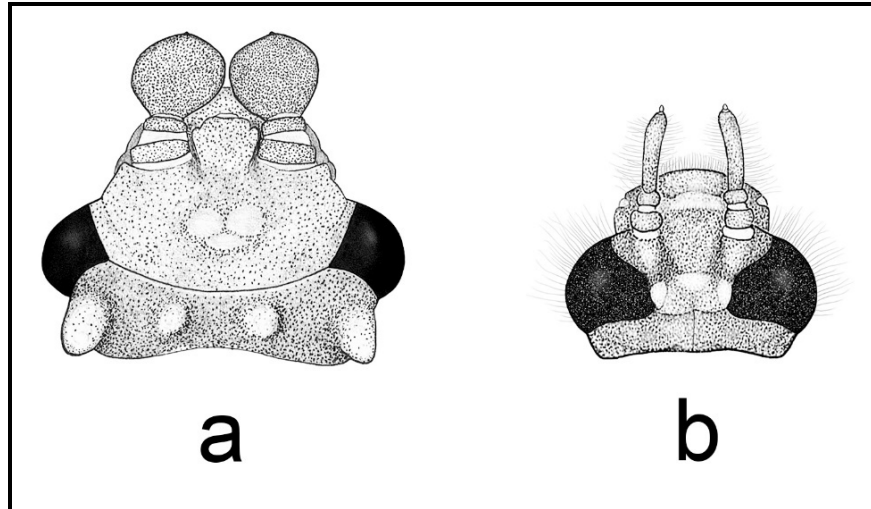


Fig. 7.4. Gomphidae, head, dorsal view: a) *Hagenius brevistylus*; b) *Dromogomphus spinosus*.

3. Wing sheaths divergent (Fig. 7.5a); labial palp with indiscernible end tooth and inner teeth (Fig. 7.6a) or all teeth small and equal in size (Fig. 7.6b); abdominal segment 2 with a middorsal hook.....4
- 3'. Wing sheaths parallel (Fig. 7.5b); labial palp with distinct large end tooth and inner teeth (Fig. 7.6c); abdominal segment 2 without a middorsal hook6

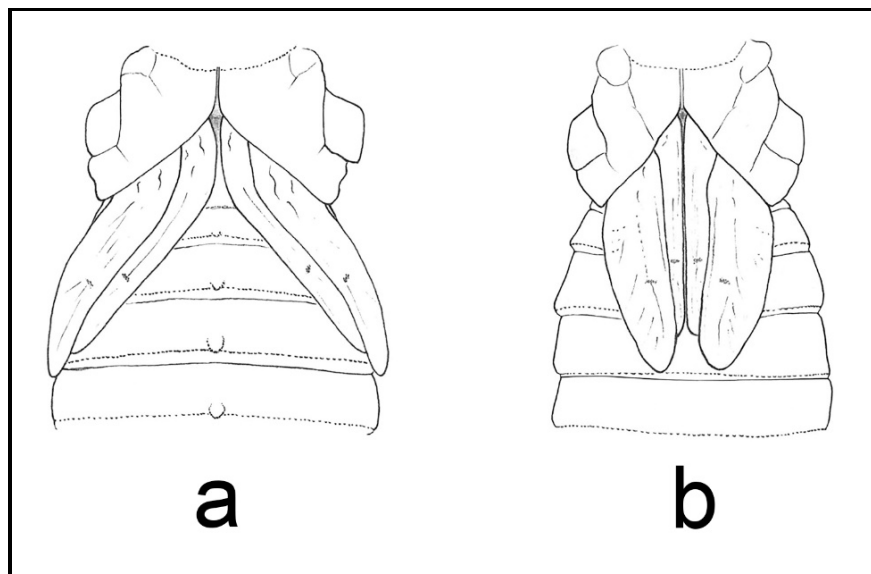


Fig. 7.5. Gomphidae, wing sheath orientation, dorsal view: a) *Ophiogomphus*; b) *Phanogomphus*.

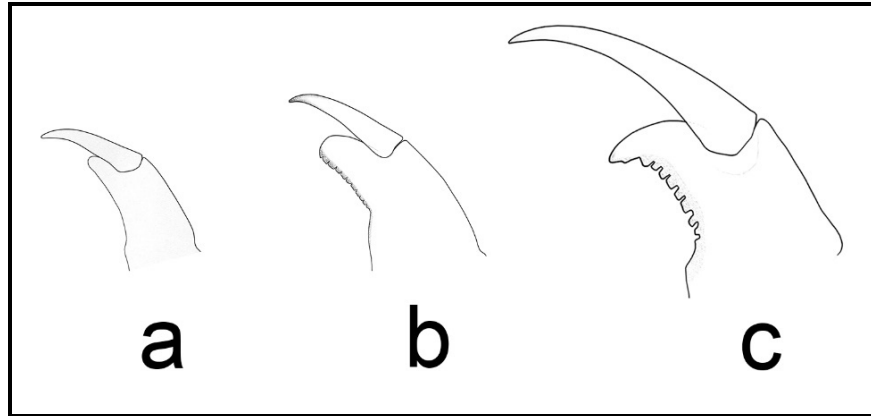


Fig. 7.6. Gomphidae, right labial palp, ental view: a) *Progomphus*; b) *Ophiogomphus*; c) *Phanogomphus*.

- 4. Antennal segment 4 elongate, cylindrical, length about 5 times basal width (Fig. 7.7a); prementum narrow, distal width about half head width (Fig. 7.8a)..... ***Progomphus***
- 4'. Antennal segment 4 short, conical, length about equal to basal width (Fig. 7.7b); prementum wider, distal width greater than half head width (Fig. 7.8b).....**6**

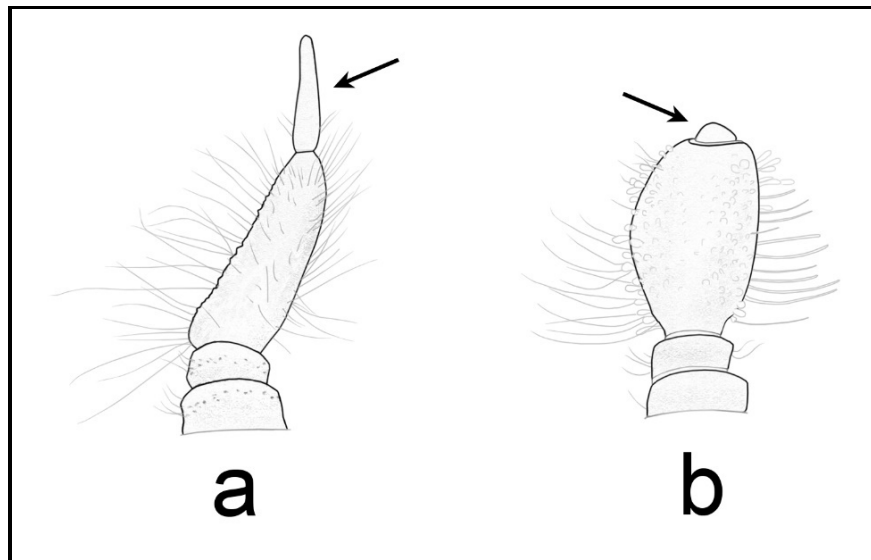


Fig. 7.7. Gomphidae, left antenna, dorsal view: a) *Progomphus*; b) *Ophiogomphus*. Arrow indicates fourth segment.

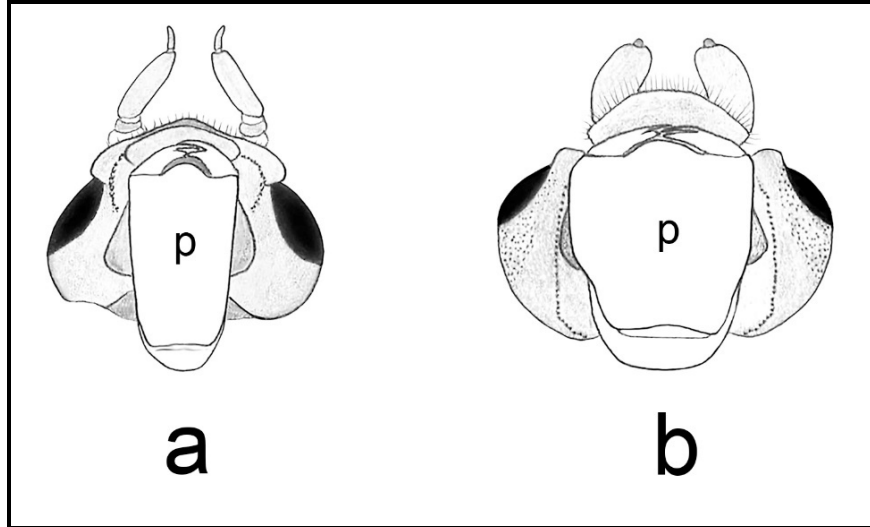


Fig. 7.8. Gomphidae, head and prementum, ventral view: a) *Progomphus*; b) *Ophiogomphus*; p = prementum.

5. Antennal segment 3 in dorsal view narrow, outer margin slightly convex (Fig. 7.9a); posterolateral spine present on abdominal segments 6–9; cerci nearly as long as epiproct (Fig. 7.10a)..... ***Erpetogomphus***
- 5'. Antennal segment 3 in dorsal view wide, outer margin markedly convex (Fig. 7.9b); posterolateral spine present only on abdominal segments 7–9; cerci distinctly shorter than epiproct (Fig. 7.10b) ***Ophiogomphus***

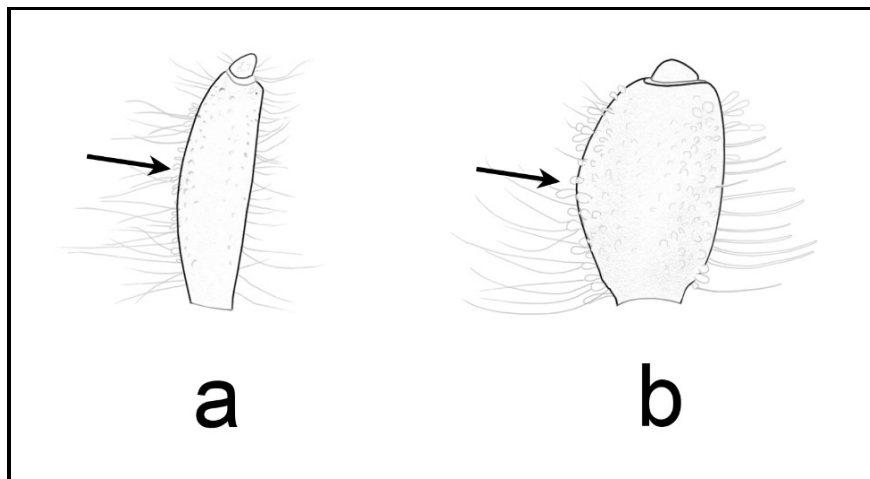


Fig. 7.9. Gomphidae, left antenna, dorsal view: a) *Erpetogomphus designatus*; b) *Ophiogomphus australis*. Arrow indicates outer margin of segment 3.

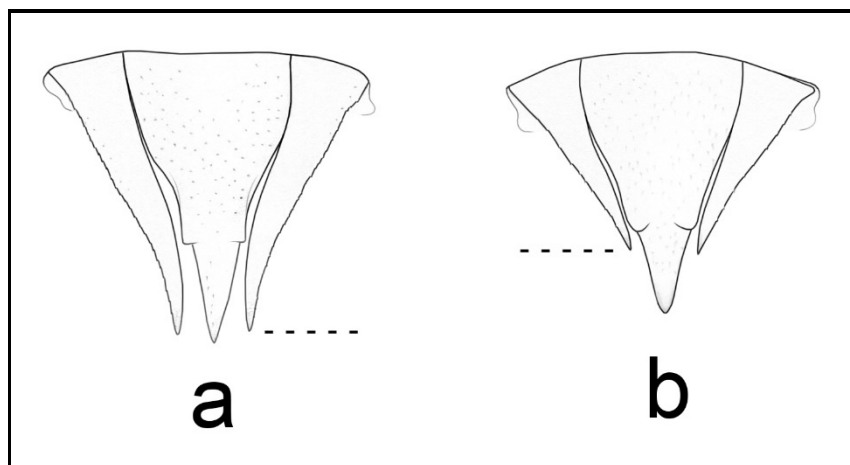


Fig. 7.10. Gomphidae, anal appendages, dorsal view: a) *Erpetogomphus designatus*; b) *Ophiogomphus australis*. Paraprocts omitted for clarity.

6. Abdominal segment 8 with 3 sclerites (Fig. 7.11a); pro- and meso-thoracic tibiae with small burrowing hook less than half width of tibia (Fig. 7.12a); metathoracic femur length about 3/4 times width of head ***Stylurus***
- 6'. Abdominal segment 8 with 5 sclerites (Fig. 7.11b); pro- and meso-thoracic tibiae with large burrowing hook greater than half width of tibia (Fig. 7.12b); metathoracic femur length equal to or greater than width of head **7**

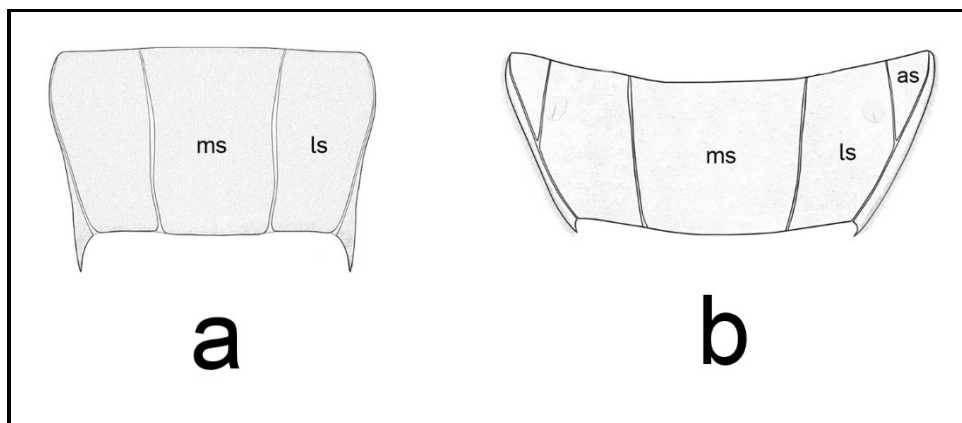


Fig. 7.11. Gomphidae, venter of abdominal segment 8: a) *Stylurus*; b) *Arigomphus*. ms = median sclerite, ls = lateral sclerite, as = anterolateral sclerite.

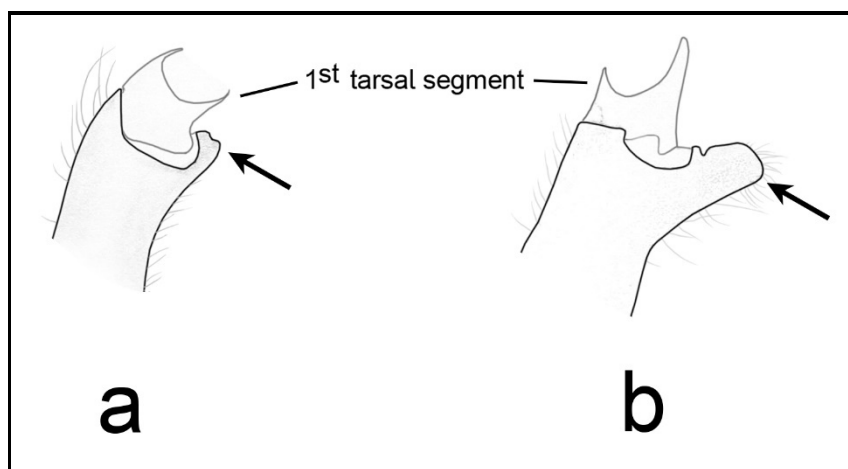


Fig. 7.12. Gomphidae, prothoracic tibia, distal portion: a) *Stylurus*; b) *Arigomphus*. Arrow indicates burrowing hook.

7. Abdomen gradually tapered apically (Fig. 7.13a); abdominal segments 3–9 in lateral view concave along dorsal margin (Fig. 7.14a), usually with a posterior middorsal hook or prominence.....8
- 7'. Abdomen more abruptly tapered apically (Fig. 7.13b); abdominal segments 3–9 in lateral view straight along dorsal margin (Fig. 7.14b), segments 3–6 without a middorsal hook or prominence.....10

[see notes and illustrations on pp. 10–12 for further diagnosis of the following genera]

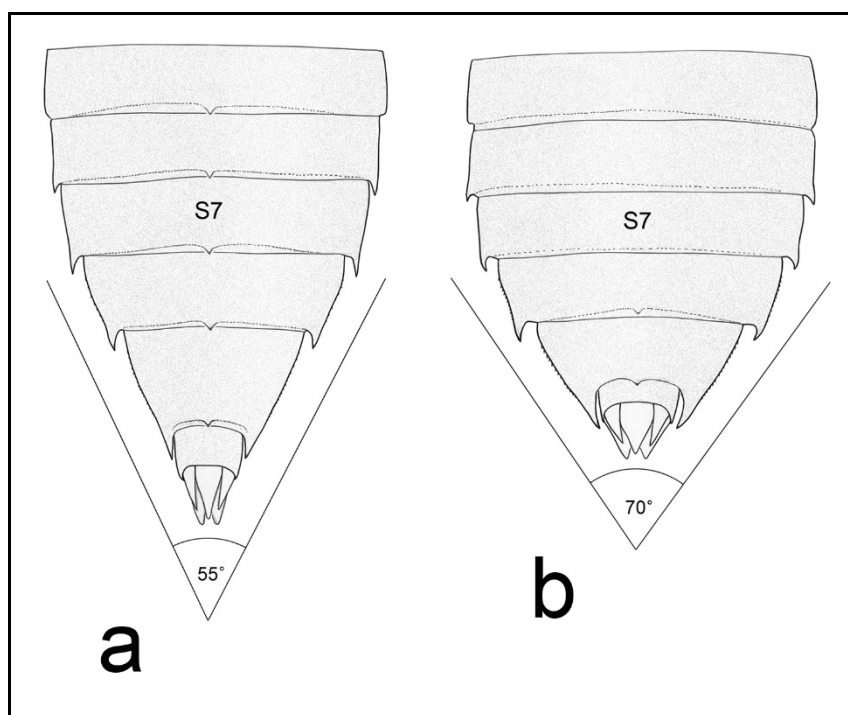


Fig. 7.13. Gomphidae, abdomen, dorsal view: a) *Phanogomphus*; b) *Gomphurus*.

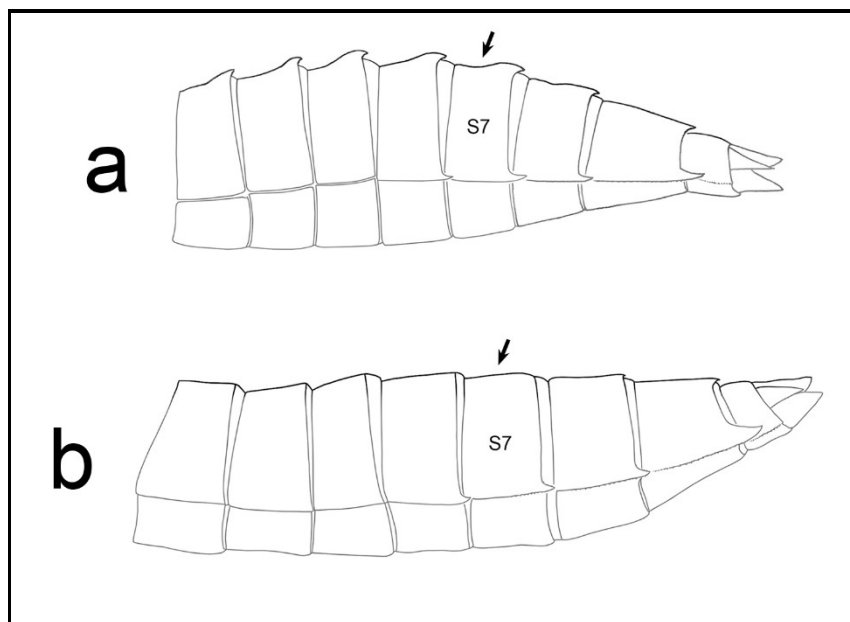


Fig. 7.14. Gomphidae, abdominal segments 3–9, lateral view: a) *Phanogomphus*; b) *Gomphurus*. Arrow indicates dorsal contour of segment 7.

8. Most inner teeth of palpal blade obliquely truncate with a sharp corner (Fig. 7.15a); lateral margin of abdominal segment 9 with very closely-set, short, gray setae and long pale setae but lacking stout spinules (Fig. 7.16a) *Arigomphus*
- 8'. Most inner teeth of palpal blade rounded or irregular without a sharp corner (Fig. 7.15b); lateral margin of abdominal segment 9 with small to prominent stout spinules and a few scattered long setae (Fig. 7.16b) 9

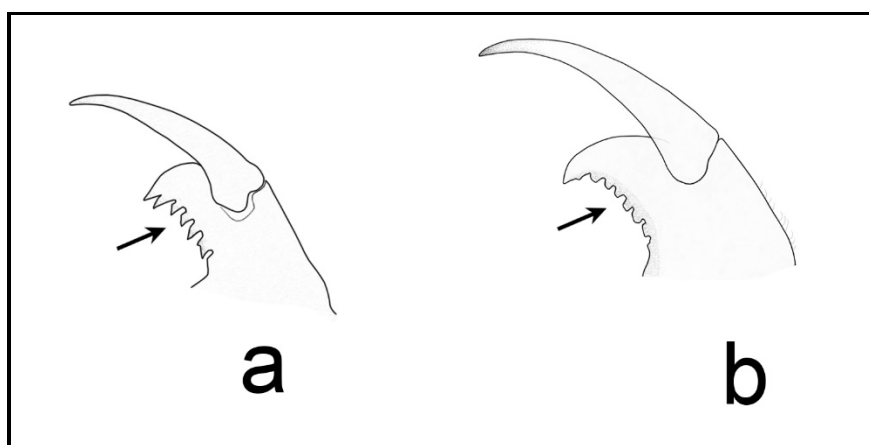


Fig. 7.15. Gomphidae, palpal blade: a) *Arigomphus pallidus*; b) *Dromogomphus spinosus*. Arrow indicates inner teeth.

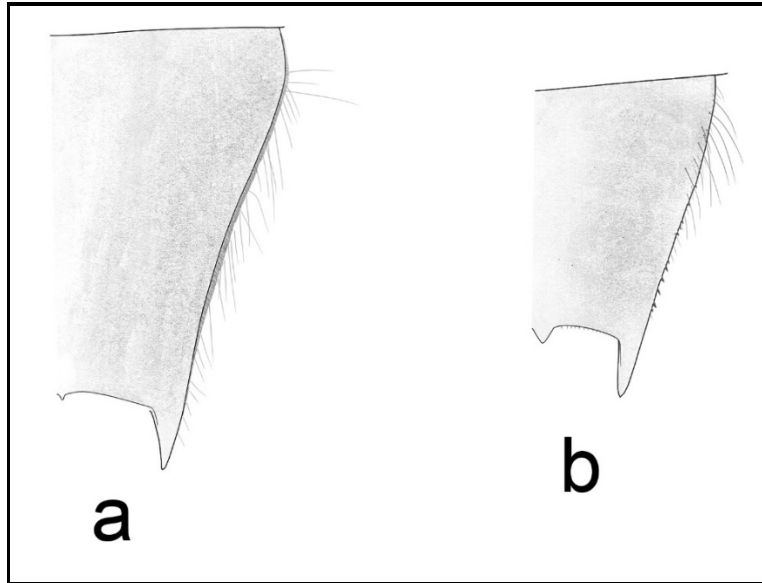


Fig. 7.16. Gomphidae, right lateral margin of abdominal segment 9, dorsal view: a) *Arigomphus pallidus*; b) *Phanogomphus minutus*.

- 9. Abdominal segments 8 and 9 with a dorsal, well-defined median ridge (Fig. 7.17a) that terminates posteriorly as a sharp middorsal hook (Fig. 7.18a); metathoracic femur length greater than 1.2 times head width***Dromogomphus***
- 9'. Abdominal segments 8 and 9 broadly rounded dorsally or with a weakly-defined ridge (Fig. 7.17b) that terminates posteriorly with a small, low middorsal hook (Fig. 7.18b); metathoracic femur length less than 1.2 times head width***Phanogomphus***

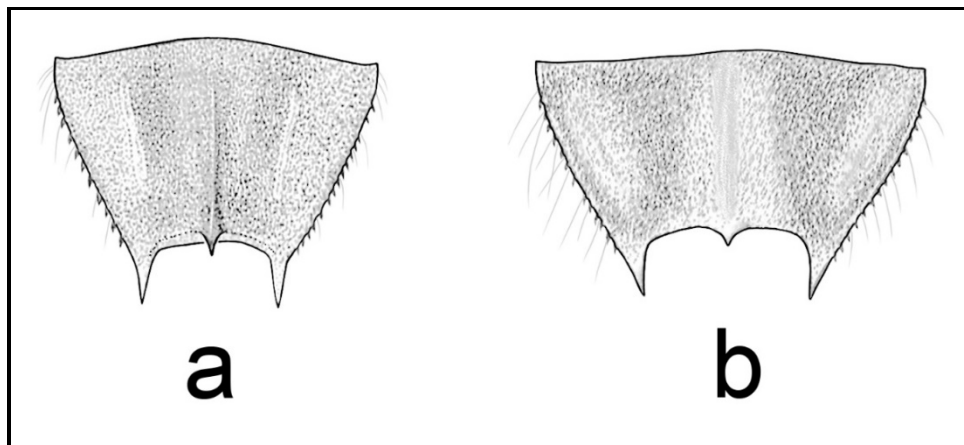


Fig. 7.17. Gomphidae, abdominal segments 8 and 9, dorsal view: a) *Dromogomphus*; b) *Phanogomphus*.

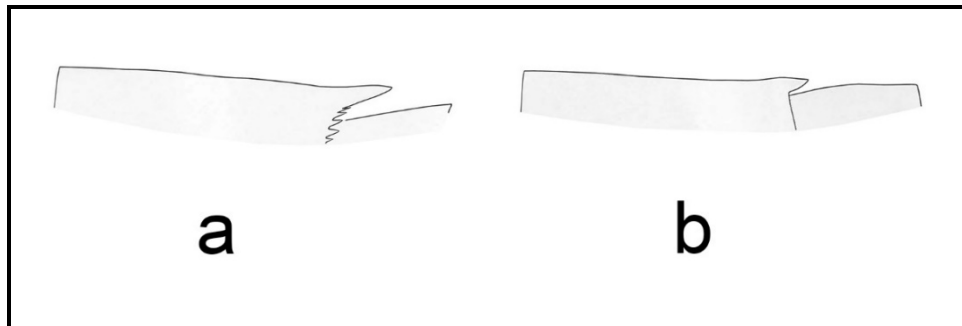


Fig. 7.18. Gomphidae, abdominal segment 9 dorsum, lateral view: a) *Dromogomphus*; b) *Phanogomphus*.

- 10. Abdominal segment 8 with a small middorsal hook (Fig. 7.19a); anterolateral sclerites on venter of abdominal segment 7 $\leq$ half segment length 7 (Fig. 7.20a); length of posterolateral spine on segment 9 > 1.6 times length of spine on segment 8 ***Gomphurus***
- 10'. Abdominal segment 8 without a middorsal hook (Fig. 7.19b); anterolateral sclerites on venter of abdominal segment 7 $>$ half segment 7 length (Fig. 7.20b); length of posterolateral spine on segment 9 ≤ 1.4 times length of spine on segment 8 ***Hylogomphus***

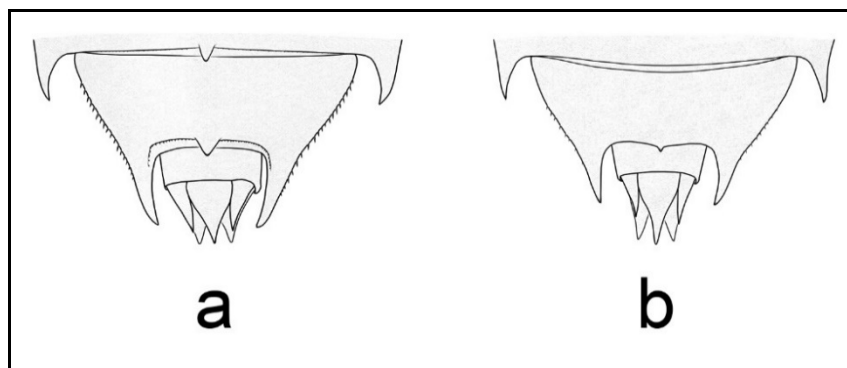


Fig. 7.19. Gomphidae, abdominal segments 9 and 10, dorsal view (fine setae omitted): a) *Gomphurus*; b) *Hylogomphus*.

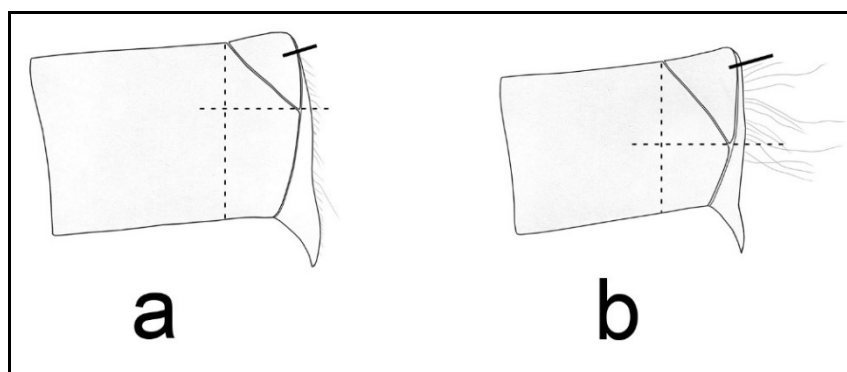


Fig. 7.20. Gomphidae, venter of abdominal segment 7, showing anterolateral sclerite, left side: a) *Gomphurus*; b) *Hylogomphus*. Black line indicates anterolateral sclerite; intersection of dashed lines indicates sclerite length relative to segment length.

Generic Notes:

The first three genera that are separated in the key (*Aphylla*, *Hagenius* and *Progomphus*) should pose no recognition problems even with early instars. The body shapes of *Aphylla* and *Hagenius* are unique, and the elongate antennal segment 4 of *Progomphus* is distinctive.

Erpetogomphus and *Ophiogomphus* closely resemble each other. Fortunately in Florida, the presence/absence of a posterolateral spine on segment 6 provides a clear dichotomy (couplet 5); in other regions of the U.S., this character is variable and will not separate the genera. In addition to the characters in couplet 5, there is a difference in the spacing between the coxae: in *Erpetogomphus*, the gap between the mesothoracic coxae is slightly greater than or about equal to the gap between the prothoracic coxae (Fig. 7.21a) whereas in *Ophiogomphus*, the gap between the mesothoracic coxae is less than the gap between the prothoracic coxae (Fig. 7.21b); although consistent, the difference is slight and therefore I did not include it in the key. The two characters discussed in this diagnosis apply to earlier instars with small wing sheaths. A word of caution on the relative lengths of cerci and epiproct: in early instars, cerci do not develop at the same rate as most other structures, therefore they are notably shorter than the epiproct in early instar *Erpetogomphus*.

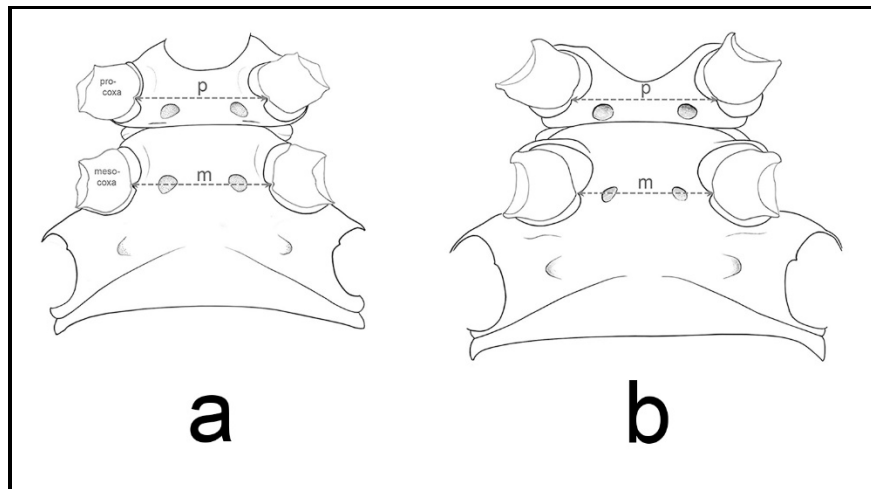


Fig. 7.21. Gomphidae, thorax, ventral view: a) *Erpetogomphus*; b) *Ophiogomphus*. p = gap between prothoracic processes, m = gap between mesothoracic processes.

Stylurus nymphs more closely resemble *Arigomphus* and *Gomphurus* than the other genera. In addition to couplet 6, the morphology of the palpal teeth offer a helpful character: in *Stylurus*, the end tooth is large and there are usually only 2–4 inner teeth (Fig. 7.22a,b); in the other genera, the end tooth is usually smaller and there are usually 5–7 inner teeth (Fig. 7.22c,d) except for a few *Gomphurus* and *Hylogomphus* species with only 4 inner teeth (Fig. 7.22e).

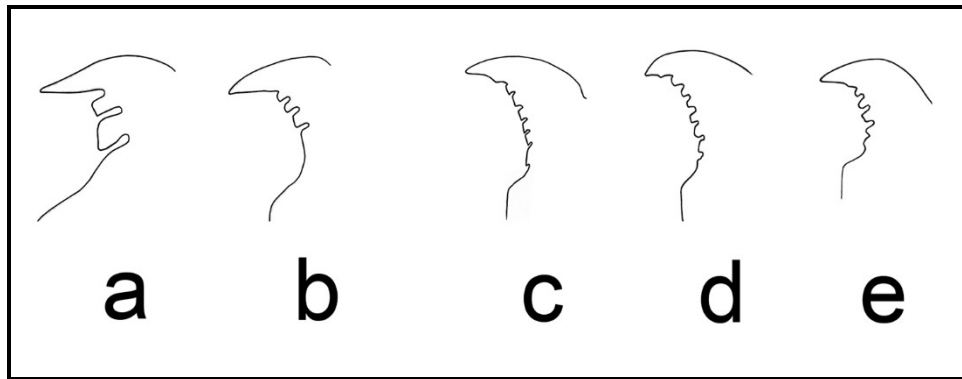


Fig. 7.22. Gomphidae, right labial palp: a) *Stylurus ivae*; b) *S. plagiatus*; c) *Phanogomphus hodgesi*; d) *Dromogomphus spinosus*; e) *Hylogomphus geminatus*.

A character that supplements the dichotomy presented in couplet 7 is the presence of a fine, pale, middorsal groove on abdominal segments 4–7 in *Gomphurus* and *Hylogomphus* (Fig. 23a) that is lacking in *Arigomphus*, *Dromogomphus* and *Phanogomphus* (Fig. 7.23b). The fine groove is often covered with silt and can be difficult to see. Continuing beyond couplet 7, the overall shape and appearance of *Arigomphus* nymphs make them stand out from the remaining four genera even in the field, although some experience is necessary in order to consistently recognize their form. Therefore, the key characters in couplet 8 should be consulted before a final determination is made.

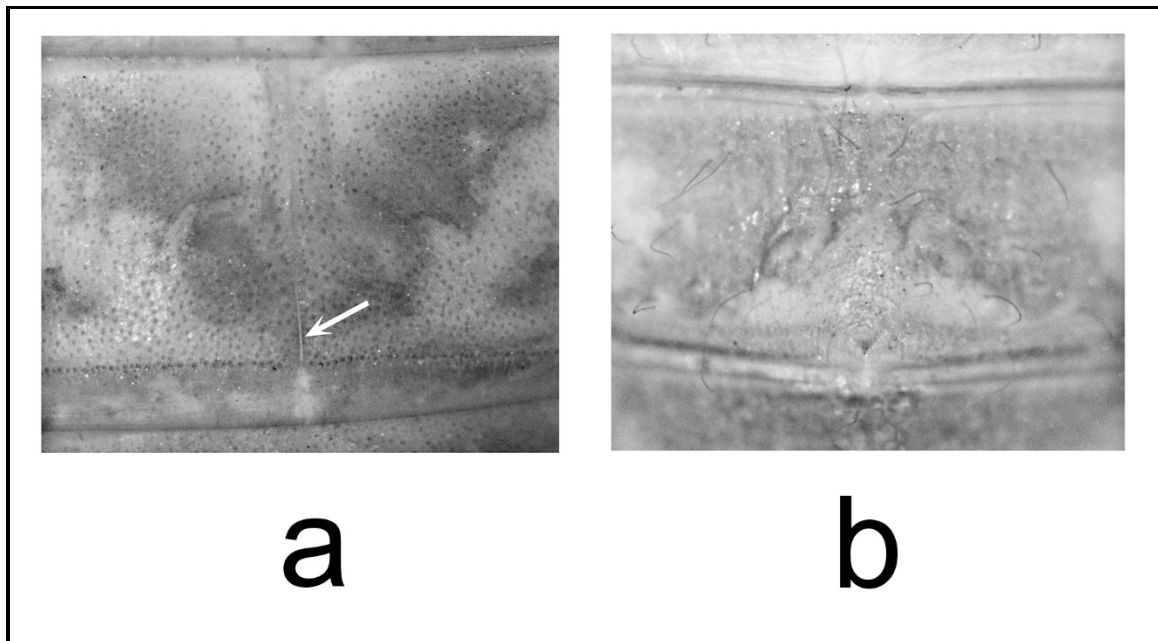


Fig. 7.23. Gomphidae, middorsum of abdominal segment 7: a) *Gomphurus*; b) *Phanogomphus*.

Most of the difficulties with identifying gomphid genera involve two closely related pairs of genera, i.e., distinguishing *Dromogomphus* from *Phanogomphus*, and *Gomphurus* from *Hylogomphus*. Separation of *Dromogomphus* and *Phanogomphus* depends on critically examining the middorsal ridge on abdominal segments 8 and 9 — the ridge is darkened and more defined in *Dromogomphus* compared to the same color as the rest of the dorsum of segment 9 and not as

clearly defined in *Phanogomphus*. If in doubt, compare metathoracic femur length and head width as stated in couplet 9. Early instars can be especially problematic. In Florida, most *Gomphurus* are larger than the single *Hylogomphus* species, although there is overlap in total length regarding one of the *Gomphurus* species (total length of *G. hybridus* F-0 varied from 22.1–26.0 mm compared to 21.5–25.4 mm for *H. geminatus* F-0). Metathoracic femur length helps distinguish F-0: greater than 5.0 mm in the smallest *Gomphurus* species and less than 5.0 mm in the *Hylogomphus* species. Also, the setal bases on the abdominal dorsum are larger and fewer in number in *Hylogomphus* versus smaller and more numerous in *Gomphurus*. All four *Gomphurus* species in Florida have a middorsal hook on abdominal segment 8 (Fig. 7.19a) whereas the *Hylogomphus* species lacks a middorsal hook on this segment in all instars. The segment 8 middorsal hook is present in *Gomphurus* as early as instar F-5 (instars earlier than F-5 were not available for examination).

The genera *Phanogomphus*, *Gomphurus* and *Hylogomphus* were historically included in the Old World genus *Gomphus* Leach. Ware et al. (2017) elevated these taxa, along with *Stenogomphurus* Carle (distribution Appalachian), to generic status. As a result, *Gomphus* sensu stricto is no longer part of the New World fauna.

Table 7.1. Summary of size measurements (mm) for the eleven genera of Gomphidae in Florida, for instar F-0.

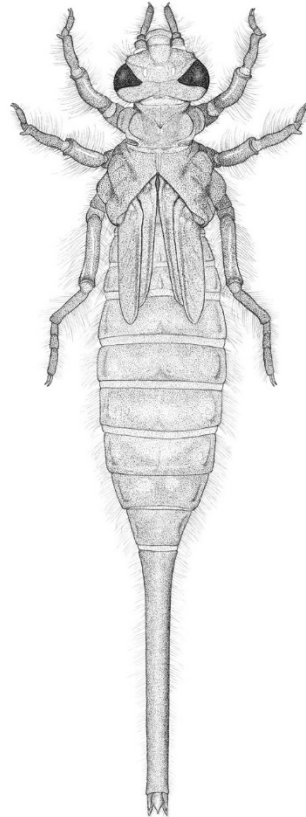
Genus	# Spp. in Florida	Total Length	Head Width	Premenum Length	Premenum Max Width	Epiproct Length
<i>Aphylla</i>	1	53.5–58.0	6.40–6.70	4.55–5.00	3.60–4.15	1.05–1.40
<i>Arigomphus</i>	1	35.5–40.8	6.10–6.55	3.90–4.25	3.05–3.25	1.35–1.45
<i>Dromogomphus</i>	2	27.6–39.3	5.40–6.20	3.15–4.55	2.60–3.90	1.25–1.75
<i>Erpetogomphus</i>	1	20.2–25.0	4.70–5.40	2.15–3.15	2.30–2.85	1.65–2.00
<i>Gomphurus</i>	4	22.1–39.2	4.80–6.60	2.60–4.30	2.45–3.75	1.10–1.55
<i>Hagenius</i>	1	34.7–42.0	7.30–8.80	4.15–4.85	4.30–5.30	2.00–2.40
<i>Hylogomphus</i>	1	21.5–24.0	4.40–5.35	2.85–3.25	2.40–2.85	1.15–1.30
<i>Ophiogomphus</i>	1	19.6–22.5	4.70–5.30	2.95–3.35	2.55–2.85	1.40–1.70
<i>Phanogomphus</i>	7	20.2–42.5	4.40–6.20	2.55–4.15	2.20–3.50	1.03–1.60
<i>Progomphus</i>	3	22.8–32.0	4.15–5.70	2.60–3.75	1.80–2.45	1.95–2.60
<i>Stylurus</i>	5	25.6–36.1	4.85–6.25	3.40–4.95	2.60–3.50	1.00–1.85

Gomphidae Generic Treatments

A total of 27 species of Gomphidae occur in Florida. One genus, *Hagenius*, is monotypic, and five genera have only one species in Florida. Species determinations in genera with multiple species are often challenging and microscopic detail and accurate measurement are required. The following key to genus should be used only for Florida specimens.

Aphylla

Elongate, slender,
light brown; antennal
segment 3 long, slender;
wing sheaths slightly
divergent; abdominal
segment 10 tubular,
very elongated



Aphylla is a large Neotropical genus, however only one species, *A. williamsoni*, occurs in Florida.

Diagnosis:

Aphylla nymphs are unmistakable in all instars due to the elongation of abdominal segment 10. The only other New World genus with a similar abdomen is *Phyllocycla* Calvert, a Neotropical genus which has not been found in Florida. The labial palp and ligula of *Aphylla* (Fig. 7.24) differ greatly from those of *Phyllocycla* (see Tennessen 2019a).

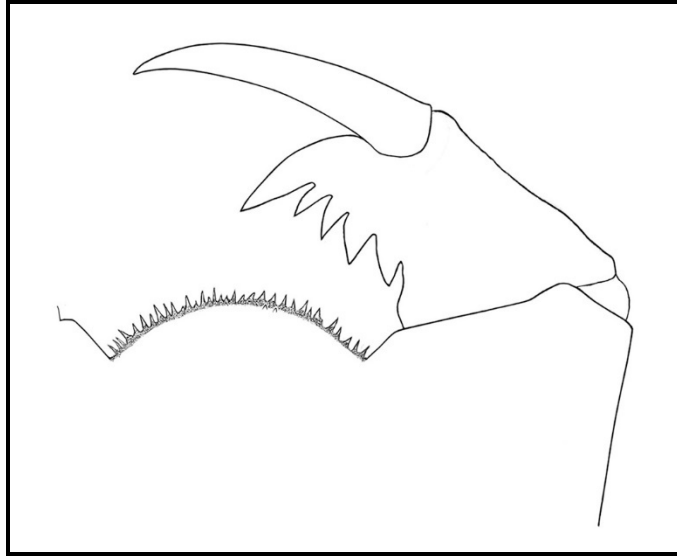


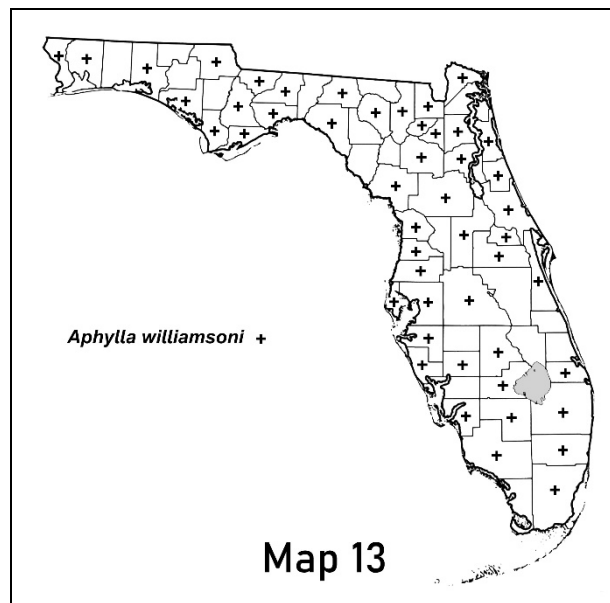
Fig. 7.24. *Aphylla williamsoni*, right labial palp and ligula.

Habitat, Distribution, Life Cycle:

Aphylla nymphs typically inhabit lotic waters, including ponds and lakes with a thick layer of mud/silt over sand (Byers 1930); the nymphs are occasionally found in slow-flowing canals.

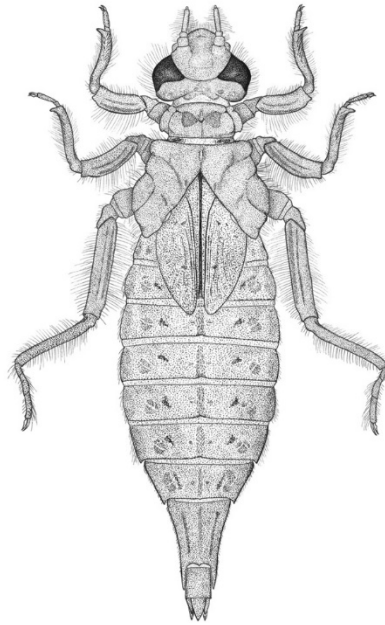
Aphylla williamsoni occurs throughout the state (Map 13). It emerges in the spring in Florida and flies until fall. Recorded flight season in the state ranges from April 7 to November 7.

Voltinism in *Aphylla* is apparently unknown; two size classes in benthic samples indicate that *A. williamsoni* is semivoltine.



Arigomphus

Elongate but stocky, tan to dark brown; antennal segment 3 long, slender; wing sheaths parallel; abdomen gradually tapered to elongate apex



Arigomphus is confined to North America with two species in Florida.

Key to *Arigomphus* Species

1. Posterolateral spines on abdominal segment 9 approximately 1/2 the ventral length of segment 10; F-0 metathoracic femur length < 6.5 mm, abdominal segment 10 length < 2.0 mm, and epiproct length < 1.3 mm *maxwelli*
- 1'. Posterolateral spines on abdominal segment 9 approximately 1/4 the ventral length of segment 10; F-0 metathoracic femur length > 7.0 mm, abdominal segment 10 length > 2.2 mm, and epiproct length > 1.3 mm *pallidus*

Diagnostic Remarks:

The elongate tip of the abdomen distinguishes *Arigomphus* nymphs from most other taxa. Taken in combination with the shape of the palpal teeth (Fig. 7.15a), the dorsomedial, longitudinal row of tightly clustered setae on abdominal segment 4–9 in southeastern species (Fig. 7.25), and the lack of stout spinules on the lateral margins of segment 9, the genus can be quite easily recognized, even in earlier instars. *Arigomphus pallidus* is usually larger than *A. maxwelli*: F-0 total length > 35 mm versus < 35 mm and head width > 6.0 mm versus < 6.0 mm.

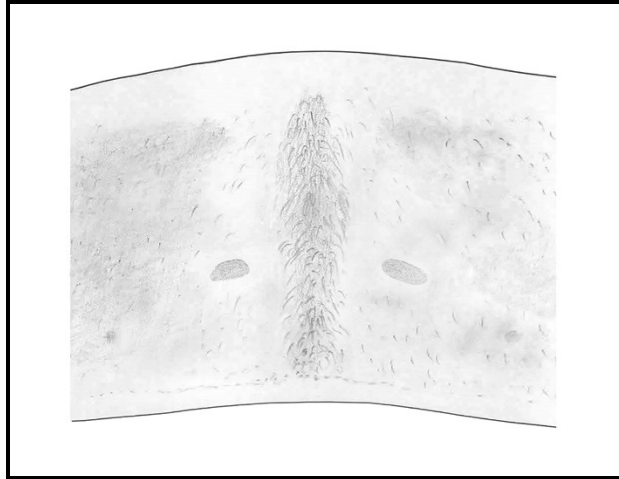


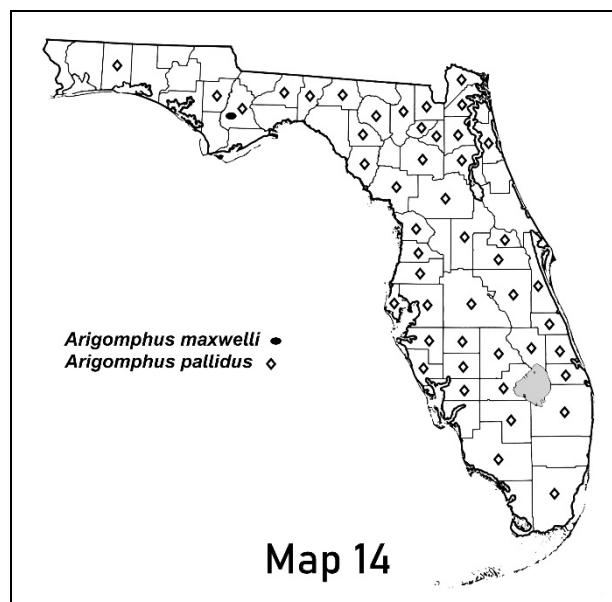
Fig. 7.25. *Arigomphus*, abdominal segment 6 middorsum.

Habitat, Distribution, Life Cycle:

Arigomphus nymphs inhabit both lentic and lotic waters, including ponds, lakes, swamps, and slow-flowing canals and small to mid-sized streams with mud substrates. *Arigomphus maxwelli* typically occupies small, slow muddy streams whereas *A. pallidus* prefers ponds, lakes, and swamps (often margined with cypress trees) but is also found occasionally in slow streams.

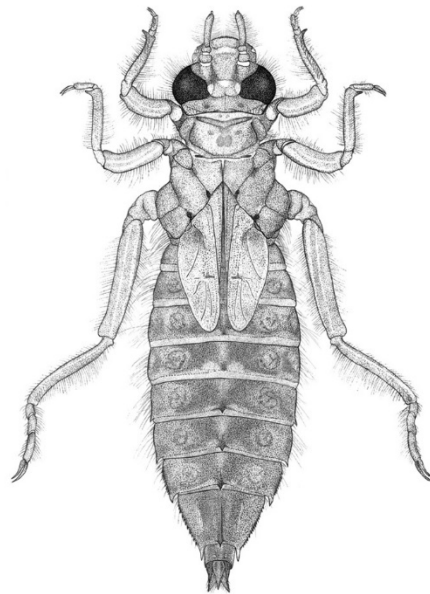
Arigomphus maxwelli was recently recorded in Florida based on a single observation in Liberty County whereas *A. pallidus* occurs throughout the state (Map 14).

The only flight date known for *A. maxwelli* in Florida is May 11; it probably flies at least a month earlier than that and may continue into June. *Arigomphus pallidus* emerges in the spring in Florida and flies until fall. Recorded flight season in the state ranges from March 20 to October 11. Voltinism in *Arigomphus* is uncertain; two size classes in benthic samples indicate that both species are semivoltine.



Dromogomphus

Elongate, stocky, dark brown; antennal segment 3 long, slender; wing sheaths parallel; legs long; abdomen gradually tapered, middorsal ridge on segments 8 and 9



Dromogomphus contains three species, two of which occur in Florida.

Key to *Dromogomphus* Species

1. Ligula convex (Fig. 7.26a); abdominal segments 7–9 with a posterolateral spine; segments 5 and 6 without a definite middorsal hook (Fig. 7.27a).....***armatus***
- 1'. Ligula straight to slightly concave (Fig. 7.26b); abdominal segments 6–9 with a posterolateral spine; segments 5 and 6 with a middorsal hook (Fig. 7.27b)..... ***spinosus***

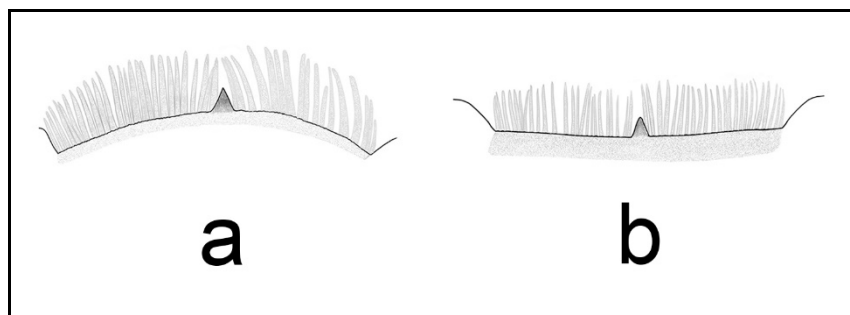


Fig. 7.26. *Dromogomphus* ligula: a) *D. armatus*; b) *D. spinosus*.

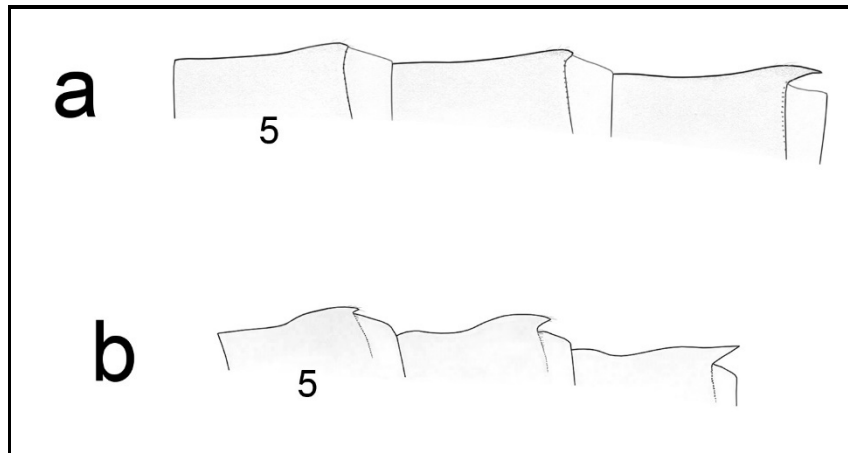


Fig. 7.27. *Dromogomphus* abdominal segments 5–7, lateral view: a) *D. armatus*; b) *D. spinosus*.

Diagnostic Remarks:

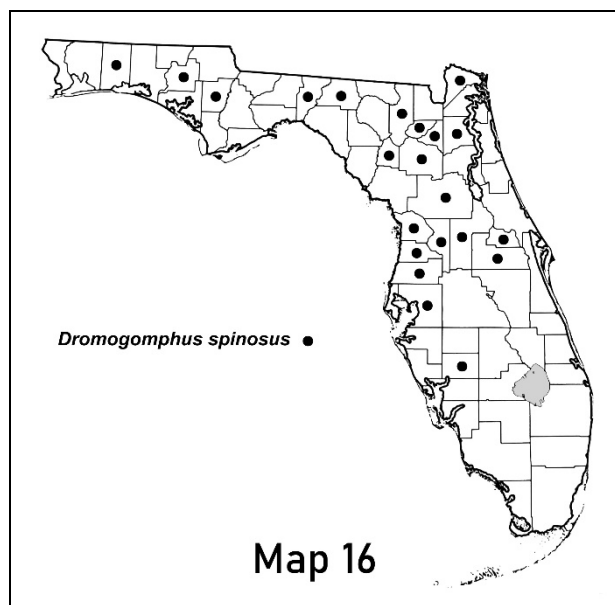
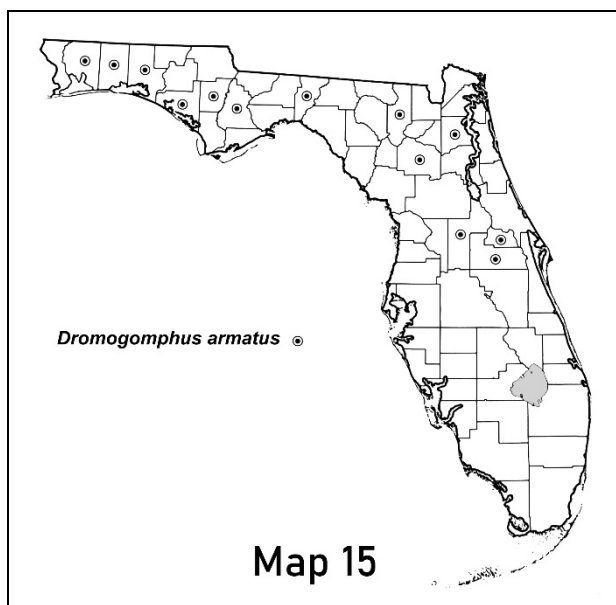
Dromogomphus is most closely related to *Phanogomphus* (Ware et al. 2017), a conclusion corroborated by nymph morphology. The ligula of *D. spinosus* is rarely slightly convex, requiring examination of the abdominal characters; the key characters to differentiate the species apply to instars back to F-4. Also, the dark median ridge on segments 8 and 9 is more pronounced in *D. armatus* than in *D. spinosus*.

Habitat, Distribution, Life Cycle:

Dromogomphus nymphs inhabit both lentic and lotic waters, including ponds, lakes, and small to large streams. *Dromogomphus armatus* inhabits small streams, mostly 1st to 3rd order mucky streams with slow flow, whereas *D. spinosus* is found in lentic waters and larger streams with faster flow.

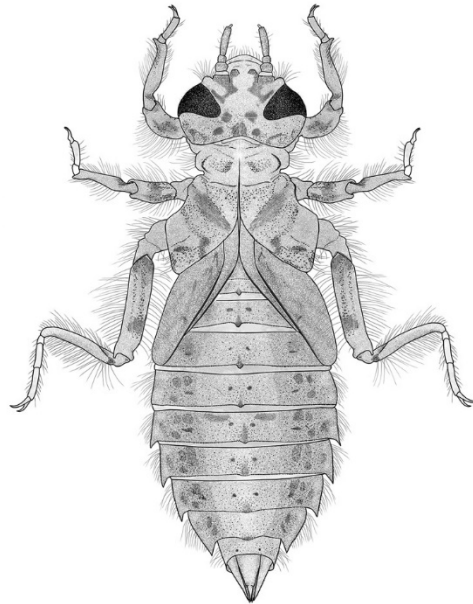
Dromogomphus armatus is found sporadically from the panhandle to about halfway down the peninsula (Map 15). *Dromogomphus spinosus* has a slightly more southern range (Map 16) and is more commonly encountered.

Dromogomphus spinosus emerges earlier in the spring than *D. armatus*; both species fly until fall. Recorded flight season in the state for *D. armatus* is from June 9 to November 20, and for *D. spinosus* from April 14 to November 11. Both *Dromogomphus* species may be semivoltine in Florida, but definitive studies are lacking.



Erpetogomphus

Compact, tan to brown; antennal segment 3 elongate; wing sheaths divergent; abdominal segment 2–9 with middorsal hooks that decrease in size on posterior segments



Erpetogomphus is mainly a Neotropical group with one species occurring in Florida, *E. designatus*.

Diagnosis:

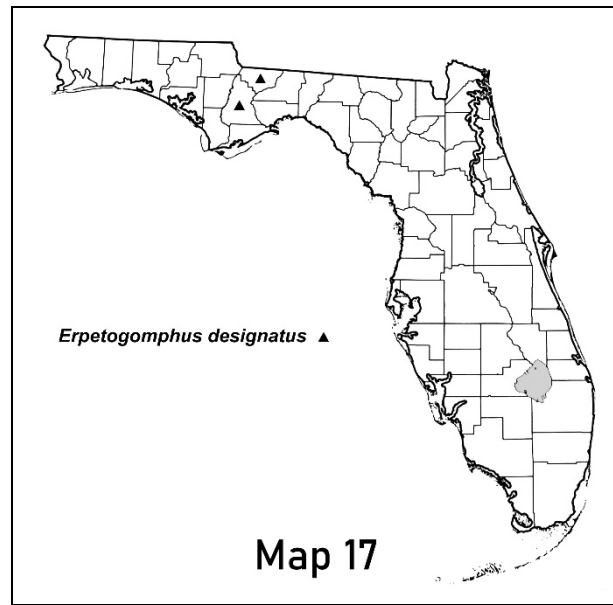
Erpetogomphus is most likely to be mistaken for *Ophiogomphus*. The ligula, palpal blades, and divergent wing sheaths are almost identical. Careful adherence to the key characters and the Generic Diagnosis under *Ophiogomphus* should result in correct identification of instars as early as F-5.

Habitat, Distribution, Life Cycle:

Erpetogomphus nymphs inhabit lotic waters, mainly mid-sized to larger streams with moderate flow and substrates of sand mixed with fine to coarse gravel.

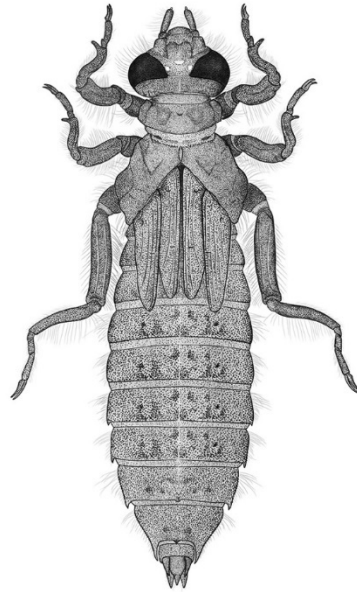
Erpetogomphus designatus has been recorded in only two counties in the panhandle (Map 17); the records are based on adults seen near the Apalachicola River.

Recorded flight season in the state for *E. designatus* is from June 1 to August 9. Studies on voltinism in *Erpetogomphus* are lacking; size classes in samples indicate at least a two-year life cycle.



Gomphurus

Elongate, stocky, dark brown; wing sheaths parallel; abdomen abruptly tapered, with fine middorsal groove on segments 4–8; segments 8 and 9 with small middorsal hooks



Gomphurus is a North American genus with four species in Florida.

Key to *Gomphurus* Species

1. End tooth of palpal blade slightly larger than or subequal with adjacent inner tooth, and 5–7 inner teeth in generally straight alignment (Fig. 7.28a); width of ligula about 0.6–0.7 times length of palpal blade..... ***hybridus***
- 1'. End tooth of palpal blade large, at least twice size of adjacent inner tooth, and 3–5 inner teeth (usually 4) in curved alignment (Fig. 7.28b); width of ligula about 0.5–0.6 times length of palpal blade..... **3**

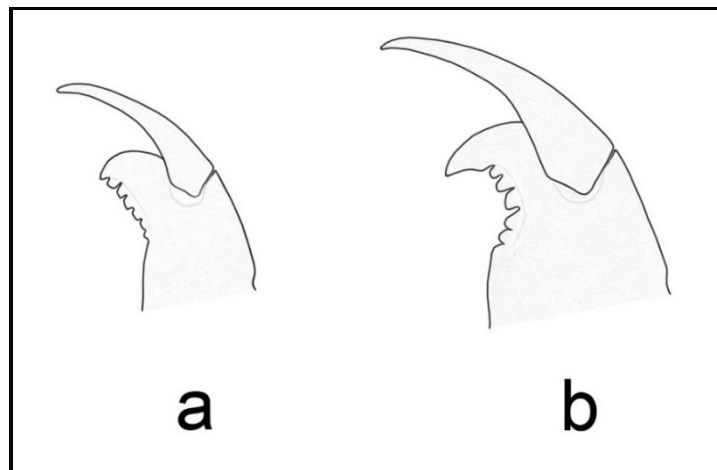


Fig. 7.28. *Gomphurus* labial palp: a) *G. hybridus*; b) *G. dilatatus*.

2. Venter of abdominal segment 9 with about 5–10 very small spinules on posterior margin of median sclerite, near base of posterolateral spine (Fig. 7.29a); segment 9 posterolateral spine 0.70–1.05 mm long; metathoracic femur length ≤ 5.8 mm **vastus**
- 2'. Venter of abdominal segment 9 without spinules on posterior margin of median sclerite (Fig. 7.29b); segment 9 posterolateral spine 1.20–1.50 mm long; metathoracic femur length ≥ 5.8 mm **3**

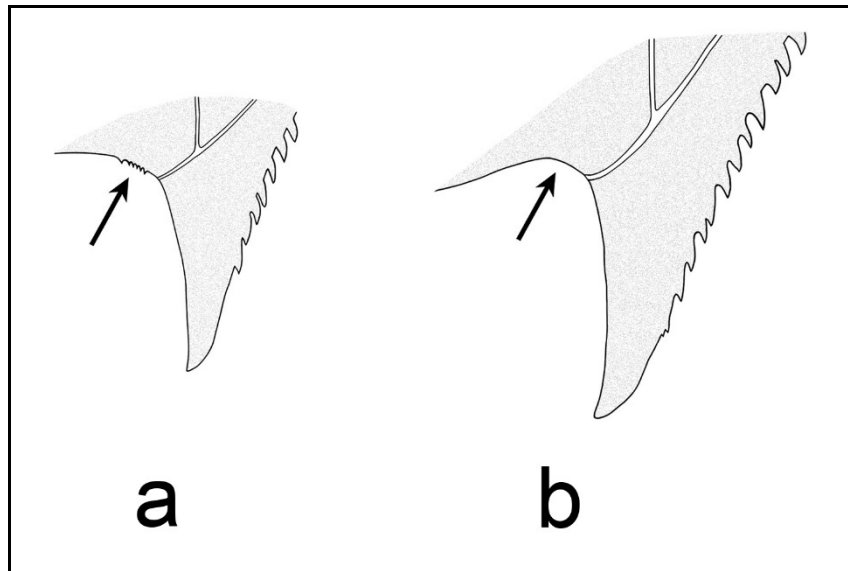


Fig. 7.29. *Gomphurus*, posterior margin of abdominal segment 9, left side, ventral view: a) *G. vastus*; b) *G. dilatatus*. Arrow indicates posterior margin of median sclerite.

3. Abdominal segment 9 middorsal hook acute (Fig. 7.30a); ligula with dark setae shorter than end tooth of palpal blade (0.15–0.16 mm long) **dilatatus**
- 3'. Abdominal segment 9 middorsal hook forming a right angle (Fig. 7.30b); ligula with pale setae as long as end tooth of palpal blade (0.20–0.22 mm long) **modestus**

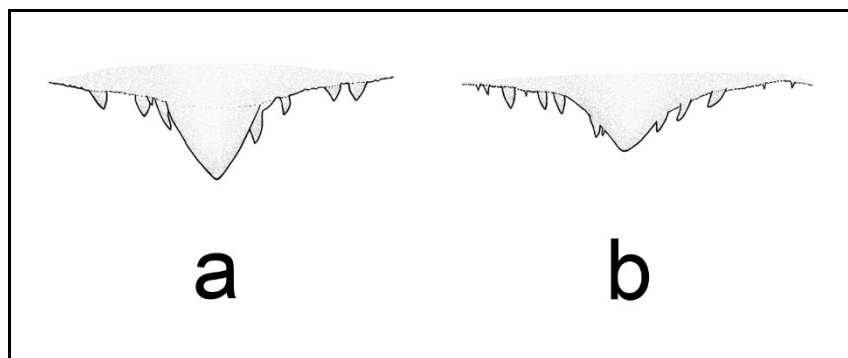


Fig. 7.30. *Gomphurus*, abdominal segment 9 middorsal hook: a) *G. dilatatus*; b) *G. modestus*.

Diagnostic Remarks:

Gomphurus nymphs most closely resemble *Hylogomphus*, but all species possess a middorsal hook on abdominal segment 8 which is lacking in *Hylogomphus*. *Gomphurus hybridus* is the only species in Florida in which the palpal blade has a small end tooth and a high number of inner teeth (usually 6).

The remaining three species have a large end tooth and only 3–5 inner teeth. *Gomphurus vastus* is typically smaller than the other two species, total length ranging from 25.7 to 30.4 mm versus 32.5 to 39.2 mm for *G. dilatatus* and 28.5 to 35.5 mm for *G. modestus*. When in doubt about *G. vastus*, check the posterior margin of abdominal segment 9 for small spinules (as shown in Fig. 7.28a) under 20X magnification or higher, being sure the margin is clear of foreign material.

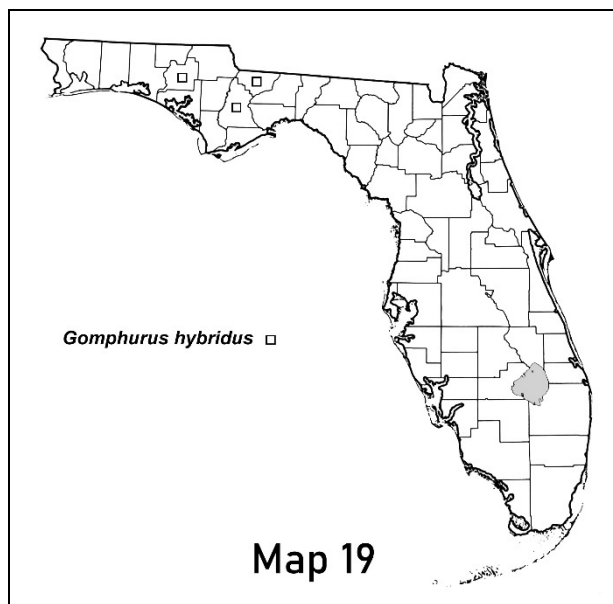
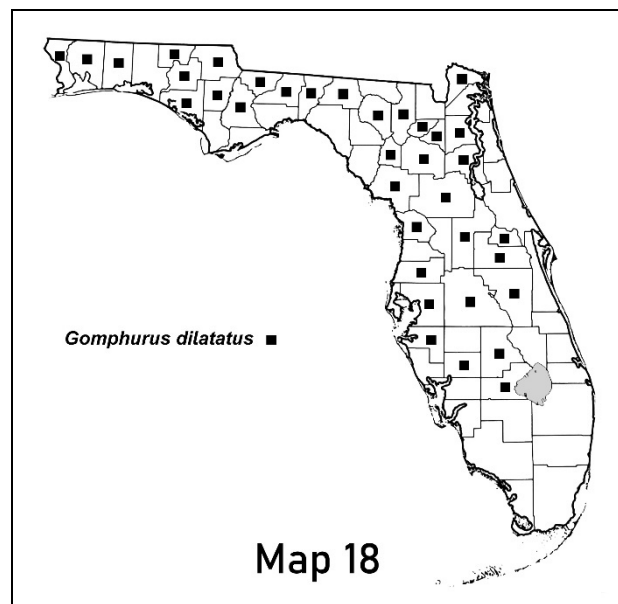
Gomphurus dilatatus and *G. modestus* are difficult to distinguish; the alleged distinction proposed by Westfall (1974), based on the number of spinules on the lateral margin of segment 9, is variable and overlaps between these two species (Tennessee 2019a). I know of no other differences besides the characters in couplet 3 above.

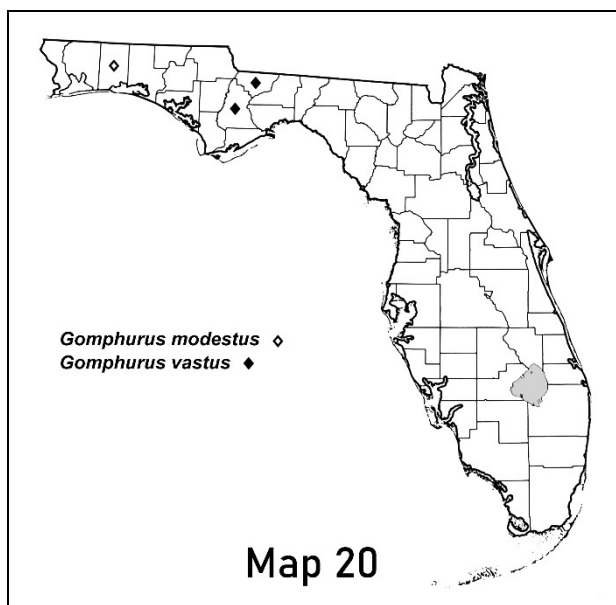
Habitat, Distribution, Life Cycle:

Gomphurus nymphs inhabit lotic waters, mainly mid-sized to large streams with moderate to rapid flow.

Gomphurus dilatatus is the most common and wide-spread member of the genus in Florida, ranging as far south in the peninsula as Glades County (Map 18). The other three species are confined to the panhandle. *Gomphurus hybridus* has been recorded in three counties (Map 19), *G. modestus* in one (Map 20) and *G. vastus* in two (Map 20).

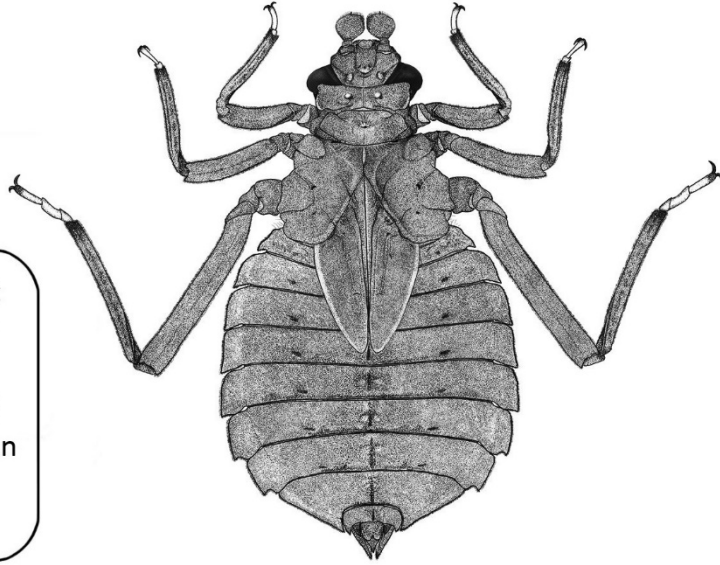
Recorded flight season in the state for *G. dilatatus* is from March 3 to August 27, *G. hybridus* from March 20 to April 26, *G. modestus* only on June 4, and *G. vastus* from June 13 to June 29. The presence of at least two distinct size classes in benthic samples indicates that *Gomphurus* is semivoltine.





Hagenius

Very broad; flat dorsoventrally; dark brown; antennal seg. 3 broad; abdomen resembling a dead leaf



Hagenius is a monotypic North American endemic: the only species is *H. brevistylus*.

Diagnosis:

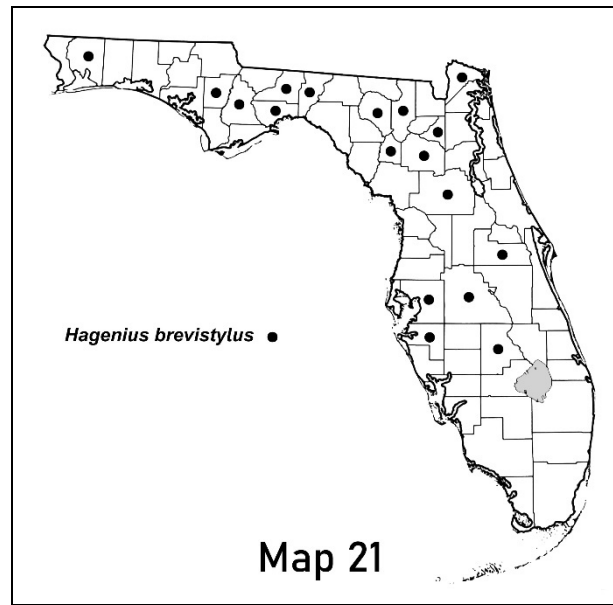
Hagenius nymphs are uniquely shaped in the North American odonate fauna, the broad flat body present throughout the life cycle. The palpal blades are similar to those of *Erpetogomphus* and *Ophiogomphus*.

Habitat, Distribution, Life Cycle:

Hagenius nymphs inhabit lotic waters in Florida, requiring streams with moderate flow and good water quality. They sprawl amongst sunken dead leaves and pieces of bark or wood; they appear to be dead leaf mimics.

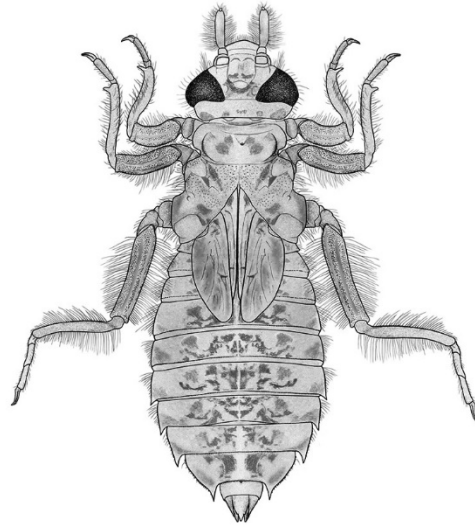
Hagenius brevistylus has been recorded throughout most of the state except for the southern part of the peninsula, undoubtedly due to a lack of stream habitat in the southernmost counties (Map 21).

Recorded flight season in the state is from April 16 to November 8. *Hagenius* is partivoltine, studies indicating a three- or four-year life cycle (Huggins and Brigham 1982).



Hylogomphus

Elongate, compact;
dark brown; antennal
segment 3 elongate;
wing sheaths parallel;
abdomen abruptly
tapered; midorsal
hook on segment 9
only



Hylogomphus is a North American genus of six species, only one of which occurs in Florida, *H. geminatus*.

Diagnosis:

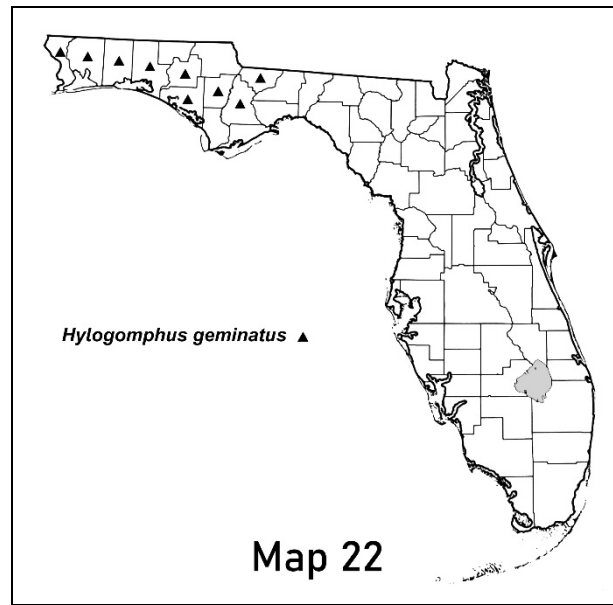
Hylogomphus resembles *Gomphurus* in general habitus and most minor morphological details. They are typically smaller than most *Gomphurus* but there is overlap in total length among several species. The most easily observed difference is the absence of a middorsal hook on abdominal segment 8 in *Hylogomphus*, the difference evident also in instars earlier than F-0.

Habitat, Distribution, Life Cycle:

Hylogomphus nymphs inhabit lotic waters with soft organic substrates over sand with woody riparian vegetation, moderate flow and good water quality.

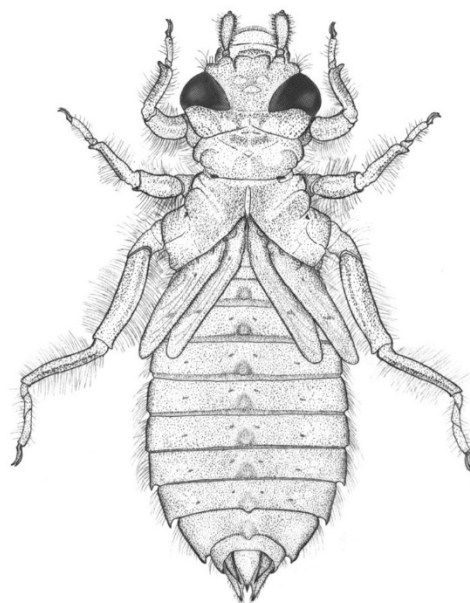
Hylogomphus geminatus is restricted to the western panhandle (Map 22).

Recorded flight season in the state is from March 3 to June 12. *Hylogomphus geminatus* is probably semivoltine.



Ophiogomphus

Elongate, compact;
white to light brown;
antennal segment 3
nearly oval; wing
sheaths divergent;
middorsal hooks on
abdominal segments
2–9



Ophiogomphus is a relatively large genus although only one species occurs in Florida, *O. australis*.

Diagnosis:

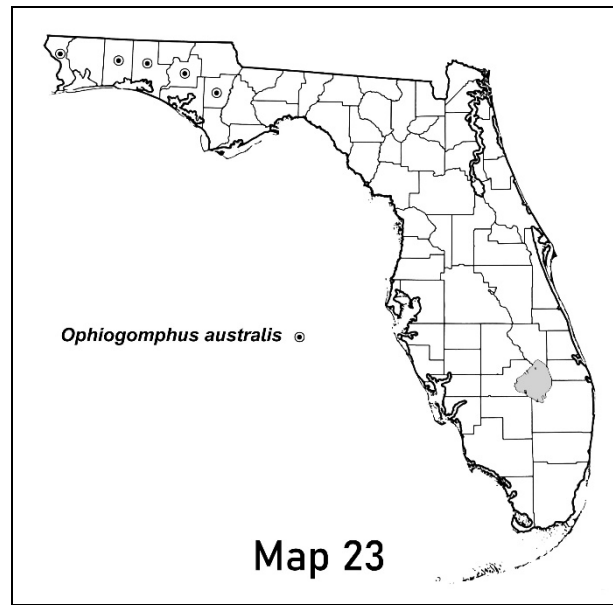
Ophiogomphus nymphs are remarkably similar to *Erpetogomphus* in general habitus and morphology. The only species in Florida, *O. australis*, has a wider antennal segment 3 than the only *Erpetogomphus* in Florida (Fig. 7.9), the difference evident also in instars earlier than F-0. In some northern species of *Ophiogomphus*, the difference in antennal segment 3 is less obvious or negligible (see Tennessen 2019a).

Habitat, Distribution, Life Cycle:

Ophiogomphus nymphs inhabit lotic waters typically with a mix of sand and fine gravel substrates, moderate flow and good water quality. *Ophiogomphus australis* is often found in small, shaded streams with white gravel; in such habitats, the nymphs are almost completely pale to white.

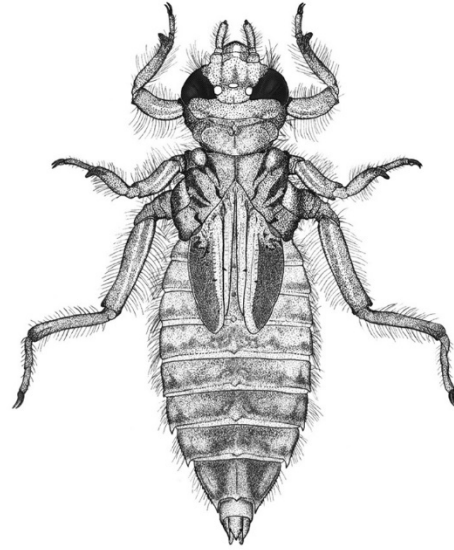
Ophiogomphus australis has been recorded in only four counties in the panhandle (Map 23).

Recorded flight season in the state is from March 10 to April 12 (Abbott 2006–2020; J. J. Daigle, pers. comm.). *Ophiogomphus australis* is probably semivoltine.



Phanogomphus

Elongate, compact,
light to dark brown;
antennal segment 3
elongate; wing sheaths
parallel; abdomen
gradually tapered
at apex; middorsal
hooks on segments
3–9



Phanogomphus is mainly a North American genus with seven species in Florida. In the following key, prementum length and width were measured ventrally; abdominal segment length and width (as maximum width near the base of the segment) also were measured ventrally. *Phanogomphus* specimens often will be covered with silt and mud, requiring cleaning with a soft brush.

Key to *Phanogomphus* Species (F-0)

1. Abdominal segment 9 length:basal width ratio ≥ 0.9 (Fig. 7.31a); segments 7 and 8 without a middorsal hook; lateral margins of abdominal segments 8 and 9 without small spinules, appearing smooth; ligula usually with two distinct median teeth (Fig. 7.32a), sometimes with a fused bifid tooth**2** (Group 1)
- 1'. Abdominal segment 9 length:basal width ratio < 0.8 (Fig. 7.31b); segments 7 and 8 with a middorsal hook; lateral margins of abdominal segment 9 and usually segment 8 with small spinules, appearing serrate at high magnification; ligula with a single undivided median tooth (Fig. 7.32b)**4** (Group 2)

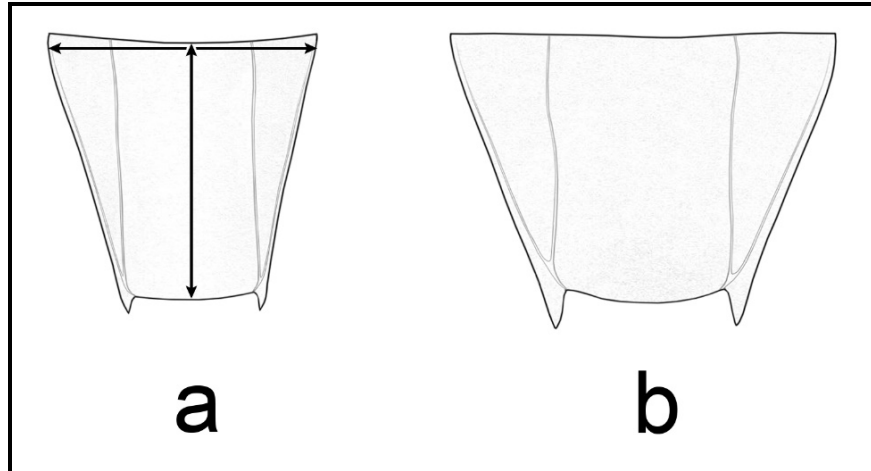


Fig. 7.31. *Phanogomphus*, abdominal segment 9, ventral view: a) *P. cavillaris*; b) *P. minutus*.

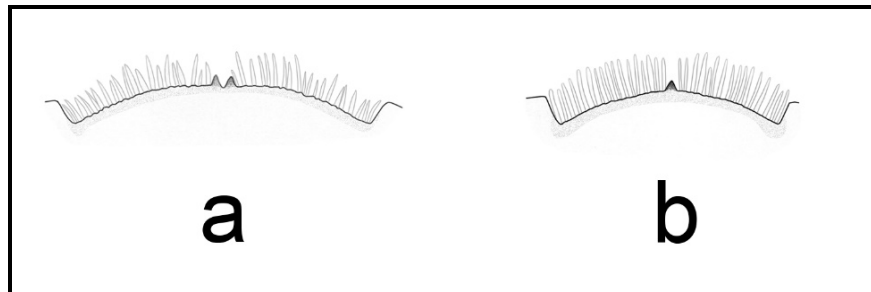


Fig. 7.32. *Phanogomphus*, ligula, ventral view: a) *P. australis*; b) *P. minutus*.

2. Posterolateral spines on abdominal segments 7–9; abdominal segment 9 length:basal width ratio 0.9–1.15; median teeth of ligula with bases close together (Fig. 33a), in some specimens appearing as a fused bifid tooth (Fig. 33b)..... *cavillaris*
- 2'. Posterolateral spines on abdominal segments 6–9; abdominal segment 9 length:basal width ratio 1.2–1.80; median teeth of ligula with bases clearly separated (Fig. 32a).....3

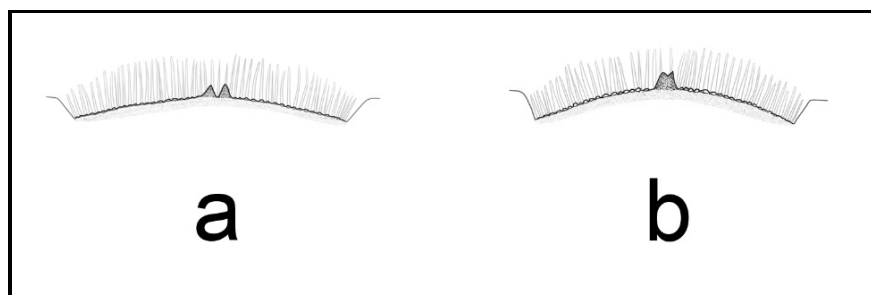


Fig. 7.33. *Phanogomphus cavillaris*, ligula, ventral view: a) separated median teeth; b) fused median teeth.

3. Abdominal segment 9 length:width ratio > 1.5 ; segment 9 at least 5 mm long in F-0; metathoracic femur at least 6 mm long in F-0 *australis*
- 3'. Abdominal segment 9 length:width ratio < 1.5 ; segment 9 about 3.5 mm long in F-0; metathoracic femur less than 6 mm long in F-0 *westfalli*
4. Dorsum of abdominal segments 5–9 nearly smooth at 25X magnification (Fig. 7.34a); F-0 antennal length 2.60–2.80 mm, metathoracic femur length 5.4–6.0 mm *lividus*
- 4'. Dorsum of abdominal segments 5–9 appearing granulate at 25X magnification (Fig. 7.34b); F-0 antennal length 2.05–2.55 mm, metathoracic femur length 4.4–5.6 mm **5**

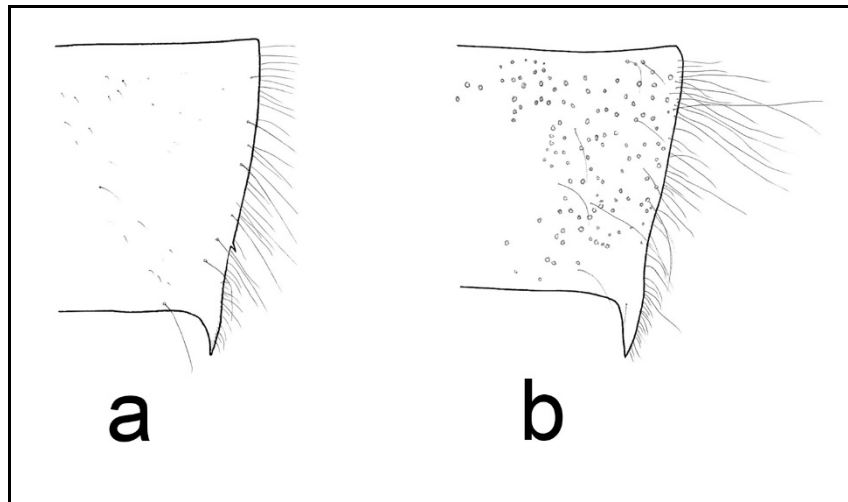


Fig. 7.34. *Phanogomphus*, abdominal segment 7, right side, dorsal view: a) *P. lividus*; b) *P. minutus*.

5. Prementum length:distal width ratio 1.11–1.16; length of abdominal segment 6 posterolateral spine ≥ 0.5 times length of segment 7 posterolateral spine (Fig. 7.35a); setal bases on abdominal segments 6–9 usually inconspicuous, dorsum appearing weakly granulate..... *exilis*
- 5'. Prementum length:distal width ratio 1.15–1.27; length of abdominal segment 6 posterolateral spine < 0.5 times length of segment 7 posterolateral spine (Fig. 7.35b); setal bases on abdominal segments 6–9 conspicuous, dorsum appearing coarsely granulate **6**

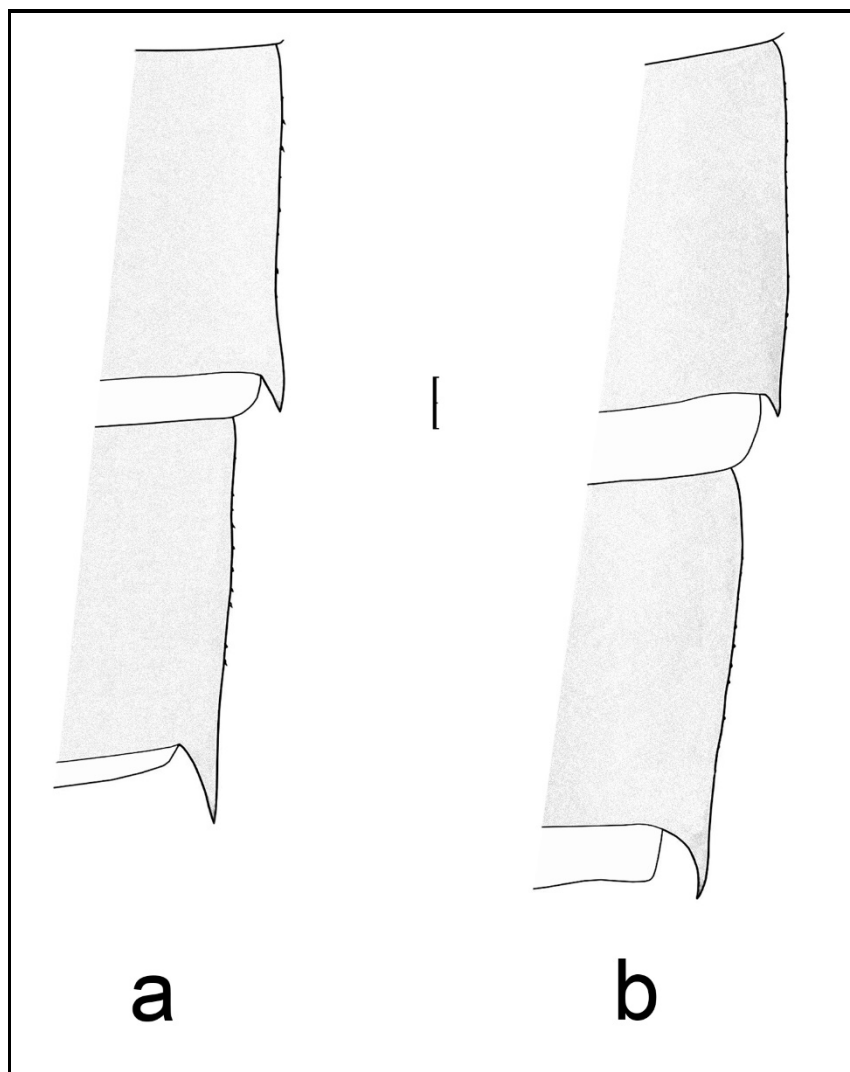


Fig. 7.35. *Phanogomphus*, abdominal segments 6 and 7, right side, dorsal view: a) *P. exilis*; b) *P. hodgesi*. Setae omitted; scale bar = 0.2 mm.

- 6. Dorsum of abdominal segment 10 with numerous setal bases, appearing mostly granulate (Fig. 7.36a); abdominal segment 10 length in F-0 2.30–2.60 mm, width 2.90–3.35 mm*hodgesi*
- 6'. Dorsum of abdominal segment 10 with a few setal bases laterally, appearing mostly smooth (Fig. 7.36b); abdominal segment 10 length in F-0 2.70–3.25 mm, width 3.20–3.90 mm*minutus*

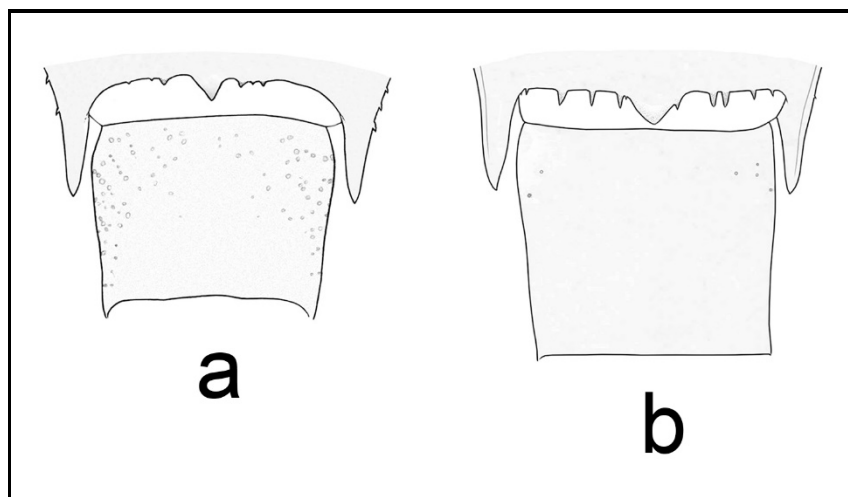


Fig. 7.36. *Phanogomphus*, abdominal segment 10, dorsal view: a) *P. hodgesi*; b) *P. minutus*.

Diagnostic Remarks:

Phanogomphus nymphs are most similar to *Dromogomphus* in general habitus and morphology (see the Generic Notes on pages 86–87). The seven species of *Phanogomphus* present numerous identification challenges. I have split the Florida species into two groups, as presented in couplet 1 of the key. In Group 1, *P. cavillaris* is distinct in lacking a posterolateral spine on abdominal segment 6 and the apex of the abdomen is less attenuated (for *cavillaris*, segment 9 length:width ratio around 1.0, and segment 10 length:width ratio about 1.3 versus ratios of at least 1.2 and at least 1.5 more for the other two species). *Phanogomphus australis* is a much larger species than *P. westfalli*, with F-0 head width of 5.65–6.20 mm versus 4.50–5.00 mm, respectively.

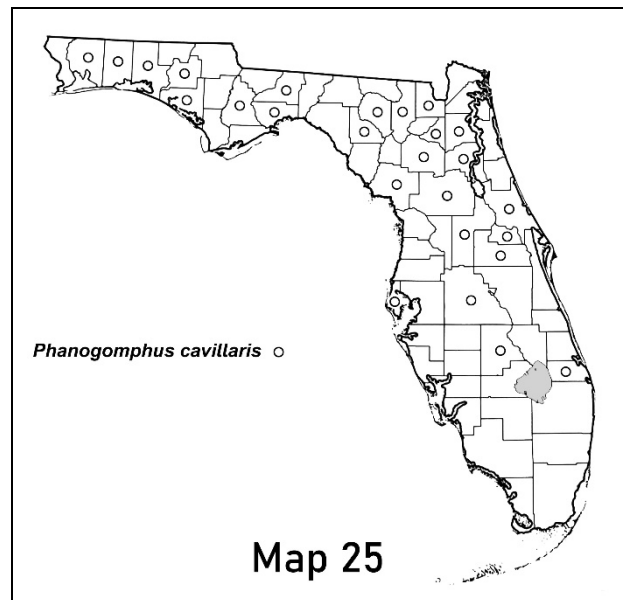
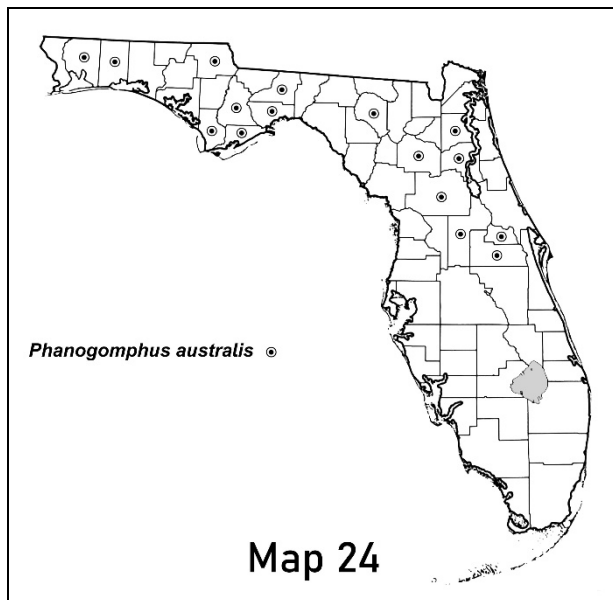
The four species in Group 2 are more difficult to distinguish. Precise measurement of certain structures and calculation of ratios are the main reliable means to separate the species. Any specimens that do not clearly fit the key characters should be identified as *Phanogomphus* sp. Also, the key is intended for F-0 specimens, and taking earlier instars through the key may result in doubtful determinations and in general is not recommended. For further treatment of this genus, see Tennessen (2019a).

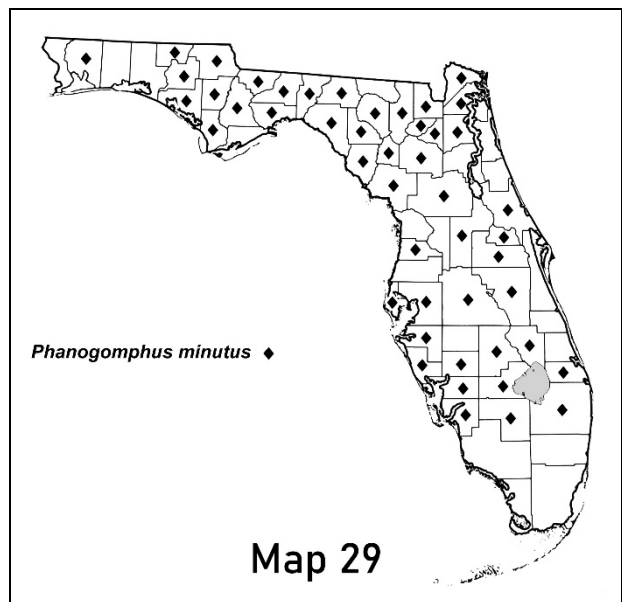
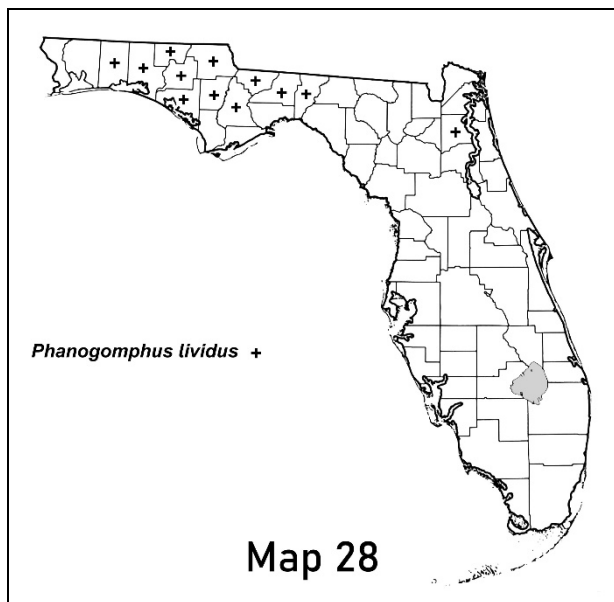
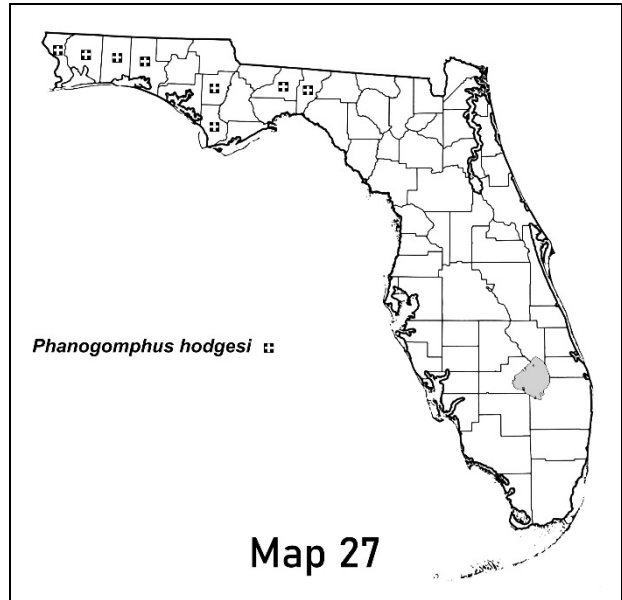
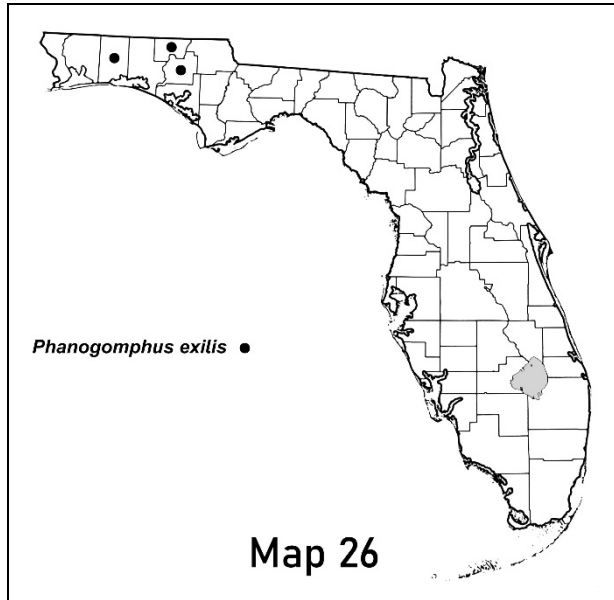
Habitat, Distribution, Life Cycle:

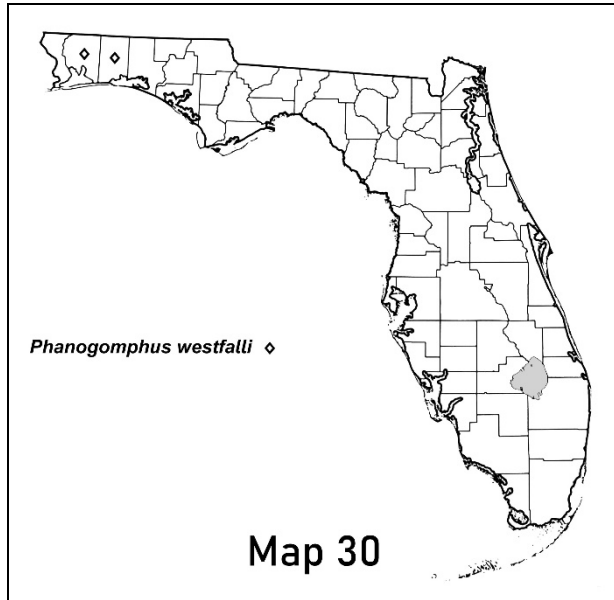
Phanogomphus nymphs occur in both lentic and lotic habitats. *Phanogomphus australis* and *P. cavillaris* are strictly lake and pond inhabitants — lentic habitats in which *P. australis* occurs are clear and sand-bottomed but with a layer of mud/silt over the sand and usually with water lilies (*Nymphaea*) or surrounding cypress; *P. cavillaris* prefers clear sand-bottomed lakes that are oligotrophic to somewhat mesotrophic. *Phanogomphus hodgesi*, *P. lividus* and *P. westfalli* typically inhabit small streams with woody riparian vegetation, although *P. westfalli* also inhabits small reservoirs formed by the damming of small streams. *Phanogomphus exilis* has been found in Florida mainly in streams in only three counties in the western panhandle (in more northern parts of its large geographic range, this species inhabits ponds, small lakes, and slow portions of streams). *Phanogomphus minutus* inhabits slow portions of small streams and also mesotrophic lakes.

Phanogomphus australis occurs throughout the northern half of the state (Map 24); *P. cavillaris* has been recorded nearly throughout the state except for the counties south of Lake Okeechobee (Map 25). *Phanogomphus exilis*, *P. hodgesi* and *P. westfalli* are restricted to the panhandle (Maps 26, 27 and 30); *P. lividus* is distributed across the panhandle with one record in northeast Florida (Map 28). *Phanogomphus minutus* occurs throughout most of the state except it has not been recorded in the four southernmost counties (Map 29).

All seven species of *Phanogomphus* emerge early in Florida and have relatively short flight seasons. Recorded flight seasons are: *P. australis* from March 14 to May 18, *P. cavillaris* from January 20 to May 24, *P. exilis* from April 11 to May 30, *P. hodgesi* from March 15 to May 26, *P. lividus* from March 18 to May 16, *P. minutus* from February 14 to May 25, and *P. westfalli* from February 26 to April 13. Regarding voltinism, little is known about the genus; *P. lividus* is semivoltine (Smock 1988) but definitive studies on the other species that occur in Florida are lacking.

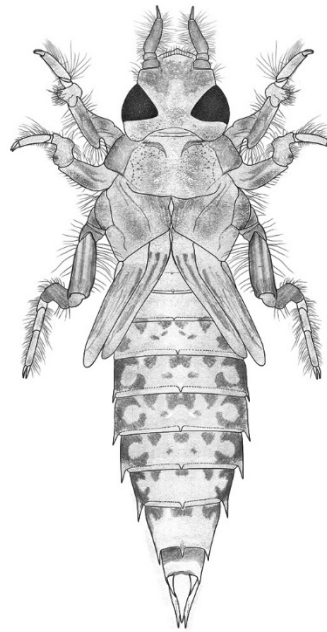






Progomphus

Elongate, slender,
pale ground color, often
with dark markings on
abdomen; wing sheaths
divergent; abdomen
with small middorsal
hooks on segments 1–9;
abdomen gradually
tapered to pointed apex



Progomphus is a species-rich Neotropical group with three species in Florida.

Key to *Progomphus* Species

1. Dorsum and venter of abdominal segments 4–9 without dark markings laterally (Fig. 7.37a); middorsal hook on abdominal segment 3 smaller than hook on segment 2 in dorsal view (Fig. 7.38a) *alachuensis*
- 1'. Dorsum and venter of abdominal segments 4–9 with dark markings laterally (Fig. 7.37b, 7.39a,b)); middorsal hook on abdominal segment 3 about same size as hook on segment 2 in dorsal view (Fig. 7.38b) 3

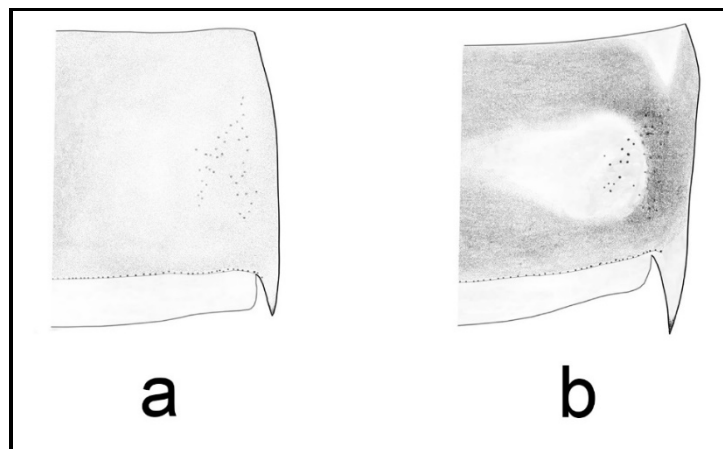


Fig. 7.37. *Progomphus*, abdominal segment 6, right side, dorsal view: a) *P. alachuensis*; b) *P. obscurus*.

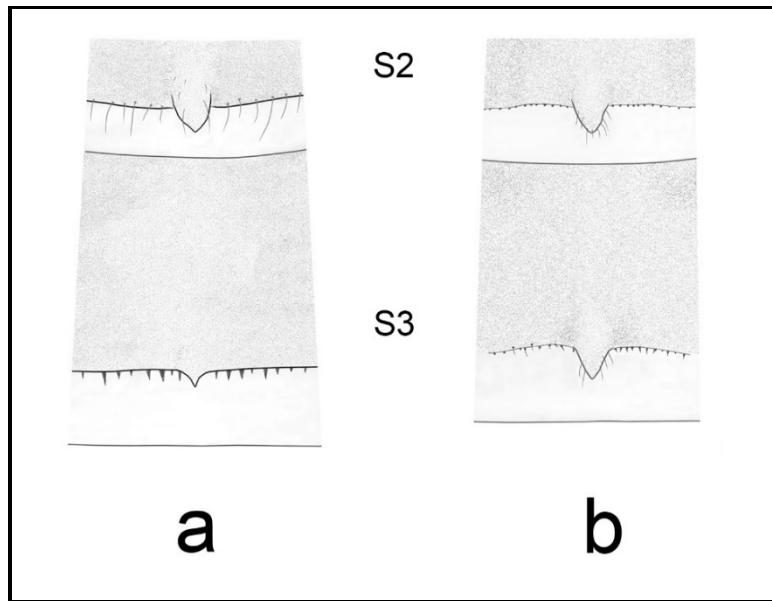


Fig. 7.38. *Progomphus*, abdominal segments 2 and 3, middorsum: a) *P. alachuensis*; b) *P. obscurus*.

2. Color pattern on dorsum of abdominal segments 5–7 with basomedial dark band usually complete (Fig. 7.39a), sometimes faded and appearing almost interrupted; prementum distal width of F-0 2.15–2.35 mm, basal width 1.35–1.50 mm; cercus length 1.10–1.37 mm*bellei*
- 2'. Color pattern on dorsum of abdominal segments 5–7 with basomedial dark band interrupted medially and sub-laterally (Fig. 7.39b); prementum distal width of F-0 1.80–2.15 mm, basal width 1.10–1.35 mm; cercus length 0.80–1.05 mm*obscurus*

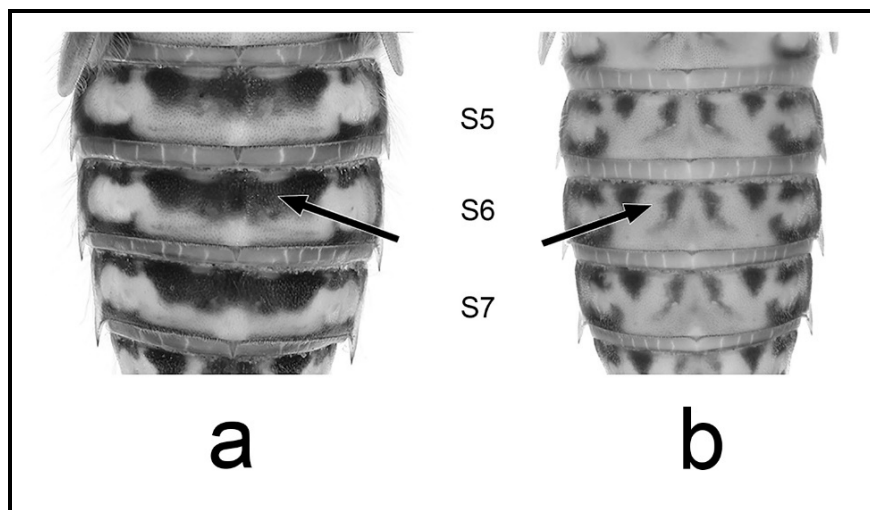


Fig. 7.39. *Progomphus*, abdominal segments 5–7, dorsal view: a) *P. bellei*; b) *P. obscurus*.

Diagnostic Remarks:

Progomphus nymphs are distinctive in habitus, making them easily recognized in the field and lab. The widely divergent wing sheaths are shared with only *Erpetogomphus* and *Ophiogomphus* among Florida gomphids, but those genera are much more compact with a much less acuminate abdomen. The elongate fourth antennal segment is diagnostic for the genus in North America.

The species key is intended mainly for F-0 specimens; taking earlier instars through the key could result in error and in general is not recommended. Precise measurement of certain structures is necessary to confirm separation of *P. bellei* and *P. obscurus*. Distribution will help in identification except where the species are sympatric.

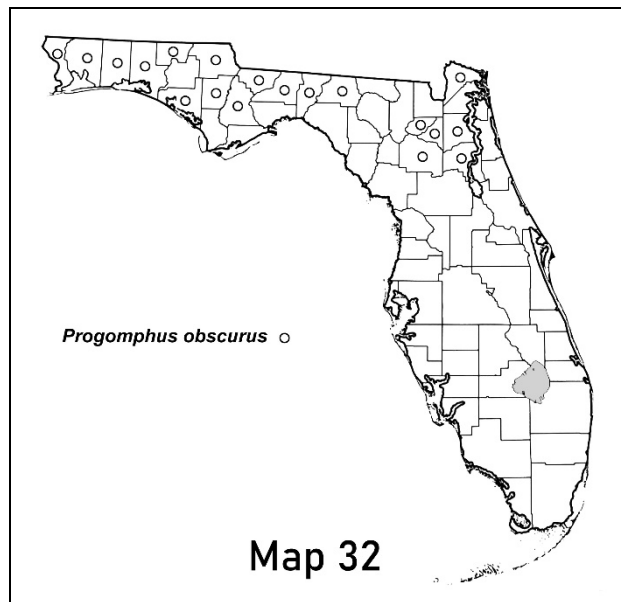
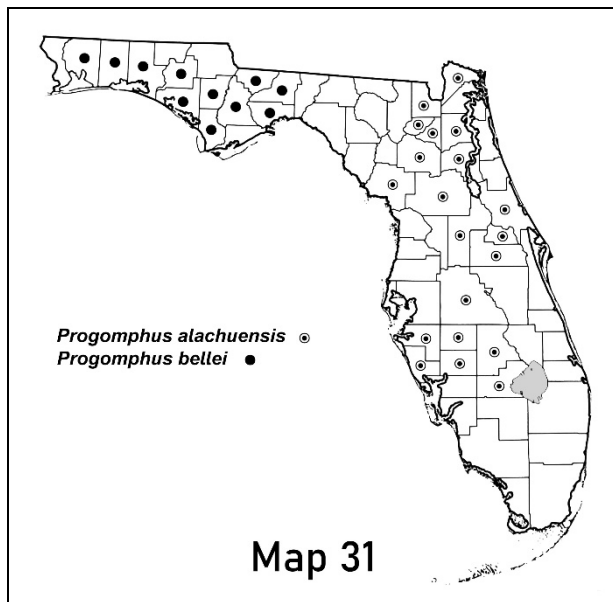
Habitat, Distribution, Life Cycle:

Progomphus nymphs occur in both lentic and lotic habitats. They occupy sandy substrates almost exclusively, and they are very rapid burrowers, completely burying themselves in the sand in a couple of seconds; this activity usually leaves a noticeable surface trail in the sand.

Progomphus alachuensis is a lake and pond inhabitant. *Progomphus bellei* and *P. obscurus* inhabit sandy ponds, lakes, and small streams.

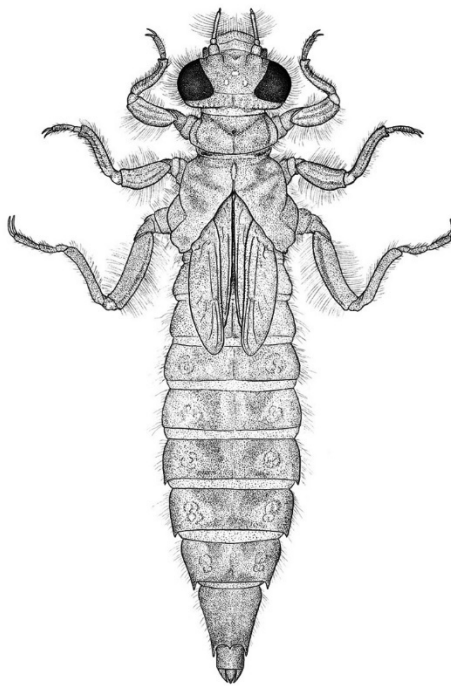
Progomphus alachuensis is a Florida endemic, recorded only in the peninsula except for the southernmost counties (Map 31). *Progomphus bellei* is limited to the panhandle (Map 31), and as such is allopatric with *P. alachuensis*. *Progomphus obscurus* occurs across the northern part of the state (Map 32), its distribution completely overlapping that of *P. bellei* and partially overlapping that of *P. alachuensis*.

Progomphus emerge relatively early in Florida and have long flight seasons. Recorded flight seasons are: *P. alachuensis* from April 10 to August 30, *P. bellei* from April 20 to August 13, and *P. obscurus* from April 2 to August 7. Phillips (2001) reported that *P. obscurus* is univoltine; further studies on the other species that occur in Florida are lacking.



Stylurus

Elongate, usually very slender; tan to brown; legs short, small burrowing hook on tarsi; wing sheaths parallel; middorsal hook usually only on abdominal segment 9



Stylurus is a relatively large genus. In the New World, the group is confined to North America, with five species in Florida.

Key to *Stylurus* Species

1. Venter of abdominal segments 3–8 with numerous dark setae, some of which are half as long as respective segment; apices of anal appendages acute, epiproct upturned in lateral view (Fig. 7.40a); paraproct length 1.50–2.10 mm.....2
- 1'. Venter of abdominal segments 3–8 with inconspicuous pale setae less than half as long as respective segment; apices of anal appendages less acute, epiproct straight in lateral view (Fig. 7.40b); paraproct length 0.65–1.35 mm3

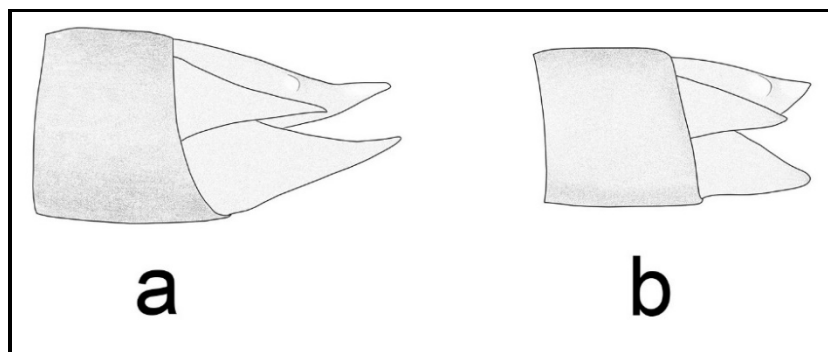


Fig. 7.40. *Stylurus* abdominal segment 10 and anal appendages, lateral view: a) *S. ivae*; b) *S. plagiatus*.

2. Paraproct length 1.50–1.65 mm, tip even with or barely extending beyond tip of epiproct (Fig. 7.41a); abdominal segment 8 with a small middorsal hook*ivae*
- 2'. Paraproct length 1.75–2.10 mm, tip extending beyond tip of epiproct by at least 0.25 mm (Fig. 7.41b); abdominal segment 8 without a middorsal hook*townesi*

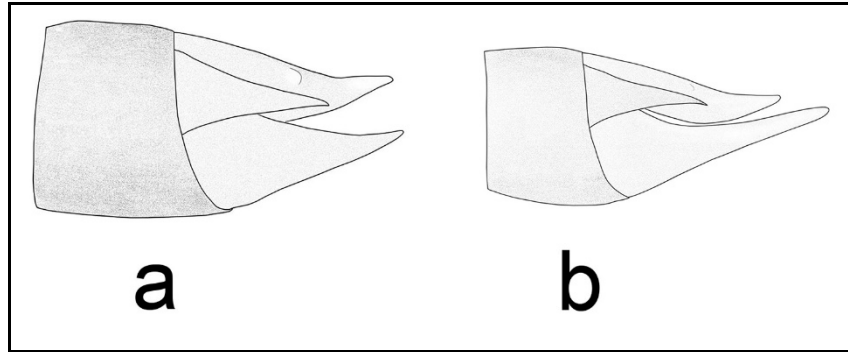


Fig. 7.41. *Stylurus* abdominal segment 10 and anal appendages, lateral view: a) *S. ivae*; b) *S. townesi*.

3. Middorsal hook on abdominal segment 9 nearly as long as cercus, ratio between 0.74–0.97 (Fig. 7.42a); ratio of abdominal segment 10 length:max width 1.08–1.17; abdomen max width 5.3–5.7 mm*potulentus*
- 3'. Middorsal hook on abdominal segment 9 usually much shorter than cercus, ratio between 0.2–0.78 (Fig. 7.42b); ratio of abdominal segment 10 length:max width 0.53–0.93; abdomen max width 6.4–8.1 mm4

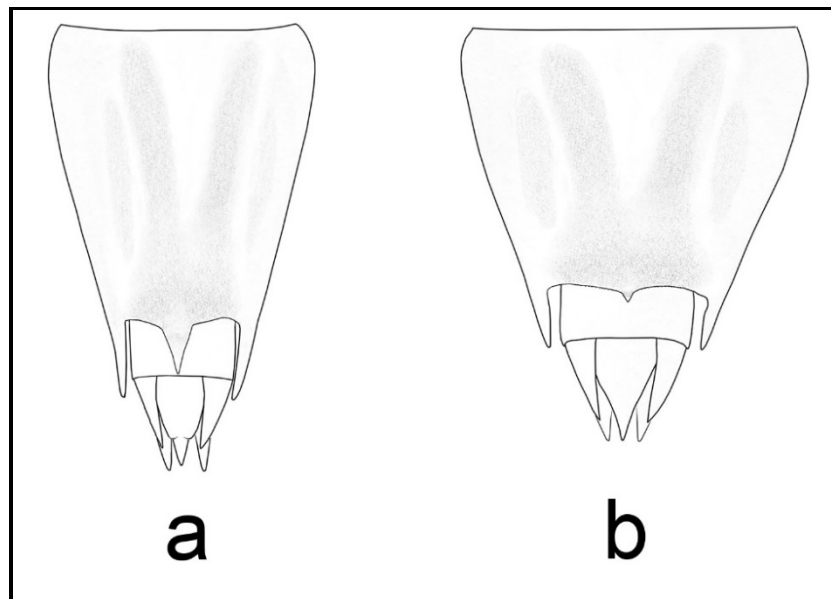


Fig. 7.42. *Stylurus* abdominal segment 9 middorsal hook, dorsal view: a) *S. potulentus*; b) *S. laurae*.

4. Antennal segment 3 with lateral margin markedly convex (Fig.7.43a) and ratio of length:max width < 4.0; ratio of abdominal segment 9 length:max width about 0.8 (0.74–0.87); venter of abdomen with relatively uniform color pattern laterally.....*laurae*
- 4'. Antennal segment 3 with lateral margin nearly straight to slightly convex (Fig.7.43b) and ratio of length:max width > 4.0; ratio of abdominal segment 9 length:max width about 1.1 (1.0–1.2); venter of abdomen with dark lateral markings (Fig. 7.44).....*plagiatus*

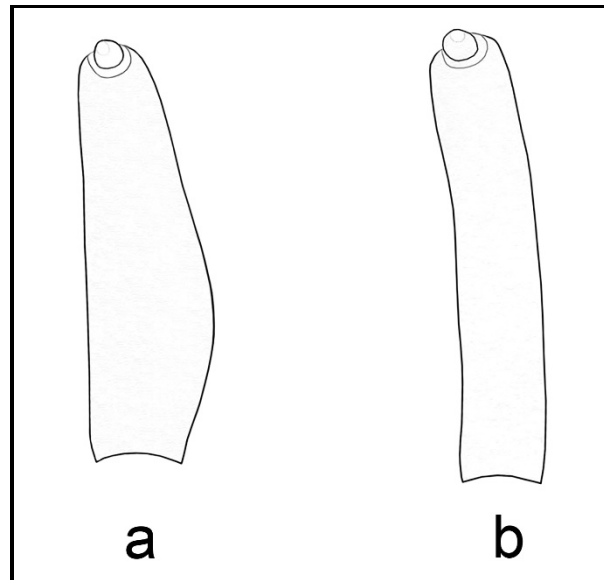


Fig. 7.43. *Stylurus* right antenna, dorsal view: a) *S. laurae*; b) *S. plagiatus*.

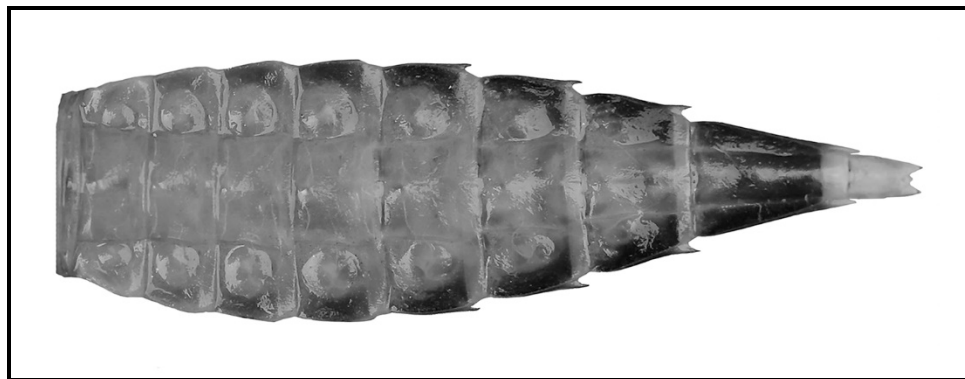


Fig. 7.44. *Stylurus plagiatus* abdomen, ventral view.

Diagnostic Remarks:

The reduced burrowing hooks on the pro- and meso-thoracic tibiae of *Stylurus* nymphs is diagnostic, especially in combination with the large end tooth on the palpal blade and the reduced number of inner teeth.

The species key is intended mainly for F-0 specimens, although F-1s will probably key out satisfactorily. In addition to the characters in couplet 2, the ratio of epiproct length to abdominal segment 10 middorsal length was 1.50–1.67 for *S. ivae* and 1.95–2.30 for *S. townesi*. Also, the

inner palpal teeth are twice as long as wide in *S. ivae* (Fig. 7.45a) versus as wide as long (Fig. 7.45b) in *S. townesi*.

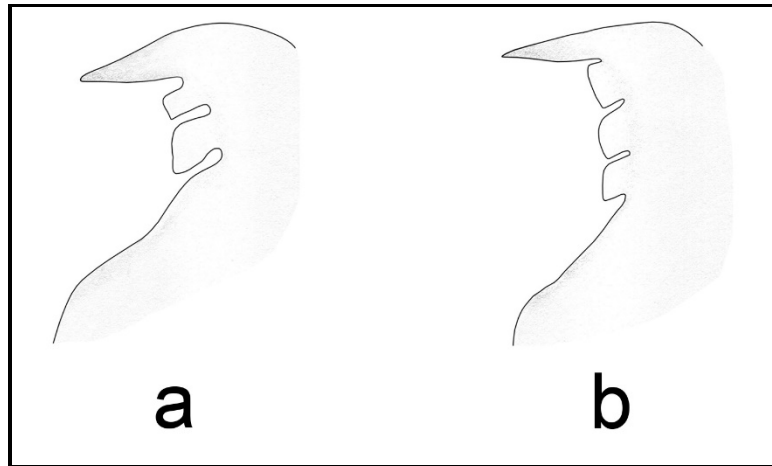


Fig. 7.45. *Stylurus* palpal teeth, ventral view: a) *S. ivae*; b) *S. townesi*.

The size of the middorsal hook on abdominal segment 9 is variable in *S. plagiatus*; specimens from Florida approach *S. potulentus* in the ratio of hook length compared to cercus length, as presented in couplet 3. Therefore, the other characters in couplet 3 must be checked in order to arrive at correct determinations.

In couplet 4, the ratio of abdominal segment 9 length:max width for *S. plagiatus* in Florida is > 1.0 , so there is no overlap in this character with *S. laurae*. In specimens of *S. plagiatus* from more northern areas, there is a decrease in the length of segment 9 and also the size of the middorsal hook, creating some overlap in the size of these structures with *S. laurae* where the species are sympatric.

Habitat, Distribution, Life Cycle:

Stylurus nymphs inhabit flowing water for the most part, from small to large streams normally with good water quality, occupying silt/sand substrates. *Stylurus ivae*, *S. potulentus* and *S. townesi* bury themselves in shifting to somewhat stable sands whereas *S. laurae* and *S. plagiatus* hide in more silty habitats and can tolerate some degree of turbidity in the water. To my knowledge, *S. plagiatus* is the only *Stylurus* species in Florida that also inhabits lakes and reservoirs, and it appears capable of tolerating somewhat eutrophic conditions.

Stylurus laurae, *S. potulentus* and *S. townesi* are limited in Florida to the western panhandle (Maps 33, 35, 36). *Stylurus ivae* occurs across northern Florida (Map 33). *Stylurus plagiatus* occurs nearly throughout the state (Map 34).

Stylurus emerge late in the season compared to most other gomphids. Recorded flight seasons are: *S. ivae* from September 1 to November 19, *S. laurae* from May 27 to August 8, *S. plagiatus* from April 21 to December 1, *S. potulentus* from May 16 to August 6, and *S. townesi* from June 9 to September 26. The species may be either semivoltine or partivoltine in Florida, although further life history studies are needed.

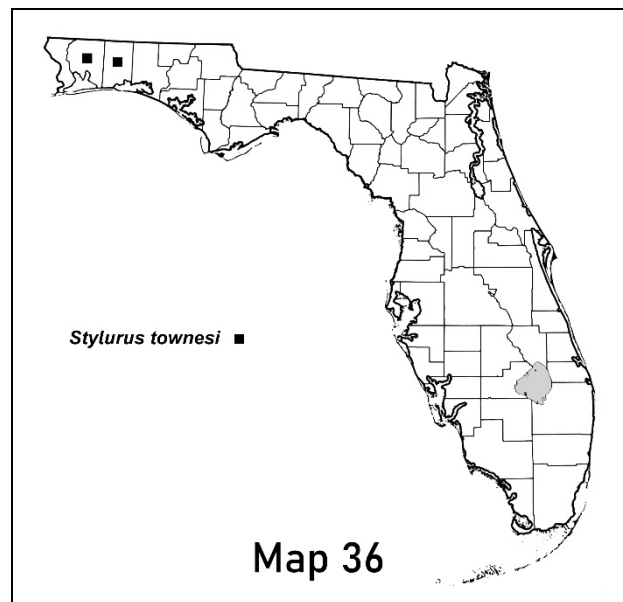
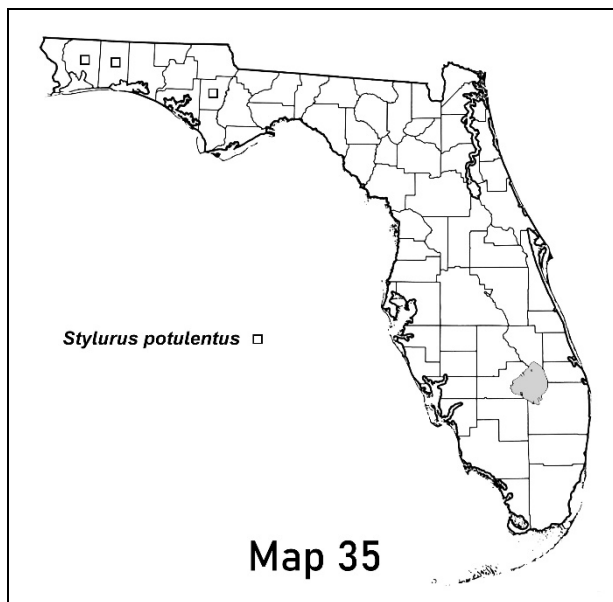
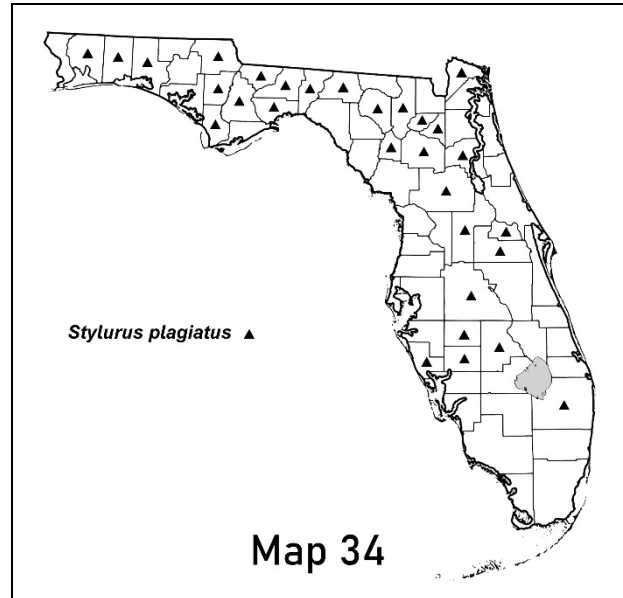
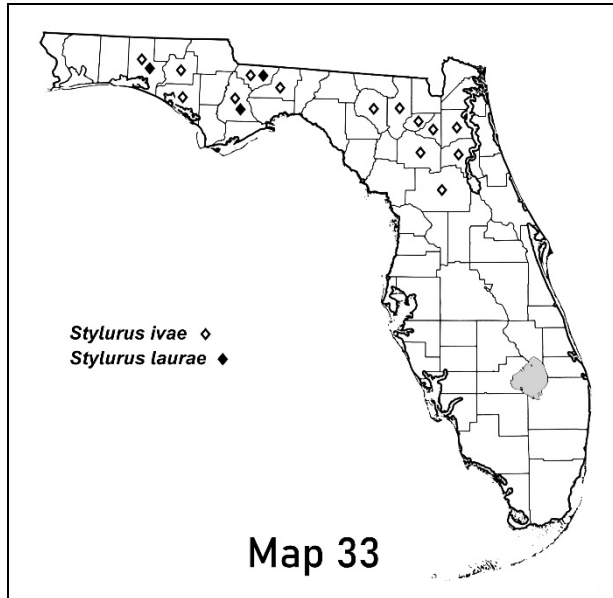
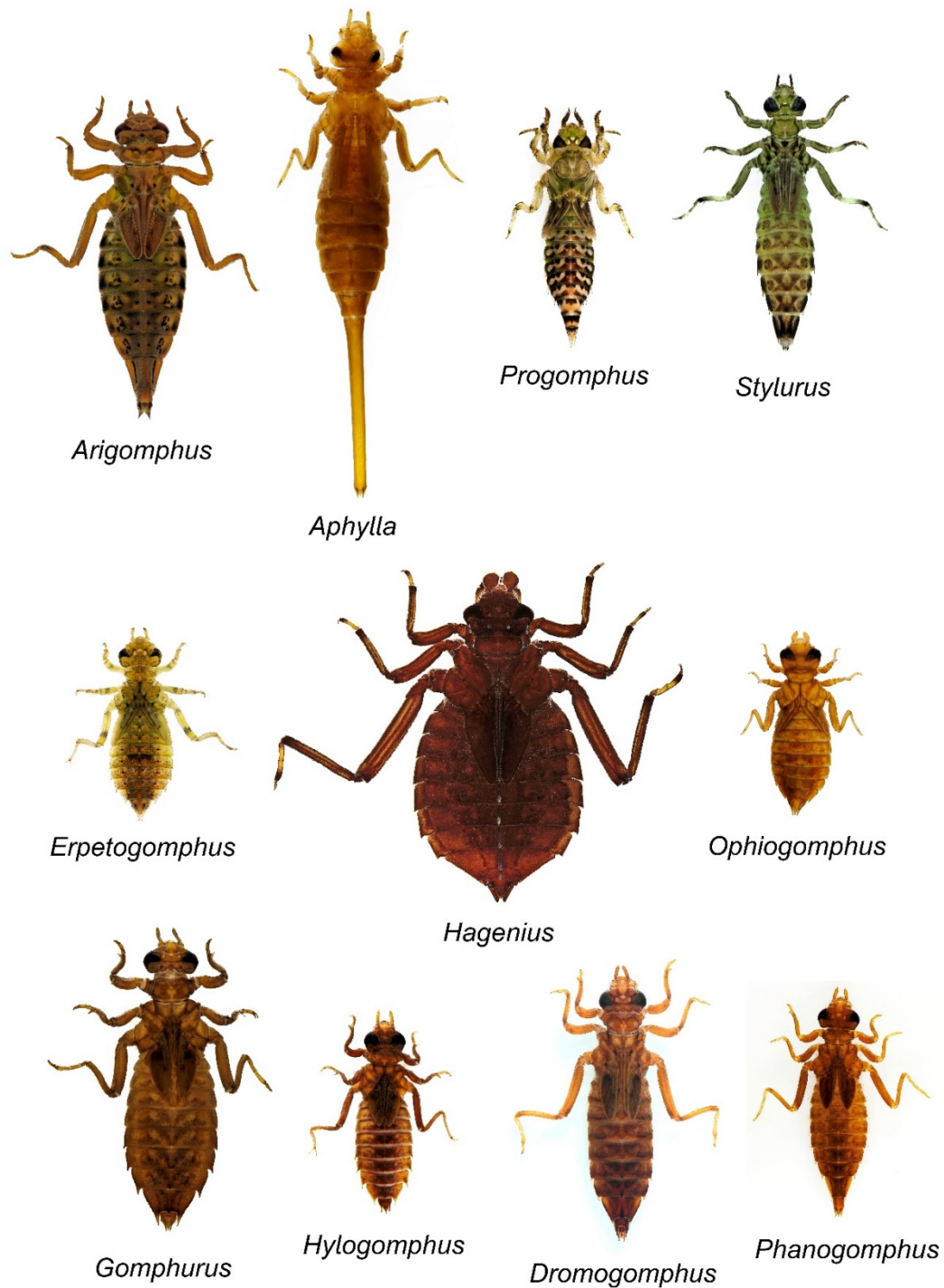


Plate 4. Representatives* of the eleven Gomphidae genera of Florida (photographs by Marla C. Garrison).



* The species represented in Plate 4 are *Aphylla williamsoni*, *Arigomphus villosipes* (non-Florida species), *Dromogomphus spinosus*, *Erpetogomphus designatus*, *Gomphurus dilatatus*, *Hagenius brevistylus*, *Hylogomphus geminatus*, *Ophiogomphus australis*, *Phanogomphus minutus*, *Progomphus obscurus*, and *Stylurus plagiatus*.

8. PETALURIDAE

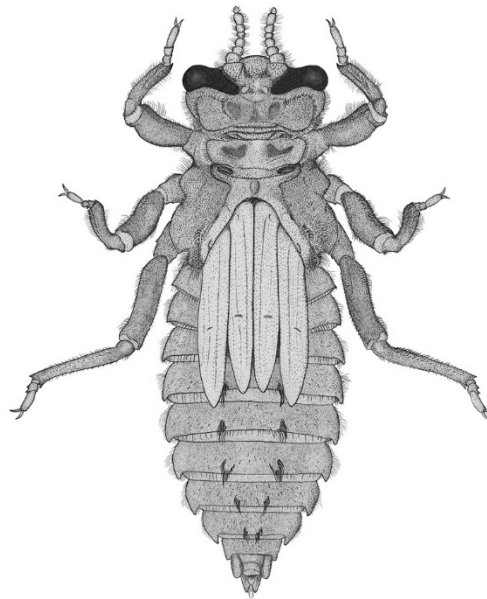
Petalurid nymphs are large and robust. Members of this family are adapted mostly for a subterranean existence, living in burrows they excavate in slow, muddy seepage areas. However, not all species burrow, including *Tachopteryx thoreyi*, the species that occurs in Florida; instead, this species is adapted for hiding in shallow seepage areas underneath moss and/or wet leaf packs.

The family is characterized by 1) mouthparts intermediate between prognathous and hypognathous; 2) antennal segments short, thick, and heavily setose; 3) prementum slightly up-turned along lateral margins (intermediate between flat and scoop-shaped); 4) palp with stout spine near base of movable hook (Fig. 8.1a); 5) ligula with open, narrow cleft; 6) tibiae with apical spurs; 7) abdomen without middorsal hooks but abdominal segments 5–9 with paired, submedian setal tufts.

Only one genus, *Tachopteryx* Uhler in Selys, occurs in Florida. Measurements for the genus are summarized in Table 8.1 (p. 124).

Tachopteryx

Compact, robust; dark brown, unpatterned; antennae thick with many setae; abdomen with two submedian, parallel rows of setal tufts and thick, blunt posterolateral spines



Generic Notes:

Tachopteryx is monotypic; the only species is *T. thoreyi*, which ranges over much of the eastern United States. The labial palpal blade has a stout distal spine (Fig. 8.1a) and the apices of the tibiae and the two basal tarsal segments bear stout spines (Fig. 8.1b). *Tachopteryx thoreyi* is further characterized by seven thick antennal segments, two rows of setal tufts on the dorsum of the abdomen, and posterolateral expansions on abdominal segments 2–9. The nymphs are unmistakable, even in early instars, without magnification.

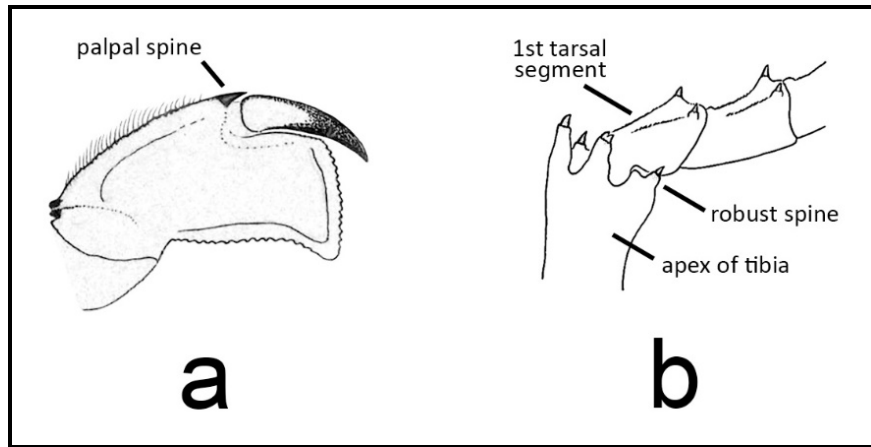


Fig. 8.1. Petaluridae, *Tachopteryx thoreyi*: a) left labial palp; b) apex of metathoracic tibia and two basal tarsal segments.

Table 8.1. Summary of size measurements (mm) for Petaluridae in Florida, for instar F-0.

Genus	# Spp. in Florida	Total Length	Head Width	Prementum Width	Epiproct L	Ovipositor Length
<i>Tachopteryx</i>	1	30.0–33.0	8.10–8.80	5.80–6.40	1.70–1.90	1.85–1.90

Habitat, Distribution, Life Cycle:

Tachopteryx nymphs typically inhabit shaded to partly open seepage areas along small streams; they also inhabit fens. They hide under wet, decaying leaves and mosses, usually where water barely trickles over soft mud, but also hide in and under wet moss. They can be found above the water, where it is merely damp. Nearby forest is critical for adult foraging and mating; adults often land on tree trunks.

The range of *Tachopteryx thoreyi* in Florida includes only the northern part of the state as far south as Alachua County (Map 37).

The amount of time required for complete development in *Tachopteryx* is unknown. Full-grown nymphs kept under laboratory conditions and offered prey did not emerge after a full year in captivity. Undoubtedly *T. thoreyi* is partivoltine, possibly requiring five or more years to complete development. Five years may be the minimum time for complete development in the family (Baird 2017). Recorded flight season in Florida ranges from March 8 to June 19.

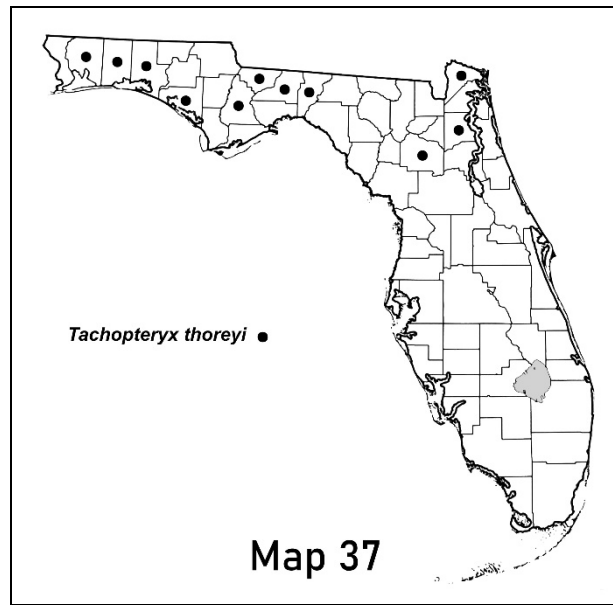


Plate 5. Petaluridae of Florida, *Tachopteryx thoreyi* (photograph by Marla C. Garrison).



9. CORDULEGASTRIDAE

Cordulegastrid nymphs are large apex predators that are adapted for burying in sand and silt substrates of seepage runs and edges of small, slow-flowing streams. Their bodies are elongate and stout with strong legs; the eyes are small but protrude dorsally. There is little variability in general body shape within this relatively small family.

The family is characterized by 1) mouthparts intermediate between prognathous and hypognathous; 2) antenna 7-segmented; 3) eyes anterior on head; 4) prementum scoop-shaped; 5) ligula with a prominent, median bifid process; 6) prementum with deep ventromedial groove in basal half; 7) teeth on distal margin of palpal lobes large and irregular; 8) no middorsal hooks; 9) small posterolateral spines only on segments 8 and 9.

Two genera, *Cordulegaster* Leach and *Zoraena* Kirby, occur in Florida. Identification to genus and species depends mainly on prementum characters. Measurements for each genus are summarized in Table 9.1 (p. 127).

Key to Genera of Cordulegastridae (F-0 to F-4)

1. Prementum in ventral view with basal transverse suture V-shaped and ventromedial groove originating distal to base (Fig. 9.1a); dorsolateral rim of labial palp with longest marginal setae 2.0–3.5 times width of a primary setal base (Fig. 9.2); posterolateral spine on segment 8 slightly curved, tip directed at base of spine on segment 9 (Fig. 9.3) *Cordulegaster*
- 1'. Prementum in ventral view with basal transverse suture nearly straight and ventromedial groove originating close to base (Fig. 9.1b); dorsolateral rim of labial palp with longest marginal setae 1.0–1.5 times width of a primary setal base (Fig. 9.2); posterolateral spine on segment 8 markedly curved, tip directed dorsad of spine on segment 9 (Fig. 9.3) *Zoraena*

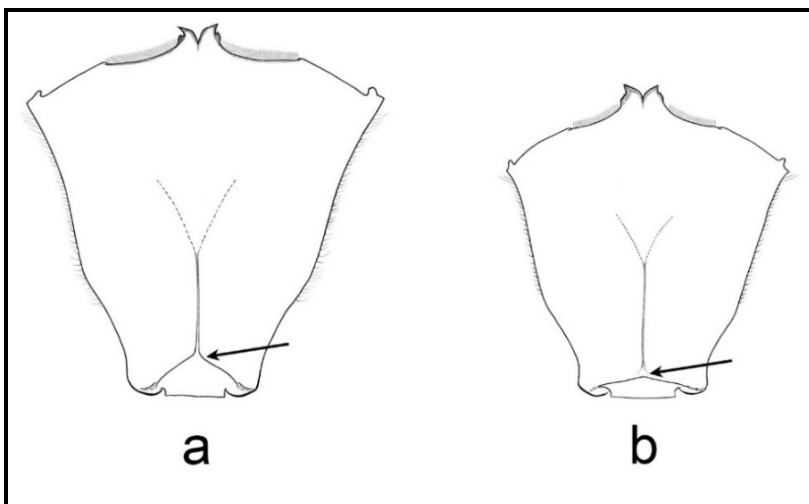


Figure 9.1. Cordulegastridae, prementum, ventral view: a) *Cordulegaster obliqua*; b) *Zoraena sayi*; arrow indicates transverse suture and origin of ventromedial groove.

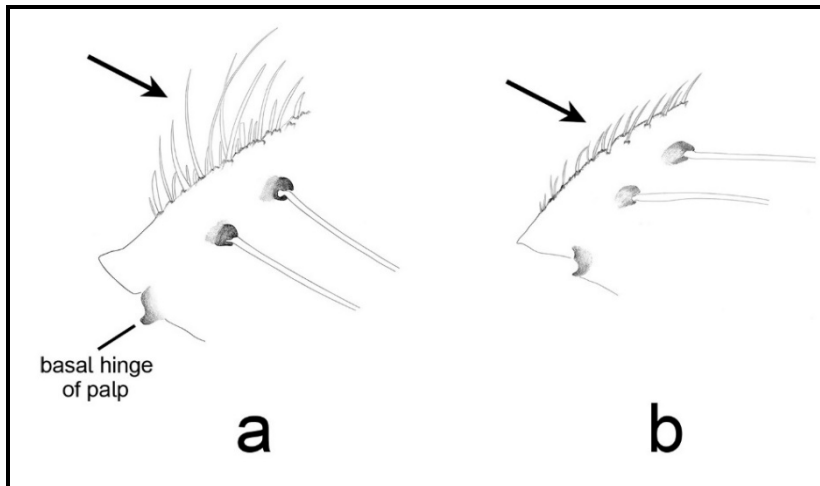


Figure 9.2. Cordulegastridae, dorsolateral rim of palp, dorsal view: a) *Cordulegaster obliqua*; b) *Zoraena sayi*; arrow indicates dorsal setae.

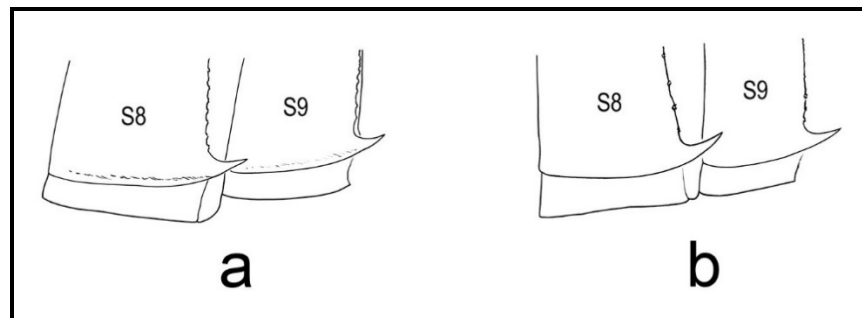


Figure 9.3. Cordulegastridae, abdominal segments 8 and 9, lateral view: a) *Cordulegaster obliqua*; b) *Zoraena sayi*.

Generic Notes:

The two North American genera of Cordulegastridae are very close in general appearance but can be distinguished readily by the characters in the generic key above. Based on these differences in the nymph stage, I have recently recognized *Zoraena* at the generic level (Tennessen 2019a). *Zoraena* was resurrected by Carle (1983) based on adult characters, even though a number of references placed the group as a synonym of the genus *Cordulegaster* (Garrison et al. 2006, Needham et al. 2014).

Table 9.1. Summary of size measurements (mm) and palpal setae counts for the two genera of Cordulegastridae in Florida, for instar F-0.

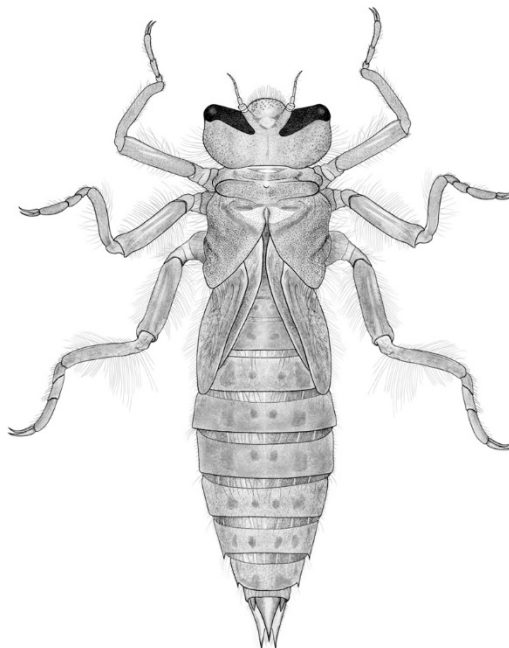
Genus	# Spp. in Florida	Total Length	Head Width	Premmentum Width	Epiproct L	# Palpal Setae
<i>Cordulegaster</i>	2	29.4–47.8	6.75–8.80	4.80–6.80	2.45–3.35	4–8
<i>Zoraena</i>	1	32.5–41.0	6.85–7.60	5.75–6.80	2.90–3.55	5–6

Cordulegastridae Generic Treatments

Three species of Cordulegastridae occur in Florida.

Cordulegaster

Elongate, stout; tan to medium brown; eyes small, protruding; legs long, stout; wing sheaths divergent; no middorsal hooks; small posterolateral spines on segments 8 and 9



There are five species of *Cordulegaster* in North America, two of which occur in Florida.

Key to *Cordulegaster* Species

1. Palpal setae usually 5 per side (Fig. 9.4a), rarely 4 or 6 on a side; prementum with 5 or 6 primary setae per side, rarely 7; all marginal setae on frontoclypeal ridge pale ***maculata***
- 1'. Palpal setae usually 6 per side, sometimes 7 (Fig. 9.4b) or 8 on a side; prementum usually with 7 or 8 primary setae per side, rarely only 6; some marginal setae on frontoclypeal ridge dark ***obliqua***

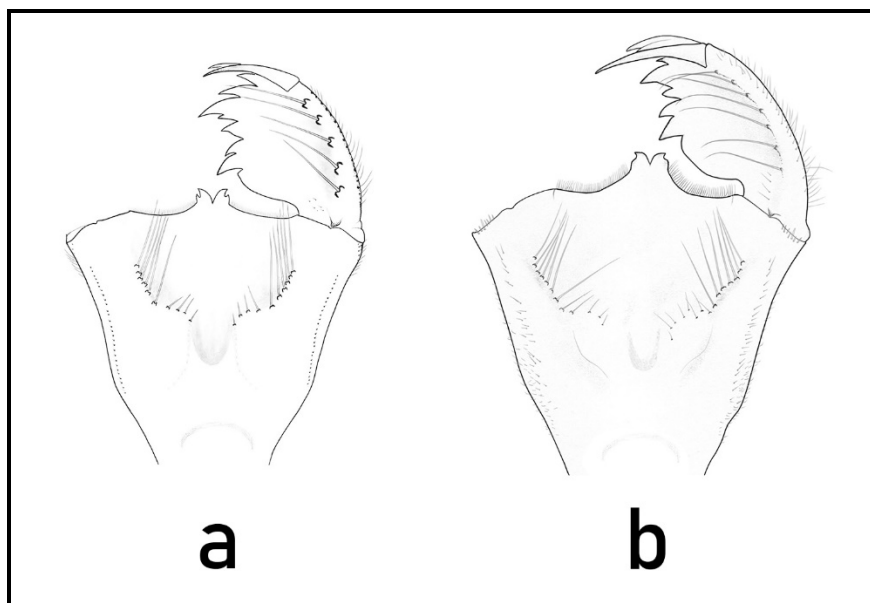


Figure 9.4. *Cordulegaster* prementum (left palp removed): a) *C. maculata*; b) *C. obliqua*.

Diagnostic Remarks:

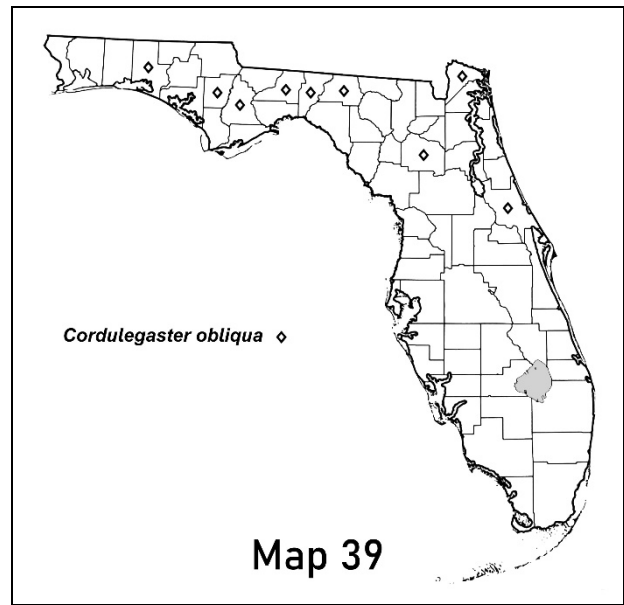
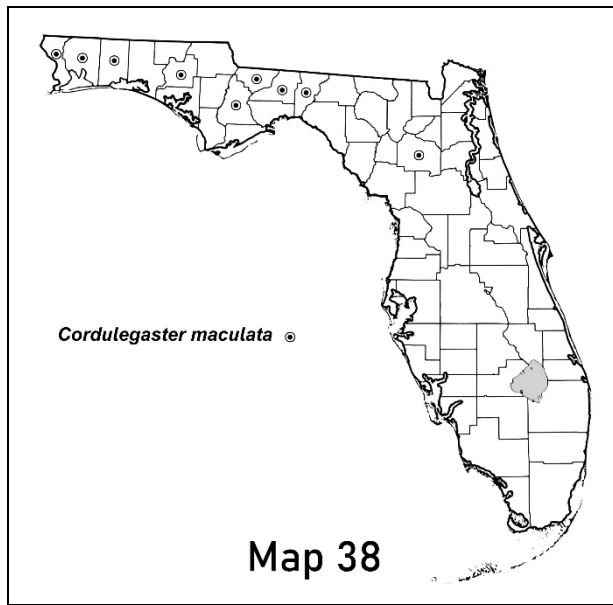
The number of palpal setae is not totally reliable, as *C. maculata* can have six on one or both sides, although six setae on a palp is highly unusual (only 4 of the 105 specimens I examined had six on one side). One specimen of *C. obliqua* had only five palpal setae on one side ($n = 53$). The number of primary premental setae is slightly more variable than the number of palpal setae, as 15% of the *C. maculata* I examined had seven primary setae on at least one side, and six specimens had seven primary setae on both sides; only one specimen of *C. obliqua* had six primary setae on both sides. In summary, if the number of total palpal and primary premental setae together equals 25 or fewer, the specimen is most likely *C. maculata*; if the total number equals 26 or more, it is probably *C. obliqua*. The difference in the total number of palpal + primary premental setae separates the species in F-1 and F-2 also. Females of the two species can be distinguished in F-0 by the length of the ovipositor valves relative to segment 9: in *C. maculata*, the tips of the valves surpass the ventral posterior margin of segment 9 whereas in *C. obliqua* the tips barely extend to the posterior margin of segment 9.

Habitat, Distribution, Life Cycle:

Cordulegaster nymphs typically inhabit slow, lotic waters, mainly 1st and 2nd order streams; they occupy sandy and silty substrates with little or no aquatic vegetation.

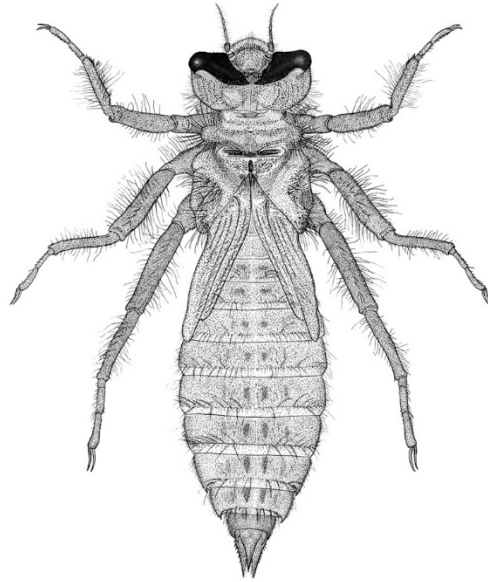
Both species of *Cordulegaster* in Florida have similar, limited distributions in the northern part of the state; each species has been recorded in nine Florida counties to date (Maps 38 and 39). *Cordulegaster maculata* emerges earlier in the year than *C. obliqua*. Recorded flight season in the state for *C. maculata* ranges from February 22 to April 19 and for *C. obliqua* from May 25 to July 23.

Both *Cordulegaster* species are probably partivoltine, based on studies of other species in the genus (Marczak et al. 2006, Glotzhober 2006).



Zoraena

Elongate, stout; light to dark brown; eyes small, protruding dorsally; legs long, relatively stout; wing sheaths divergent; no middorsal hooks; small posterolateral spines on segments 8 and 9



Zoraena is a North American endemic, with one of the five species, *Z. sayi*, occurring in Florida.

Diagnosis:

In addition to the key characters in the above generic key, the lateral margins of the head are straight in *Zoraena* versus bulging in *Cordulegaster*. Also, the ratio of prementum basal width to length is different, >0.40 in *Zoraena*, <0.40 in *Cordulegaster*. The only species of *Zoraena* discovered in Florida to date is *Z. sayi*; one other species of the genus, *Z. bilineata* Carle, occurs in southern Alabama, close to the Florida state line (for identification of *Z. bilineata*, see Tennessen 2019a).

Habitat, Distribution, Life Cycle:

Zoraena nymphs typically inhabit slow, lotic waters with muddy edges, mostly seepage runs and small 1st order streams; the microhabitat has little or no aquatic vegetation but is usually surrounded by woody vegetation and quite shaded.

Zoraena sayi is restricted to the northern part of the state where it has been recorded in 12 Florida counties (Map 40). It emerges early in the year and flies for only a short period. Recorded flight season in the state ranges from February 22 to April 22.

Zoraena sayi appears to be partivoltine, the life cycle probably taking three years to complete.

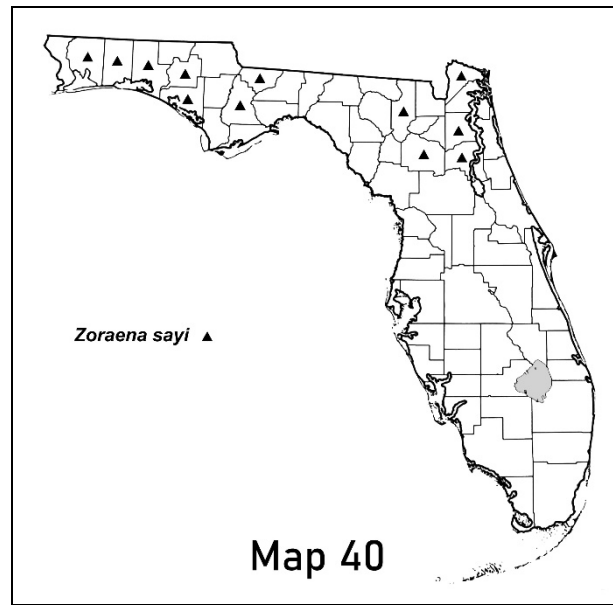


Plate 6. Representatives* of the two Cordulegastridae genera of Florida (photographs by Marla C. Garrison).



Cordulegaster



Zoraena

* The species represented in Plate 6 are *Cordulegaster maculata* and *Zoraena sayi*.

10. MACROMIIDAE

Macromiid nymphs are large dragonflies adapted for sprawling in sand and silt substrates, although they also hide among roots and other substrates. They are large and have robust, stout bodies with extremely long legs; their eyes protrude dorsally. There is little variability in general body shape within the family.

The family is characterized by 1) mouthparts hypognathous; 2) antenna 7-segmented; 3) prementum scoop-shaped, ligula entire; 4) teeth on distal margin of palpal lobes prominent and either rounded or pointed; 5) mesinfraepimeron with a triangular projection; 6) poststernum with a medial tubercle; 7) middorsal hooks on abdominal segments 2–9; 8) prominent posterolateral spines on segments 8 and 9. In North America the family is further characterized by a prominent triangular up-turned projection on the frontal ridge.

Both North American genera, *Didymops* Rambur and *Macromia* Rambur, occur in Florida. Measurements for each genus are summarized in Table 10.1 (p. 136).

Key to Genera of Macromiidae

1. Head widest behind compound eyes (Fig. 10.1a); meso- and metathoracic tarsal claws 0.9–1.0 times length of third tarsal segment (Fig. 10.2a); abdominal segment 10 without a middorsal ridge or posterior projection (Fig. 10.3a)..... *Didymops*
- 1'. Head widest across compound eyes (Fig. 10.1b); meso- and metathoracic tarsal claws 0.6–0.75 times length of third tarsal segment (Fig. 10.2b); abdominal segment 10 with a middorsal ridge and usually a posterior projection (Fig. 10.3b)..... *Macromia*

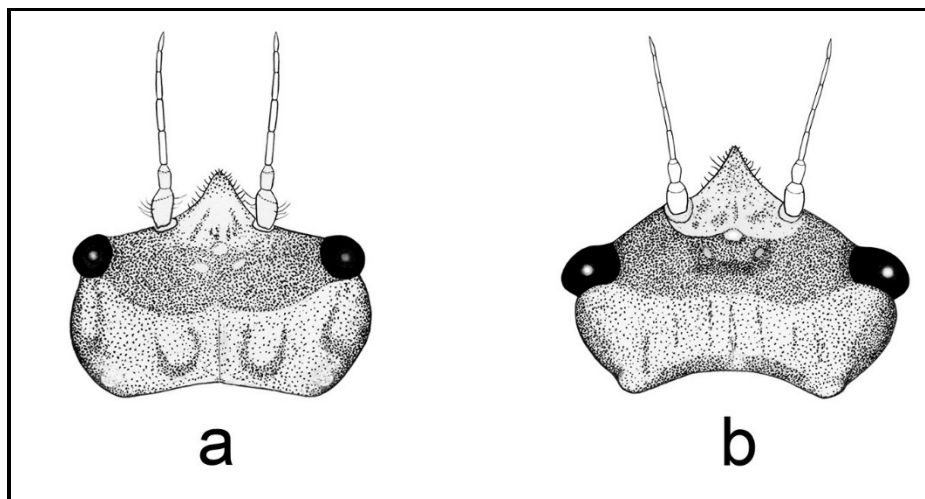


Figure 10.1. Macromiidae, head, dorsal view: a) *Didymops transversa*; b) *Macromia illinoensis*. Dashed line indicates eye in relation to lateral margin of head behind eye.

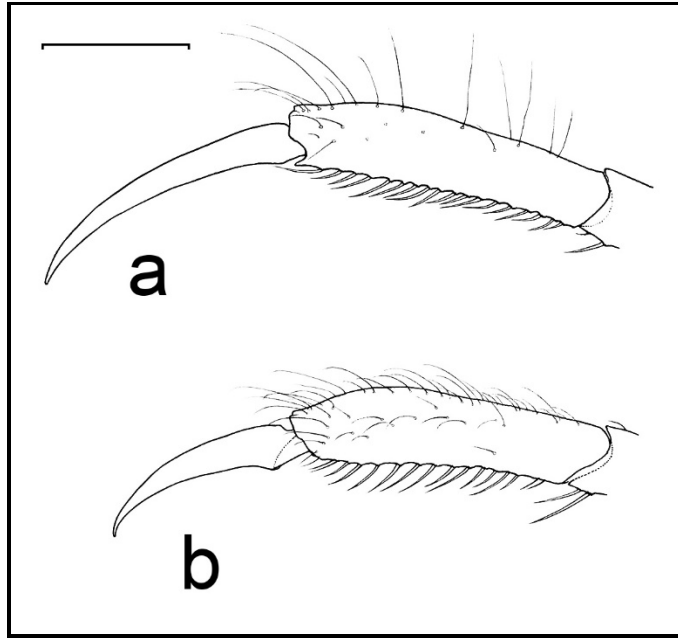


Figure 10.2. Macromiidae, metathoracic tarsus and tarsal claws: a) *Didymops transversa*; b) *Macromia illinoiensis*; scale bar = 1 mm.

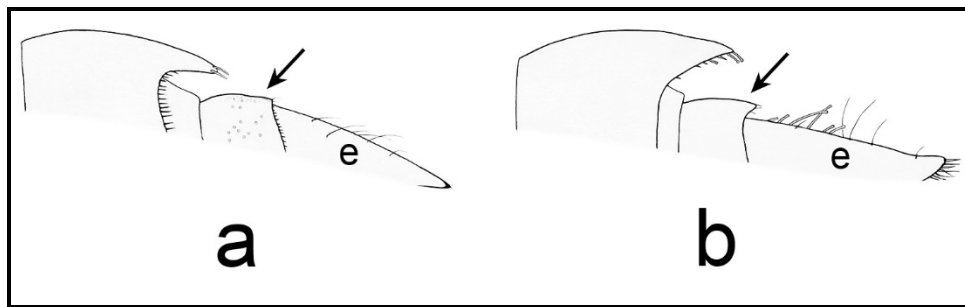


Figure 10.3. Macromiidae, abdominal segment 10, lateral view: a) *Didymops transversa*; b) *Macromia illinoiensis*; arrow indicates dorsum of segment 10, e = epiproct.

Generic Notes:

In addition to the generic key characters, *Didymops* has either a short setella (Fig. 10.4a) or no setella; conversely, *Macromia* has a long setella at the base of the labial palp (Fig. 10.4b). On the dorsolateral rim of the palpal lobe of *Didymops*, stout setae are present continuously from the base of the palp to the apex (Fig. 10.4a), whereas in *Macromia*, these setae are slightly thinner and more elongate, and the series terminates proximal to the apex (Fig. 10.4b). In *Didymops transversa*, the tubercles on the posterolateral corners of the head are small and more directly posterior to the eyes (Fig. 10.5a); in *D. floridensis*, tubercles are absent. The prominent tubercles on the posterolateral corners of the head of *Macromia* are not directly in line with the compound eyes but rather are slightly medial to them (Fig. 10.5b).

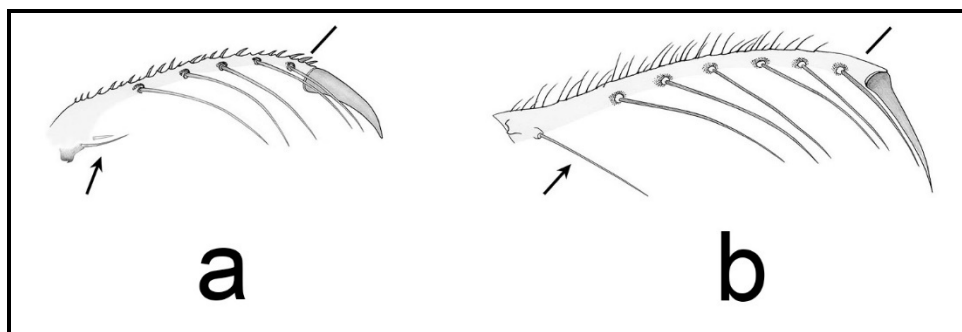


Figure 10.4. Macromiidae, dorsolateral rim of palpal lobe, dorsomedial view: a) *Didymops transversa*; b) *Macromia illinoiensis*. Arrow indicates setella, line indicates absence/presence of setae at distal end of rim.

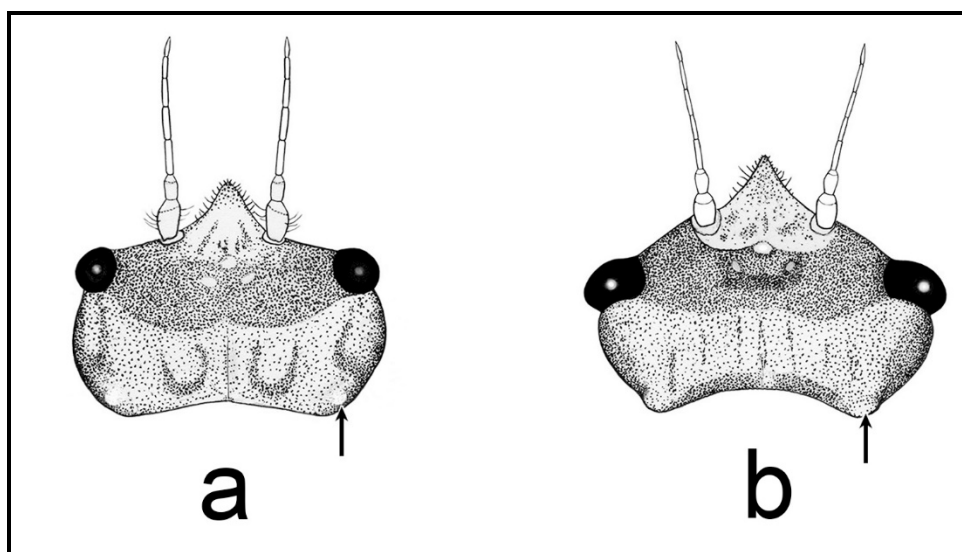


Figure 10.5. Macromiidae, head, dorsal view: a) *Didymops transversa*; b) *Macromia illinoiensis*. Arrow indicates position of posterolateral tubercle relative to position of compound eye.

Table 10.1. Summary of size measurements (mm) and palpal setae counts for the two genera of Macromiidae in Florida, for instar F-0.

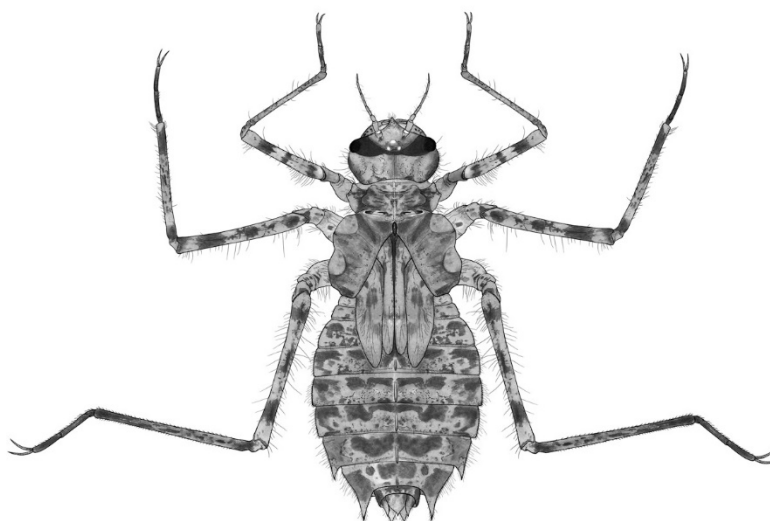
Genus	# Spp. in Florida	Total Length	Head Width	Premmentum Width	Epiproct L	# Palpal Setae
<i>Didymops</i>	2	22.9–33.5	5.35–7.20	5.35–7.20	1.40–2.25	2–6
<i>Macromia</i>	3	23.0–38.0	6.75–9.00	5.95–8.80	1.50–2.30	6–7

Macromiidae Generic Treatments

Five species of Macromiidae occur in Florida. Species determination in *Didymops* is straightforward but relatively challenging in *Macromia*.

Didymops

Elongate-oval;
extremely long
legs give spider-
like appearance;
triangular frontal
projection; mid-
dorsal hooks on
abdominal seg-
ments 2–9; long
posterolateral
spines on seg. 9



Didymops is a North American endemic with only two species, both of which occur in Florida.

Generic Notes:

The head of *Didymops* is proportionately smaller relative to the thorax when compared to that of *Macromia*. The lateral margins of the head behind the eyes bulge outward more in *Didymops* so that the head is wider behind the eyes than it is across the eyes; in *Macromia*, the lateral margins of the head are less prominent, so that the head is slightly wider across the eyes than it is posterior to the eyes.

Key to *Didymops* Species

1. Palpal setae usually 3 per side, setella absent; distal margin of palp with pointed crenations each bearing 1–3 spiniform setae (Fig. 10.6a).....*floridensis*
- 1'. Palpal setae usually 5 per side, small setella present; distal margin of palp with rounded crenations each bearing 5 or 6 spiniform setae (Fig. 10.6b)..... *transversa*



Figure 10.6. *Didymops*, distal margin of palp: a) *D. floridensis*; b) *D. transversa*.

Diagnostic Remarks:

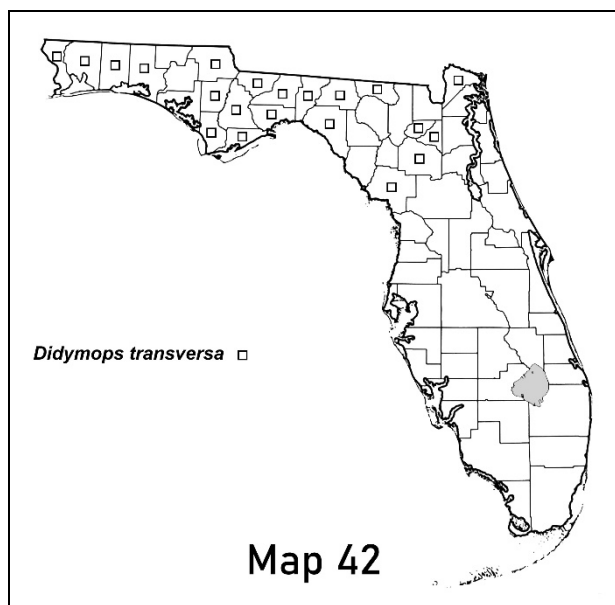
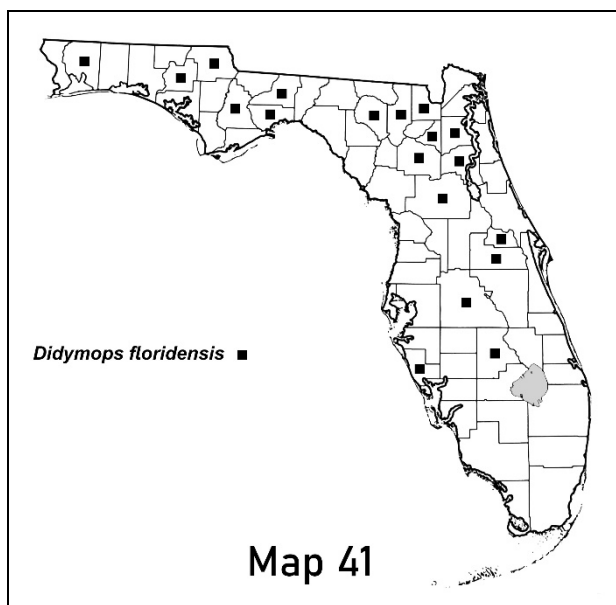
The number of palpal setae is nearly constant in the two species with no overlap in the specimens examined. Rarely *D. floridensis* has only two setae on one side (three on the other side) and *D. transversa* has six setae on one side (five on the other side). The number of primary premental setae also differs, *D. floridensis* usually with four primary setae per side versus five or six for *D. transversa*. The posterolateral corner of the head of *D. transversa* has a small but distinct tubercle whereas in *D. floridensis* the corner is slightly squared but is not raised. Lastly, *D. floridensis* is larger, head width ranging from 6.60 to 7.20 mm in F-0 compared with 5.35 to 6.40 mm for *D. transversa*.

Habitat, Distribution, Life Cycle:

Didymops nymphs are both lentic and lotic, inhabiting lakes, ponds, and streams; they are usually found in sandy and silty substrates with little or no aquatic vegetation.

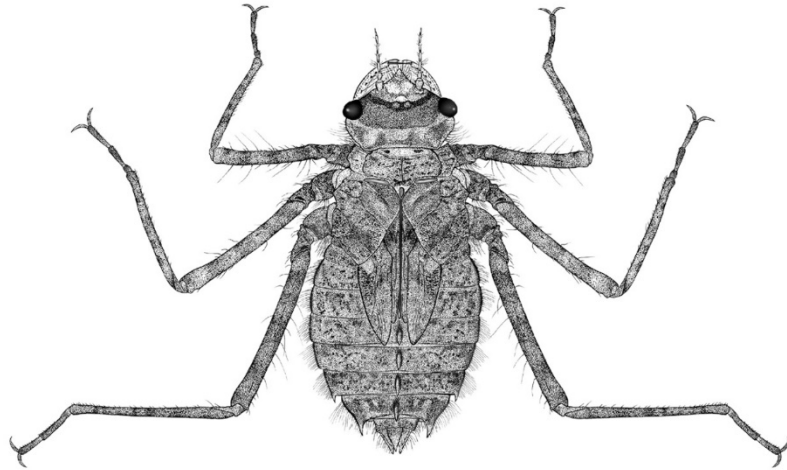
Didymops floridensis is distributed throughout most of Florida except for the counties south of Lake Okeechobee (Map 41); based on field observations, it is restricted to sand-bottomed lakes and appears to inhabit deeper portions of these lakes than does *D. transversa*. *Didymops transversa* is more limited in range in Florida, occurring only as far south as Levy County (Map 42); it occurs in streams, ponds, and lakes. Both species emerge early in the year. Recorded flight season in the state for *D. floridensis* ranges from January 20 to May 3 and for *D. transversa* from January 25 to May 11.

Both *Didymops* species are probably semivoltine based on Paulson and Jenner (1971) and benthic samples containing different size classes.



Macromia

Elongate-oval;
extremely long
legs give spider-
like appearance;
triangular frontal
projection; mid-
dorsal hooks on
abdominal seg-
ments 2–9; post-
erolateral spines
on seg. 8 and 9



Macromia comprises seven species in North America, three of which occur in Florida.

Generic Notes:

The lateral margin of the head of *Macromia* does not bulge outward beyond the lateral extremity of the eye (Fig. 10.7a) as compared to *Didymops* in which the bulge of the lateral margin slightly exceeds the lateral extremity of the eye (Fig. 10.7b).

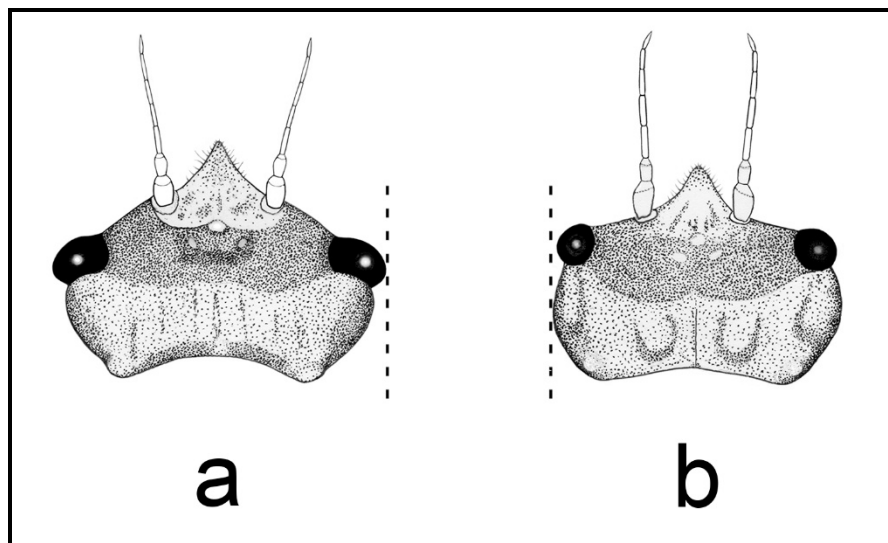
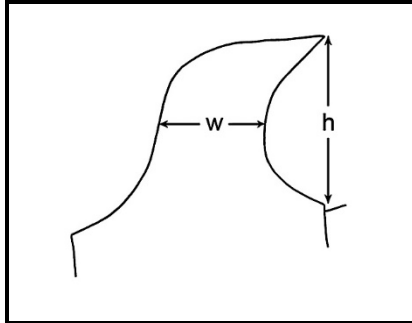


Figure 10.7. Macromiidae, head, dorsal view: a) *Macromia illinoensis*; b) *Didymops floridensis*.

Key to *Macromia* Species

Note: middorsal hook width (**w**) was measured in lateral view near the middle of the hook, and height (**h**) was measured from the tip of the hook to base of the segment, as figured here.



1. Middorsal hook on abdominal segment 6 slender, ratio of width:height 0.35–0.50, dorsal margin gradually arched (Fig. 10.8a); pterothorax with 6–10 long dorsal setae (> 2.0 mm) near base of wing sheaths (Fig. 10.9a).....*allegghaniensis*
- 1'. Middorsal hook on abdominal segment 6 wider, ratio of width:height 0.55–0.80, dorsal margin abruptly arched (Fig. 10.8b); pterothorax with fewer shorter dorsal setae (< 1.5 mm) near base of wing sheaths (Fig. 10.9b)2

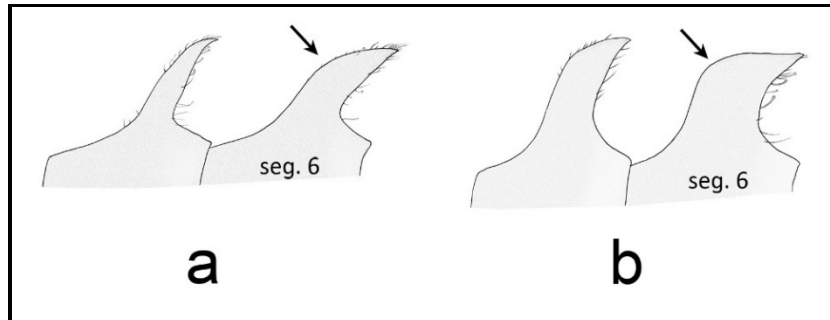


Figure 10.8. *Macromia* abdominal segment 6, lateral view: a) *M. allegghaniensis*; b) *M. illinoiensis*; arrow indicates degree of arch of dorsal margin of hook.

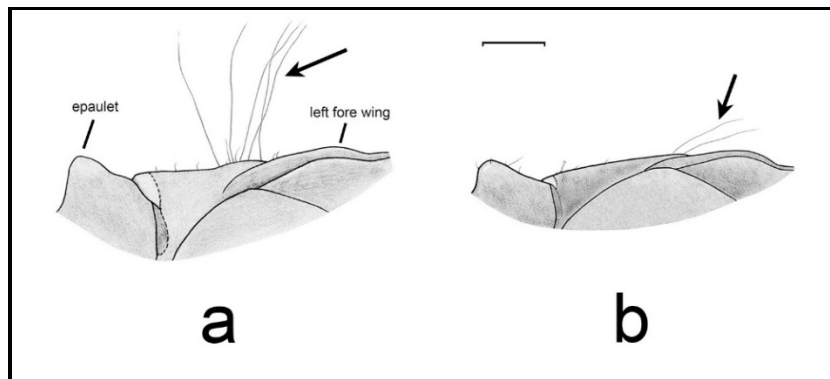


Figure 10.9. *Macromia* upper part of pterothorax, lateral view: a) *M. allegghaniensis*; b) *M. illinoiensis*; arrow indicates dorsal setae.

2. Metathoracic femur less than 12 mm long in F-0; ratio of segment 9 posterolateral spine width:length 0.5–0.7 (Fig. 10.10a)*illinoiensis*
- 2'. Metathoracic femur at least 12 mm long in F-0; ratio of segment 9 posterolateral spine width:length 0.8–0.9 (Fig. 10.10b) *taeniolata*

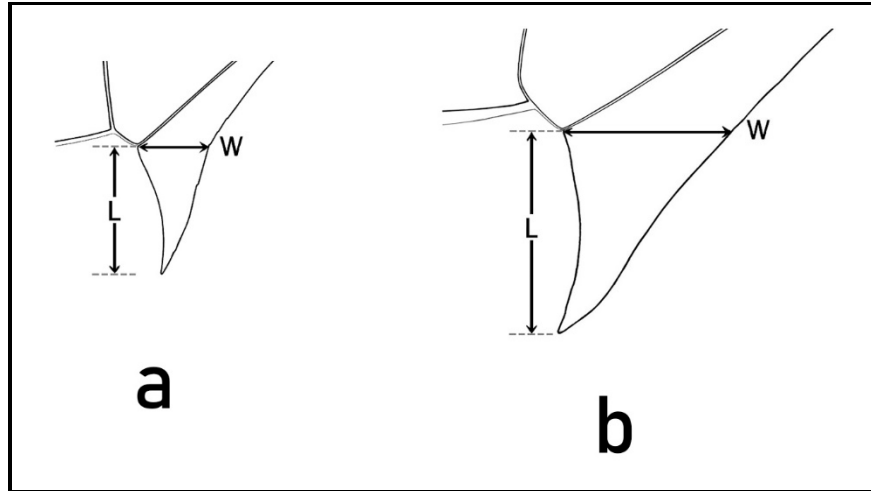


Figure 10.10. *Macromia* abdominal segment 9 posterolateral spine, setae omitted, ventral view: a) *M. illinoiensis*; b) *M. taeniolata*.

Diagnostic Remarks:

In addition to the key characters, the ratio of max prementum width:head width distinguishes most *M. alleghaniensis* from *M. illinoiensis* (0.91–1.00 versus 0.84–0.92 respectively), the overlap slight. These two species are similar in all other characters examined. *Macromia taeniolata* is larger on average than both *M. alleghaniensis* and *M. illinoiensis* but there is overlap in most measurements. Abdomen width (max across segment 6) was greater in F-0 *M. taeniolata* (12.6–16.3 mm) than in F-0 *M. alleghaniensis* and *M. illinoiensis* (9.1–12.5 mm).

Habitat, Distribution, Life Cycle:

Macromia nymphs typically inhabit lotic waters in Florida, mainly 4th order up to 10th order streams (Strahler method). They sprawl in sand and silt substrates but also cling to roots in undercut stream banks.

The only records of *Macromia alleghaniensis* in Florida are based on a reared specimen collected in Santa Rosa County and an exuviae collected in Calhoun County (Map 43); the specimens are deposited in the FSCA in Gainesville. *Macromia illinoiensis* ranges south to Highlands County (Map 44); *M. taeniolata* ranges further south to Miami-Dade County (Map 45).

Macromia emerge in late spring and fly for much of the summer, sometimes into fall. The only flight season data for *M. alleghaniensis* is May 16 based on an emerging individual; this species probably flies well into August. Recorded flight season in the state for *M. illinoiensis* ranges from March 7 to November 9, and for *M. taeniolata* from April 14 to November 23. *Macromia* species are probably either semivoltine or partivoltine although studies on voltinism in Florida are needed.

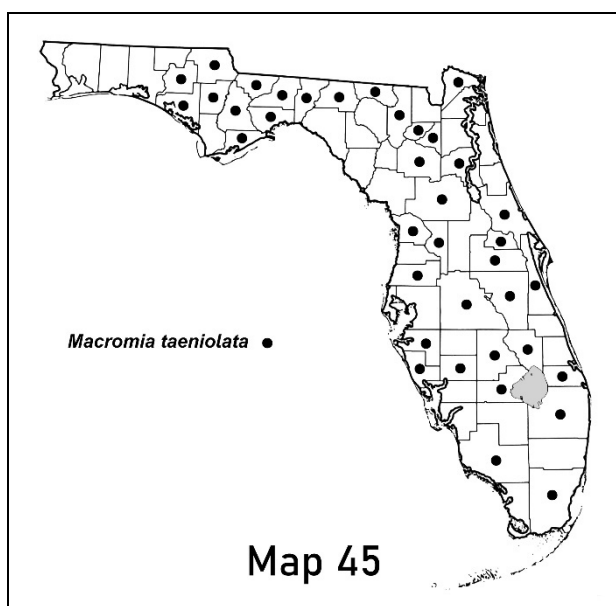
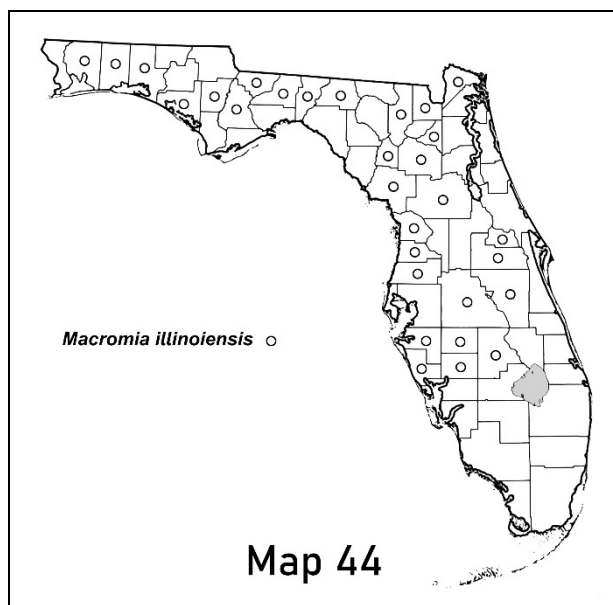
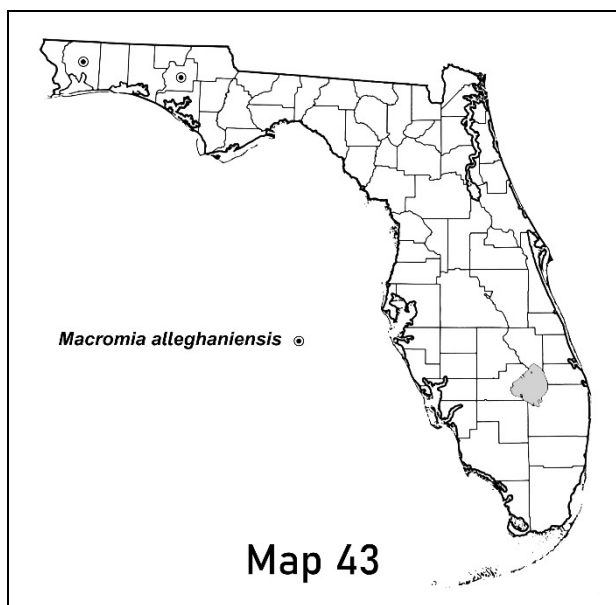


Plate 7. Representatives* of the two Macromiidae genera of Florida (photographs by Marla C. Garrison).



Didymops



Macromia

* The species represented in Plate 7 are *Didymops transversa* and *Macromia taeniolata*.

11. CORDULIIDAE

Corduliid nymphs sprawl in sandy, silty or muddy bottoms, hide in detritus, moss or other vegetation, or cling to logs, roots, and rocks at or just above the benthic layer. They are medium-sized dragonflies with relatively long legs and eyes that protrude laterally. There is considerable variability in general body shape within the family, facilitating field identification to genus, especially with familiarity and low magnification.

The Florida members of this family are characterized by 1) antenna 7-segmented, nearly as long as or longer than head; 2) frontoclypeal ridge prominent; 3) prementum with ventromedial groove; 4) prementum scoop-shaped, ligula entire; 5) teeth on distal margin of palpal lobes with relatively large crenations; 6) middorsal hooks present on at least apical abdominal segments (NOTE: middorsal hooks are highly variable in North American Corduliidae, including sometimes completely lacking, but all species in Florida have middorsal hooks on some segments); 7) prominent posterolateral spines present on segments 8 and 9, sometimes reduced. In North America, one species has a triangular frontal projection resembling that of the Macromiidae.

Four genera of Corduliidae are found in Florida, namely *Epitheca* Charpentier, *Helocordulia* Needham, *Neurocordulia* Selys and *Somatochlora* Selys. The following generic key should not be used for regions outside of Florida. Measurements for each genus are summarized in Table 11.1 (p. 148).

Key to Genera of Corduliidae (F-0 to F-2)

1. Abdominal segment 2 with a prominent middorsal hook; segment 8 lateral sternites without a small anterolateral sclerite (Fig. 11.1a); posterolateral spines on segment 9 long, tips usually extending well beyond level of cerci tips (Fig. 11.2a)2
- 1'. Abdominal segment 2 without a middorsal hook; segment 8 lateral sternites with a small anterolateral sclerite (Fig. 11.1b); posterolateral spines on segment 9 variable, tips usually not extending beyond level of cerci tips (Fig. 11.2b)3

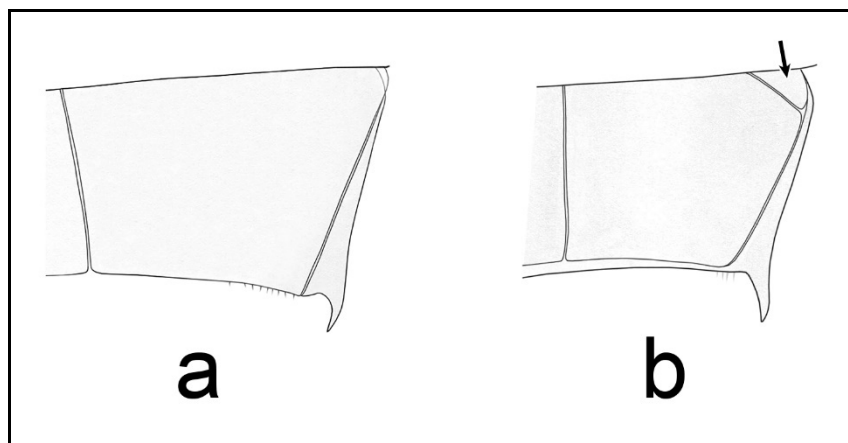


Figure 11.1. Corduliidae, abdominal segment 8, left side, ventral view: a) *Epitheca*; b) *Helocordulia*. Arrow indicates anterolateral sclerite; setae on lateral margin omitted.

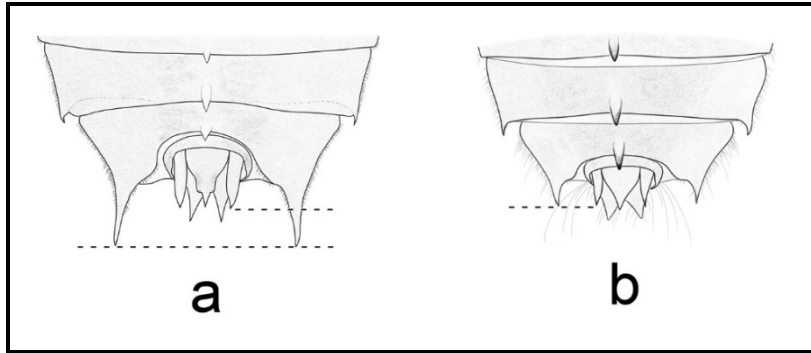


Figure 11.2. Corduliidae, abdominal segment 9 and anal appendages, dorsal view: a) *Epitheca*; b) *Helocordulia*.

- 2. Thorax with a dark lateral stripe (Fig. 11.3a); abdominal segment 6 lateral sternites without an anterolateral sclerite (Fig. 11.4a) *Epitheca*
- 2'. Thorax without a dark lateral stripe, dark markings if present obscure (Fig. 11.3b); abdominal segment 6 lateral sternites with a definite anterolateral sclerite (Fig. 11.4b) *Neurocordulia*

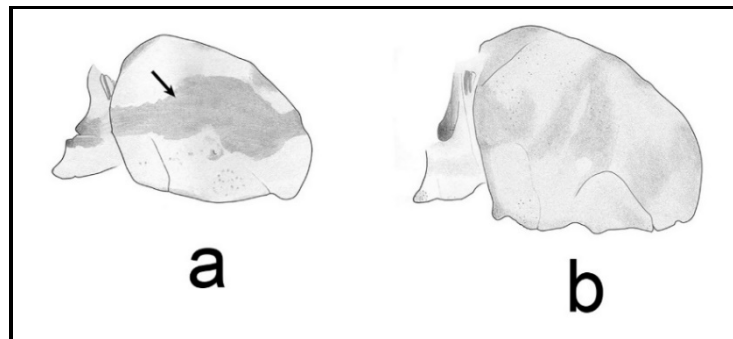


Figure 11.3. Corduliidae, thorax, lateral view: a) *Epitheca*; b) *Neurocordulia*. Arrow indicates dark lateral stripe.

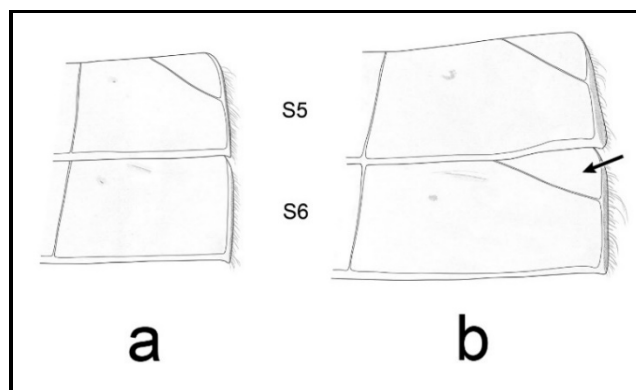


Figure 11.4. Corduliidae, abdominal segment 6, left side, ventral view: a) *Epitheca*; b) *Neurocordulia*. Arrow indicates anterolateral sclerite on segment 6 (S6).

3. Middorsal hooks present on abdominal segments 6–9 only (small on seg. 6); combined length of antennal segments 1 + 2 $\leq$ 0.35 times middorsal length of head along midline from frontoclypeal ridge to posterior margin; dorsolateral rim of prementum with only fine setae, mostly on distal half of rim (Fig. 11.5a) ***Helocordulia***
- 3'. Middorsal hooks present on abdominal segments 4–9 (small on seg. 4); combined length of antennal segments 1 + 2 $\geq$ 0.37 times middorsal length of head along midline from frontoclypeal ridge to posterior margin; dorsolateral rim of prementum with 3–12 stiff setae near mid-length and fine setae along entire length (Fig. 11.5b) ***Somatochlora***

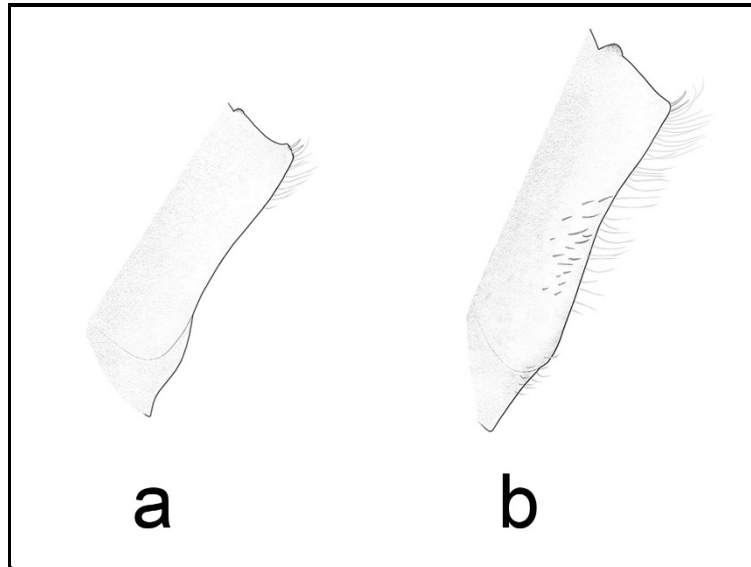


Figure 11.5. Corduliidae, dorsolateral rim on right side of prementum: a) *Helocordulia*; b) *Somatochlora*.

Generic Notes:

In couplet 1', regarding the second character, the fine suture on segment 8 that delineates the anterolateral sclerite from the lateral sternite can be difficult to detect; careful inspection at high magnification and changing the direction of the illumination help to reveal the suture and thus the small triangular sclerite.

In addition to the key characters in couplet 2, the posterolateral spines on segment 9 are usually much longer than the spines on segment 8 in *Epithea* (ratio 2.4–8.4) versus *Neurocordulia* (ratio 1.5–3.5); however, there is some overlap in the ratio, especially between *E. spinosa* (ratio 2.35–2.65) and *N. molesta* (ratio 1.90–3.55).

Couplet 3' characters apply only to the Florida species of *Somatochlora*. All species of *Somatochlora* that occur in Florida possess middorsal hooks. However, middorsal hooks are highly variable in species from more northern areas, many species lacking them altogether. The setae on the dorsolateral rim of the prementum and the dorsal rim of the palps are also variable in *Somatochlora* from other regions. Therefore, couplet 3 should not be applied to specimens from areas outside of Florida. Couplet 3 is probably reliable for instars as early as F-2 and F-3; instars smaller than F-3 should be left identified as Corduliidae.

Table 11.1. Summary of size measurements (mm) and palpal setae counts for the four genera of Corduliidae in Florida, for instar F-0.

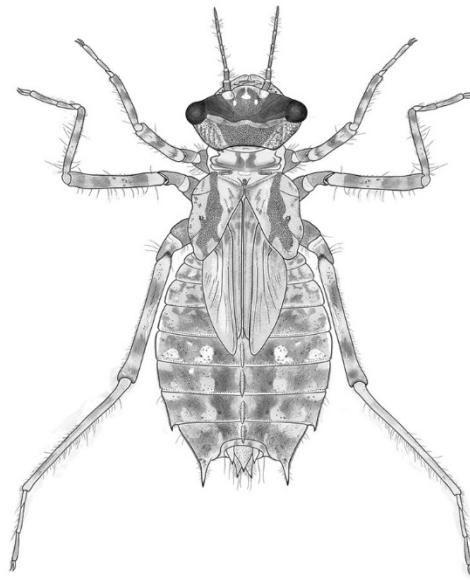
Genus	# Spp. in Florida	Total Length	Head Width	Premenum Width	Epiproct L	# Palpal Setae
<i>Epithea</i>	7	15.5–27.6	4.75–8.00	3.35–5.95	0.95–2.00	4–9
<i>Helocordulia</i>	1	18.3–19.1	5.15–5.40	3.95–4.15	0.90–1.03	6–8
<i>Neurocordulia</i>	4	15.3–22.6	5.45–6.85	4.00–5.25	1.00–1.45	4–8
<i>Somatochlora</i>	6	17.5–24.3	5.80–6.95	4.00–4.95	1.15–1.40	7–9

Corduliidae Generic Treatments

A total of 18 species of Corduliidae occur in Florida; only one species of *Helocordulia* occurs in the state, *H. selysii*. Species determinations in the other three genera are challenging, and microscopic detail and accurate measurement are often required. The following keys to species should be used only for Florida specimens due to variation within certain genera, so that when all species are included, some of the characters are rendered inapplicable.

Epitheca

Elongate-oval, compact, dark brown; long legs; dark stripes on thorax; middorsal hooks on abdominal segments 2–9; apex of abdomen abrupt, long postero-lateral spines on segment 9



Epitheca is mainly a North American group with seven species in Florida.

Generic Notes:

Epitheca nymphs are unique in the Florida corduliid fauna in possessing a well-defined dark stripe on each side of the thorax. Although the genus is distinct in this character from other Florida corduliids, two genera of Libellulidae that occur in Florida, *Celithemis* and *Dythemis*, superficially resemble *Epitheca* in their dorsal color pattern (likely due to character convergence, or homoplasy). However, those libellulid genera do not possess a ventromedial groove on the prementum, and they lack a middorsal hook on abdominal segment 2.

Two species of *Epitheca*, *E. princeps* and *E. spinosa*, can be readily identified using the following key. The other five species are among the most challenging dragonfly nymphs to separate. I believe it is best to consider identifications derived from couplet 3 onward to be provisional, as further taxonomic research on this group is needed. The key will most likely be revised as more data are obtained.

Key to *Epitheca* Species

1. Prementum with 3 or 4 primary setae plus numerous small setae scattered on broad portion of ental surface (Fig. 11.6a); palpal setae 4 or 5, none in basal third; prementum distal width:length ratio > 1.6*princeps*
- 1'. Prementum with 6–9 primary setae plus a few secondary setae but without small setae on ental surface (Fig. 11.6b); palpal setae 5–8, at least 2 in basal third close to palpal hinge; prementum distal width:length ratio < 1.3 2

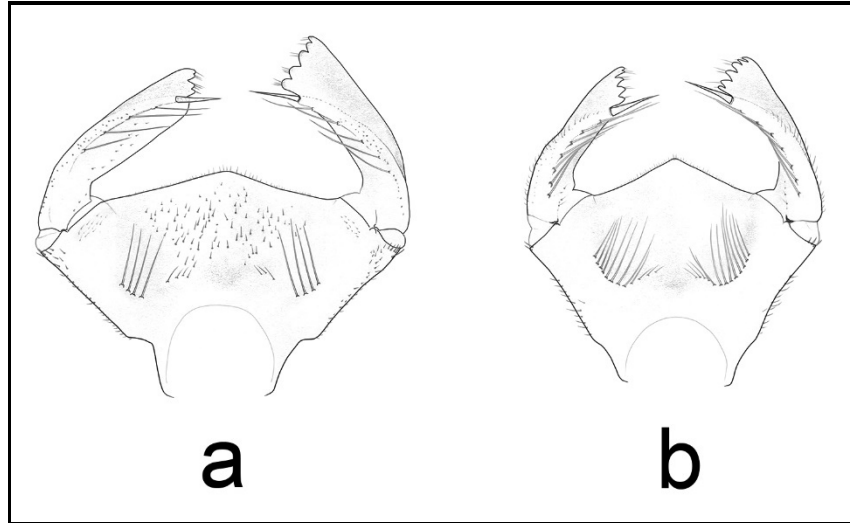


Figure 11.6. *Epitheca*, prementum: a) *E. princeps*; b) *E. cynosura*.

2. Posterolateral spines on segment 9 relatively short, tips extending to level of paraproct tips (Fig. 11.7a); ratio of segment 8 posterolateral spine length:segment 9 posterolateral spine length 0.36–0.48; max width of abdomen (F-0) > 8.5 mm.....*spinosa*
- 2'. Posterolateral spines on segment 9 relatively long, tips extending beyond level of paraproct tips (Fig. 11.7b); ratio of segment 8 posterolateral spine length:segment 9 posterolateral spine length 0.12–0.32; max width of abdomen (F-0) < 8.0 mm.....3

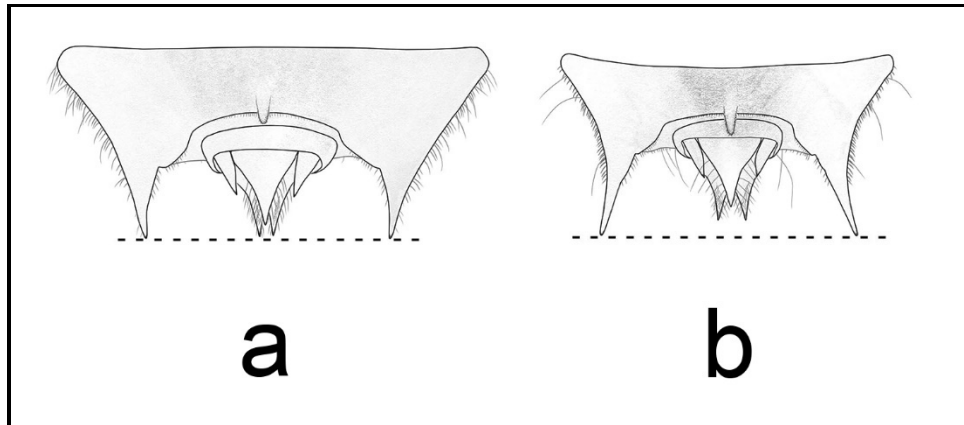


Figure 11.7. *Epitheca*, abdominal segment 9 and anal appendages: a) *E. spinosa*; b) *E. cynosura*.

3. Middorsal hook on abdominal segments 5 and 6 inclined relative to horizontal axis, and middorsal hook on segment 7 raised (Fig. 11.8a); segment 9 posterolateral spine length 1.10–1.90 mm, ratio of spine length:space between spine bases 0.40–0.65 (Fig. 11.9a).....4
- 3'. Middorsal hook on abdominal segments 5 and 6 closer to parallel with horizontal axis, and middorsal hook on segment 7 low (Fig. 11.8b); segment 9 posterolateral spine length 1.80–3.00 mm, ratio of spine length:space between spine bases 0.55–1.05 (Fig. 11.9b).....5

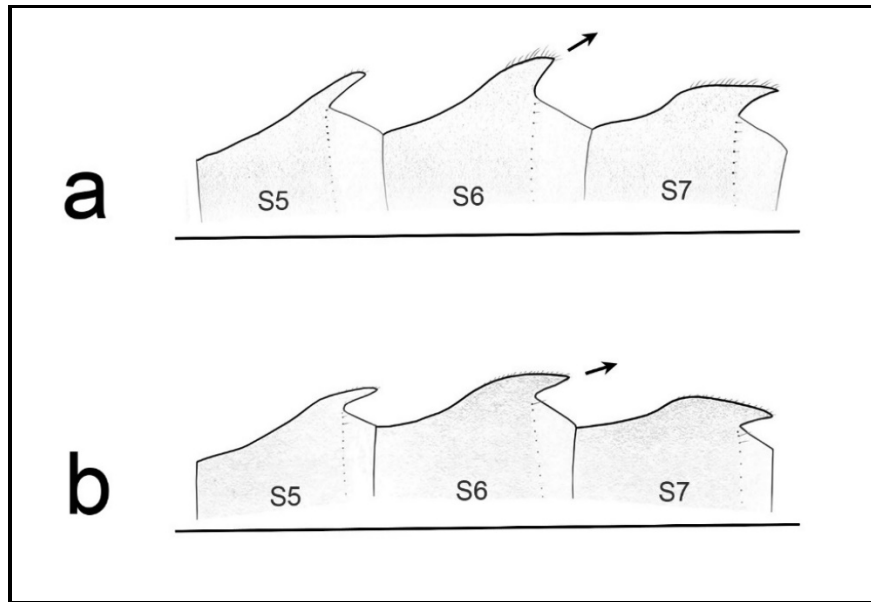


Figure 11.8. *Epitheca*, abdominal segments 5–7, lateral view: a) *E. cynosura*; b) *E. costalis*. Horizontal axis of abdomen represented by line.

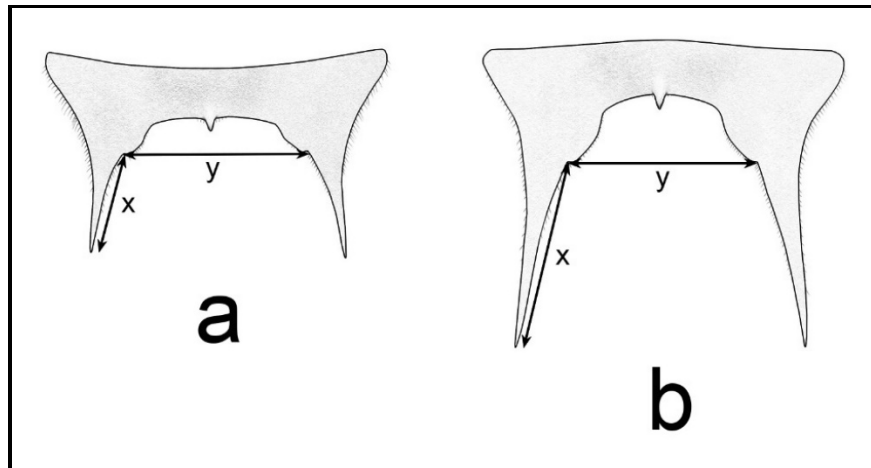


Figure 11.8. *Epitheca*, abdominal segment 9, dorsal view: a) *E. cynosura*; b) *E. costalis*; $x \div y$ = ratio of spine length:space between spine bases.

4. Head width 5.00–5.65 mm; middorsal hook on abdominal segment 6 much thicker at base than hook on segment 5 (Fig. 11.10a) *cynosura*
- 4'. Head width 4.75–5.15 mm; middorsal hook on abdominal segment 6 slightly thicker at base than hook on segment 5 (Fig. 11.10b) *semiaquea*

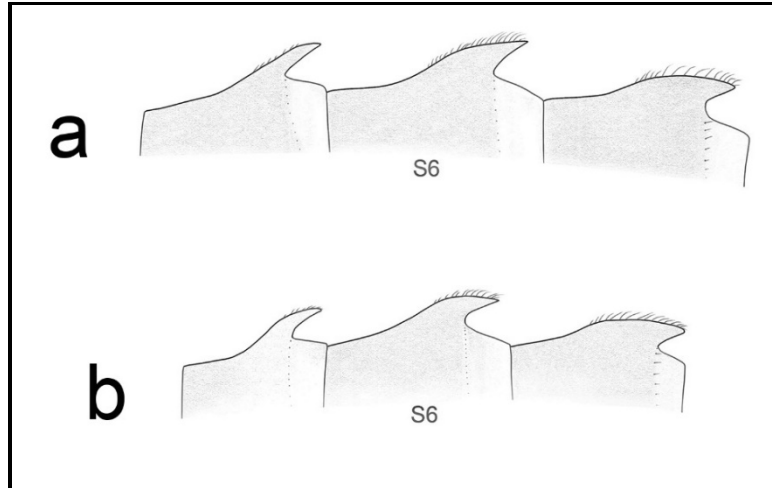


Figure 11.10. *Epitheca*, abdominal segments 5–7, lateral view: a) *E. cynosura*; b) *E. semiaquea*.

5. Ratio of cercus length:epiproct length 0.83–0.96 for males, 0.64–0.96 for females *costalis*
- 5'. Ratio of cercus length:epiproct length 0.60–0.82 for males, 0.55–0.67 for females 6
6. Femora with dark bands faint, not strongly contrasting with tan base color (Fig. 11.11a); middorsal hooks on segments 6 and 7 relatively high, tips about 0.25 mm above ventral base (Fig. 11.12a) *sepia*
- 6'. Femora with dark bands well-defined, strongly contrasting with tan base color (Fig. 11.11b); middorsal hooks on segments 6 and 7 relatively low, tips about 0.15 mm above ventral base (Fig. 11.12b) *stella*

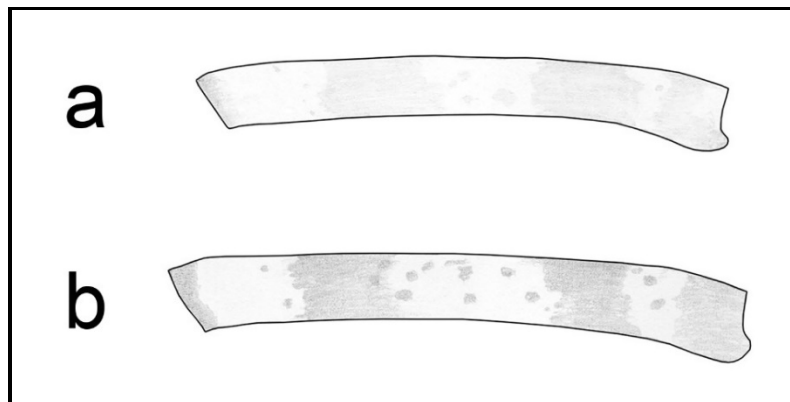


Figure 11.11. *Epitheca*, Left mesothoracic femur, lateral view: a) *E. sepia*; b) *E. stella*. Setae omitted.

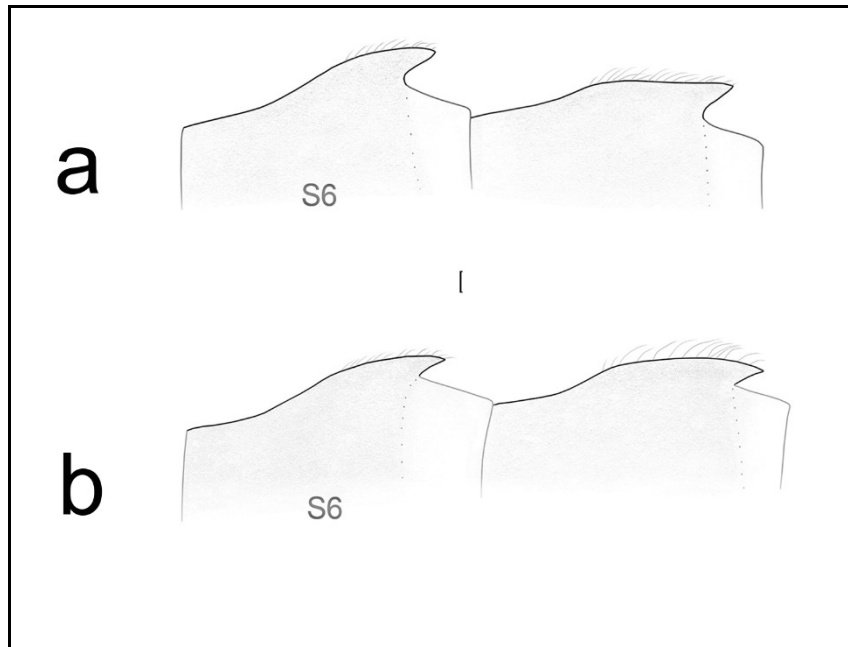


Figure 11.12. *Epitheca*, abdominal segments 6 and 7, lateral view: a) *E. sepia*; b) *E. stella*. Scale bar = 0.1 mm.

Diagnostic Remarks:

Epitheca princeps is classified in the subgenus *Epicordulia* as compared to the other nine North American species which are placed in the subgenus *Tetragoneuria*, according to most references (see Walker 1966, Needham et al. 2014); it and *E. spinosa* are the only two readily identifiable species in the genus. Unfortunately, no other morphological differences between the five problematic species that key out from couplet 3 onward were found. However, one of these species, *E. semiaquea*, appears to be extremely rare in Florida; therefore, specimens that fit the characters in the first part of couplet 3 will most likely be *E. cynosura*. *Epitheca costalis*, *E. sepia* and *E. stella* are quite common in lakes and ponds, and their separation based on the key characters above will not always be possible.

Habitat, Distribution, Life Cycle:

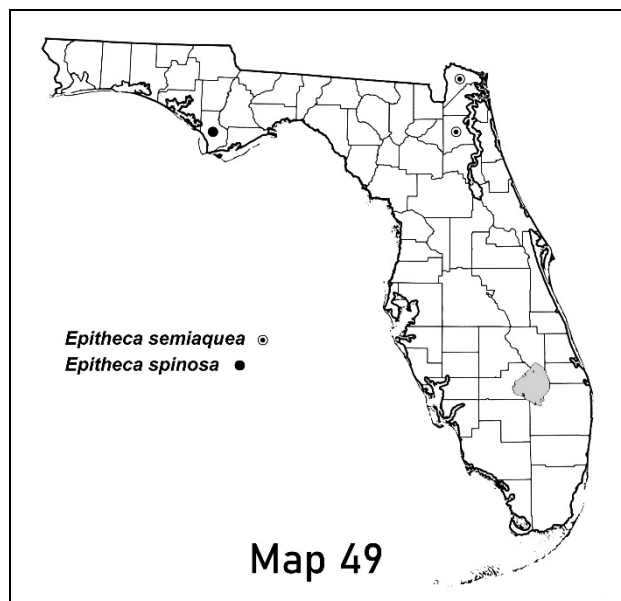
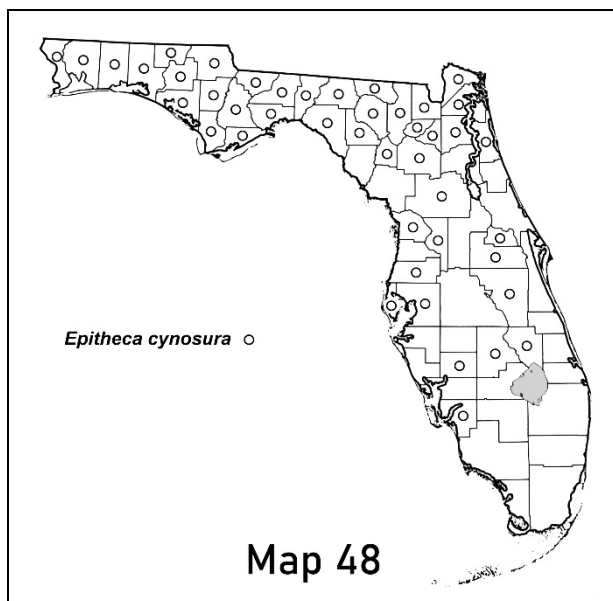
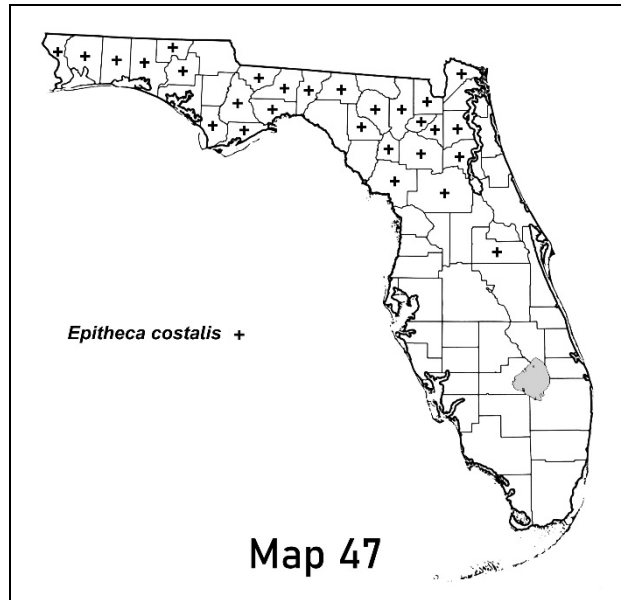
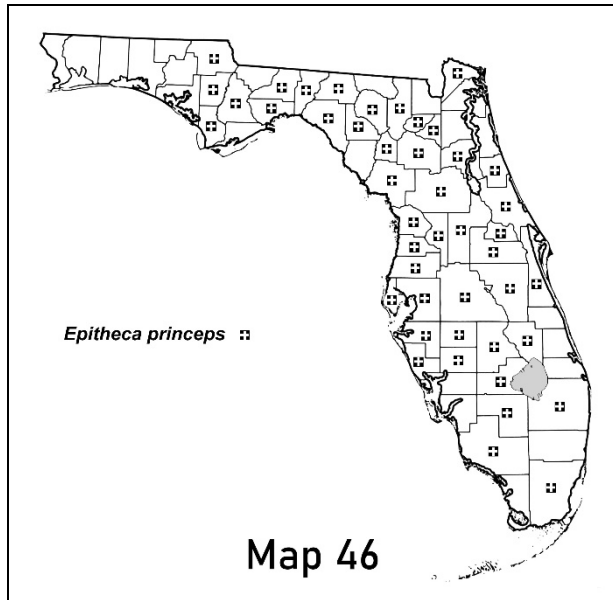
Epitheca nymphs are predominantly lentic, inhabiting lakes, ponds, reservoirs, forest backwaters, canals, and ditches, usually with aquatic vegetation, but several species also inhabit slow areas of streams.

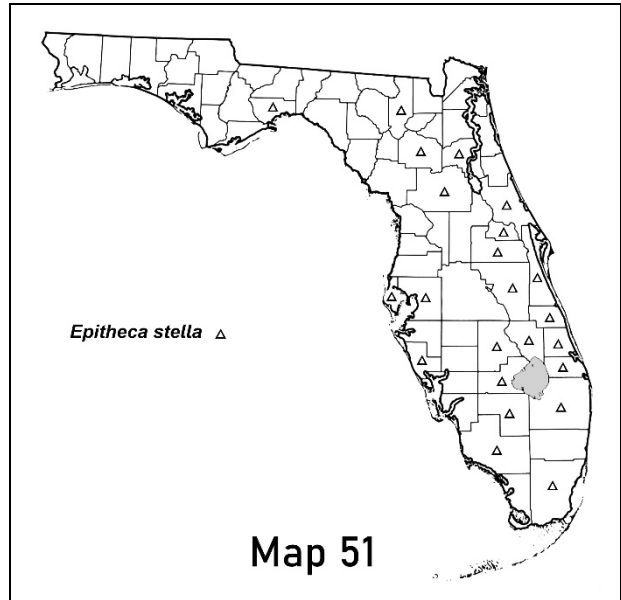
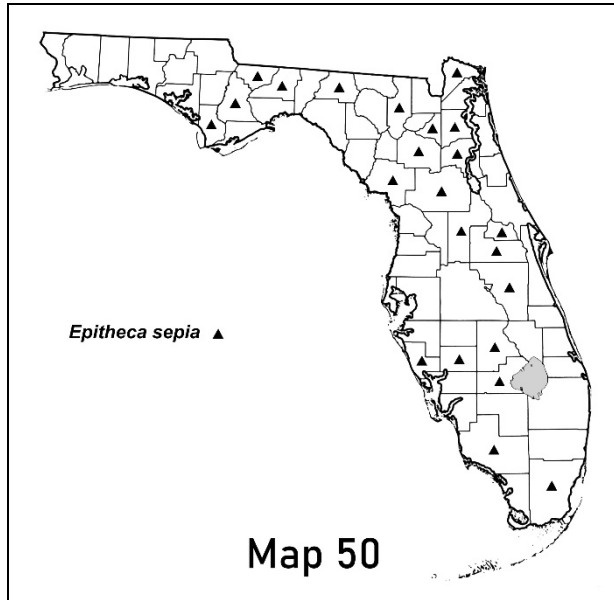
Epitheca princeps is distributed throughout the state (Map 46), and *E. cynosura* (Map 48), *E. sepia* (Map 50) and *E. stella* (Map 51) are distributed nearly throughout the state. *Epitheca costalis* occurs from the panhandle south to the center of the peninsula (Map 47). *Epitheca spinosa* has been recorded in only one county in the peninsula and *E. semiaquea* has been collected in only two counties in the northern part of the peninsula (Map 49).

Epitheca species emerge early in the year. Recorded flight season in the state for *E. princeps* ranges from March 15 to December 3, for *E. costalis* from January 20 to April 18, for *E. cynosura* from January 8 to May 7 9 (plus an apparent late season period from October to

December), for *E. semiaquea* from February 25 to April 3, for *E. sepia* from March 3 to November 25, for *E. spinosa* from March 13 to March 25, and for *E. stella* from December 27 to April 25.

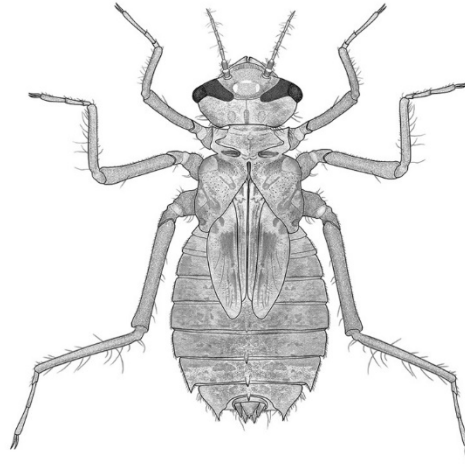
Most *Epitheca* species in Florida are probably univoltine (see Lutz and Jenner 1964 for data on more northern populations), although the two separate flight seasons of *E. cynosura* indicate that some populations could be bivoltine.





Helocordulia

Elongate-oval, compact, dark brown; long legs; prominent middorsal hooks on abdominal segment 7–9, very small hook on seg. 6; short posterolateral spines on segments 8 and 9



Helocordulia is an endemic North America genus of only two species, one of which, *H. selysii*, occurs in Florida.

Generic Notes:

Helocordulia can be confused with *Somatochlora*. The middorsal hooks provide the most obvious difference between these genera, *Helocordulia* lacking middorsal hooks anterior to segment 6 whereas the Florida species of *Somatochlora* have middorsal hooks (though small) on segment 4 and 5. *Helocordulia* is smaller than *Somatochlora* in several characters in F-0, including head width (< 5.9 mm versus > 6.0 mm), epiproct length (< 1.05 mm versus > 1.15 mm), and cercus length (< 0.85 mm versus > 0.85 mm).

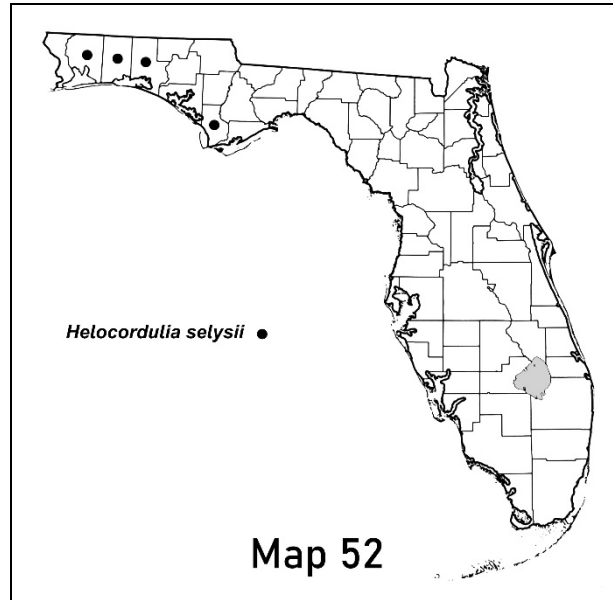
Habitat, Distribution, Life Cycle:

Helocordulia nymphs are predominantly lotic, inhabiting small streams in wooded areas. They apparently cling to roots and sunken wood and twigs.

Helocordulia has been recorded only from the western part of the panhandle (Map 52).

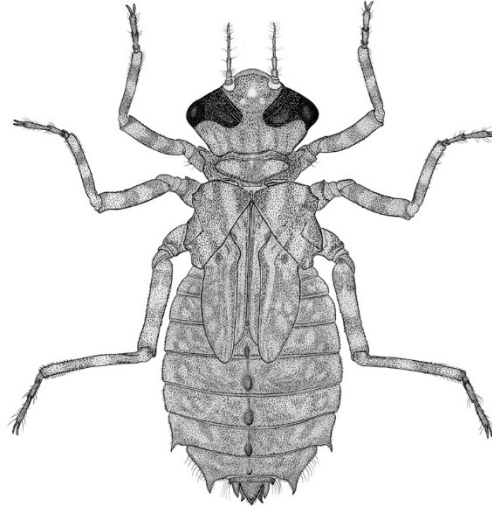
Helocordulia selysii emerges early in the year and flies for a relatively short period. Recorded flight season in the state ranges from February 26 to April 11.

Helocordulia is probably univoltine, although no data on voltinism in this genus is available.



Neurocordulia

Elongate-oval, robust, dark brown; sturdy legs; middorsal hooks on abdominal segments 2–9 knoblike; apex of abdomen abrupt, posterolateral spines on segments 8 and 9



Neurocordulia is an endemic North America genus of seven species, four of which occur in Florida.

Generic Notes:

Neurocordulia nymphs are stockier and more stiff-jointed than other corduliids. Full-grown *Neurocordulia* have a pair of tubercles on the dorsum of the head that most other corduliids lack, although some *Epitheca* species have very low tubercles in F-0, such as *Epitheca princeps*. The tubercles are variable in earlier instar corduliids; as a word of caution, most other corduliids also have tubercles on the head in instars earlier than F-0. The middorsal hooks on *Neurocordulia* are blunt to rounded compared to the more acuminate hooks of *Epitheca*.

Key to *Neurocordulia* Species

1. Frontoclypeal ridge with an acute triangular projection (Fig. 11.13a); mesothoracic trochanter of male nymphs with a prominent ventral swelling (Fig. 11.14a).....*molesta*
- 1'. Frontoclypeal ridge convex, without triangular projection (Fig. 11.13b); mesothoracic trochanter of male nymphs with a very slight ventral swelling (Fig. 11.14b).....2

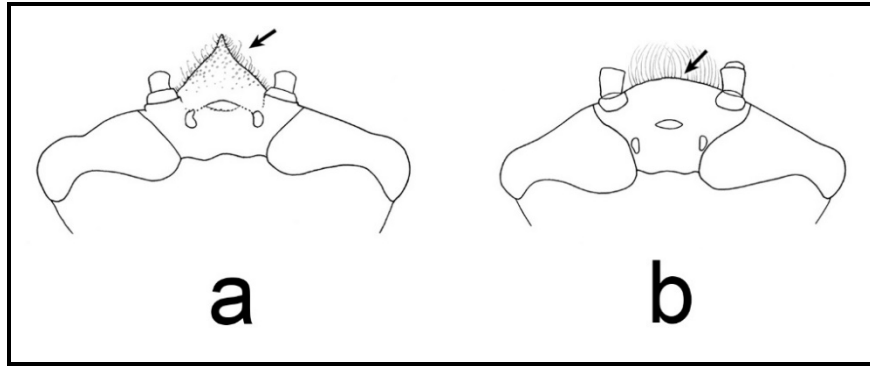


Figure 11.13. *Neurocordulia*, head, dorsal view: a) *N. molesta*; b) *N. alabamensis*.

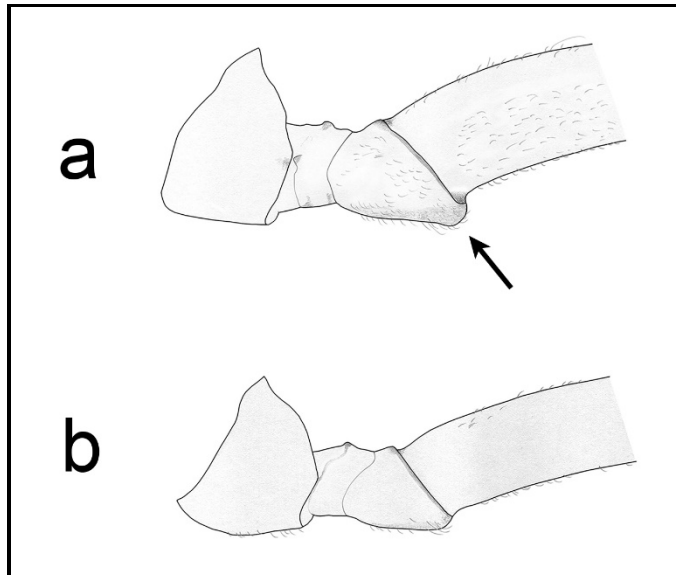


Figure 11.14. *Neurocordulia*, mesothoracic trochanter, posterior view: a) *N. molesta*; b) *N. alabamensis*.

2. Posterolateral spines on abdominal segment 8 parallel to longitudinal axis of abdomen (Fig. 11.15a); frontoclypeal ridge with fringe setae long (0.8–0.9 mm), most about half as long as space between antennal bases (Fig. 11.16a) ***alabamensis***
- 2'. Posterolateral spines on abdominal segment 8 divergent relevant to longitudinal axis of abdomen (Fig. 11.15b); frontoclypeal ridge with fringe setae short (0.1–0.2 mm), at most about one-fifth as long as space between antennal bases (Fig. 11.16b) **3**

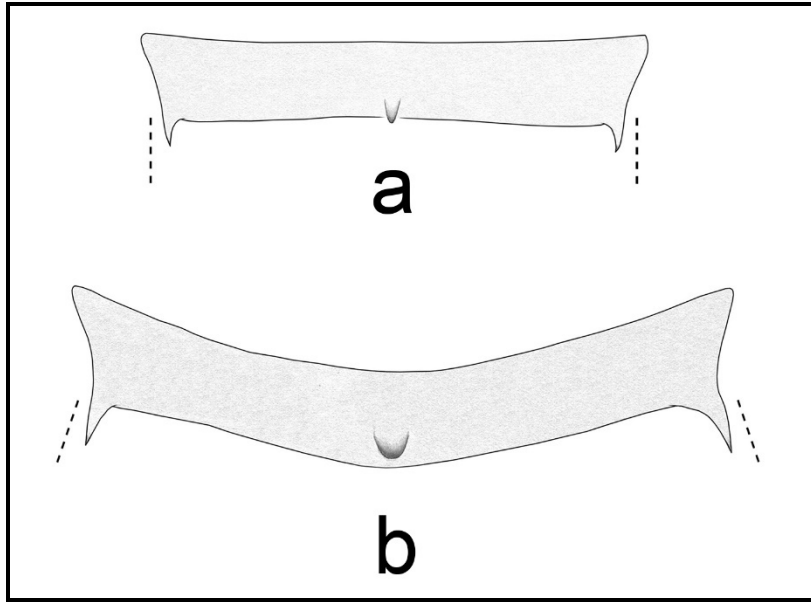


Figure 11.15. *Neurocordulia*, abdominal segment 8, dorsal view: a) *N. alabamensis*; b) *N. virginiensis*.

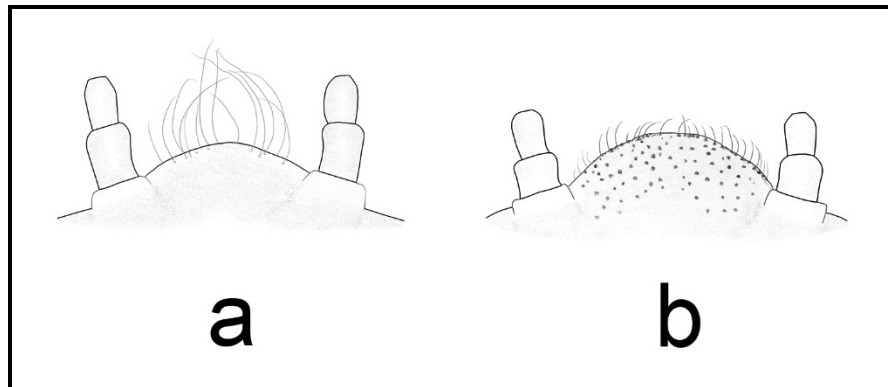


Figure 11.16. *Neurocordulia*, frontoclypeal ridge setae, dorsal view: a) *N. alabamensis*; b) *N. virginiensis*.

3. Frontoclypeal ridge broadly convex, nearly straight medially (Fig. 11.17a); apex of prothoracic epaulet triangular, relatively short (Fig. 11.18a); abdominal segment 8 posterolateral spines strongly divergent (Fig. 11.19a).....***obsoleta***
- 3'. Frontoclypeal ridge evenly convex (Fig. 11.17b); apex of prothoracic epaulet parallel-sided, relatively long though variable (Fig. 11.18b,c); abdominal segment 8 posterolateral spines moderately divergent (Fig. 11.19b) ***virginiensis***

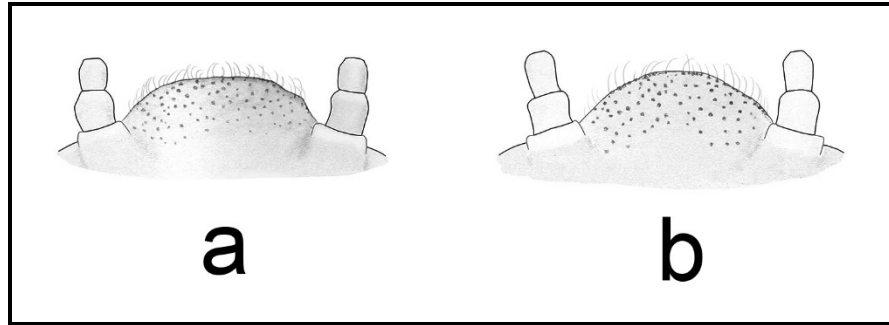


Figure 11.17. *Neurocordulia*, frontoclypeal ridge, dorsal view: a) *N. obsoleta*; b) *N. virginiensis*.

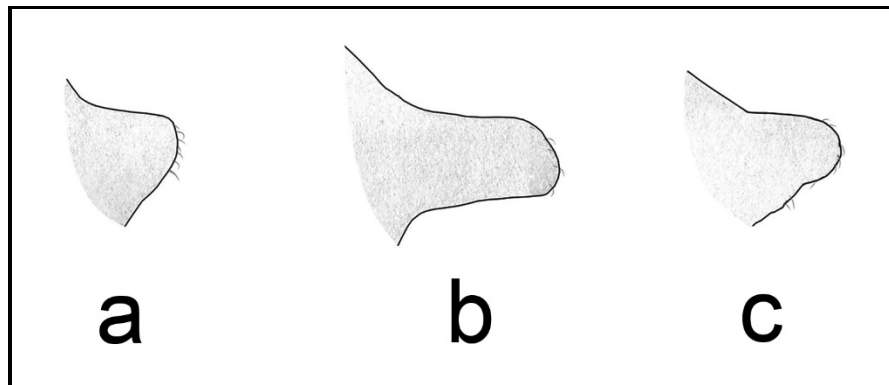


Figure 11.18. *Neurocordulia*, prothoracic right epaulet, dorsolateral view: a) *N. obsoleta*; b, c) *N. virginiensis*.

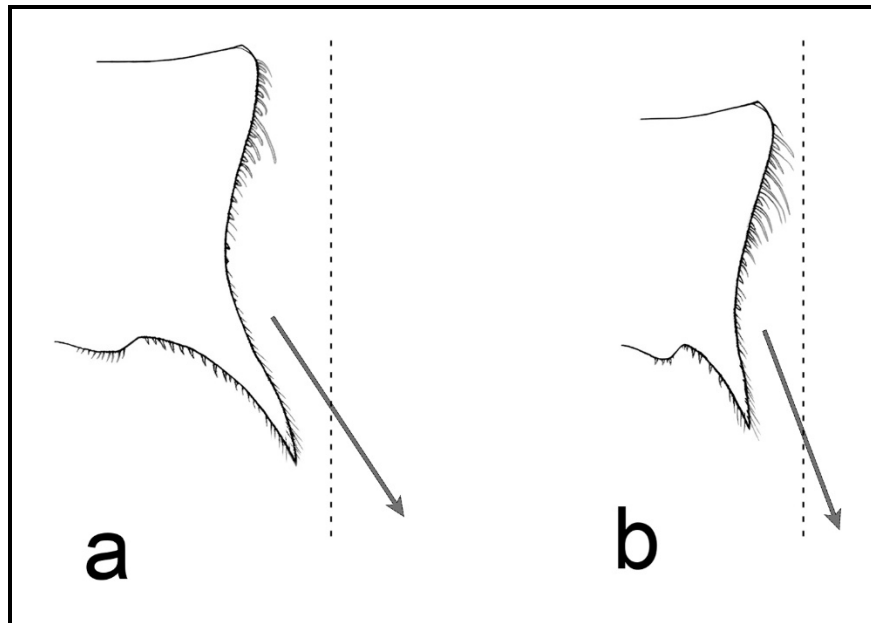


Figure 11.18. *Neurocordulia*, abdominal segment 8 posterolateral spine orientation, left side, ventral view: a) *N. obsoleta*; b) *N. virginiensis*. Dashed line indicates longitudinal axis of body, arrow indicates divergence of posterolateral spine from longitudinal axis.

Diagnostic Remarks:

The unique triangular frontal projection of *Neurocordulia molesta* is present in early instars. Other than this character, *N. molesta* is very similar to the other three species. In addition to the key characters, *Neurocordulia alabamensis* is, on average, smaller than either *N. obsoleta* or *N. virginiensis*: head width of *N. alabamensis* was 5.5–6.0 mm versus 5.9–6.6 mm for *N. obsoleta* and *N. virginiensis* combined; prementum max width was 4.0–4.55 mm for *N. alabamensis* versus 4.55–5.25 mm for the other two species. *Neurocordulia obsoleta* and *N. virginiensis* are very similar; in addition to the more divergent posterolateral spines on segment 8 of *N. obsoleta*, the spines are distinctly longer in F-0 *N. obsoleta* (0.80–1.05 mm vs. 0.50–0.70 mm). I do not recommend attempting to identify earlier instars of the latter three species.

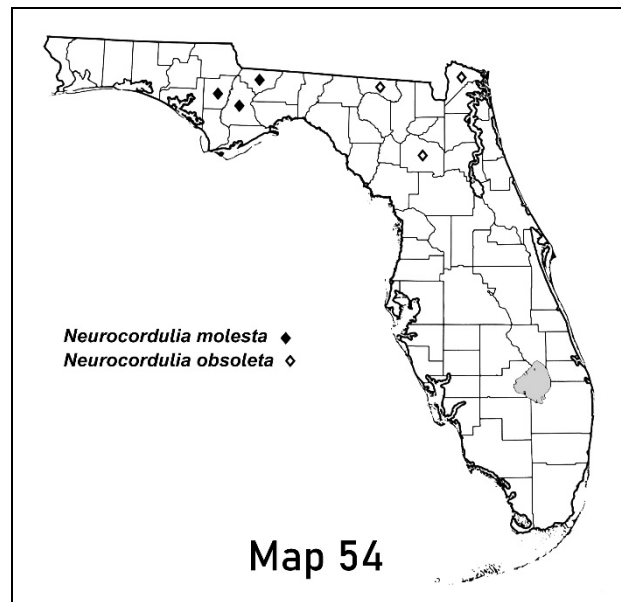
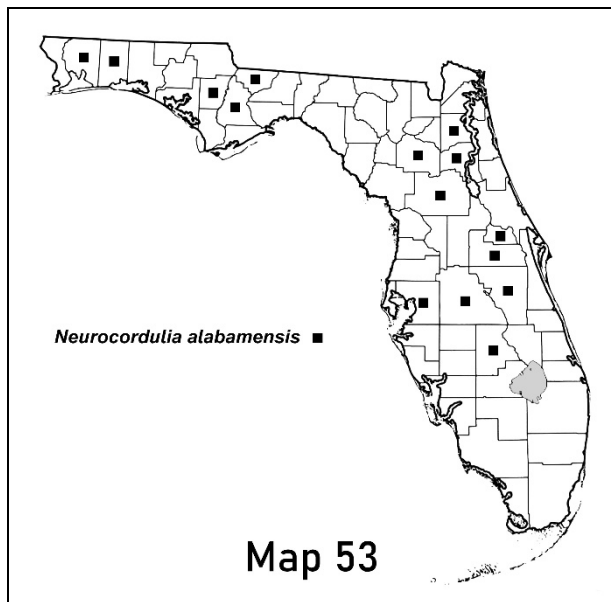
Habitat, Distribution, Life Cycle:

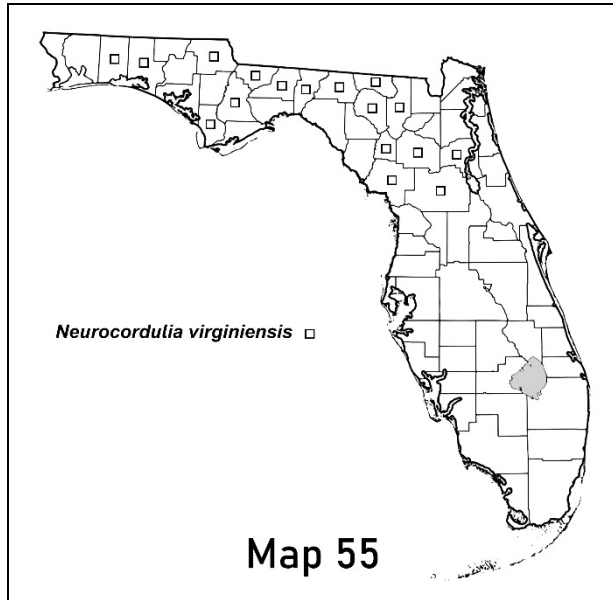
Neurocordulia nymphs are predominantly lotic but one species, *N. obsoleta*, has been found emerging on cypress trunks at the edge of a lake. *Neurocordulia* nymphs typically cling to rocks, logs, and roots in moderately sized to large streams; *N. alabamensis* is usually found in small tannic streams with sandy substrates, often among roots in undercut banks.

Neurocordulia alabamensis occurs rather sporadically throughout most of the state except it has not been recorded south of Lake Okeechobee (Map 53); the other three species are more limited in range, being found mainly in northern Florida (Maps 54 and 55).

Neurocordulia species emerge early in spring in Florida but flight seasons are relatively short: *N. alabamensis* from May 6 to August 2, *N. molesta* from June 15 to August 8, *N. obsoleta* from March 26 to April 15, and *N. virginiensis* from March 18 to June 11.

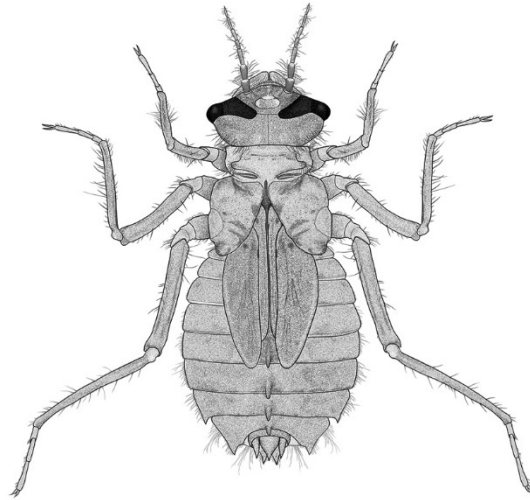
Neurocordulia species are probably semivoltine, based on small to half-grown nymphs in samples taken shortly following adult emergence.





Somatochlora

Elongate-oval, mostly light to dark brown; long legs; middorsal hooks on abdominal segments 4–9, hook on seg. 4 small; short posterolateral spines on segments 8 and 9; apex of abdomen abrupt



Somatochlora is a species-rich genus in North America; six species are recorded for Florida.

Generic Notes:

Slightly more than half of the species of Corduliidae in North America (26/50) are in the genus *Somatochlora*, most of which are northern in distribution. *Somatochlora* nymphs are most likely to be confused with *Helocordulia*, although that genus lacks middorsal hooks on segments 4 and 5. Also, the middorsal hook on segment 6 is prominent in Florida *Somatochlora* versus very small to vestigial in *Helocordulia*. Another character that will confirm identification is the combined length of antennal segments 1 & 2: less than 0.35 times the middorsal length of the head in *Somatochlora* compared to greater than 0.35 in *Helocordulia*. Species identification is challenging; for the following provisional key, posterolateral spine length and paraproct length were measured in ventral view.

Key to *Somatochlora* Species

1. Middorsal hooks on abdominal segments 7–9 curved, tips directed posteriorly to slightly dorsoposteriorly (Fig. 11.19a); metathoracic tibia length 8.2–9.2 mm2
- 1'. Middorsal hooks on abdominal segments 7–9 straighter, tips directed dorsoposteriorly (Fig. 11.19b); metathoracic tibia length 6.8–8.2 mm3

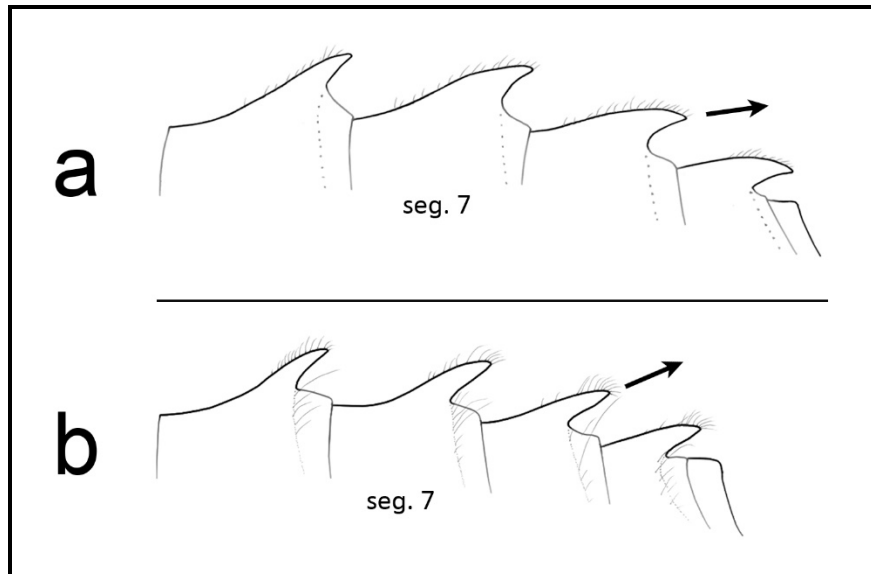


Figure 11.19. *Somatochlora*, middorsal hooks on abdominal segments 6–9, lateral view: a) *S. linearis*; b) *S. provocans*.

2. Middorsal hook on abdominal segment 4 ≤ 0.5 times length of hook on segment 5; ratio of metathoracic tibia length:head width > 1.3 ; abdominal segments 6–8 with 0–3 long setae on posterior margin between middorsal hook and lateral margin *linearis*
- 2'. Middorsal hook on abdominal segment 4 ≥ 0.5 times length of hook on segment 5; ratio of metathoracic tibia length:head width < 1.3 ; abdominal segments 6–8 with 10–36 long setae on posterior margin between middorsal hook and lateral margin.....*tenebrosa*
3. Prothoracic epaulet lobe-like, margins parallel proximal to rounded apex (Fig. 11.20a); F-0 paraproct 0.90–1.05 mm long*georgiana*
- 3'. Prothoracic epaulet triangular, margins convergent proximal to rounded apex (Fig. 11.20b); F-0 paraproct 1.05–1.35 mm long.....4

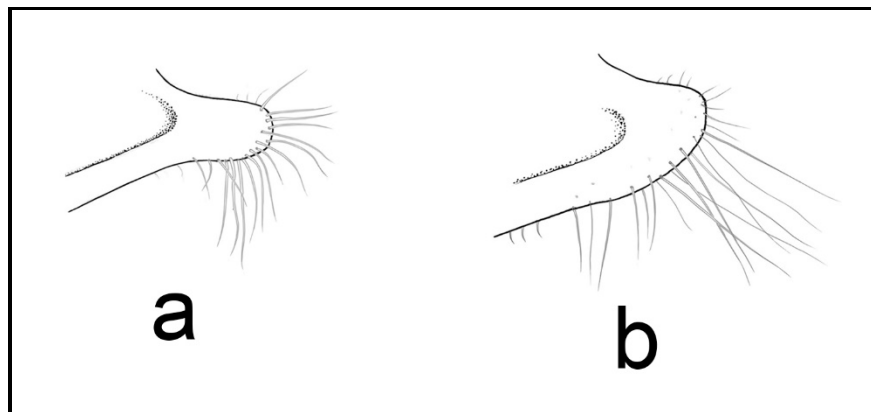


Figure 11.20. *Somatochlora*, prothoracic right epaulet, dorsal view: a) *S. georgiana*; b) *S. calverti*.

4. Abdominal segment 9 posterolateral spine 0.60–0.65 mm long (Fig. 11.21a); ratio of prementum distal width:length > 1.2; cercus 1.20 mm long, epiproct about 1.40 mm long *calverti*
- 4'. Abdominal segment 9 posterolateral spine 0.35–0.50 mm long (Fig. 11.21b); ratio of prementum distal width:length < 1.1; cercus 0.90–1.10 mm long, epiproct 1.15–1.30 mm long5

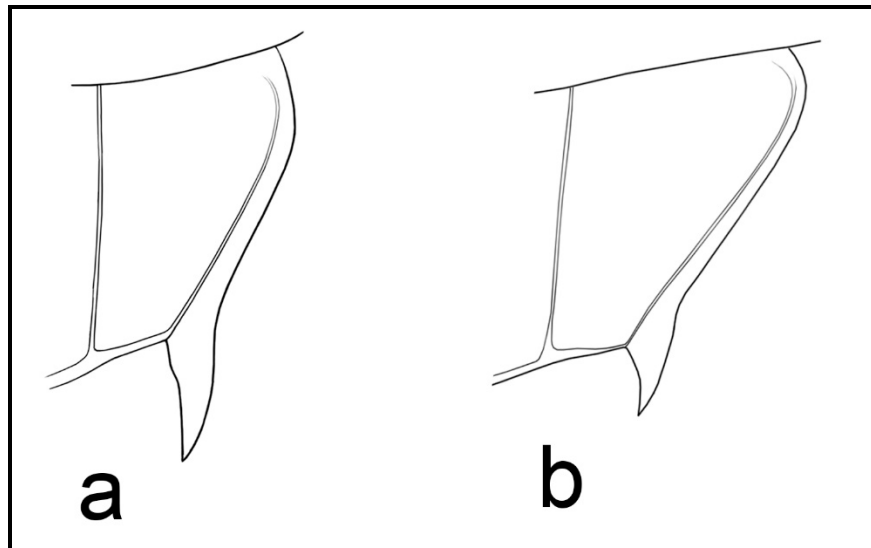


Figure 11.21. *Somatochlora*, abdominal segment 9 posterolateral spine, left side, ventral view: a) *S. calverti*; b) *S. filosa*. Setae omitted.

5. Palpal setae 9; apex of prothoracic epaulet slightly narrowed and curved anteriorly (Fig. 11.22a); setae on posterolateral corner of head < 0.8 mm long *filosa*
- 5'. Palpal setae 7 or 8; apex of prothoracic epaulet wide, not curved anteriorly (Fig. 11.22b); setae on posterolateral corner of head > 1.0 mm long *provocans*

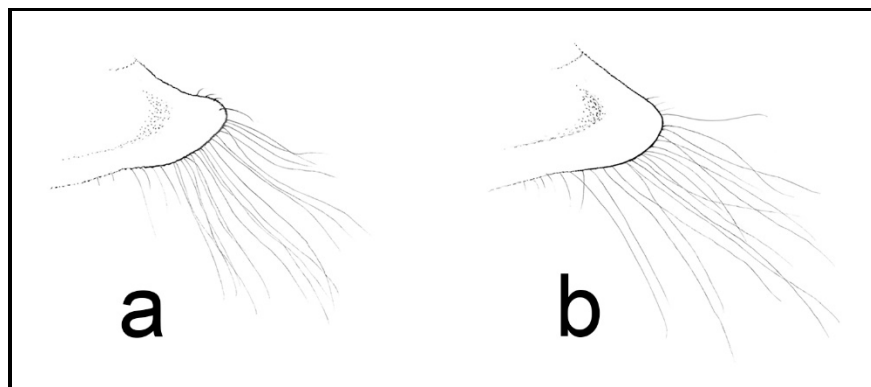


Figure 11.22. *Somatochlora*, prothoracic right epaulet, dorsal view: a) *S. filosa*; b) *S. provocans*.

Diagnostic Remarks:

In couplet 1, also check the ventral margin of the middorsal hooks on segments 7–9: this margin is slightly concave in *S. linearis* and *S. tenebrosa* compared to the straight margin of the other four species. Male nymphs of *S. tenebrosa* are distinctive in F-0 in the shape of the epiproct — the preapical median tubercle, in lateral view, is much more prominent than in the other five species (Fig. 23). The key is based on only one specimen of *Somatochlora calverti* (reared to F-0 from an egg; field-collected specimens of this uncommon and secretive species are sorely needed); therefore the characters in couplet 4 need verification. Species identifications are difficult in this genus and much more collecting and rearing is needed. The species distinctions presented in the key are slight. With few specimens available for most of the species, there are no further diagnostic remarks offered at this time. I do not recommend trying to identify instars earlier than F-0.

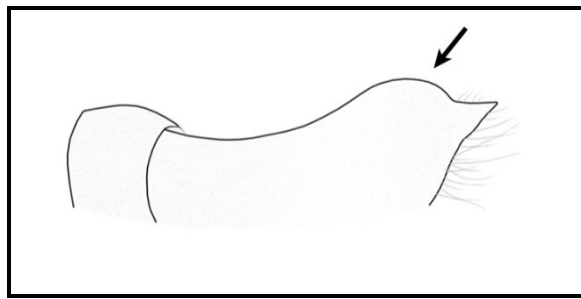


Figure 11.23. *Somatochlora tenebrosa*, epiproct, lateral view. Arrow indicates preapical raised tubercle.

Habitat, Distribution, Life Cycle:

Somatochlora species in North America are both lotic and lentic, however, it is highly probable that all six species in Florida inhabit small streams. Depending on species and habitat, *Somatochlora* nymphs typically are found in or near the undercut banks of small shady stream edges where they conceal themselves in detritus, aquatic plant debris and moss. However, the microhabitat of *S. calverti* is unknown. Nymphs of *Somatochlora* are notoriously difficult to find and they require specific intensive searches; they are rarely collected by general benthic survey methods.

Somatochlora georgiana, *S. provocans* and *S. tenebrosa* are limited to a few counties in the panhandle (Maps 57 and 58). *Somatochlora calverti* is limited in Florida to the northern counties whereas *S. filosa* occurs from the panhandle to Lake Okeechobee (Map 56). *Somatochlora linearis* occurs from the panhandle south to Orange County (Map 57).

Somatochlora species emerge in late spring or early summer in Florida and have relatively long flight seasons: *S. calverti* from June 11 to August 30, *S. filosa* from June 30 to December 21, *S. georgiana* from May 18 to August 3, *S. linearis* from May 11 to September 2, *S. provocans* from June 6 to August 30, and *S. tenebrosa* from June 24 to August 10.

Somatochlora species are probably semivoltine, based on small to half-grown nymphs in samples taken after adult emergence.

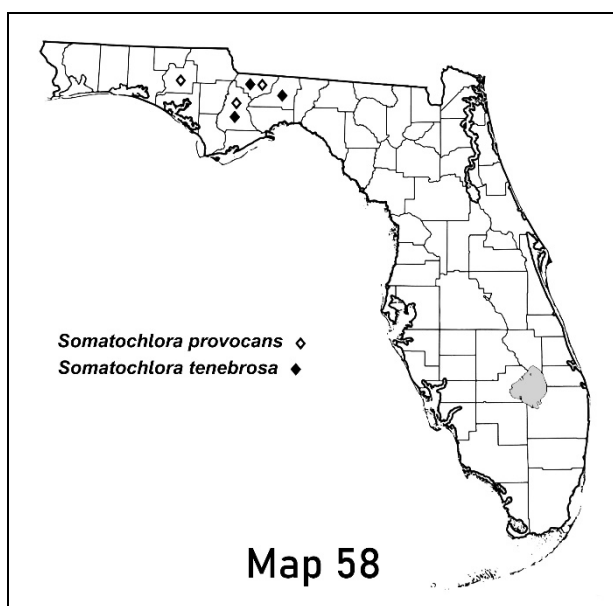
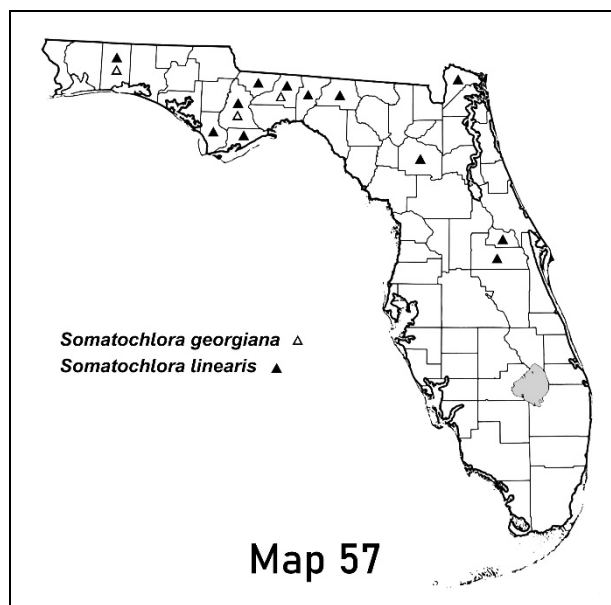
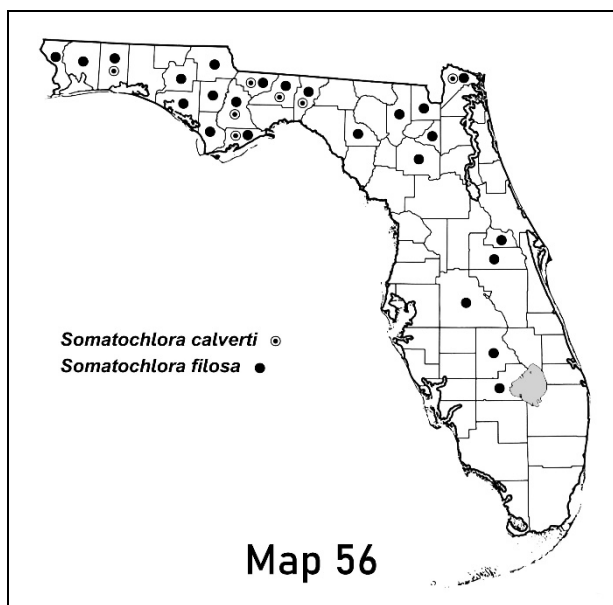


Plate 8. Representatives* of the four Corduliidae genera of Florida (photographs by Marla C. Garrison).



Epitheca



Neurocordulia



Helocordulia



Somatochlora

*The species represented in Plate 8 are *Epitheca cynosura*, *Neurocordulia molesta*, *Helocordulia selysii*, and *Somatochlora linearis*.

12. LIBELLULIDAE

Libellulid nymphs sprawl in and cling to detritus and vegetation in or above the substrate. They are mostly medium-sized dragonflies but range from very small to large. There is limited variability in general body shape within the family.

The family is characterized by 1) mouthparts hypognathous; 2) labium scoop-shaped and with prominent palpal and premental setae; 3) antenna 6- or 7-segmented, usually 7-segmented and considerably shorter than head; 4) reduced frontoclypeal ridge; 5) prementum without ventromedial groove; 6) ligula entire; 7) teeth on distal margin of palpal lobes with small to large crenations; 8) middorsal hooks variable in the family, including sometimes completely absent; 9) posterolateral spines usually present on segments 8 and 9, sometimes reduced to vestigial.

Twenty-two genera occur in Florida: *Brachymesia* Kirby, *Celithemis* Hagen, *Crocothemis* Brauer, *Dythemis* Hagen, *Erythemis* Hagen, *Erythrodiplax* Brauer, *Idiataphe* Cowley, *Ladona* Needham, *Libellula* Linnaeus, *Macrodiplax* Brauer, *Miathyria* Kirby, *Micrathyria* Kirby, *Nannothemis* Brauer, *Orthemis* Hagen, *Pachydiplax* Brauer, *Pantala* Hagen, *Perithemis* Hagen, *Plathemis* Hagen, *Sympetrum* Newman, *Tauriphila* Kirby, *Tholymis* Hagen, and *Tramea* Hagen. Identification to genus and species ranges from straightforward to difficult, depending on the group. Measurements for each genus are summarized in Table 12.1 (p. 190).

Key to Genera of Libellulidae (F-0)

1. Eyes, in dorsal view, occupying one third or less head length, protruding slightly beyond anterior limit and slightly above dorsal limit of head capsule (Fig. 12.1a); frontoclypeal ridge with numerous setae along entire width, some setae equal to combined length of 3 basal antennal segments (Fig. 12.2a)2
- 1'. Eyes, in dorsal view, occupying at least one half of head length, continuous with anterior and dorsal limits of head capsule (Fig. 12.1b); frontoclypeal ridge usually with few setae, mostly lateral and usually shorter than combined length of 3 basal antennal segments (Fig. 12.2b)5

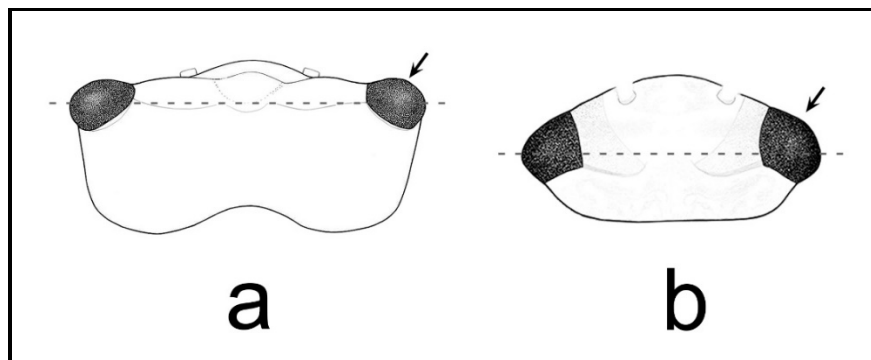


Figure 12.1. Libellulidae, head, dorsal view: a) *Libellula*; b) *Pachydiplax*.

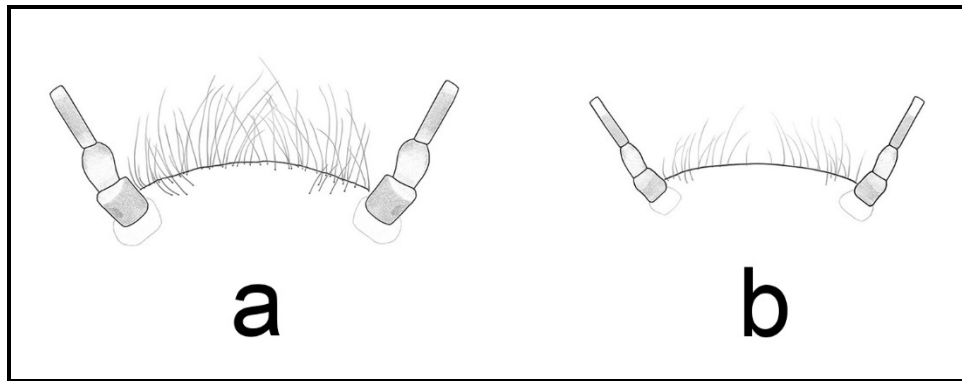


Figure 12.2. Libellulidae, frontoclypeal ridge setae, dorsal view: a) *Libellula*; b) *Pachydiplax*.

2. Distal margin of ligula straight to slightly concave, appearing smooth at low magnification (Fig. 12.3a) although at 15X or higher 2–4 small crenulations visible between adjacent stout setae (Fig. 12.3a enlargement) ***Libellula***
- 2'. Distal margin of ligula convex, crenate (Fig. 12.3b), a single crenation present between adjacent stout setae (Fig. 12.3b enlargement).....**3**

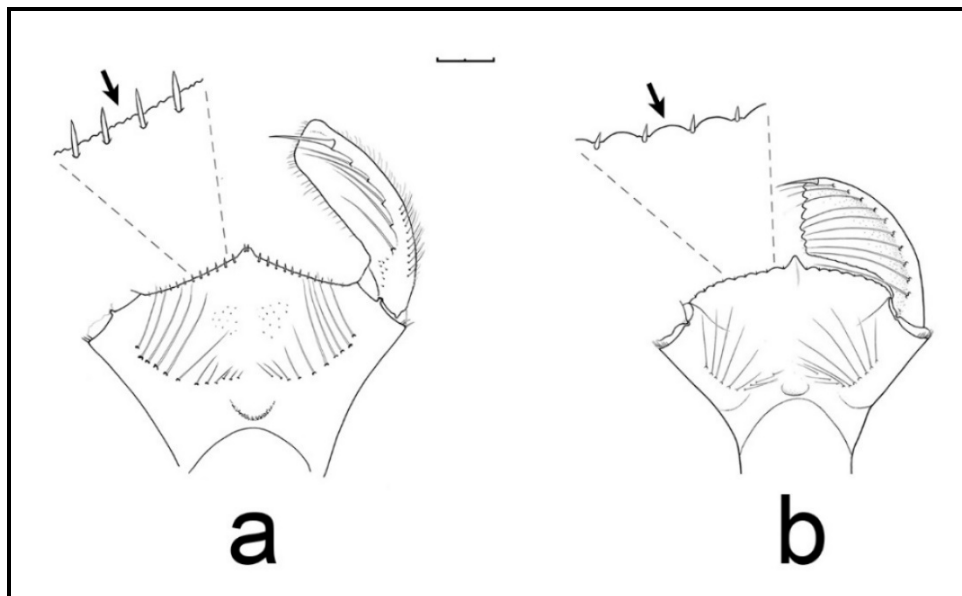


Figure 12.3. Libellulidae, prementum, ental view: a) *Libellula*; b) *Plathemis*. In enlargements, arrow points to small portion of ligula between adjacent setae — margin with several tiny crenulations for *Libellula* versus one rounded crenation for *Plathemis*; scale bar = 0.2 mm.

3. Middorsal hooks absent on all abdominal segments (Fig. 12.4a); ratio of prementum max width:length 1.10–1.37 (Fig. 12.5a)..... ***Orthemis***
- 3'. Middorsal hooks present on several abdominal segments (Fig. 12.4b,c); ratio of prementum max width:length 0.92–1.13 (Fig. 12.5b), usually < 1.10.....**4**

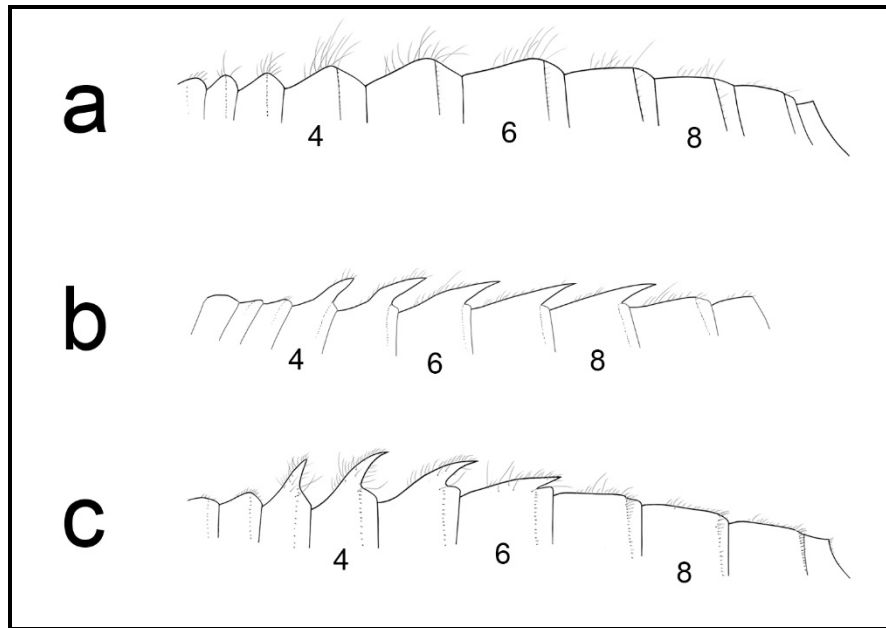


Figure 12.4. Libellulidae, abdominal profile, lateral view: a) *Orthemis*; b) *Ladona*; c) *Plathemis*. Numbers indicate segment.

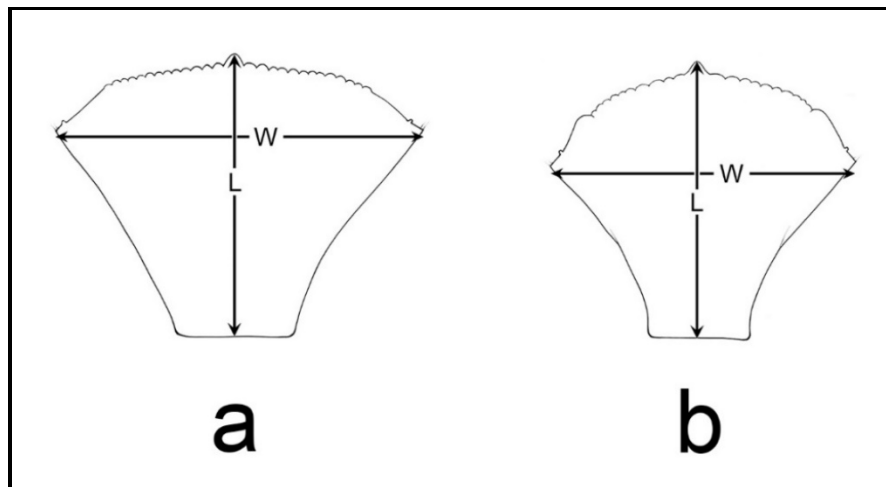


Figure 12.5. Libellulidae, prementum, ectal view: a) *Orthemis*; b) *Ladona*.

4. Middorsal hooks present on abdominal segments 4–8 (Fig. 12.4b); prementum with 3 primary setae on each side; ratio of epiproct length:segment 10 middorsal length 4.00–5.15 ***Ladona***
- 4'. Middorsal hooks present on abdominal segments 3–6 (Fig. 12.4c); prementum with 6 or 7 primary setae on each side; ratio of epiproct length:segment 10 middorsal length 3.20–3.70 ***Plathemis***

5. Some abdominal segments with middorsal hooks (as in Fig. 12.4b), usually prominent, sometimes present only on anterior segments (hidden by wing sheaths) and absent on posterior segments6
- 5'. All abdominal segments without middorsal hooks, including segments covered by wing sheaths (as in Fig. 12.4a).....16
6. Middorsal hook present on abdominal segment 9 (Fig. 12.6a).....7
- 6'. Middorsal hook absent on abdominal segment 9 (Fig. 12.6b).....11

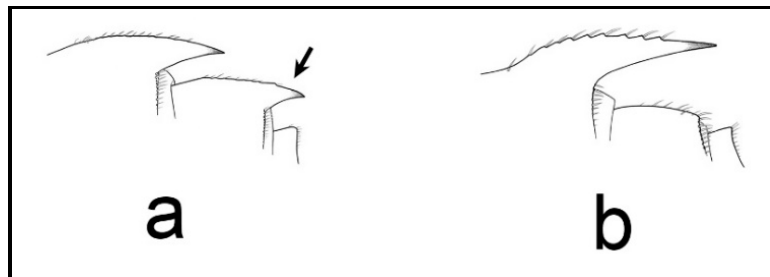


Figure 12.6. Libellulidae, abdominal segments 8–10, lateral view: a) *Dythemis*; b) *Tauriphila*. Arrow indicates middorsal hook on segment 9.

7. Epiproct as long as or longer than combined middorsal length of segments 8 and 9 (Fig. 12.7a); prementum dorsolateral rim without spiniform setae (Fig. 12.8a)8
- 7'. Epiproct shorter than combined middorsal length of segments 8 and 9 (Fig. 12.7b); prementum dorsolateral rim with at least a few spiniform setae (Fig. 12.8b)9

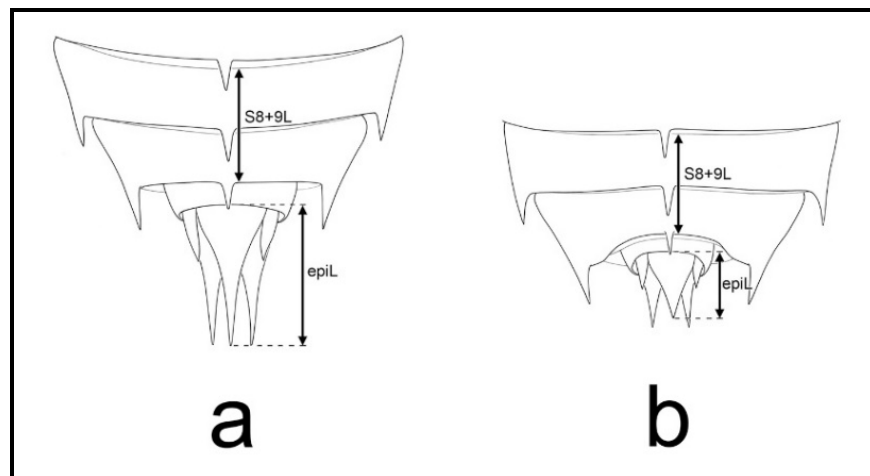


Figure 12.7. Libellulidae, abdominal segments 8 and 9 and anal appendages, dorsal view: a) *Brachymesia*; b) *Dythemis*. epi = epiproct, S = segment, L = length.

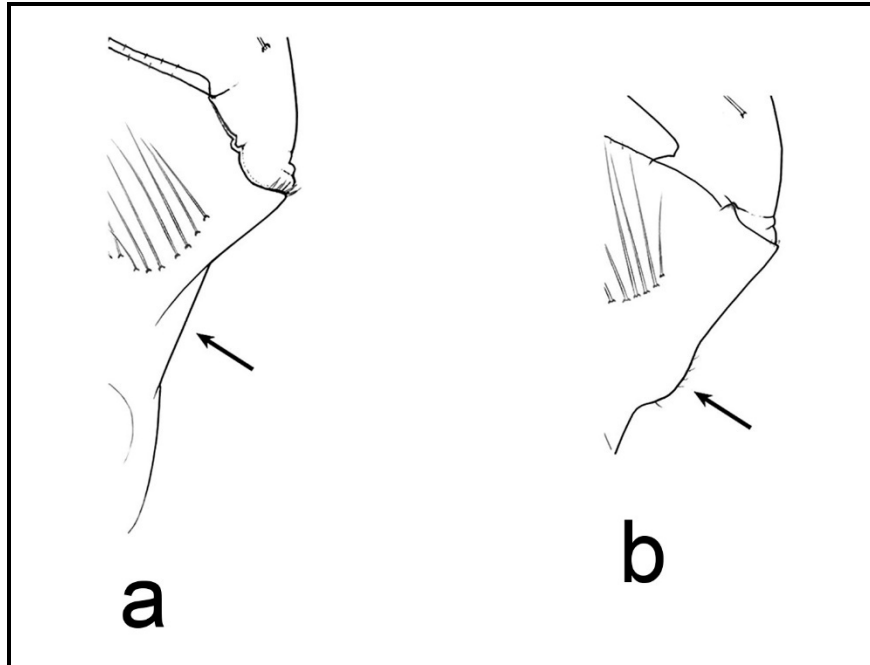


Figure 12.8. Libellulidae, prementum dorsolateral rim, ental view: a) *Brachymesia*; b) *Perithemis*. Arrow indicates absence (a) or presence (b) of setae.

- 8. Labial hinge with numerous short stout pale setae (Fig. 12.9a); venter of abdominal segments 8 and 9 with a small anterolateral sclerite (Fig. 12.10a) ***Brachymesia***
- 8'. Labial hinge without short stout setae (Fig. 12.9b); venter of abdominal segments 8 and 9 without an anterolateral sclerite (Fig. 12.10b) ***Idiataphe***

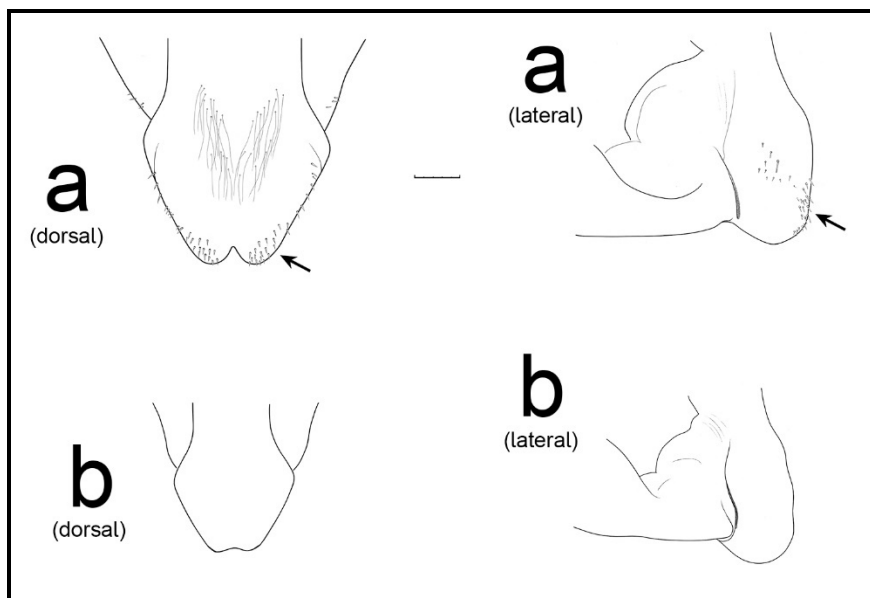


Figure 12.9. Libellulidae, labial hinge of prementum in dorsal and lateral views: a) *Brachymesia*; b) *Idiataphe*. Arrow indicates location of stout setae; scale bar = 0.5 mm.

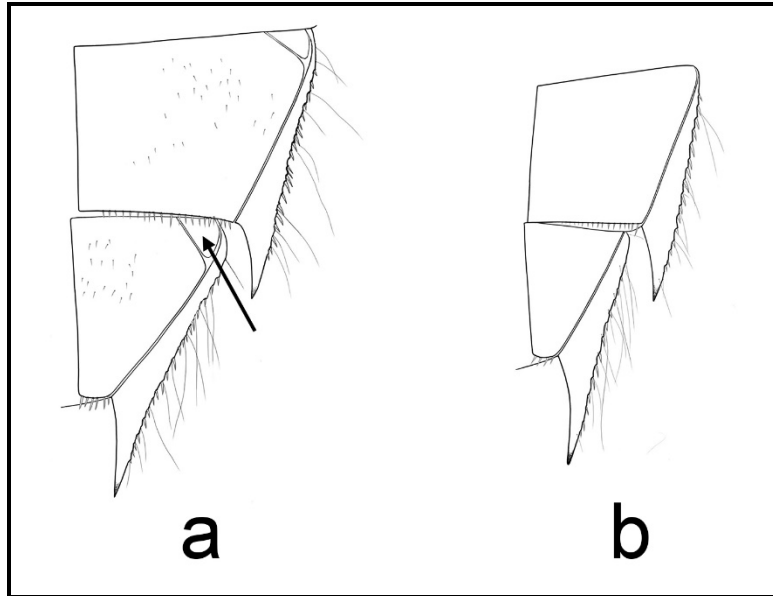


Figure 12.10. Libellulidae, abdominal segments 8 and 9, left side, ventral view: a) *Brachymesia*; b) *Idiataphe*. Arrow indicates anterolateral sclerite.

9. Venter of segments 8 and 9 with an oval anterolateral sclerite on each side (Fig. 12.11a); segment 10 with a blunt middorsal hook; antennal segment 7 with a bulbous, pointed tip (Fig. 12.12a)..... *Tholymis*
- 9'. Venter of segments 8 and 9 without an anterolateral sclerite on each side (Fig. 12.11b); segment 10 without a middorsal hook; antennal segment 7 acuminate (Fig. 12.12b).....10

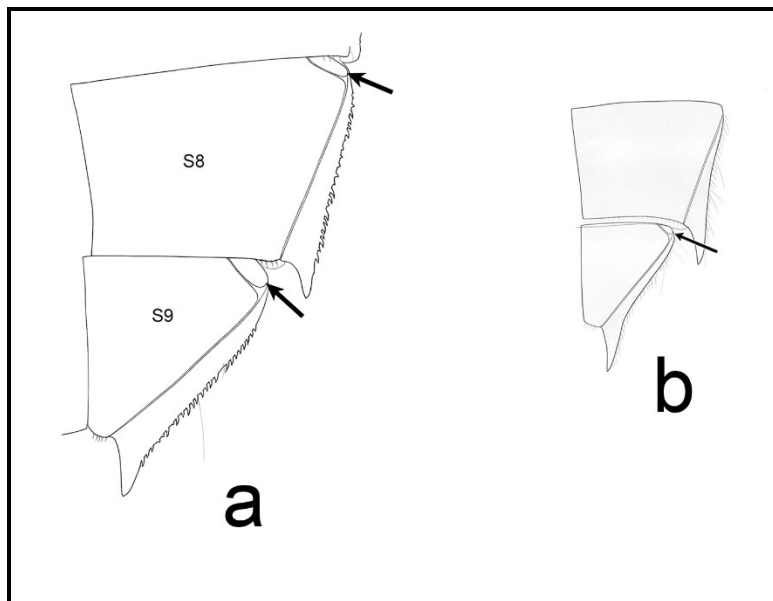


Figure 12.11. Libellulidae, abdominal segments 8 and 9, left side, ventral view: a) *Brachymesia*; b) *Perithemis*. Arrow indicates anterolateral sclerite.

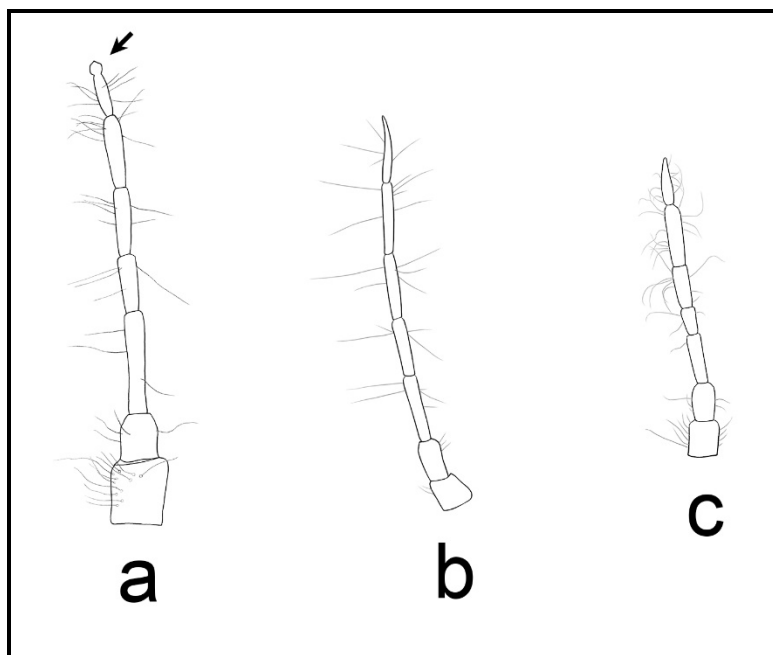


Figure 12.12. Libellulidae, antennal segment 7: a) *Tholymis*; b) *Dythemis*; c) *Perithemis*. Arrow indicates bulbous tip of 7th antennal segment.

10. Hinge of retracted labium between mesothoracic coxae (Fig. 12.13a); ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length 0.80–1.20; head width (F-0) > 5.0 mm.....***Dythemis***
- 10'. Hinge of retracted labium between prothoracic coxae (Fig. 12.13b); ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length 0.25–0.55; head width (F-0) < 4.0 mm.....***Perithemis***

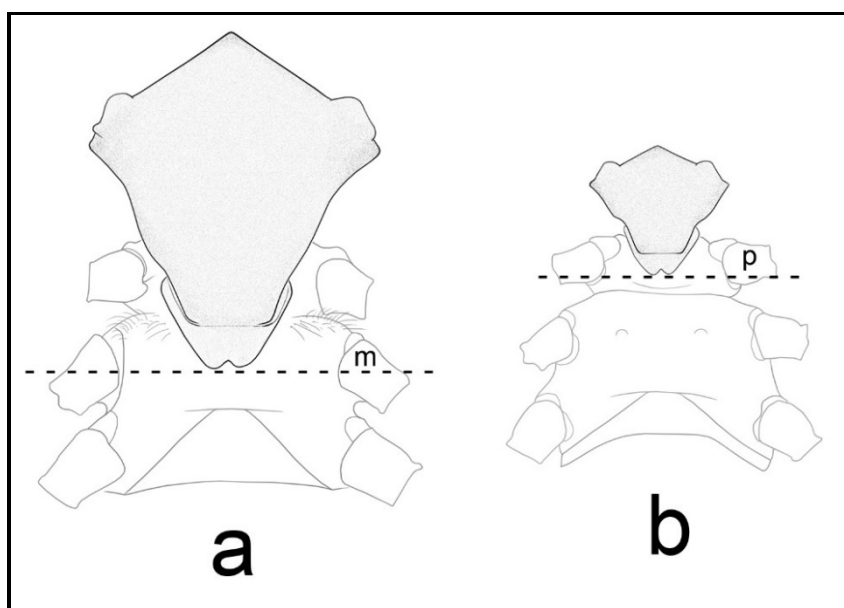


Figure 12.13. Libellulidae, thoracic venter and labial hinge: a) *Dythemis*; b) *Perithemis*; m = mesothoracic coxa, p = prothoracic coxa.

11. Abdominal segments 5–8 without a middorsal hook; proximal margin of retracted labium posterior to mesothoracic coxae (Fig. 12.14a); distal margin of palpal lobe with deep spaces between crenations (Fig. 12.15a) *Pantala*
- 11'. Abdominal segments 5–8 usually with a middorsal hook, may be reduced or absent on segments 7 and 8; proximal margin of retracted labium between mesothoracic coxae (Fig. 12.14b); distal margin of palpal lobe with shallow spaces between crenations (Fig. 12.15b) **12**

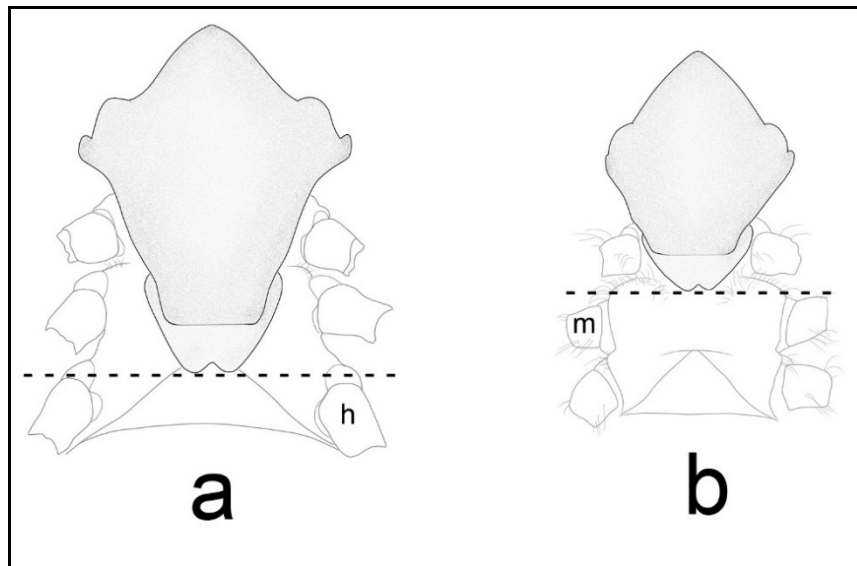


Figure 12.14. Libellulidae, thorax and labial hinge, ventral view: a) *Pantala*; b) *Miathyria*; h = metathoracic coxa; m = mesothoracic coxa.

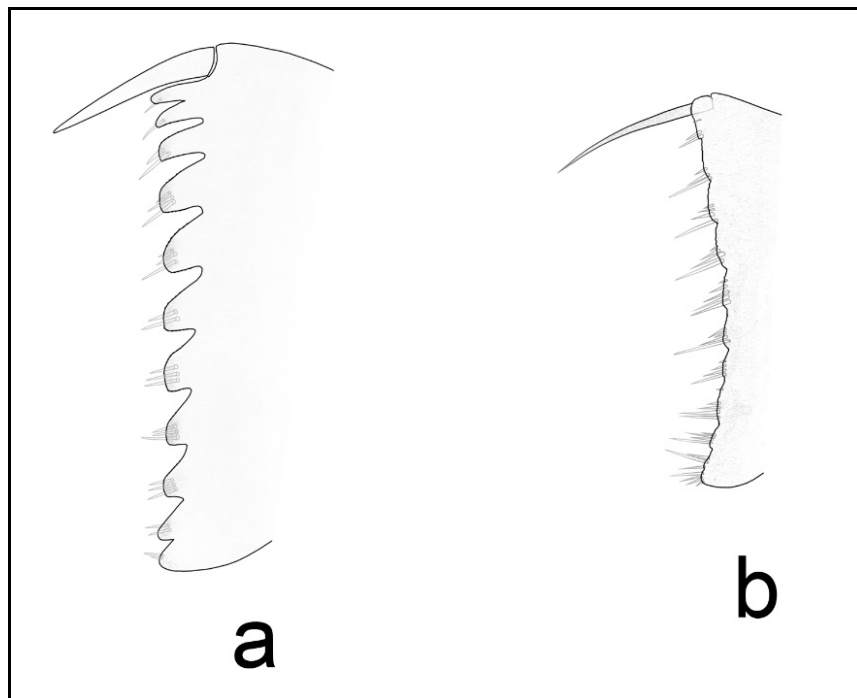


Figure 12.15. Libellulidae, distal margin of palpal lobe: a) *Pantala*; b) *Miathyria*.

12. Abdominal segment 8 middorsal hook extending beyond posterior margin of segment 9 (Fig. 12.16a); compound eye sloping markedly posteriorly, nearly twice as long as wide, widest point near posterior margin of eye (Fig. 12.17a).....13
- 12'. Abdominal segment 8 middorsal hook variable, at most extending nearly to posterior margin of segment 9 (Fig. 12.16b), in some species reduced in size or absent (Fig. 12.16c); compound eye sloping less markedly posteriorly, less than 1.5 times as long as wide, widest point near mid-length of eye (Fig. 12.17b).....15

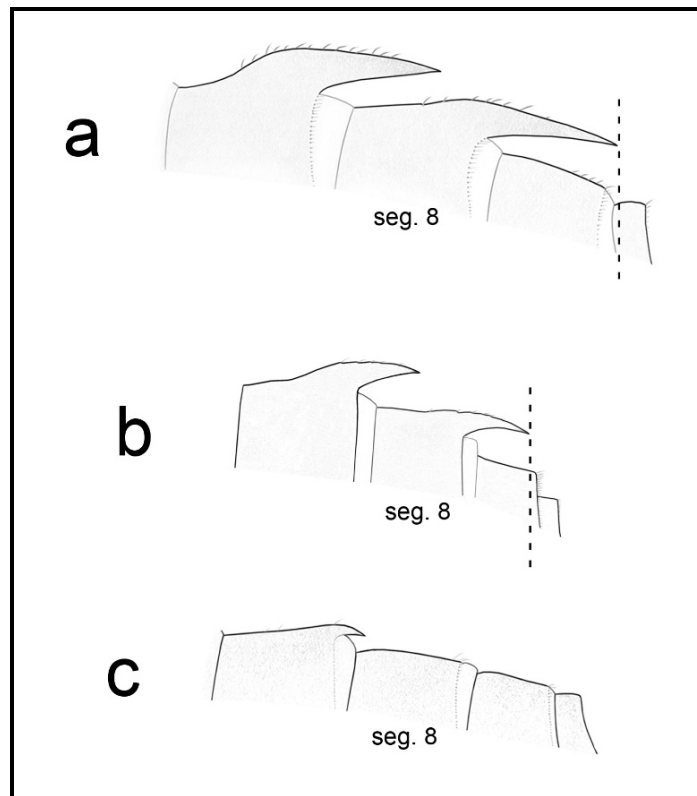


Figure 12.16. Libellulidae, abdominal segments 7–10, profile: a) *Macrodiplax*; b) *Sympetrum vicinum*; c) *Celithemis*. Vertical dashed line indicates posterior limit of tip of segment 8 middorsal hook.

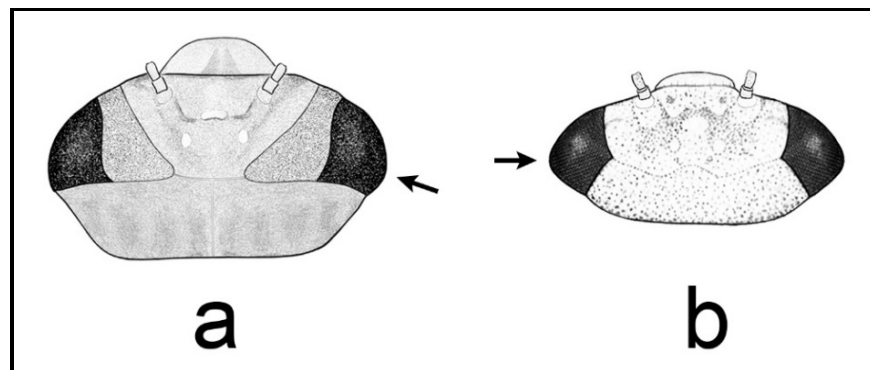


Figure 12.17. Libellulidae, head capsule, dorsal view: a) *Macrodiplax*; b) *Celithemis*. Arrow indicates widest bulge of eye.

13. Epiproct long, triangular (Fig. 12.18a); usually 12 or 13 palpal setae (each side), premental setae 16 or more (each side)..... ***Macrodiplax***
- 13'. Epiproct short, triangular-ovate or semicircular (Fig. 12.18b,c); usually 6–9 palpal setae (each side), premental setae 12 or fewer (each side)14

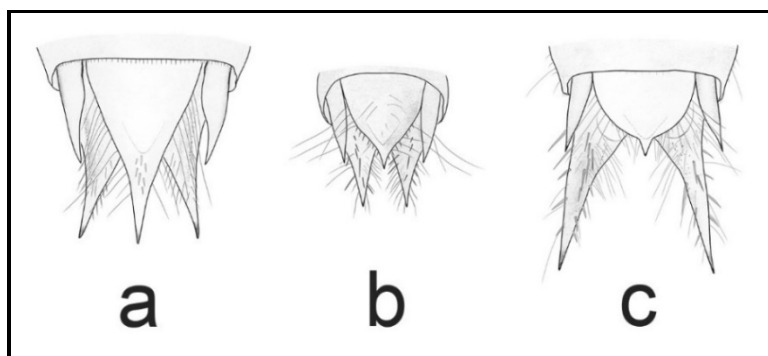


Figure 12.18. Libellulidae, anal appendages, dorsal view: a) *Macrodiplax*; b) *Miathyria*; c) *Tauriphila*.

14. Palpal setae 5–7 (each side); antenna length < middorsal length of head; epiproct triangular-ovate, > half as long as paraproct in dorsal view (Fig. 12.18b)..... ***Miathyria***
- 14'. Palpal setae 9–10 (each side); antenna length > middorsal length of head; epiproct semicircular, < half as long as paraproct in dorsal view (Fig. 12.18c)..... ***Tauriphila***
15. Anterior margin of compound eye angled and gradually curved posteriorly from medial corner to lateral extremity, not transverse at any part of its anterior margin (Fig. 12.19a); abdominal segment 7 without a middorsal hook; crenations on distal margin of palpal lobe each with 4 or 5 spiniform setae (Fig. 12.20a) ***Celithemis***
- 15'. Anterior margin of compound eye transverse for about half its anterior margin from medial corner to lateral extremity before curving abruptly posteriorly (Fig. 12.19b); abdominal segment 7 with a middorsal hook; crenations on distal margin of palpal lobe each with 2 or 3 spiniform setae (Fig. 12.20b) ***Sympetrum* (in part)**

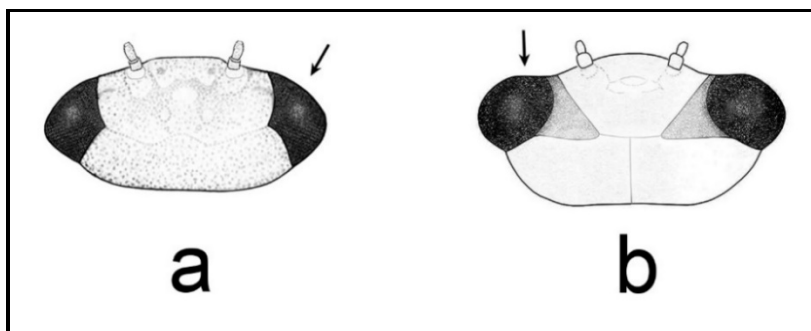


Figure 12.19. Libellulidae, head capsule, dorsal view: a) *Celithemis*; b) *Sympetrum*. Arrow indicates curvature of anterior portion of eye.

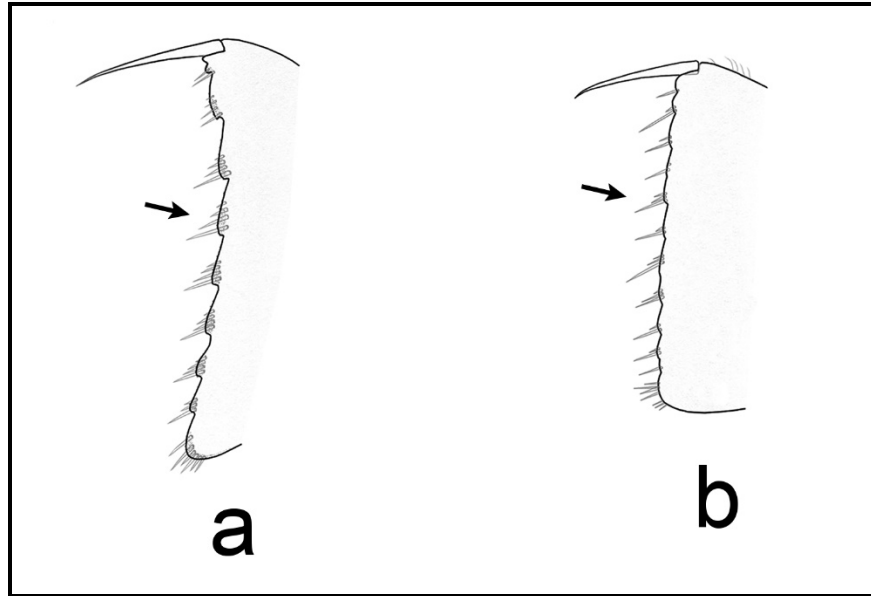


Figure 12.20. Libellulidae, middle crenation on distal margin of palpal lobe, ectal view: a) *Celithemis*; b) *Sympetrum*.

16. Paraprocts markedly decurved at apex (Fig. 12.21a); hind lobe of pronotum and mesothoracic spiracle raised above level of imaginary line drawn from dorsal margin of head to dorsal margin of wing sheaths (Fig. 12.22a).....*Erythemis*
- 16'. Paraprocts straight (Fig. 12.21b) or slightly decurved at apex (Fig. 12.21c); hind lobe of pronotum and mesothoracic spiracle even with or below level of imaginary line drawn from dorsal margin of head to dorsal margin of wing sheaths (Fig. 12.22b)17

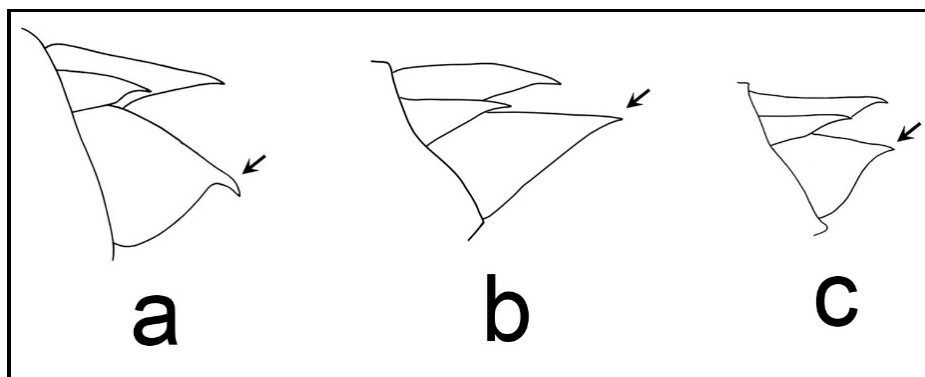


Figure 12.21. Libellulidae, anal appendages left paraproct, lateral view: a) *Erythemis*; b) *Pachydiplax*; c) *Erythrodiplax*. Arrow indicates tip of paraproct; setae omitted.

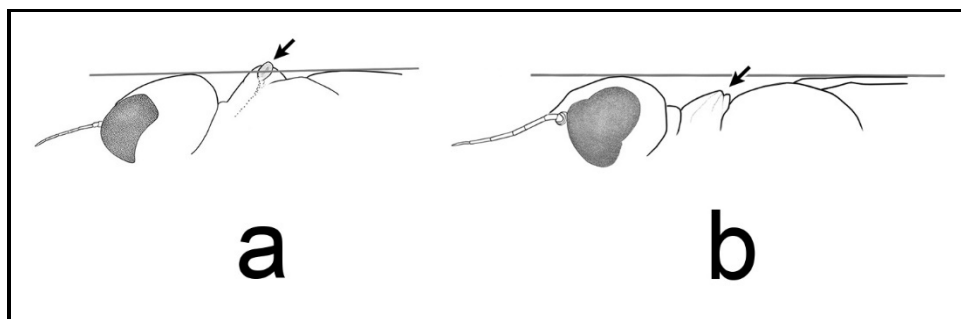


Figure 12.22. Libellulidae, apex of mesothoracic spiracle relative to dorsal margin of head and wing sheaths, lateral view: a) *Erythemis*; b) *Pachydiplax*.

17. F-0 total length < 9.2 mm, head width < 3.1 mm; antenna 6-segmented; posterior margin of abdominal segments 9 and 10 with fringe of long curved setae as long as combined length of segments 8 and 9 (Fig. 12.23a)..... *Nannothemis*
- 17'. F-0 total length $\geq$ 9.2 mm, head width > 3.4 mm; antenna 7-segmented; posterior margin of abdominal segments 9 and 10 with numerous short spiniform setae and few long setae (Fig. 12.23b)18

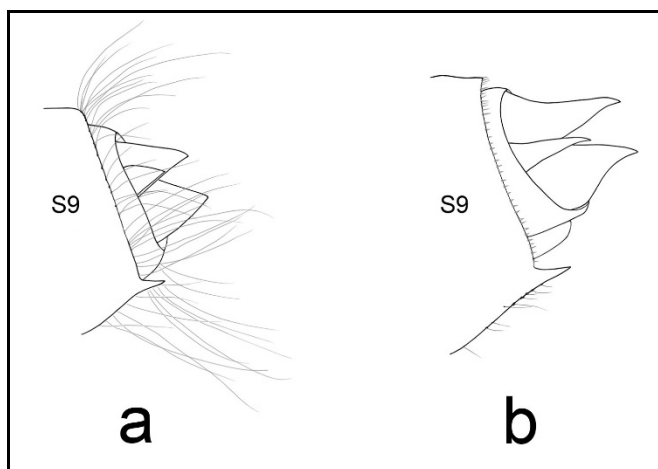


Figure 12.23. Libellulidae, abdominal segments 9–10, lateral view: a) *Nannothemis*; b) *Erythrodiplax*.

18. Abdominal segment 9 posterolateral spine long, at least 1.5 times dorsomedial length of segment 8 (Fig. 12.24a); epiproct constricted near mid-length and tapered to a long narrow point (Fig. 12.24a enlargement), epiproct length > 2 mm *Tramea*
- 18'. Abdominal segment 9 posterolateral spine shorter, less than dorsomedial length of segment 8 (Fig. 12.24b); epiproct gradually tapered (Fig. 12.24b enlargement), epiproct length < 2 mm19

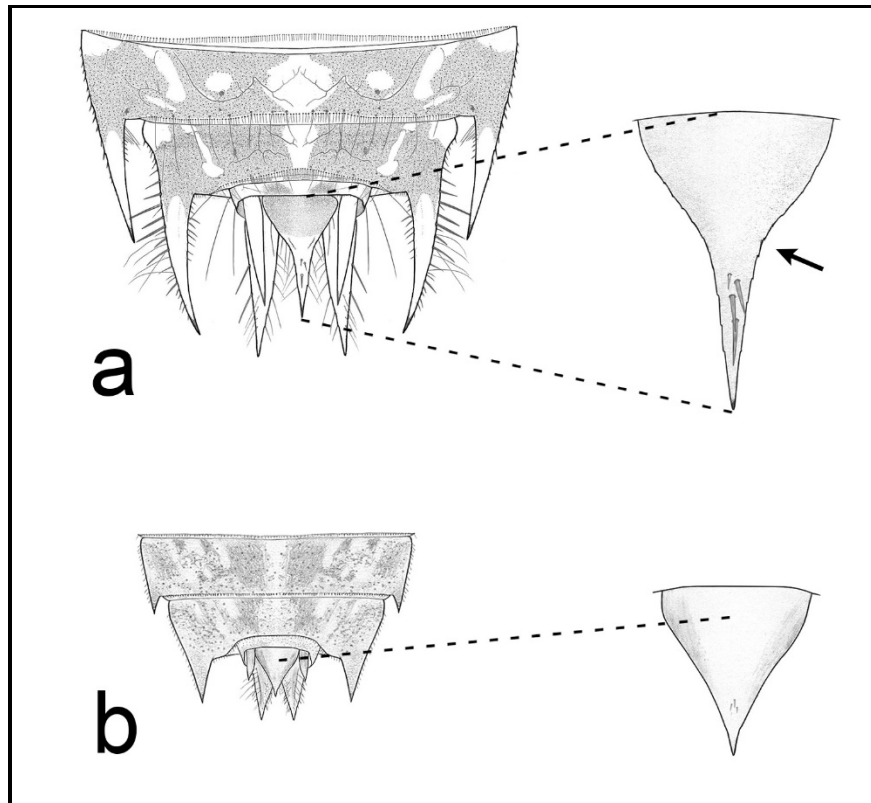


Figure 12.24. Libellulidae, apex of abdomen, dorsal view: a) *Tramea*; b) *Pachydiplax*. Arrow indicates constriction of epiproct.

- 19. Venter of abdominal segments 8 and 9 with an anterolateral sclerite (Fig. 12.25a); dorsum of abdomen appearing maculose due to dark setal bases (Fig. 12.26a).....20
- 19'. Venter of abdominal segment 8 without an anterolateral sclerite, segment 9 venter with or without an anterolateral sclerite (Fig. 12.25b); dorsum of abdomen usually appearing smooth to slightly maculose, dark setal bases small (Fig. 12.26b).....21

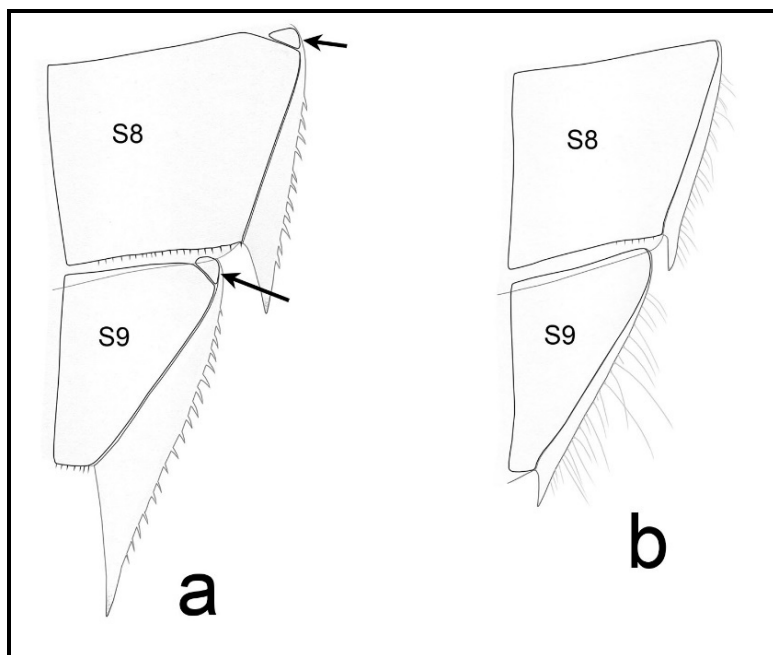


Figure 12.25. Libellulidae, venter of abdominal segments 8 and 9, left side: a) *Pachydiplax*; b) *Sympetrum*.

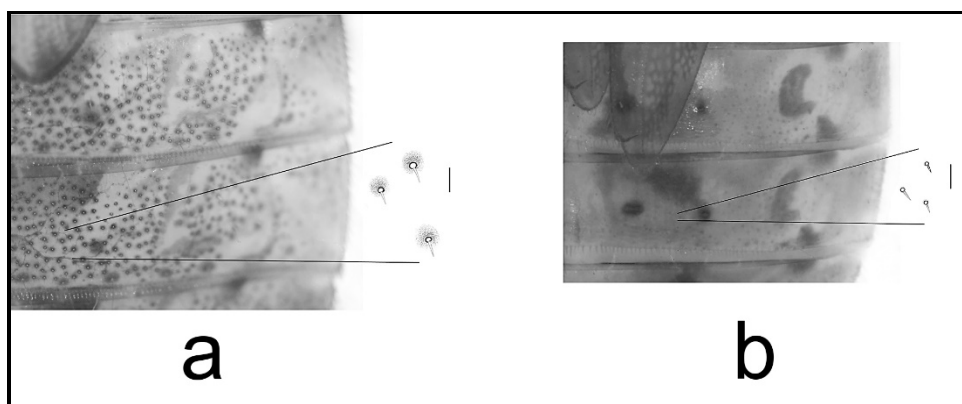


Figure 12.26. Libellulidae, dorsum of abdominal segments 6 and 7, right side: a) *Pachydiplax*; b) *Sympetrum*.

- 20.** Posterolateral spine on abdominal segment 9 about 0.6–1.15 times middorsal length of segment 9; lateral margins of segments 3–6 with few inconspicuous spiniform setae (Fig. 12.27a); venter of segments 2–7 without paired submedian dark spots (Fig. 12.28a).....*Micrathyria*
- 20'.** Posterolateral spine on abdominal segment 9 at least 1.2 times middorsal length of segment 9; lateral margins of segments 3–6 with distinct spiniform setae (Fig. 12.27b); venter of segments 2–7 with a pair of submedian dark spots (Fig. 12.28b).....*Pachydiplax*

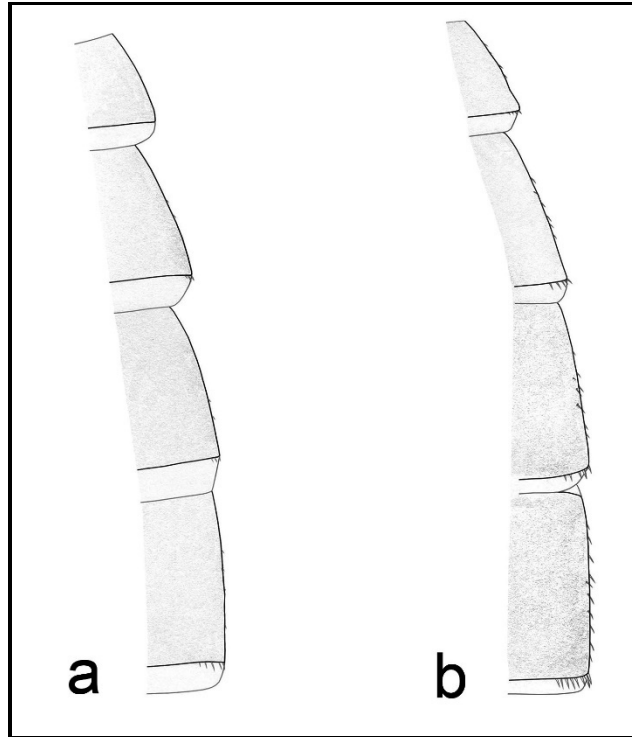


Figure 12.27. Libellulidae, abdominal segments 3–6 lateral margin, right side, dorsal view: a) *Micrathyria*; b) *Pachydiplax*.

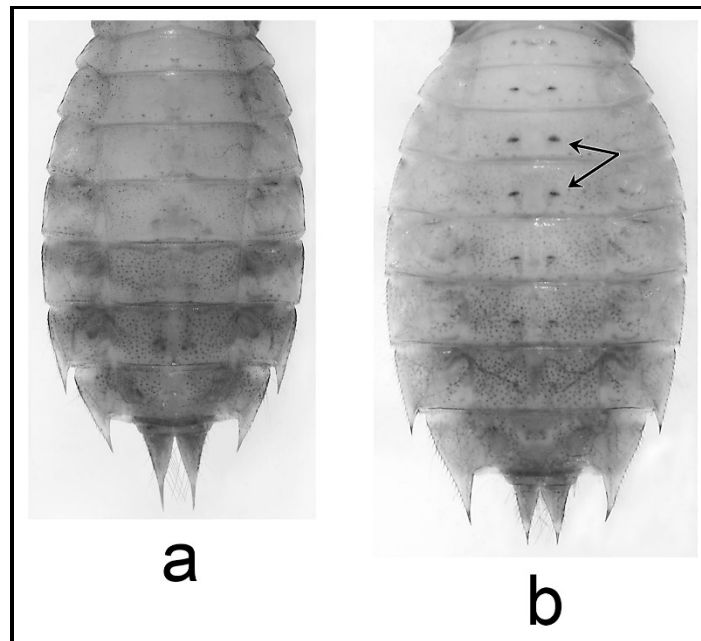


Figure 12.28. Libellulidae, abdominal segments 2–7 venter: a) *Micrathyria*; b) *Pachydiplax*. Arrows indicate paired dark submedian spots.

21. Prothorax with 0–2 long, piliform dorsomedial setae (Fig. 12.29a); 13–15 palpal setae (each side); ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length < 0.4 ***Sympetrum* (in part)**
- 21'. Prothorax with dorsomedial cluster of 6–10 stout setae on each side of midline (Fig. 12.29b); 7–11 palpal setae (each side); ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length ≥ 0.5 **22**

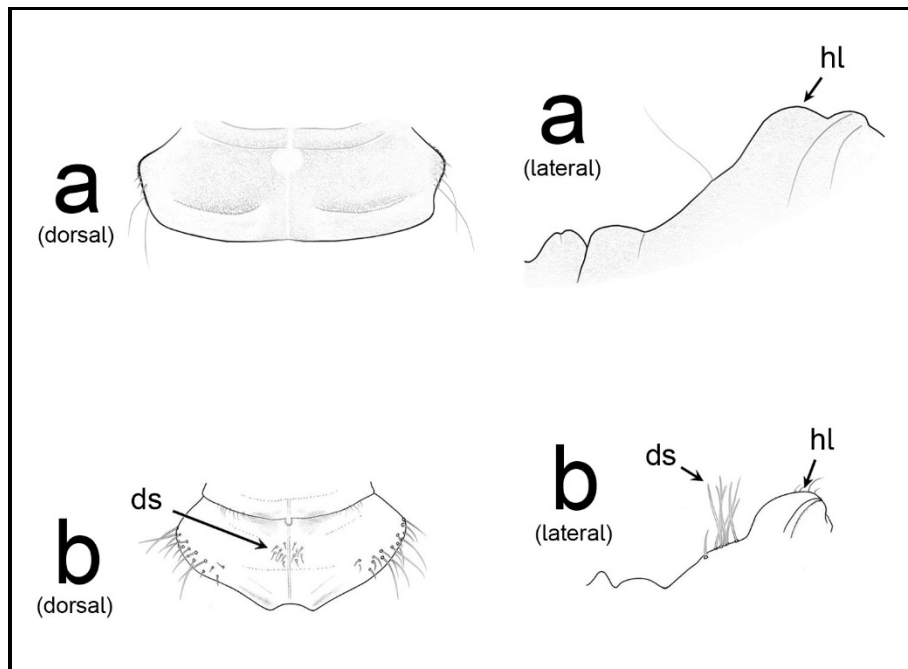


Figure 12.29. Libellulidae, prothorax in dorsal and lateral views: a) *Sympetrum*; b) *Erythrodiplax*; “ds” = dorsal setae, hl = hind lobe.

22. Distal palpal crenations extremely shallow, barely distinct (Fig. 12.30a); lateral margin of abdominal segment 6 with 5–9 small stout spinules and at most 1 anterior longer dark seta (Fig. 12.31a); prementum distal width (F-0) 3.8–4.15 mm ***Crocothemis***
- 22'. Distal palpal crenations shallow but distinct (Fig. 12.30b); lateral margin of abdominal segment 6 with numerous relatively long, fine, pale setae but without small spinules (Fig. 12.31b); prementum distal width (F-0) 2.5–3.8 mm ***Erythrodiplax***

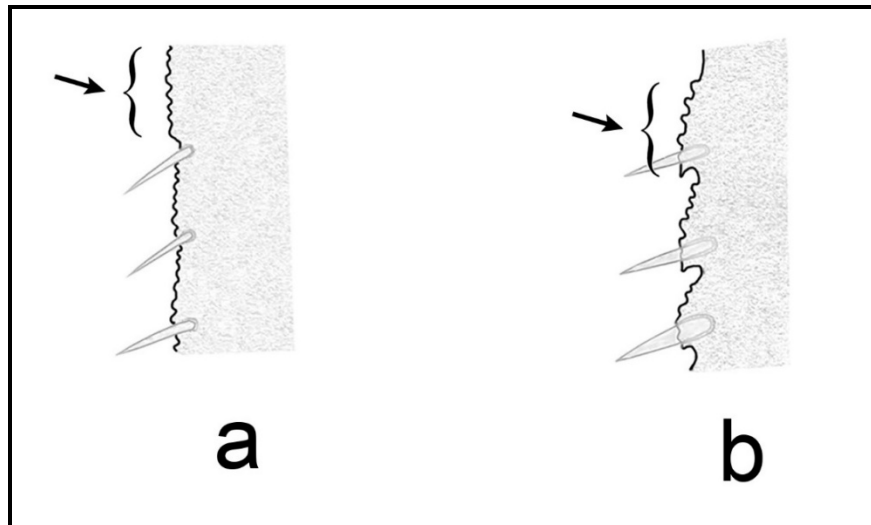


Figure 12.30. Libellulidae, palpal lobe distal margin showing three palpal crenations: a) *Crocothemis*; b) *Erythrodiplax*. Arrow and bracket indicate one crenation.

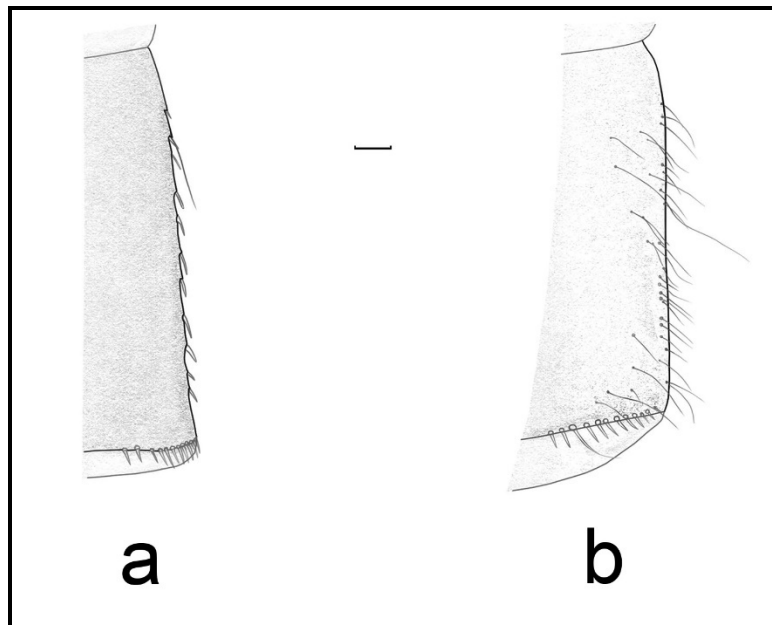


Figure 12.31. Libellulidae, abdominal segment 6 lateral margin setae, right side, dorsal view: a) *Crocothemis*; b) *Erythrodiplax*. Scale bar = 0.1 mm.

Generic Notes:

The above generic key is applicable for most of the region known as the southeastern United States although there are limitations to its use in states north of Mississippi, Alabama, and Georgia. A few additional diagnostic notes regarding difficult parts of the key are provided here.

Before deciding whether or not middorsal hooks are present, check all segments in dorsal and lateral views. In some species, middorsal hooks are not hook-like but rather are straight and pointed (e.g. *Brachymesia*), or they are present only beneath the wing sheaths (e.g. *Pantala*). On the contrary, some species without middorsal hooks have the dorsum of some segments slightly

produced or the posteromedial portion of some segments have several stiff setae that accumulate silt thus giving the impression of a middorsal protuberance (e.g. *Erythrodiplox*, some species of which have mistakenly been reported to have middorsal hooks).

Brachymesia and *Idiataphe* have a very similarly shaped habitus. In addition to the key characters in couplet 8, the number of palpal setae is 6–10 per side in *Brachymesia* versus consistently only 6 per side in *Idiataphe*. Abdominal segment 10 in *Brachymesia* has a blunt middorsal projection; in *Idiataphe*, the middorsal hook on abdominal segment 10 varies from distinct (Fig. 12.32a) to vestigial (Fig. 12.32b), the latter condition resembling segment 10 of *Brachymesia*.

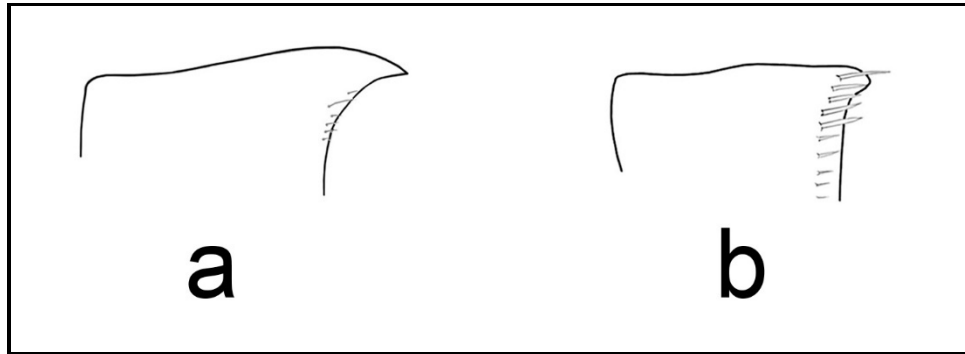


Figure 12.32. *Idiataphe*, variation in middorsal hook on abdominal segment 10, lateral view: a) middorsal hook distinct; b) middorsal hook vestigial.

Pantala has often been characterized as lacking middorsal hooks on the abdominal segments (e.g., Needham and Westfall 1955, Walker and Corbet 1975, Needham et al. 2000); this oversight was corrected in the 3rd edition of the latter work (Needham et al. 2014). To be sure, sharp middorsal hooks are present on segments 2–4 in both species of *Pantala*. Because the hooks are hidden by the wing sheaths in late instars, nymphs of *Pantala* are often confused with *Tramea*. The two genera are not closely related. *Tramea* lacks middorsal hooks altogether. Furthermore, the movable hook in *Pantala* is short and stout (Fig. 12.33a) versus long and slender in *Tramea* (Fig. 12.33b), the distal palpal crenations are prominently produced in *Pantala* (Fig. 12.33a) versus reduced in *Tramea* (Fig. 12.33b). Another conspicuous difference between these two genera is the dark, often black, meso- and metathoracic tarsi of *Pantala*, these tarsi being mostly pale in *Tramea* (see Plate 9, page 258).

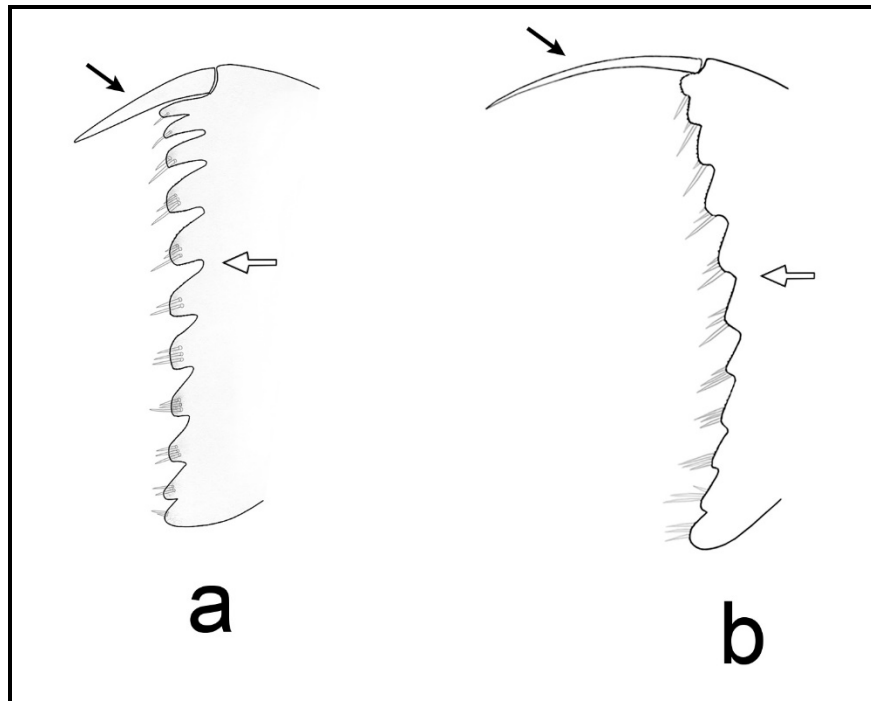


Figure 12.33. *Pantala* and *Tramea*, distal margin of labial palp, ectal view: a) *Pantala*; b) *Tramea*. Solid arrow indicates movable hook, open arrow indicates depth of a crenation.

Sympetrum keys out in two places (couplets 15 and 21) because of variation in the presence/absence of middorsal hooks within the genus. Based on size and color pattern, *Sympetrum* species with middorsal hooks are most likely to be confused with *Celithemis*; the characters in couplet 15 should allow correct determinations. The only *Sympetrum* species in Florida lacking middorsal hooks is *S. corruptum*; in addition to the characters in couplet 21, it differs from *Crocothemis* and *Erythrodiplax* by the number of long, piliform setae on the median of the metasternum: in *S. corruptum* there are only two such setae (Fig. 12.34a) compared to at least five or six in the other two genera (Fig. 12.34b).

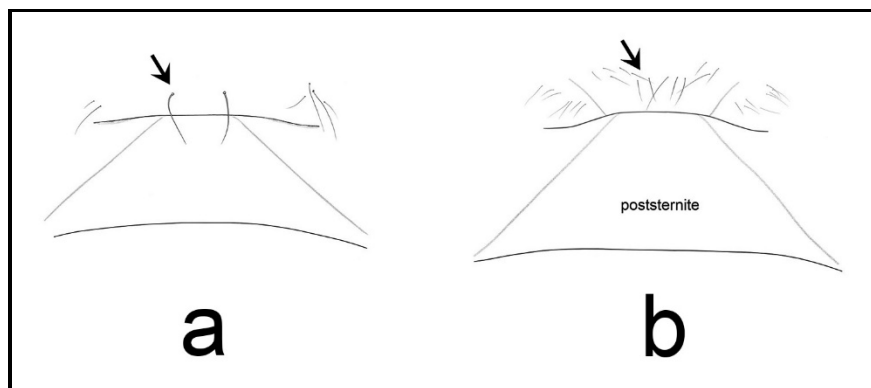


Figure 12.34. *Sympetrum* and *Crocothemis*, setae on metasternum: a) *Sympetrum*; b) *Crocothemis*. Arrow indicates medial setae.

Pachydiplax and *Micrathyria* are extremely similar and difficult to distinguish morphologically. A feature the two genera share is the darker shade of antennal segment 6—it

contrasts markedly with the other segments (Fig. 12.35a), as compared to the paler shade of segment 6 in *Sympetrum*, *Crocothemis* and *Erythrodiplax* (Fig. 12.35b). To help separate *Pachydiplax* from *Micrathyria*, the middle palpal crenations of *Pachydiplax* bear 5 or 6 spiniform setae versus 1–3 in *Micrathyria*. *Pachydiplax* is distributed throughout the state whereas *Micrathyria* has been recorded in only three counties south of Lake Okeechobee.

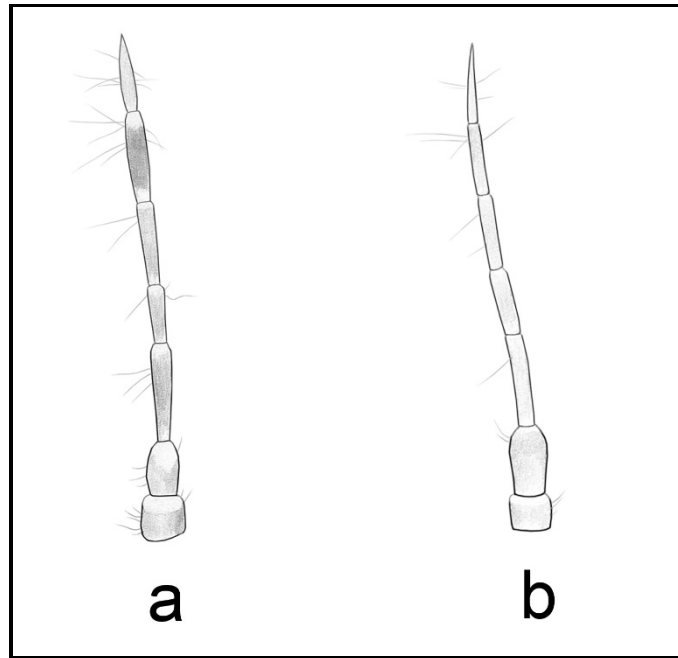


Figure 12.35. *Pachydiplax* and *Crocothemis*, antenna: a) *Pachydiplax*; b) *Crocothemis*.

Data on size show that the ranges for most measurable characters overlap among the genera (Table 12.1), especially comparing closely related genera. Palpal setae counts are helpful in some instances. Consulting the table for doubtful specimens can help resolve some determinations.

Table 12.1. Summary of size measurements (mm) and palpal setae counts for the 22 genera of Libellulidae in Florida, for instar F-0.

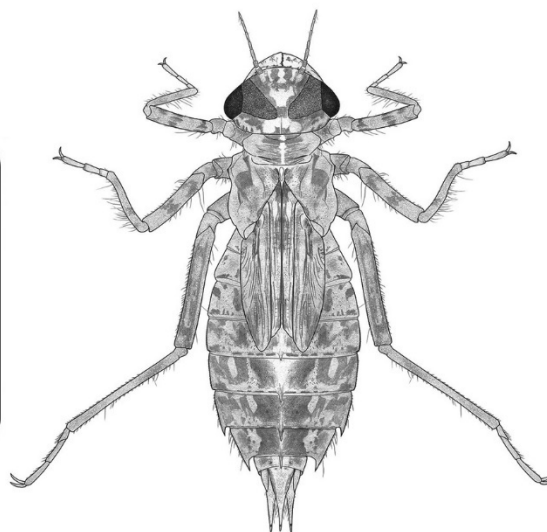
Genus	# Spp. in Florida	Total Length	Head Width	Premontum Max Width	Epiproct L	# palpal setae
<i>Brachymesia</i>	3	18.5–25.0	5.10–5.80	4.00–4.85	2.55–3.60	6–10
<i>Celithemis</i>	7	13.0–19.3	4.30–5.65	3.30–4.20	0.85–1.65	7–10
<i>Crocothemis</i>	1	14.3–17.0	5.40–5.65	3.80–4.15	1.55–1.70	10
<i>Dythemis</i>	1	15.5–17.2	5.05–5.30	4.05–4.30	1.10–1.25	9–11
<i>Erythemis</i>	3	13.2–18.8	4.90–6.25	4.25–4.75	1.10–1.55	8–13
<i>Erythrodiplax</i>	3	9.2–16.3	3.45–4.95	2.50–3.80	0.65–1.35	9–11
<i>Idiataphe</i>	1	14.6–18.3	4.25–4.75	3.40–3.95	2.35–2.70	5–6
<i>Ladona</i>	1	16.0–22.0	4.10–4.75	3.25–3.75	1.80–3.00	5–8
<i>Libellula</i>	10	19.6–25.9	5.10–6.20	4.05–5.30	1.85–2.60	5–10
<i>Macrodiplax</i>	1	19.5–21.5	6.35–6.75	5.00–5.30	1.80–2.05	12–13
<i>Miathyria</i>	1	12.4–14.0	5.05–5.15	3.65–3.95	0.90–0.95	6–7
<i>Micrathyria</i>	2	12.1–16.3	4.00–4.65	2.85–3.65	1.00–1.15	10–11
<i>Nannothemis</i>	1	6.8–9.2	2.85–3.10	1.70–1.85	0.45–0.55	6
<i>Orthemis</i>	2	20.0–25.0	4.60–5.10	4.20–4.90	2.45–2.80	8–9
<i>Pachydiplax</i>	1	15.4–19.7	4.85–5.55	3.35–3.90	1.10–1.30	10
<i>Pantala</i>	2	21.2–27.5	5.95–6.75	4.90–5.95	2.90–3.25	13–18
<i>Perithemis</i>	1	12.0–14.4	3.60–3.95	2.20–2.55	0.80–0.95	4–7
<i>Plathemis</i>	1	18.0–23.0	4.50–4.75	3.80–4.05	1.55–1.75	9–11
<i>Sympetrum</i>	3	11.0–20.5	3.90–5.65	2.60–4.50	0.80–1.70	8–15
<i>Tauriphila</i>	2	16.0–18.5	5.75–6.20	4.50–5.15	0.90–1.15	8–9
<i>Tholymis</i>	1	19.3–21.5	5.40–5.80	3.65–3.90	1.80–1.95	7
<i>Tramea</i>	7	19.8–26.0	6.60–7.85	5.60–6.80	1.85–3.00	6–13

Libellulidae Generic Treatments

A total of 55 species of Libellulidae occur in Florida. *Nannothemis* and *Pachydiplax* are monotypic. Only one species of the following genera occurs in the state: *Crocothemis*, *Dythemis*, *Idiataphe*, *Ladona*, *Macrodiplax*, *Miathyria*, *Perithemis*, *Plathemis* and *Tholymis*. Species determinations in the other eleven genera can be difficult. The following keys to species should be used only for Florida specimens.

Brachymesia

Slender, light brown; eyes large, sloping; labial hinge with spiniform setae; mid-dorsal hooks on abd. segs. 3–9; epiproct and paraprocts long, sharply tipped



Brachymesia is mainly Neotropical in distribution; all three species, *B. furcata*, *B. grvida* and *B. herbida*, are recorded in Florida.

Generic Notes:

Brachymesia nymphs are unique in the Florida libellulid fauna in possessing small stout setae on the postmentum. The only other genera with a similarly tapered abdomen are *Idiataphe* and *Ladona*.

Key to *Brachymesia* Species

1. 6 palpal setae, sometimes 7 (each side); epiproct length 1.45–1.6 times combined length of abdominal segments 9 and 10, and segment 9 posterolateral spine 0.45–0.55 times segment 9 middorsal length (Fig. 12.36a).....***grvida***
- 1'. 8–10 palpal setae, rarely 7 (each side); epiproct length 1.6–2.0 times combined length of abdominal segments 9 and 10, and segment 9 posterolateral spine 0.5–1.35 times segment 9 middorsal length (Fig. 12.36b,c).....**2**

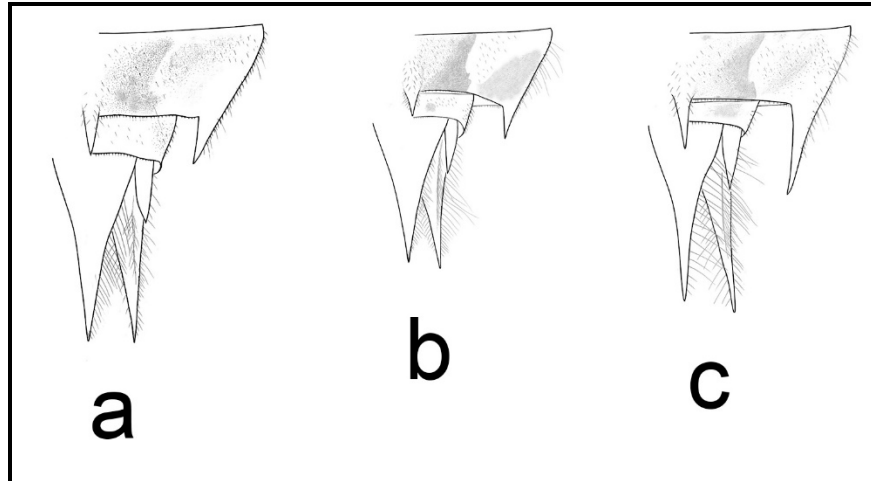


Figure 12.36. *Brachymesia*, abdominal segments 9–10 and anal appendages, right side, dorsal view: a) *B. gravida*; b) *B. furcata*; c) *B. herbida*.

2. Abdominal segment 9 posterolateral spine 0.5–0.9 times segment 9 middorsal length (Fig. 12.36b); segment 3 middorsal hook length > 0.25 mm (Fig. 12.37a); epiproct length < 3.0 mm; usually 9 or 10 palpal setae, rarely 7 or 8 (each side)*furcata*
- 2'. Abdominal segment 9 posterolateral spine 1.0–1.35 times segment 9 middorsal length (Fig. 12.36c); segment 3 middorsal hook length < 0.25 mm (Fig. 12.37b); epiproct length < 3.0 mm; usually 8 palpal setae, rarely 9 (each side)*herbida*

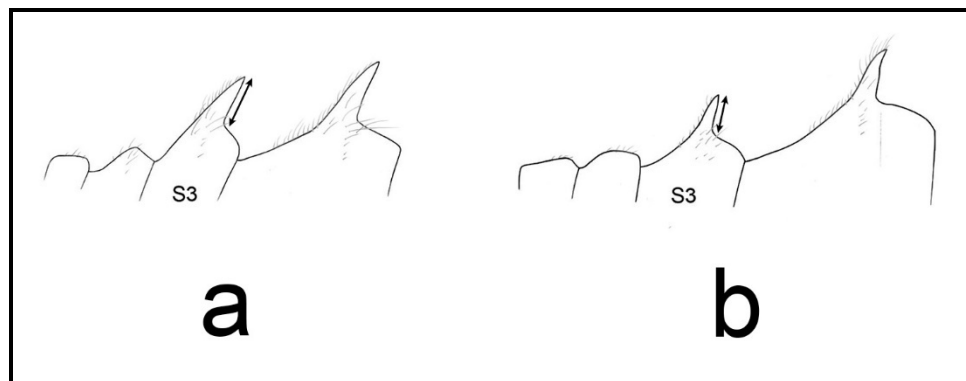


Figure 12.37. *Brachymesia*, abdominal segments 1–4, lateral view: a) *B. furcata*; b) *B. herbida*.

Diagnostic Remarks:

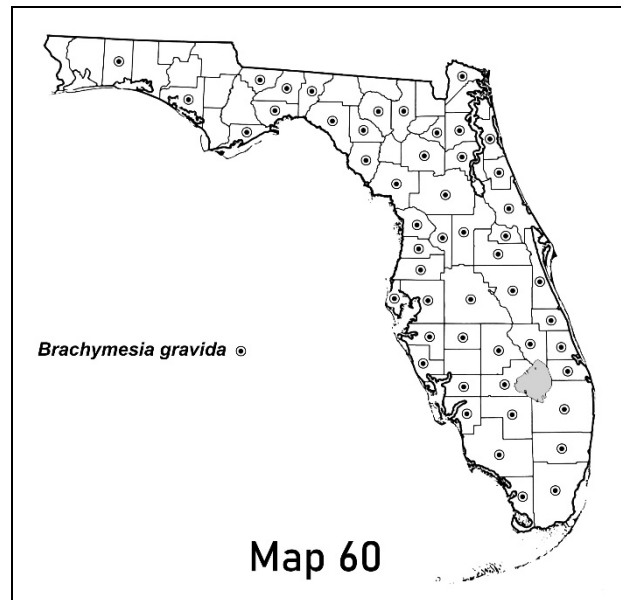
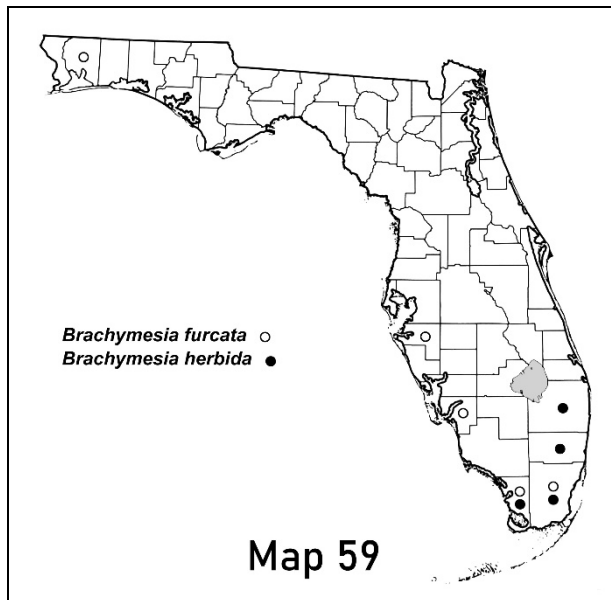
The nymphs of the three species of *Brachymesia* are remarkably similar despite the distinct color differences of the adults (Paulson 2011). In addition to the key characters, *B. gravida* usually has fewer premental setae than does *B. furcata* (8–10 on each side versus 11–14); however, *B. herbida* has 7–10 premental setae. The posterolateral spines on abdominal segment 9 are longer relative to those on segment 8 in *B. herbida* (ratio 1.48–1.76 versus 1.12–1.44 for *B. furcata* and *B. gravida*).

Habitat, Distribution, Life Cycle:

Brachymesia nymphs are predominantly lentic, inhabiting lakes and ponds with aquatic vegetation, and also occasionally are found in certain marshes and ditches. The habitats are often alkaline or mildly saline.

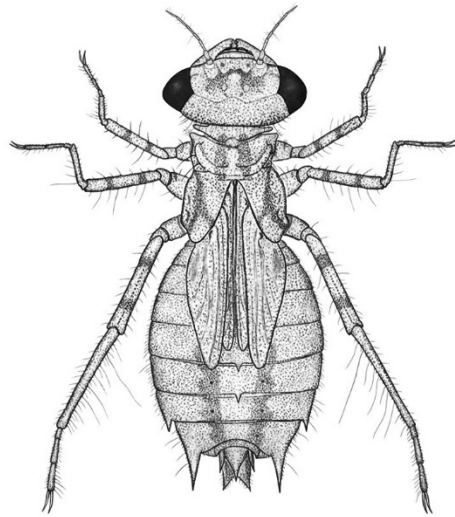
Brachymesia furcata and *B. herbida* are recorded from very few localities (Map 59), whereas *B. gravaida* is distributed throughout the state (Map 60). *Brachymesia* appear to fly year-round in south Florida, although the recorded flight season for *B. herbida* is from April 20 to October 14.

Brachymesia species are probably univoltine or possibly bivoltine.



Celithemis

Oval, tan to greenish brown; eyes large; middorsal hooks on abd. segs. 4–7, long posterolateral spines on seg. 9; abdomen truncate



Celithemis is a North American genus comprising eight species, seven of which occur in Florida.

Generic Notes:

Celithemis resembles *Dythemis* in color pattern but lacks middorsal hooks on abdominal segments 8 and 9. The color pattern is similar also to that of the corduliid genus *Epithec*a, which of course has a ventromedial groove on the prementum and stout middorsal hooks on segments 2–9.

Key to *Celithemis* Species

1. Lateral margin of each eye tapered to a distinct point (Fig. 12.38a)2
- 1'. Lateral margin of each eye rounded (Fig. 12.38b), sometimes slightly angled4

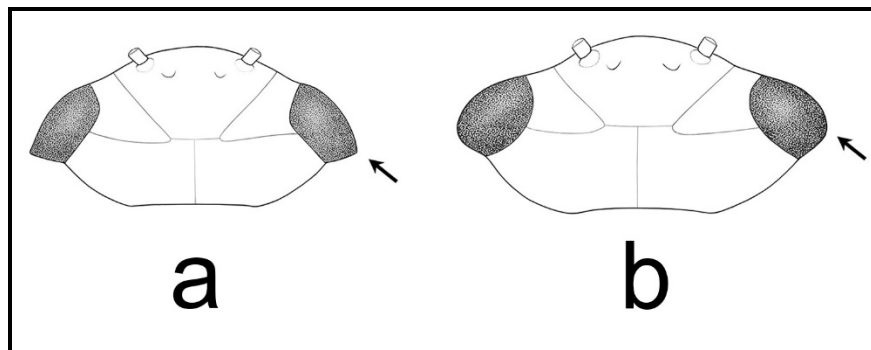


Figure 12.38. *Celithemis*, head, dorsal view: a) *C. fasciata*; b) *C. eponina*.

2. Occiput with a pair of hair pencils formed by a tight cluster of at least 12 dark piliform setae (Fig. 12.39a); ratio of epiproct L:paraproct L 0.84–0.91 *verna*
- 2'. Occiput without dark hair pencils, at most with a loose cluster of 6–8 pale, piliform setae (Fig. 12.39b); ratio of epiproct L:paraproct L 0.93–1.04 **3**

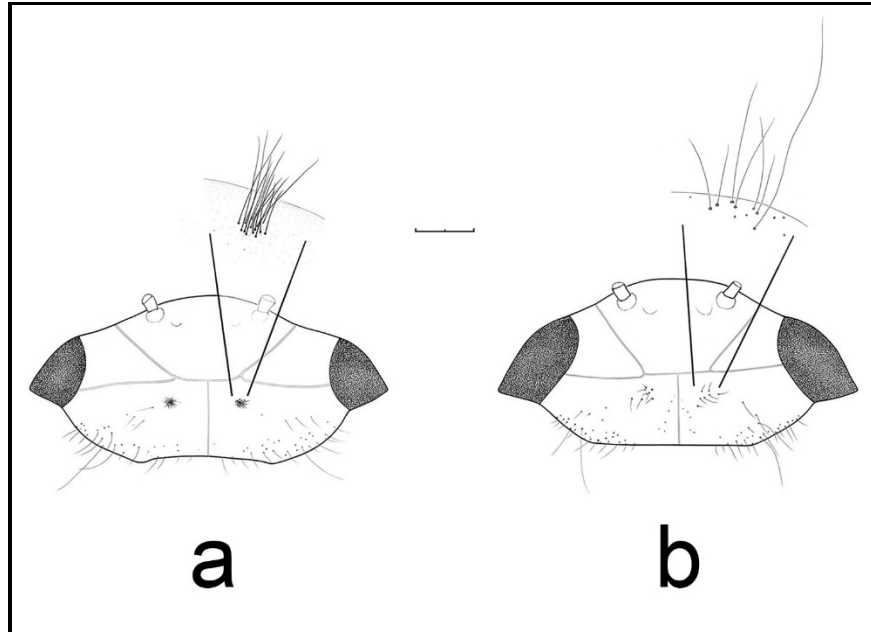


Figure 12.39. *Celithemis*, occiput of head, dorsal view, inset showing setae enlarged: a) *C. verna*; b) *C. ornata*.

3. Palpi with distinct dark blotches on ectal surface (Fig. 12.40a); dark bands on femora markedly contrasting with pale areas *fasciata*
- 3'. Palpi with small dark spots on ectal surface (Fig. 12.40b); dark bands on femora faintly contrasting with pale areas *ornata*

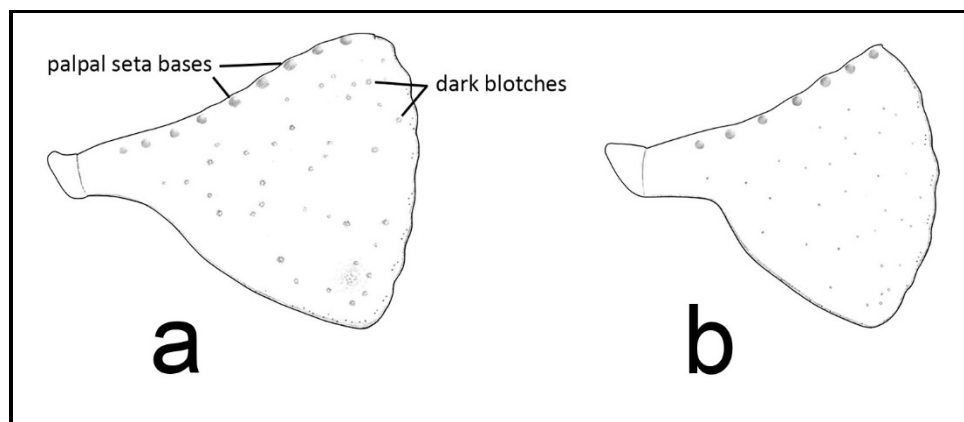


Figure 12.40. *Celithemis*, right palp, ectal view: a) *C. fasciata*; b) *C. ornata*.

4. Total length (F-0) 17.0–19.3 mm; abdomen width > 6 mm, paraproct length ≥ 1.40 mm; abdominal segment 7 usually without a middorsal hook (Fig. 12.41a) *eponina*
- 4'. Total length (F-0) 13.5–17.0 mm; abdomen width < 6 mm, paraproct length < 1.35 mm; abdominal segment 7 with a middorsal hook (Fig. 12.41b)5

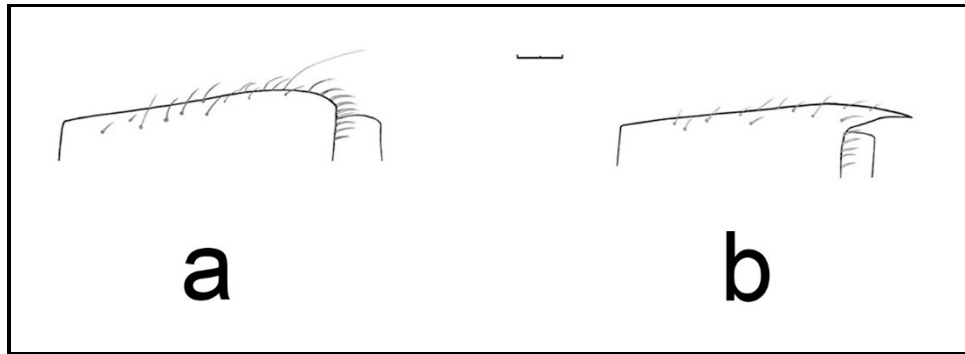


Figure 12.41. *Celithemis*, abdominal segment 7 profile: a) *C. eponina*; b) *C. elisa*.

5. 7 palpal setae (each side); ratio of abdominal segment 9 posterolateral spine length:segment 8 posterolateral spine length 1.80–2.20; segment 9 posterolateral spines parallel to each other to slightly convergent *amanda*
- 5'. 8 palpal setae (each side); ratio of abdominal segment 9 posterolateral spine length:segment 8 posterolateral spine length 2.50–3.75; segment 9 posterolateral spines divergent6
6. Abdominal segment 3 usually with a small middorsal hook (Fig. 12.42a); prementum length (F-0) 3.90–4.20 mm; ratio of prementum max width:head width 0.80–0.85 *bertha*
- 6'. Abdominal segment 3 usually without a small middorsal hook (Fig. 12.42b); prementum length (F-0) 3.40–3.90 mm; ratio of prementum max width:head width 0.72–0.81 *elisa*

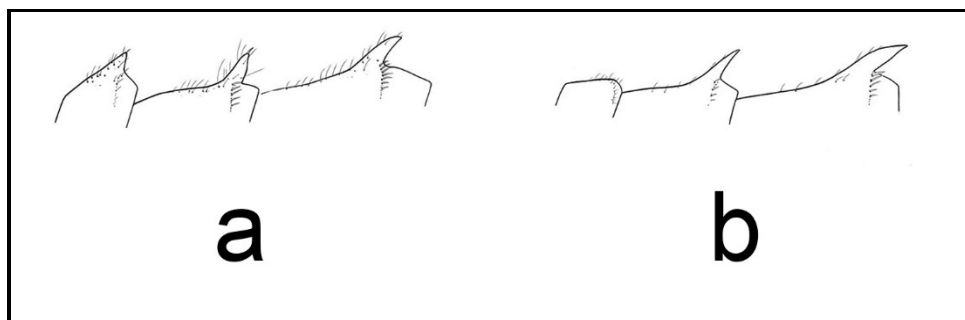


Figure 12.42. *Celithemis*, abdominal segments 3–5 profile: a) *C. bertha*; b) *C. elisa*.

Diagnostic Remarks:

Species identification within *Celithemis* is difficult. The above key probably has limitations as the characters have not been thoroughly tested. More research on variability in Florida populations is needed.

As in other libellulid genera, the number of palpal setae is variable within most *Celithemis* species, but *C. amanda* consistently has 7 per side compared to usually 8 or more in the other six species; some *C. ornata* specimens have 7 palpal setae. Furthermore, *C. amanda* has the shortest posterolateral spines on abdominal segment 9 (length 0.90–1.05 mm versus an overall range of 1.10–2.35 mm for the other species), and the spines are essentially parallel versus divergent in the other species.

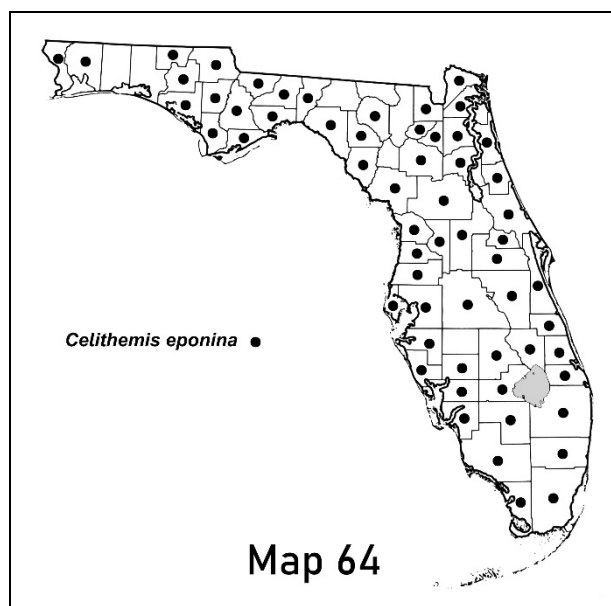
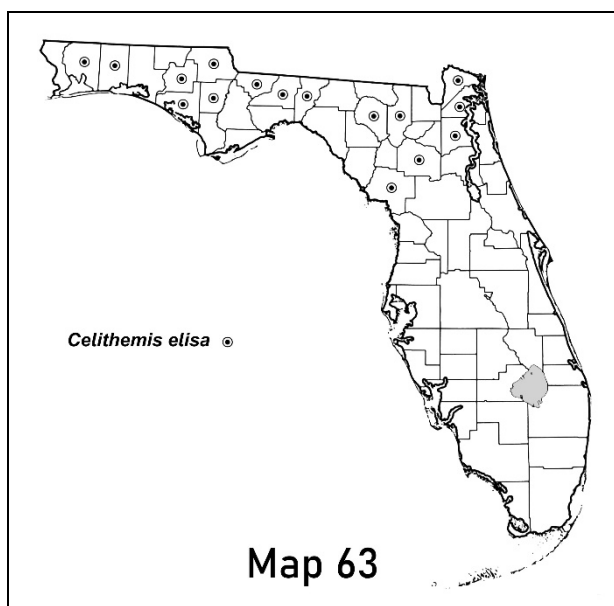
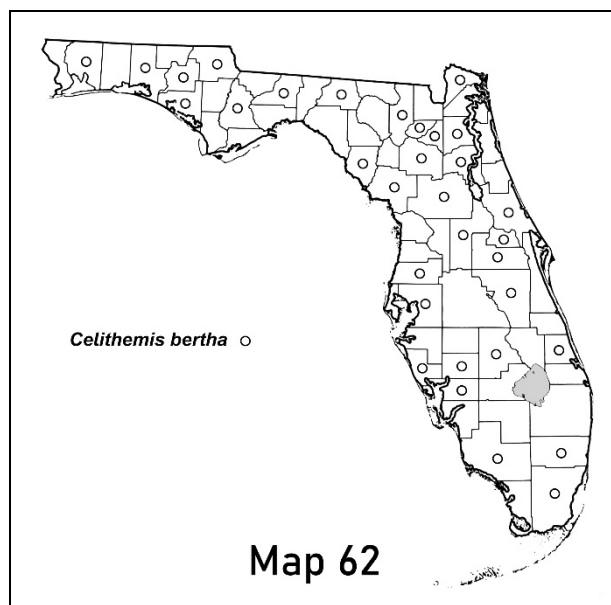
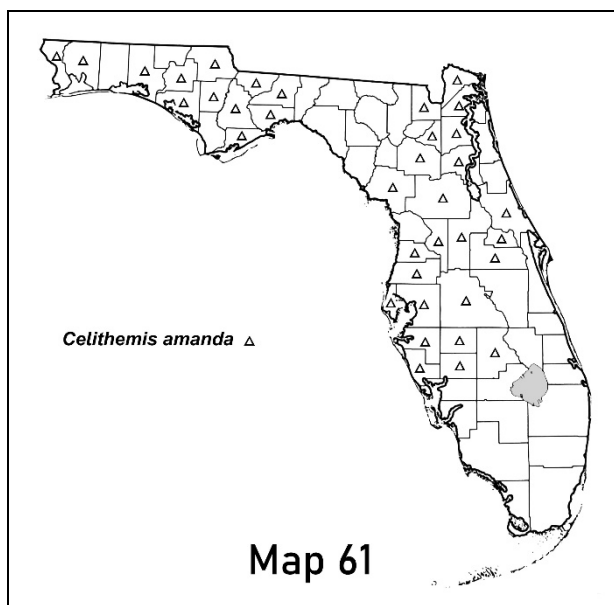
The color pattern differences used to separate *C. fasciata* and *C. ornata* may be variable, especially under different methods of preservation. *Celithemis eponina* is larger on average than *C. amanda*, *C. bertha* and *C. elisa* but size is quite variable in all four species. The presence/absence of a middorsal hook on abdominal segment 3 used to separate *C. bertha* and *C. elisa* may also be variable. Posterolateral spine length and middorsal hook size have been shown to depend on whether or not insectivorous fish are present in the habitat where nymphs develop in the genus *Leucorrhinia* Brittinger (Johansson and Samuelsson 1994, McCauley et al. 2008), and the phenomenon appears to be manifest in *Celithemis* (R. DuBois pers. comm). Spines are notably longer in nymphs that exist where fish are present, creating a problem in using spine length to separate species. Note that the ratio of segment 9 spine length:paraproct length distinguishes some specimens of *C. bertha* and *C. elisa* (1.06–1.51 for *bertha* versus 1.03–1.12 for *elisa*) but there is overlap in the ratio. In summary, only F-0 specimens of *Celithemis* should be taken through the key, and caution should be used in species determinations.

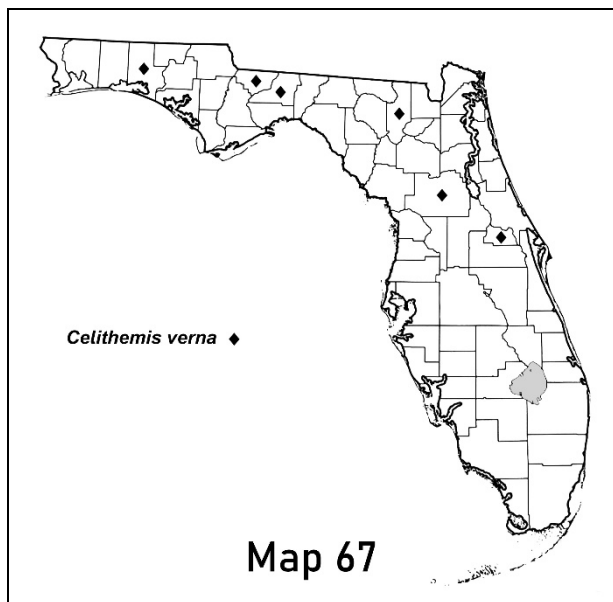
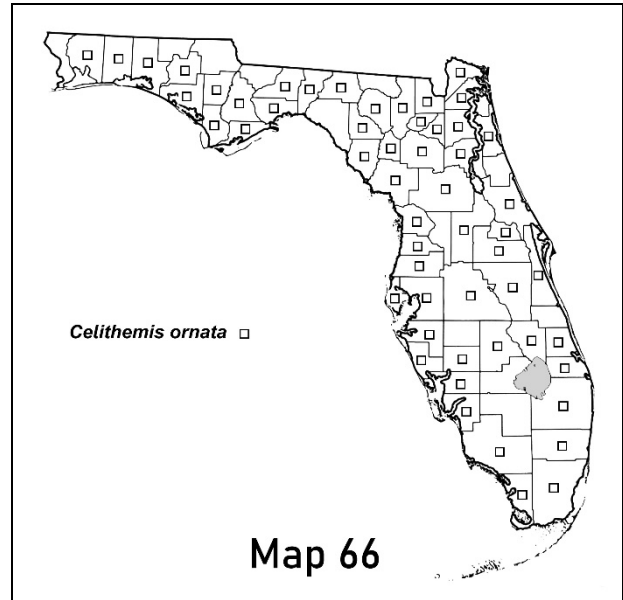
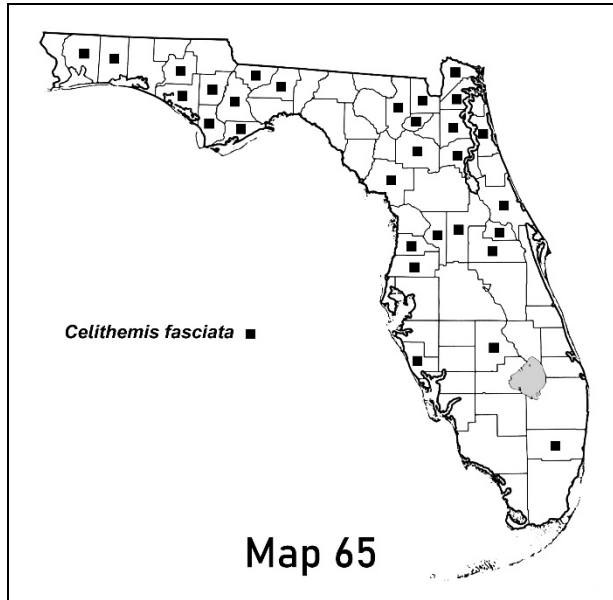
Habitat, Distribution, Life Cycle:

Celithemis nymphs are lentic, inhabiting lakes, ponds, and marshes with sparse to thick aquatic vegetation.

Five species occur nearly statewide or throughout the state: *C. amanda*, *C. bertha*, *C. eponina*, *C. fasciata* and *C. ornata* (Maps 61, 62, 64, 65 and 66). *Celithemis elisa* and *C. verna* are limited to the northern part of the state (Maps 63 and 67).

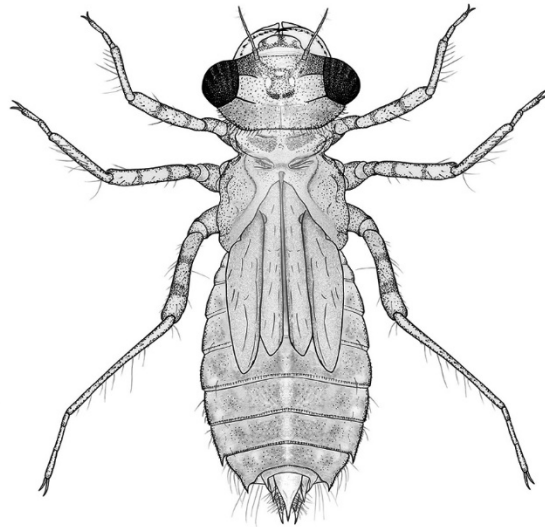
Two species of *Celithemis*, *C. eponina* and *C. ornata*, fly year-round in most regions of the state. Four other species emerge early and fly throughout the summer into fall: recorded flight seasons begin in March or April and end anytime from October to December; however, *C. verna* has been recorded only in April in Florida. *Celithemis* species are probably univoltine with extended emergence periods.





Crocothemis

Oval, tan to green; eyes large; no mid-dorsal hooks on abdomen; small, sharp posterolateral spines on 8 and 9; abdomen truncate



Crocothemis is an Old World genus, one species of which, *C. servilia*, was first found in Florida in the 1970s (Paulson 1978); it is considered an invasive species that has spread northward through the peninsula.

Diagnosis:

Crocothemis resembles *Erythrodiplax* in most aspects, but it also is similar to *Sympetrum* species that lack middorsal hooks on all abdominal segments. The epiproct of *Crocothemis* is approximately as long as the paraprocts in dorsal view (Fig. 12.43a) whereas the epiproct of *Erythrodiplax* and *Sympetrum* is about 2/3 to 3/4 as long as the paraprocts (Fig. 12.43b). The prothorax of *Crocothemis* has a cluster of stout medial setae similar to that of *Erythrodiplax* whereas *Sympetrum* usually has a single seta on the prothorax. The spiniform setae on the dorsal surface of the abdomen may be variable, from inconspicuous to giving the dorsum a more maculose appearance.

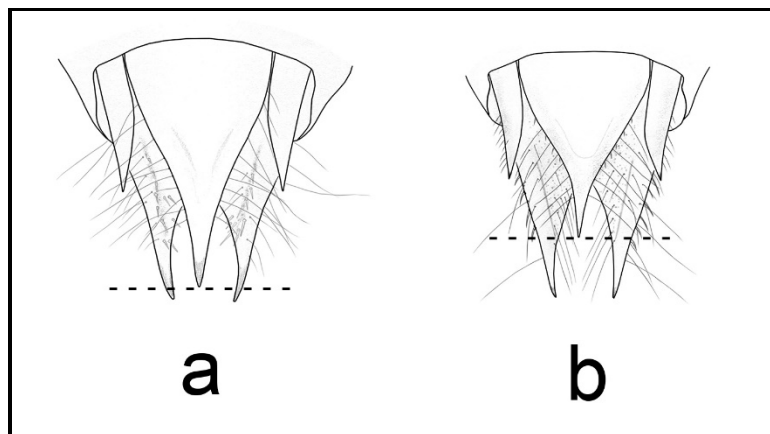


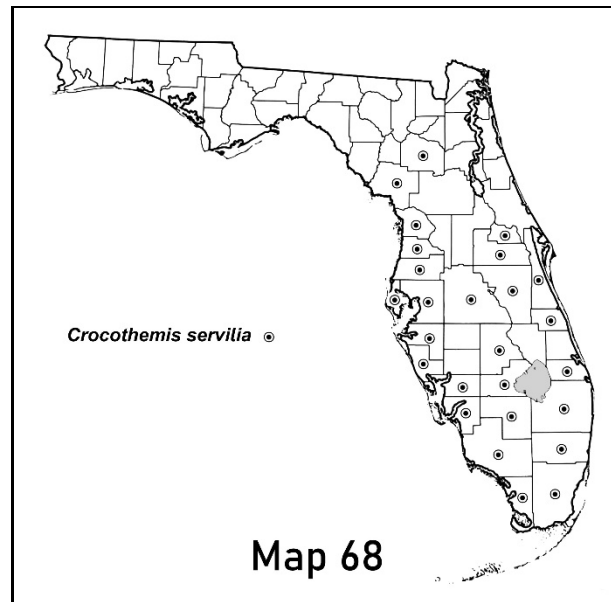
Figure 12.43. Libellulidae, abdominal appendages, dorsal view: a) *Crocothemis servilia*; b) *Erythrodiplax umbrata*.

Habitat, Distribution, Life Cycle:

Crocothemis nymphs are lentic, inhabiting canals and ponds, sometimes temporary and often with sparse vegetation.

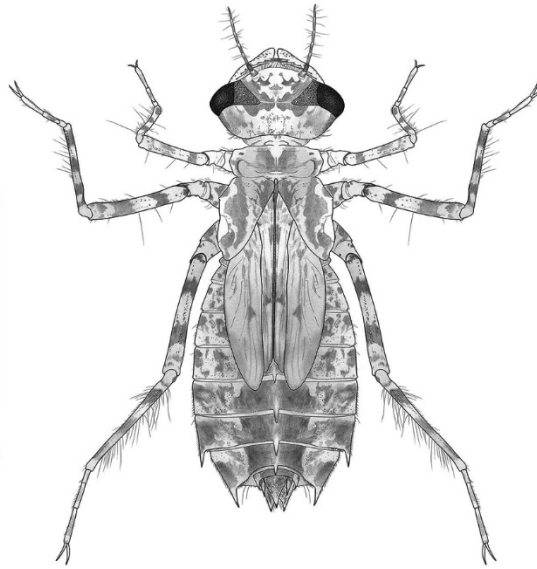
Crocothemis servilia has expanded its range northward since first being detected in southern Florida in 1977, now occurring throughout the peninsula as far north as Alachua County (Map 68).

Crocothemis servilia flies year-round; the species is probably bivoltine or multivoltine, with egg-laying and emergence occurring throughout the year.



Dythemis

Elongate-oval, brown, intricately patterned; eyes large; middorsal hooks on abdominal segments 3–9; sharp posterolateral spines on segments 8 and 9; abdomen truncate



Dythemis is a Neotropical genus, one species of which, ***D. velox***, occurs in Florida.

Diagnosis:

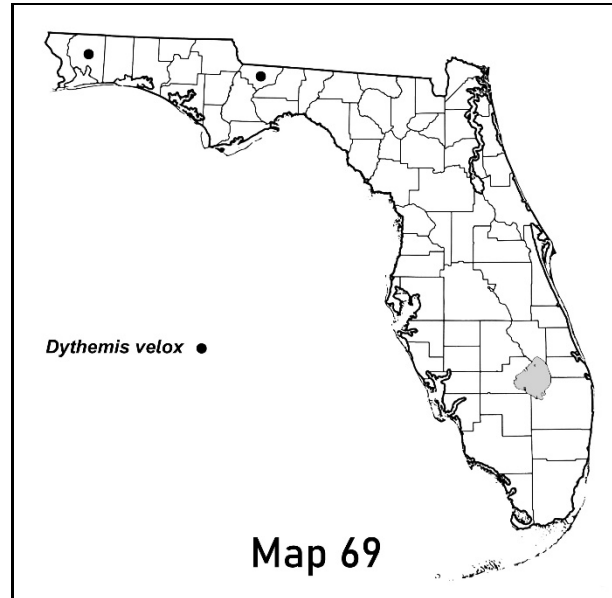
Dythemis resembles *Celithemis* in color pattern but has middorsal hooks on abdominal segments 3–9; *Celithemis* lacks a middorsal hook on segments 8 and 9. The color pattern on the dorsum of the abdomen is similar to that of *Epitheca* but the prementum lacks a ventromedial groove, the posterolateral spines on segment 9 are shorter than those of most *Epitheca* species, and segment 2 lacks a middorsal hook.

Habitat, Distribution, Life Cycle:

Dythemis nymphs are primarily lotic, inhabiting slow-flowing portions of streams and canals but also inhabiting reservoirs.

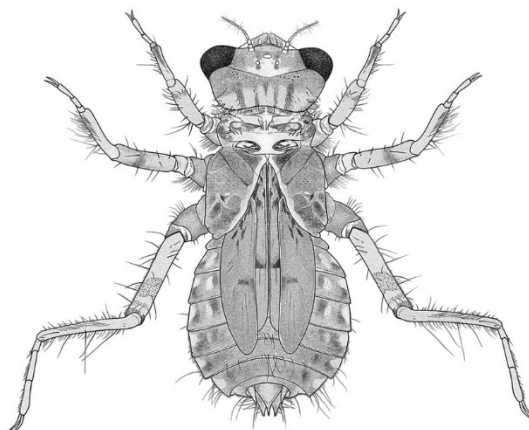
Dythemis velox has been recorded from only two counties in the panhandle (Map 69).

The flight season of *Dythemis velox* is from May 27 to September 23; the species is probably univoltine.



Erythemis

Oval, compact, variable in color — green, tan, black; eyes large; abdomen nearly circular, without middorsal hooks; small posterolateral spines present only on segment 9, sometimes absent



Erythemis is mainly a Neotropical genus, with three of the ten species present in Florida.

Generic Notes:

Erythemis nymphs are stockier and more compact than any other libellulid genus in Florida. Similar in habitus but less stocky are *Crocothemis* and *Erythrodiplax* which have paraprocts that are straight to only slightly decurved in lateral view (Fig. 12.21b,c). Also, the spiniform setae on the ligula are more numerous and more prominent in *Erythemis* (12.44a) than in *Crocothemis* and *Erythrodiplax* (Fig. 12.44b).

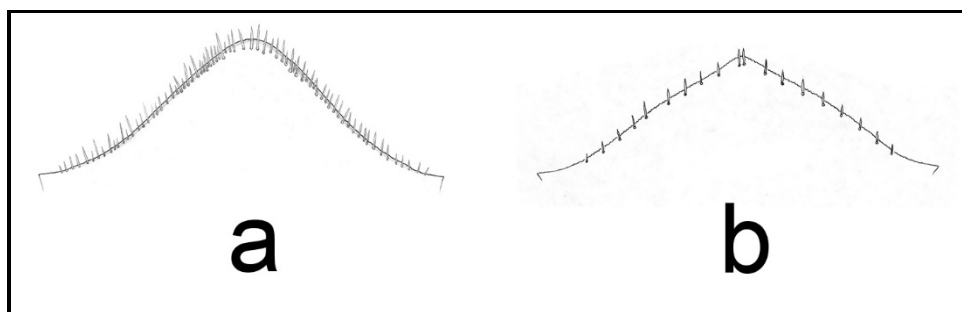


Figure 12.44. Libellulidae, ligula, ental view: a) *Erythemis simplicicollis*; b) *Erythrodiplax umbrata*.

Key to *Erythemis* Species

1. Abdominal segment 9 without a definite posterolateral spine (Fig. 12.45a); cerci in dorsal view slightly curved laterad, nearly straight (Fig. 12.46a)***simplicicollis***
- 1'. Abdominal segment 9 with a distinct, curved posterolateral spine (Fig. 12.45b); cerci in dorsal view notably curved laterad (Fig. 12.46b)**2**

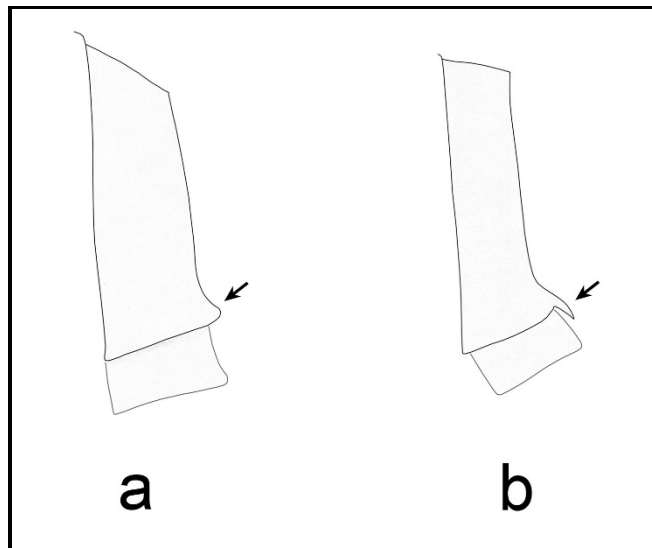


Figure 12.45. *Erythemis*, abdominal segment 9, lateral view: a) *E. simplicicollis*; b) *E. plebeja*. Arrow indicates posteroventral corner of segment.

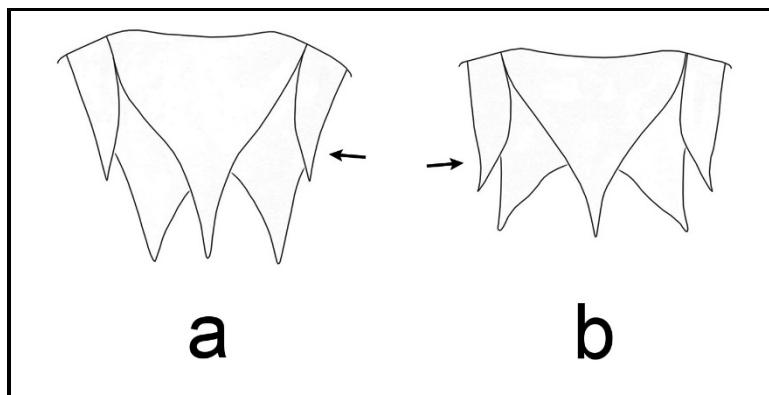


Figure 12.46. *Erythemis*, anal appendages, dorsal view: a) *E. simplicicollis*; b) *E. plebeja*. Arrow indicates cercus.

- 2. 8 or 9 palpal setae (each side); metathoracic femur length 4.7–5.0 mm*plebeja*
- 2'. 11–13 palpal setae (each side); metathoracic femur length 6.7–7.3 mm.....*vesiculosa*

Diagnostic Remarks:

Besides metathoracic femur length, *Erythemis vesiculosa* is larger in F-0 than both *E. plebeja* and *E. simplicicollis* in a number of features such as metathoracic tibia length (8.90–9.75 mm versus 6.20–7.65 mm), head width (5.90–6.25 mm versus 4.90–5.25 mm), and epiproct length (1.50–1.55 mm versus 1.10–1.45 mm). Also, the prementum is narrower at its base in *E. vesiculosa*, with a ratio of prementum length:basal width of 3.15–3.45 versus 2.20–3.00 for the other two species. There is no difference between *E. plebeja* or *E. simplicicollis* in overall size, the number of palpal setae (both usually having either 8 or 9 on each palp, though *E. simplicicollis* rarely has 10), nor the number of premental setae per side (12–15). The most obvious difference between these two

species is in the posterolateral spine on abdominal segment 9, in *E. plebeja* being definitely pointed and more than 0.1 mm long, in *E. simplicicollis* either entirely absent or slightly produced and rounded, less than 0.1 mm long. In F-0, the length of the metathoracic tibia is usually longer in *E. simplicicollis* than in *E. plebeja* (6.5–7.65 mm versus 6.20–6.50 mm). Also, the dorsolateral rim of the prementum in *E. simplicicollis* has numerous stout setae (Fig. 12.47a) whereas in *E. plebeja* it has only fine setae (Fig. 12.47b).

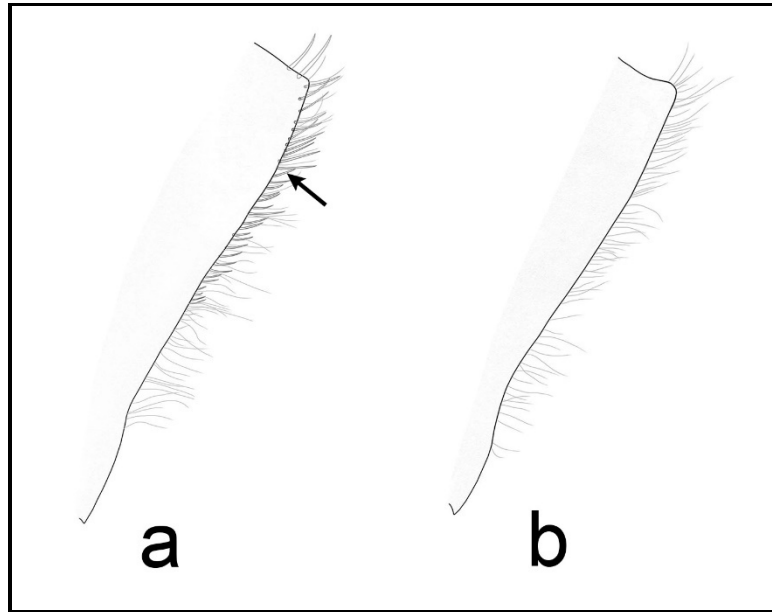


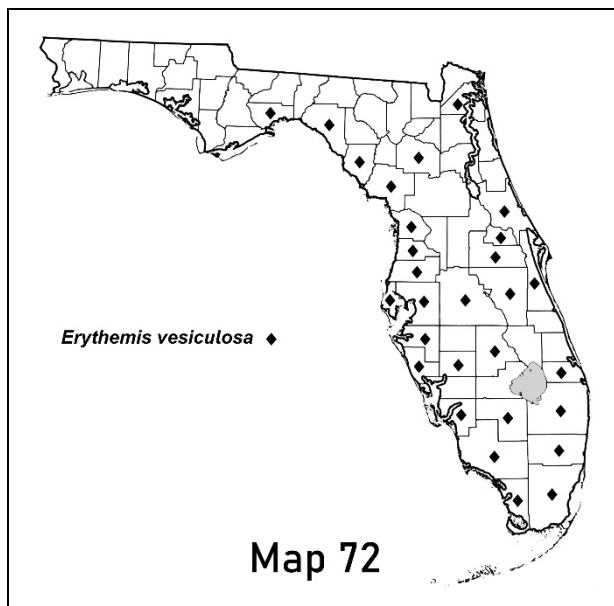
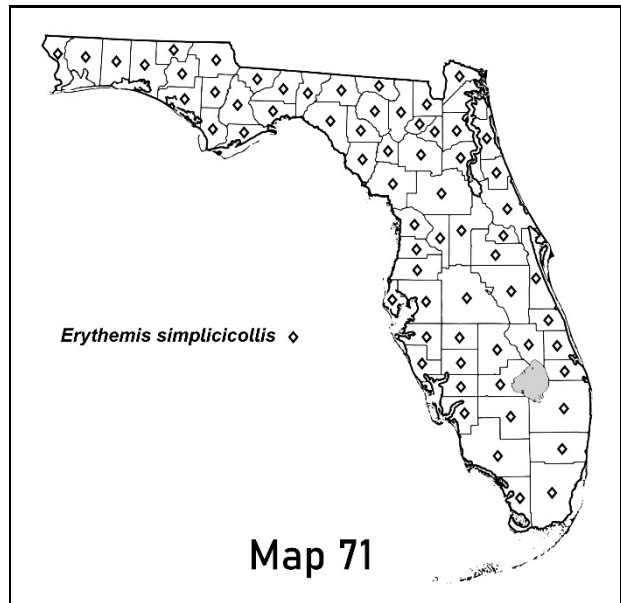
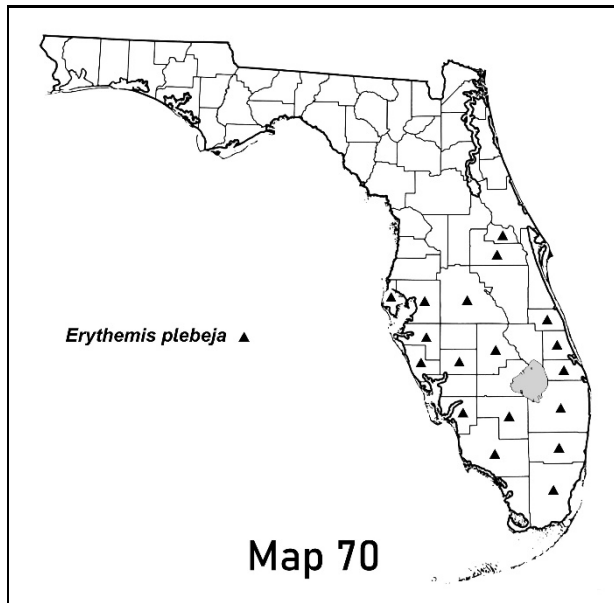
Figure 12.46. *Erythemis*, dorsolateral rim of prementum, dorsal view: a) *E. simplicicollis*; b) *E. plebeja*. Arrow indicates stout seta.

Habitat, Distribution, Life Cycle:

Erythemis nymphs are primarily lentic, the main habitats being vegetated ponds, small lakes, and ditches; occasionally nymphs are found in slow-flowing portions of canals and streams. Nymphs often inhabit dense algal mats.

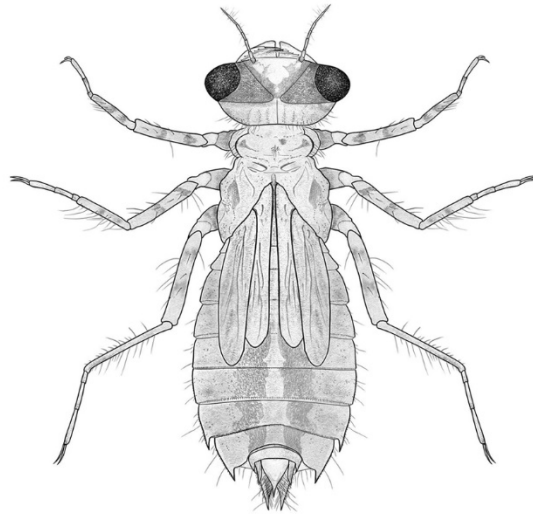
The range of *E. plebeja* barely extends north of the middle of the peninsula (Map 70). *Erythemis simplicicollis* occurs throughout the state and undoubtedly will be recorded in every county (Map 71); it is one of the two most common, ubiquitous species of Odonata in Florida, the other being *Pachydiplax longipennis*. *Erythemis vesiculosa* occurs throughout the peninsula plus there are a few records in the panhandle along the Gulf Coast (Map 72).

The flight season of all three species is throughout the year. *Erythemis* is undoubtedly multivoltine as generation time is approximately two months; egg-laying and emergence continue throughout most of the year.



Erythrodiplax

Elongate-oval, brown, faint color pattern; eyes large; abdomen without middorsal hooks; small to prominent posterolateral spines on segments 8 and 9; apex truncate



Erythrodiplax is a large Neotropical genus, with three of the 56 species present in Florida.

Generic Notes:

Erythrodiplax nymphs are most similar to *Crocothemis* in habitus and in possessing a cluster of stiff setae on the prothorax (Fig. 12.29b). In addition to the key characters in couplet 22, the epiproct of *Erythrodiplax* is about 2/3 as long as the paraprocts versus about as long in *Crocothemis*. *Erythrodiplax* also resembles *Sympetrum* in general habitus, but in that genus, the species without middorsal hooks have few or no short middorsal setae on the prothorax.

Key to *Erythrodiplax* Species

1. Dorsum of abdominal segments 6–9 with a medial, longitudinal cluster of spiniform setae (Fig. 12.48a); segments 8 and 9 posterolateral spines incurved (Fig. 12.49a)*berenice*
- 1'. Dorsum of abdominal segments 6–9 with spiniform setae not clustered medially, about as numerous laterally as medially (Fig. 12.48b); segments 8 and 9 posterolateral spines straight although usually angled toward median (Fig. 12.49b)2

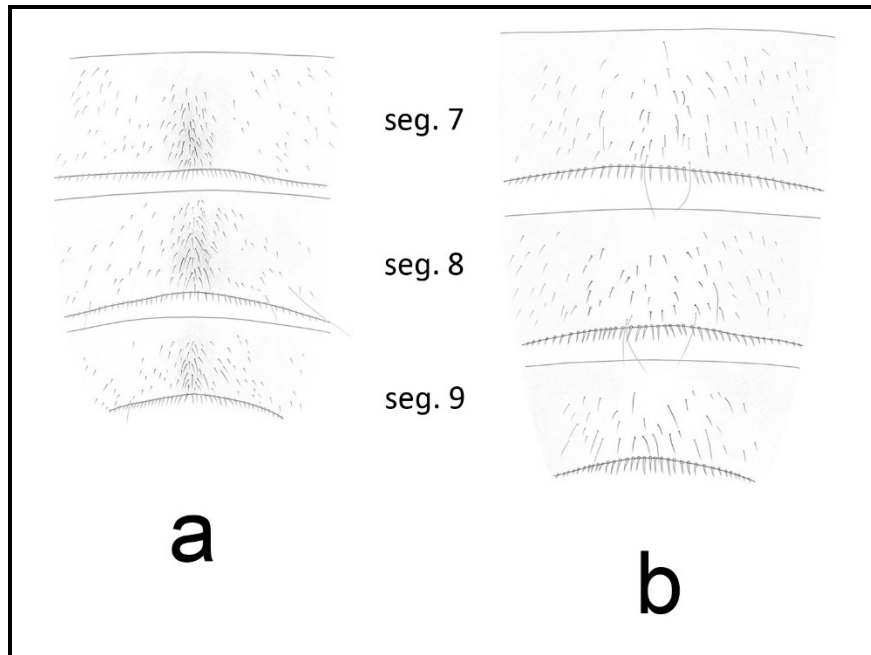


Figure 12.48. *Erythrodiplax*, abdominal segments 7–9, dorsal view: a) *E. berenice*; b) *E. umbrata*.

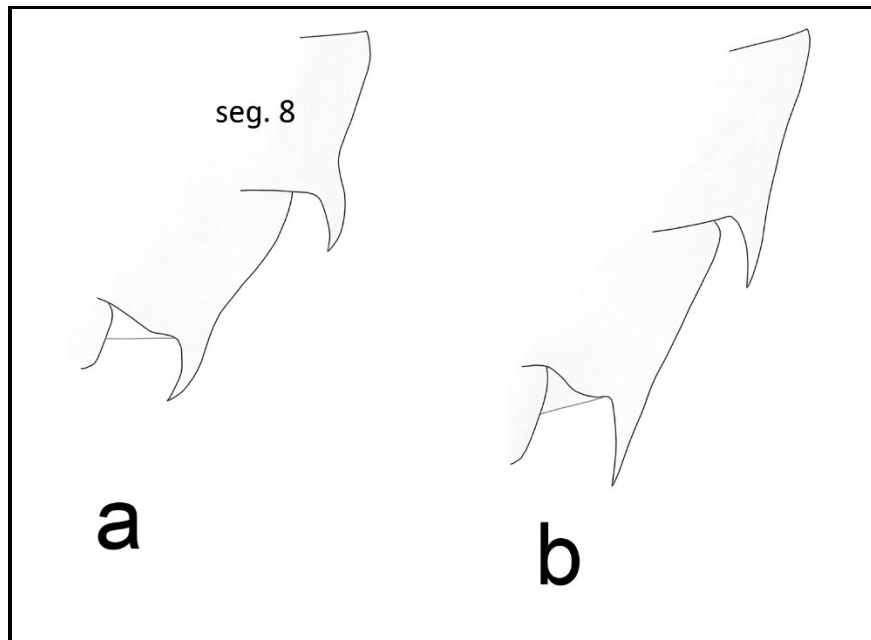


Figure 12.49. *Erythrodiplax*, abdominal segments 8 and 9, right side, dorsal view: a) *E. berenice*; b) *E. umbrata*. Setae omitted.

2. 7 palpal setae, 11–12 premental setae (each side); for F-0, head width 3.45–3.75 mm, prementum max width 2.5–2.6 mm, and epiproct length 0.65–0.85 mm ***minuscula***
- 2'. 10 or 11 palpal setae, 13–14 premental setae (each side); for F-0, head width 4.65–4.95 mm, prementum max width 3.4–3.8 mm, and epiproct length 1.20–1.35 mm ***umbrata***

Diagnostic Remarks:

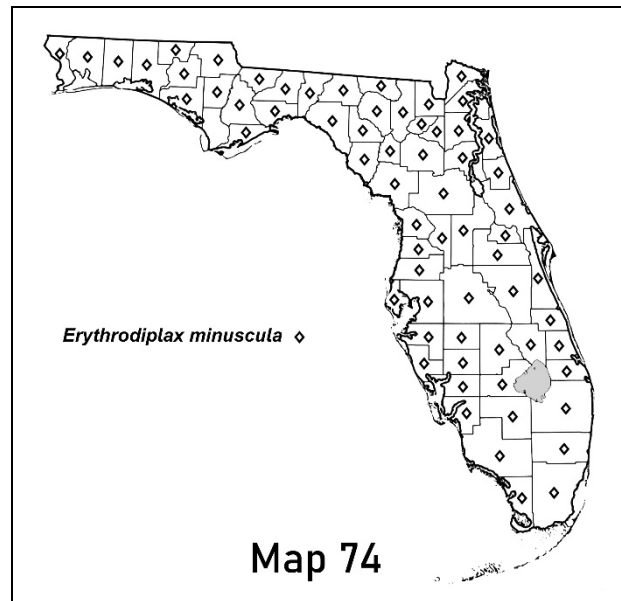
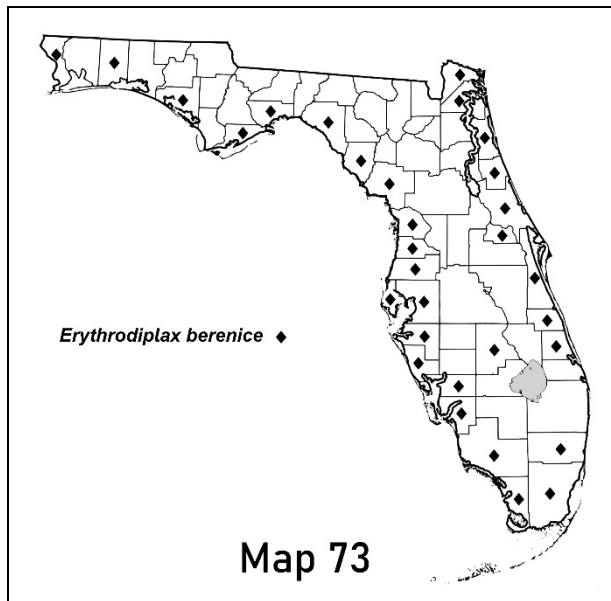
The number of palpal setae in *E. berenice* varies from 7 to 10, though most specimens have 8 or 9 per palp; the species is intermediate between *E. minuscula* and *E. umbrata* in this character. No other reliable morphological differences between the three species, other than those stated in the key, were found.

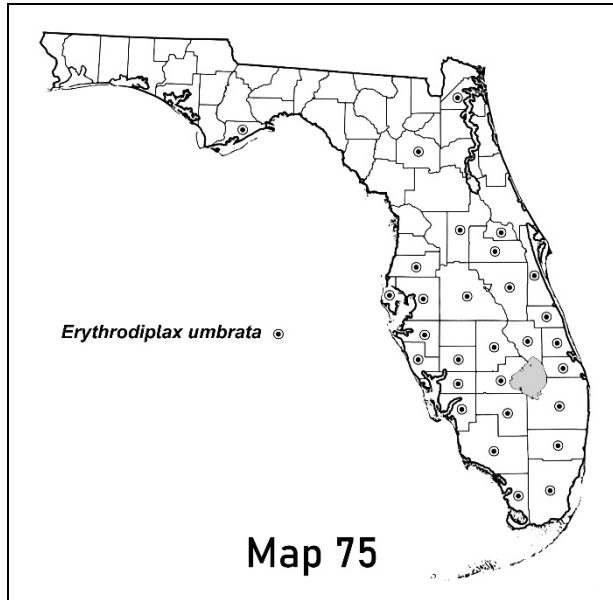
Habitat, Distribution, Life Cycle:

Erythrodiplax nymphs are lentic, the main habitats being vegetated ponds, marshes, and edges of lakes; one species, *E. berenice*, occurs in brackish water.

Erythrodiplax berenice and *E. minuscula* occur throughout the state (Maps 73 and 74). *Erythrodiplax umbrata* occurs throughout the peninsula; as yet there is only one county record in the panhandle (Map 75).

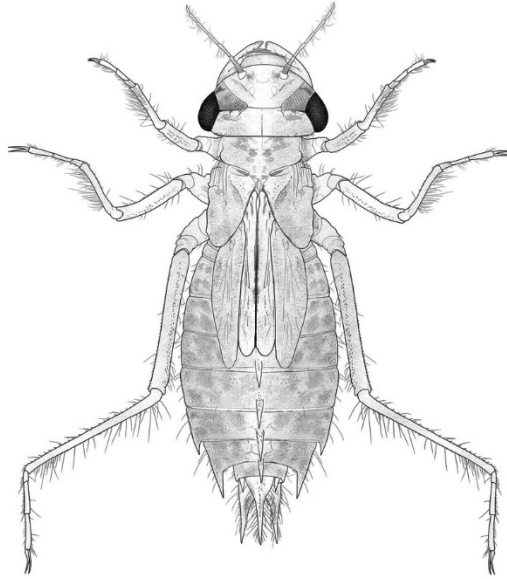
The flight season of all three species is throughout the year. Most *Erythrodiplax* populations are probably bivoltine.





Idiataphe

Elongate, tan, little color pattern; eyes slanting posteriorly; abdominal segments 3–10 with middorsal hooks; stout postero-lateral spines on segments 8 and 9; apex tapering to acute end



Idiataphe is a small Neotropical genus, one species of which, *I. cubensis*, is present in Florida.

Diagnosis:

Idiataphe nymphs are most similar to *Brachymesia* in habitus. In addition to the characters in couplet 8 of the generic key, the ligula of *Idiataphe* is convex with indistinct spiniform setae (Fig. 12.50a) compared to the straight sides on the ligula of *Brachymesia* that bear more prominent spiniform setae (Fig. 12.50b).

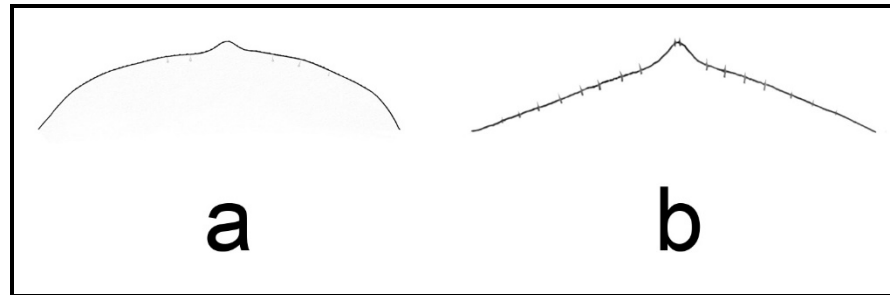


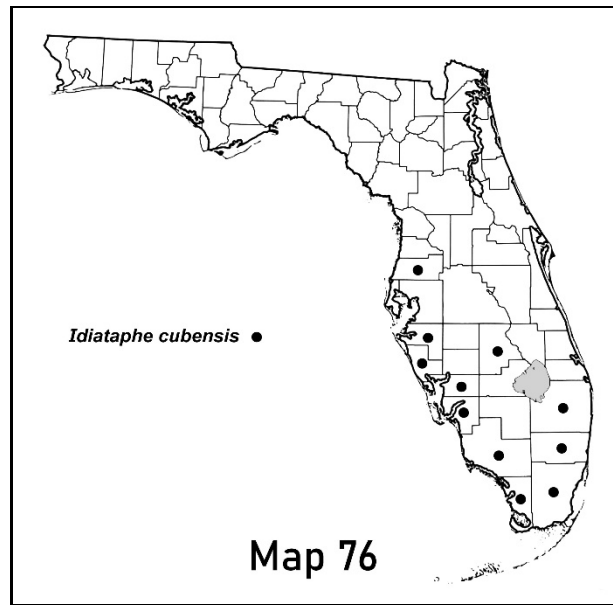
Figure 12.50. Libellulidae, ligula, ental view: a) *Idiataphe cubensis*; b) *Brachymesia grvida*.

Habitat, Distribution, Life Cycle:

Idiataphe nymphs are lentic, the main habitat being small lakes with sparse emergent vegetation; the species has been found in both fresh and brackish waters.

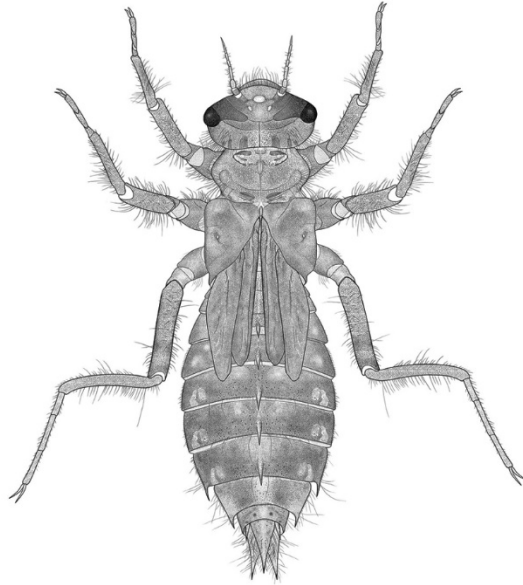
Idiataphe cubensis has been recorded only in the southern half of the peninsula (Map 76).

The flight season of *Idiataphe cubensis* is throughout the year. The species is probably univoltine, with egg-laying and emergence continuing throughout most of the year.



Ladona

Elongate, brown; eyes small, anteriorly positioned; abdominal segments 4–8 with sharp middorsal hooks; sharp posterolateral spines on segments 8 and 9; apex acute



Ladona is a North American genus of three species, one of which, *L. deplanata*, occurs in Florida.

Diagnosis:

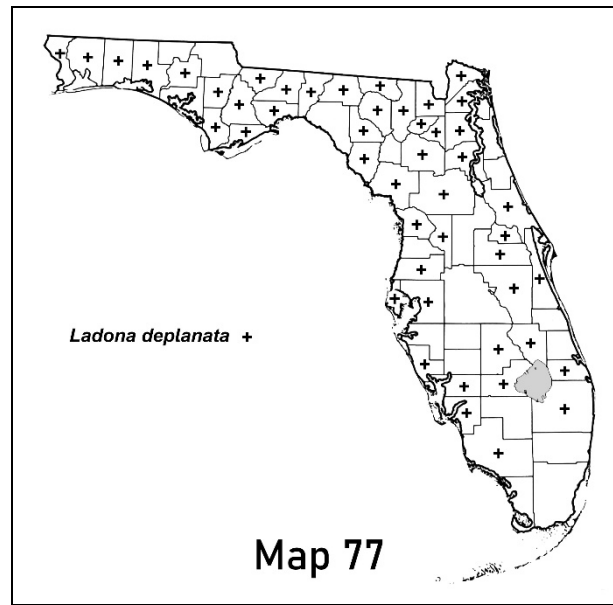
Ladona nymphs are most similar to *Plathemis* in habitus but have middorsal hooks on abdominal segments 4–8 compared to 3–6 in *Plathemis*. In addition, *Ladona* has 3 very fine primary premental setae compared to 6 in the *Plathemis* species that occurs in Florida. *Ladona* usually has 5 or 6 palpal setae per side whereas *Plathemis* has 9–11. *Orthemis* nymphs are similar in habitus but lack middorsal hooks altogether. *Ladona* has been regarded as a subgenus and synonym of *Libellula* in many references but was shown to be distinct by Artiss et al. (2001).

Habitat, Distribution, Life Cycle:

Ladona nymphs are both lotic and lentic; they are common inhabitants of muddy ponds, small lakes, swamps, and edges of slow streams.

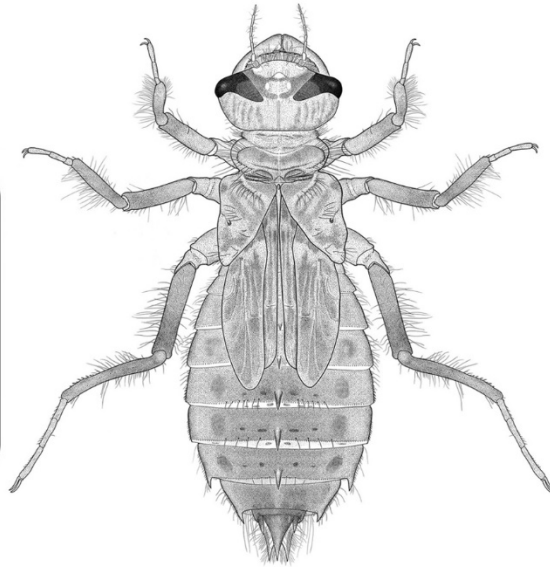
Ladona deplanata occurs throughout the state except it has been recorded in only one of the four southernmost counties (Map 76).

The flight season of *Ladona deplanata* is January 4 to May 6 for most of the state, although Paulson (1966) reported it flying in southern Florida from November 25 through most of the winter. *Ladona* is semivoltine according to Benke and Benke (1975).



Libellula

Elongate-oval, brown; eyes small, anteriorly positioned; middorsal hooks usually on abdominal segments 4–8; posterolateral spines on segments 8 and 9



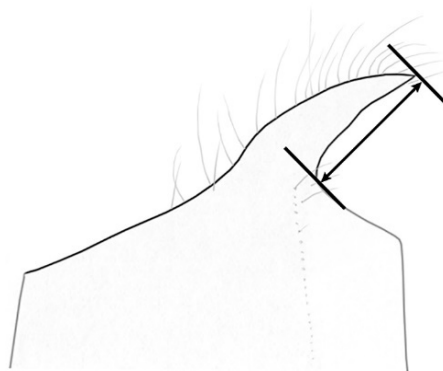
Libellula is a relatively large genus distributed worldwide with ten species recorded in Florida.

Generic Notes:

Libellula nymphs are most similar to *Ladona*, *Orthemis* and *Plathemis* in general habitus and being highly setose but the ligula has several very small crenulations between adjacent setae (Fig. 12.3a) compared to a single large crenation between adjacent setae in the other three genera (Fig. 12.3b). All species of *Libellula* that occur in Florida have middorsal hooks on some abdominal segments, usually on segments 3 or 4 to segments 7 or 8. The species of *Libellula* that lack middorsal hooks are distributed in western North America.

Only F-0 nymphs can be reliably identified to species in this mostly difficult genus. Instars F-1 and F-2 usually have the same complement of palpal setae as the last instar and therefore can be determined to species group, placing them either in the group with 5 palpal setae (*axilena*, *auripennis*, *incesta*, *jesseana*, *needhami*, *vibrans*) or the group with 7–10 palpal setae (*flavida*, *luctuosa*, *pulchella*, *semifasciata*). It is inadvisable to try to determine instars younger than F-2 to species group.

Middorsal hooks are measured in lateral view, from base to apex along the ventral margin, as shown here:



Key to *Libellula* Species (F-0)

1. 7–10 palpal setae (each side), rarely 6 (Fig. 12.51a); ratio of prementum length:max width usually ≤ 1.0 (exception *L. semifasciata*)2
- 1'. 5 palpal setae (Fig. 12.51b); ratio of prementum length:max width usually ≥ 1.0 (exception *L. incesta*)5

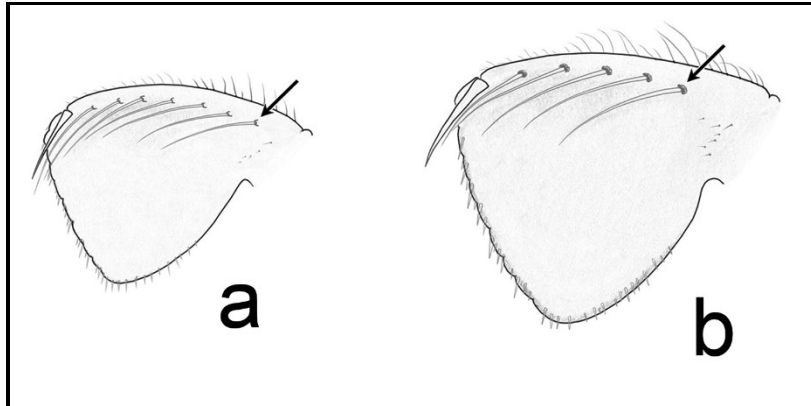


Figure 12.51. *Libellula*, right palpal lobe, ental view: a) *L. luctuosa*; b) *L. auripennis*. Arrow indicates a palpal seta.

2. Abdominal segment 8 usually without a middorsal hook (Fig. 12.52a), if present < 0.25 mm long; segments 5–8 with numerous long, dark brown to black setae, especially at middorsum and posterior margin (Fig. 12.52a) ***pulchella***
- 2'. Abdominal segment 8 with a prominent middorsal hook, > 0.25 mm long (Fig. 12.52b); segments 5–8 with few long, pale to light brown setae (Fig. 12.52b)3

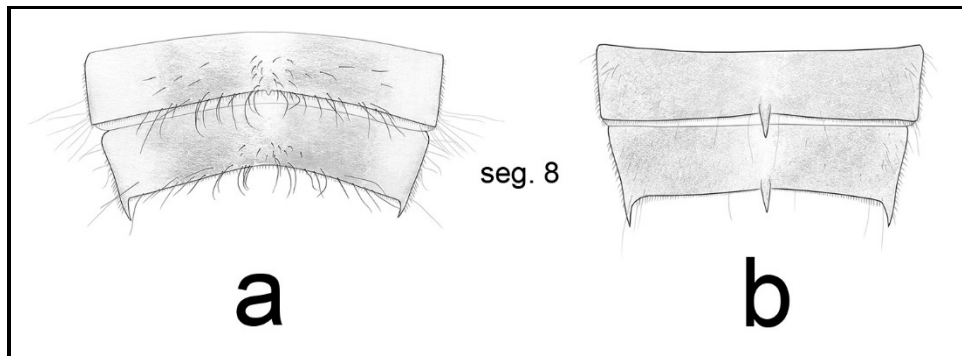


Figure 12.52. *Libellula*, abdominal segments 7 and 8, dorsal view: a) *L. pulchella*, b) *L. semifasciata*.

3. Femora with banding indistinct (Fig. 12.53a); ratio of prementum length:max width 1.03–1.05, and ratio of prementum length:basal width 2.80–3.00; total number of premental setae 27–29 *semifasciata*
- 3'. Femora with distinct basal and preapical brown bands (Fig. 12.53b); ratio of prementum length:max width 0.90–0.99, and ratio of prementum length:basal width 2.53–2.75; total number of premental setae 19–274

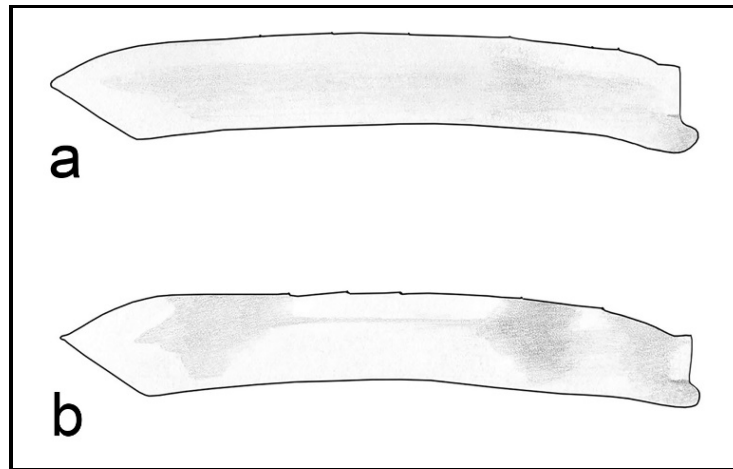


Figure 12.53. *Libellula*, metathoracic femur: a) *L. semifasciata*; b) *L. luctuosa*. Setae omitted.

4. 8 palpal setae (each side), rarely 7 or 9; total number of premental setae 22–28; ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length 0.51–0.66..... *flavida*
- 4'. 7 palpal setae (each side), rarely 8; total number of premental setae 19–20; ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length 0.43–0.46.....*luctuosa*
5. Total length of F-0 usually > 25 mm, head width > 6.0 mm, and abdomen width > 8.0 mm; majority of palpal crenations with 5 or 6 spiniform setae (Fig. 12.54a)..... *vibrans*
- 5'. Total length of F-0 usually < 25 mm, head width < 6.0 mm, and abdomen width < 8.0 mm; majority of palpal crenations usually with 4 spiniform setae (Fig. 12.54b) although some crenations with 5 setae6



Figure 12.54. *Libellula*, two middle palpal crenations, ectal view: a) *L. vibrans*; b) *L. incesta*. Scale bar = 0.5 mm.

6. Abdominal segment 3 with a distinct middorsal hook, best seen in lateral view (Fig. 12.55a); segment 7 middorsal hook length 0.58–0.79 mm, segment 8 middorsal hook length 0.62–0.81 mm7
- 6'. Abdominal segment 3 without a distinct middorsal hook, some specimens with a very small point (Fig. 12.55b); segment 7 middorsal hook length 0.45–0.61 mm, segment 8 middorsal hook length 0.40–0.63 mm8



Figure 12.55. *Libellula*, abdominal segments 3 and 4, lateral view: a) *L. axilena*, b) *L. auripennis*.

7. Abdominal segments 1–7 cream-colored on venter, contrasting sharply with brown segments 8–10; ratio of prementum length:basal width 2.67–2.89; majority of middle palpal crenations with 5 spiniiform setae..... ***axilena***
- 7'. Abdominal segments 1–7 light orange-tan on venter, blending gradually with slightly darker segments 8–10; ratio of prementum length:basal width 2.55–2.63; majority of middle palpal crenations with 4 spiniiform setae ***needhami***

8. Abdominal dorsum mostly brown, segments 6–9 usually as dark medially as sublaterally (Fig. 12.56a); prementum length 4.15–4.55 mm, basal width 1.45–1.70 mm*.....*incesta*
- 8'. Abdominal dorsum relatively even tan to orange brown, slightly paler medially but on segments 8 and 9 distinctly darker sublaterally (Fig. 12.56b); prementum length 4.75–5.30 mm, basal width 1.75–2.05 mm.....9

*see diagnostic notes below on *L. cyanea*.

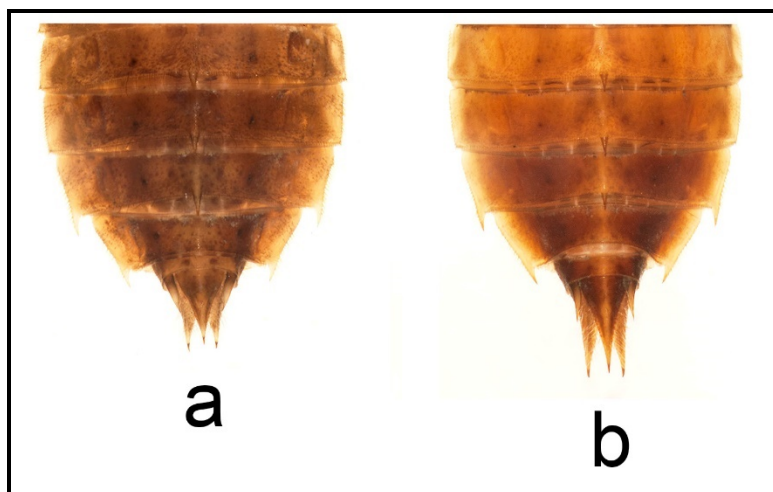


Figure 12.56. *Libellula*, abdominal segments 6–9, dorsal view: a) *L. incesta*, b) *L. auripennis*

9. Dorsum of abdominal segments 5–9 mostly uniform brown, not obviously mottled; ratio of abdomen length:width 1.88–2.24.....*auripennis*
- 9'. Dorsum of abdominal segments 5–9 with dark spots, appearing mottled; ratio of abdomen length:width 2.12–2.29*jesseana*

Diagnostic Remarks:

Very few differences exist other than those presented in the key; for further diagnostic notes, see Tennessen (2019a).

It is extremely rare to find a specimen with more than five palpal setae in any of the six species that key out in couplet 1' leading to couplet 5. However, it is possible that another species of *Libellula* (*L. cyanea* Fabricius) occurs in northern Florida (it occurs in the southernmost counties of Alabama and Georgia). *Libellula cyanea* often has 6 palpal setae per side (sometimes 5 on one side and 6 on the other), the dorsum of the abdomen is uniformly brown, and the prementum is relatively short (3.90–4.35 mm). Therefore, it will key out to couplet 8 with *L. incesta*. Although *L. cyanea* is smaller on average, most size measurements overlap between the two species; the only reliable differences found thus far include epiproct length (1.80–1.95 mm in *L. cyanea*, 1.95–2.15 mm in *L. incesta*) and abdominal segment 3 width (< 6.0 mm in *L. cyanea* and > 6.0 mm in *L. incesta*).

Libellula is an important group in Florida wetlands surveys because there are numerous species, and they are relatively common in many types of habitats.

Habitat, Distribution, Life Cycle:

Libellula nymphs are predominantly lentic but are also found marginally in some lotic habitats. As a group, they occur in a wide variety of waters including mud- or sand-bottomed ponds and lakes, marshes, swamps, ditches, small seepage streams and pooled areas of small to mid-sized slow streams. *Libellula auripennis*, *L. axilena*, *L. incesta* and *L. needhami* are lake, pond, and marsh dwellers whereas *L. vibrans* inhabits swamps, including slow-flowing dark streams. *Libellula flavida* inhabits shallow, mucky, partly shaded seepage streams, whereas *L. luctuosa* and *L. pulchella* are mainly small lake and pond inhabitants; the latter two species are northern species that are rarely collected in Florida. *Libellula jesseana* is endemic to Florida, requiring open sandy lakes with little marginal aquatic vegetation in the panhandle and northeastern part of the state. *Libellula semifasciata* occupies shallow ponds and seepage flow in partly forested areas.

Five species of *Libellula* occur throughout or nearly throughout the state, including *L. auripennis* (Map 78), *L. axilena* (Map 79), *L. incesta* (Map 81), *L. needhami* (Map 83) and *L. vibrans* (Map 86); in extreme southern Florida, *L. needhami* is much more common than its congener, *L. auripennis*. *Libellula flavida* (Map 80), *L. luctuosa* (Map 82) and *L. pulchella* (Map 84) are restricted to northern Florida. *Libellula jesseana* (Map 82) is restricted to parts of the panhandle and northeastern Florida whereas *L. semifasciata* (Map 85) occurs throughout the northern half of the state. If *L. cyanea* occurs in Florida, it will most likely be found in small ponds or shaded slow muddy streams, similar to habitats in which *L. incesta* occurs.

Flight seasons for the ten *Libellula* species are:

auripennis February 23 to November 27

axilena March 25 to October 19

flavida April 4 to September 26

incesta March 21 to November 7

luctuosa May 19 (in Georgia, April to October)

jesseana April 21 to September 12

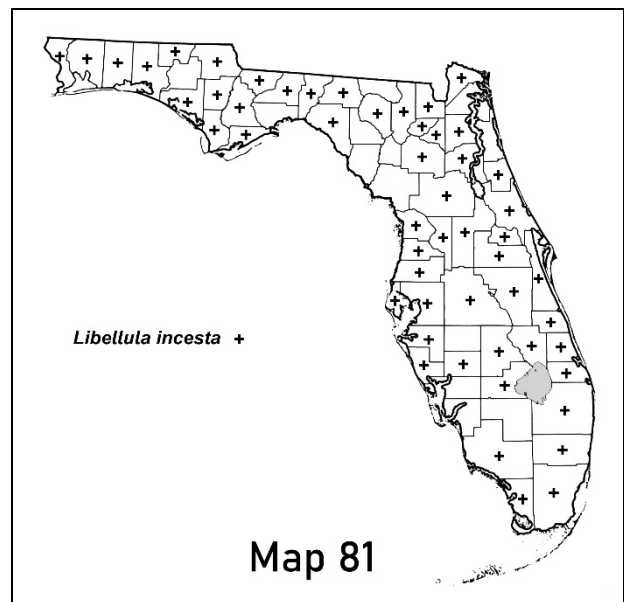
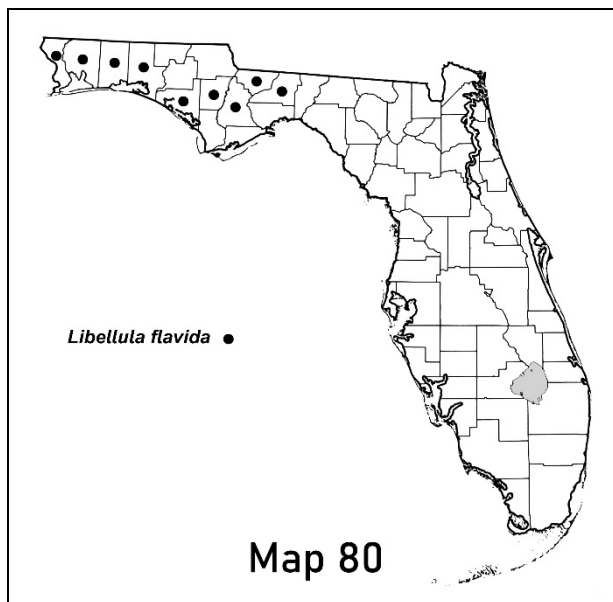
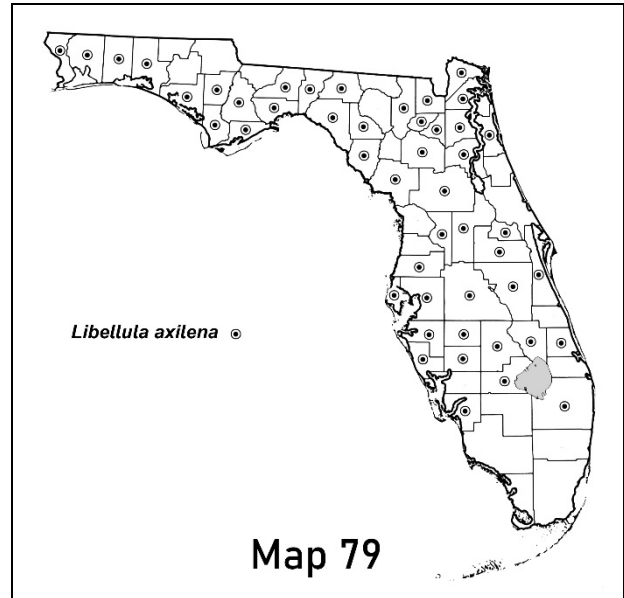
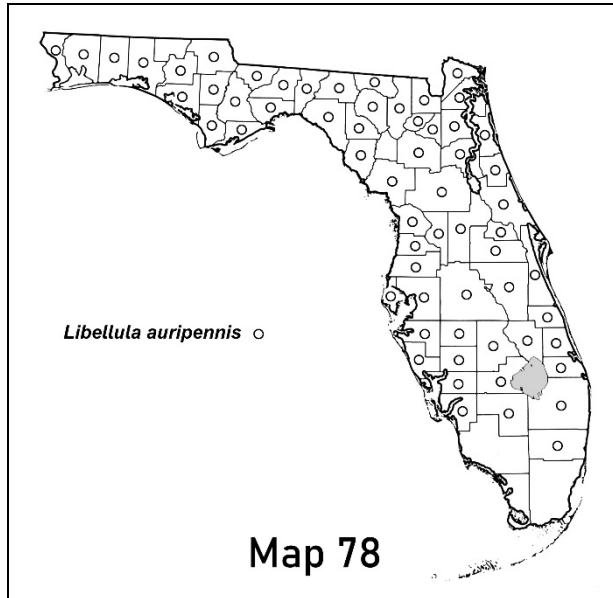
needhami February 16 to November 1

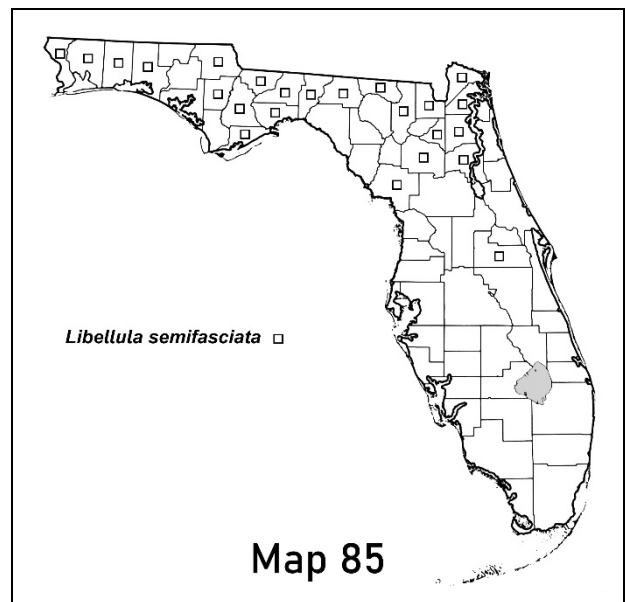
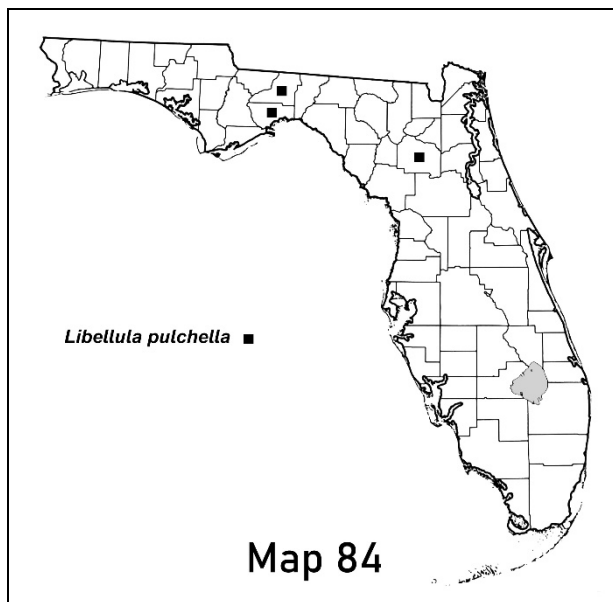
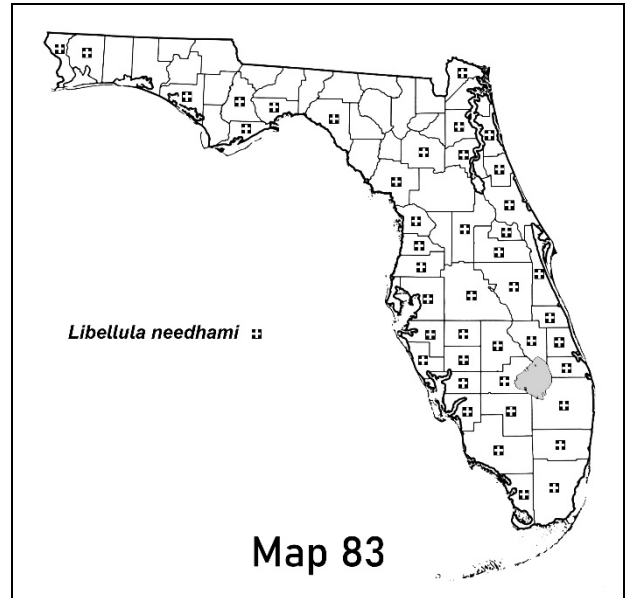
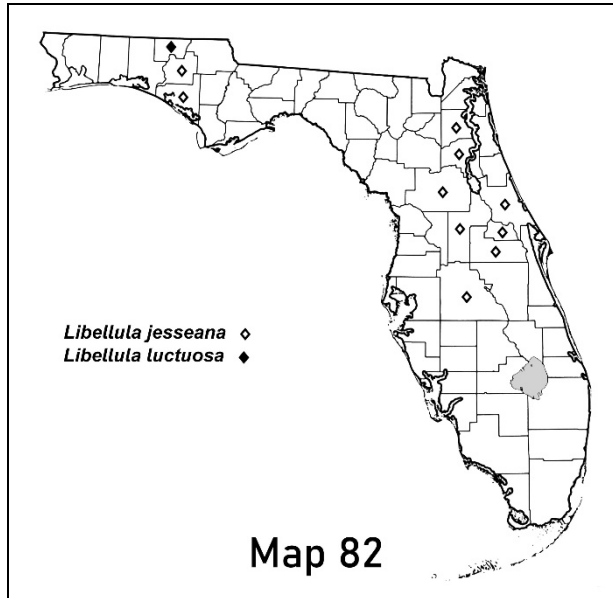
pulchella recorded only in September and October in Florida but it probably flies earlier

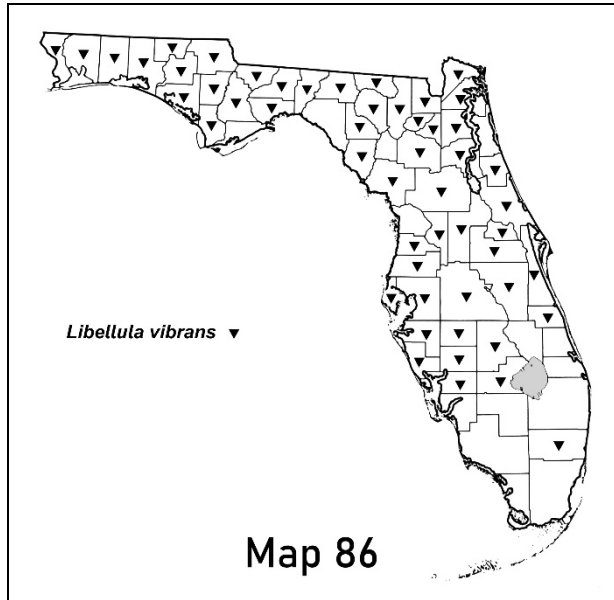
semifasciata February 20 to September 19

vibrans March 24 to October 11

Based on field samples and rearing, most *Libellula* species are univoltine.

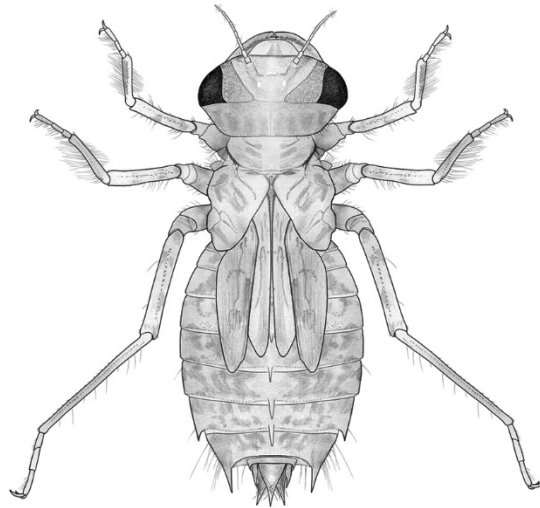






Macrodiplax

Elongate-oval, tan; eyes large, sloping posteriorly; middorsal hooks on abdominal segments 2–8 or 3–8; posterolateral spines on segments 8 and 9, long on seg. 9



Macrodiplax comprises only two species, one in the New World and one in the Old World; the New World species, *M. balteata*, occurs in Florida.

Diagnosis:

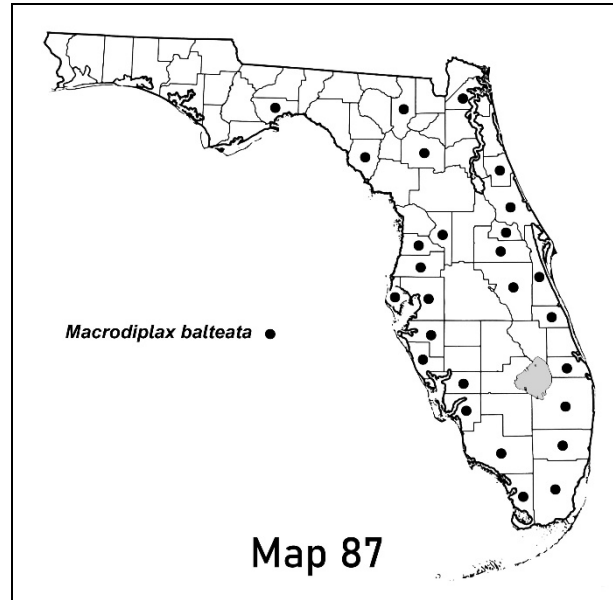
Macrodiplax nymphs are most similar to *Miathyria* and *Tauriphila* in habitus and the long, sharp middorsal hook on abdominal segment 8 that reaches posteriorly to segment 10. The shape of the epiproct separates these three genera, as shown in couplets 13 and 14 of the generic key. The epiproct of *Macrodiplax* has a length:basal width ratio > 1.6 compared to < 1.2 in *Miathyria* and *Tauriphila*. Also, the number of palpal setae is greater, 11–13 (very rarely 10) versus 6–9.

Habitat, Distribution, Life Cycle:

Macrodiplax nymphs are lentic, the habitat usually being open freshwater or brackish marl lakes with emergent aquatic vegetation.

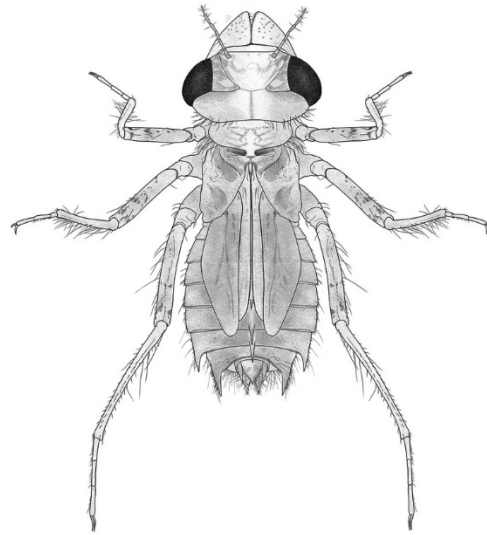
Macrodiplax balteata occurs throughout the state except it has not been recorded west of the Apalachicola River (Map 87).

The flight season of *Macrodiplax balteata* in southern Florida spans the entire year, although further north in the state it may be more restricted. *Macrodiplax* is probably univoltine.



Miathyria

Elongate-oval, tan to brown; eyes large, sloping posteriorly; midorsal hooks on abdominal segments 3–8 or 4–8; prominent posterolateral spines on segments 8 and 9



Miathyria comprises two Neotropical species; only *M. marcella* has been recorded in Florida.

Diagnosis:

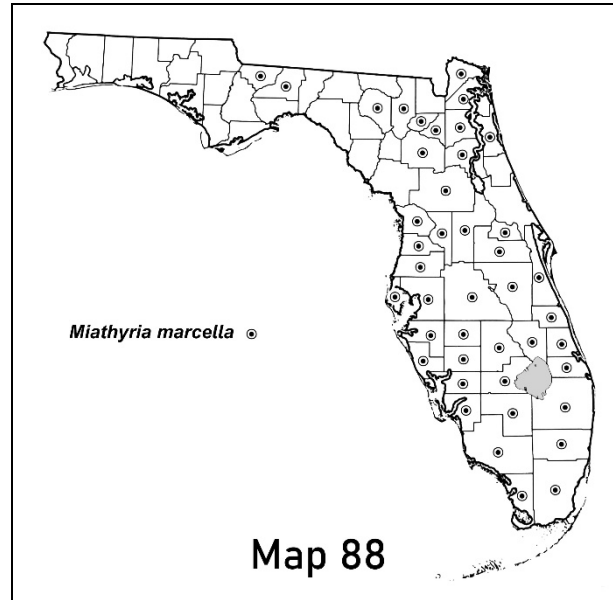
Miathyria nymphs are most likely to be confused with *Tauriphila*. However, the epiproct is longer than its basal width in *Miathyria* (less than its basal width in *Tauriphila*) and over half as long as the paraprocts (less than half as long in *Tauriphila*); compare Figs. 12.18b and 12.18c. The number of palpal setae is 6 or 7 (each side) in *Miathyria* versus 8 or 9 in *Tauriphila*.

Habitat, Distribution, Life Cycle:

Miathyria nymphs are lentic, habitats ranging from open ponds to ditches and drainage canals with abundant floating aquatic vegetation; they hide in the roots of water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*).

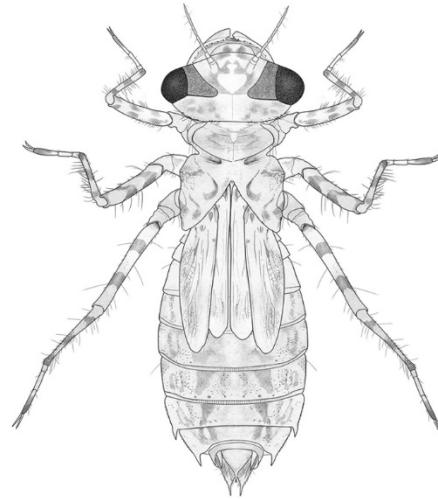
Miathyria marcella occurs throughout the state except it has not been recorded west of the Apalachicola River (Map 88), a range similar to that of *Macrodiplax balteata*.

The flight season of *Miathyria marcella* in southern Florida spans the entire year, although further north in the state it may be more restricted. *Miathyria* is either bivoltine or multivoltine, depending on latitude.



Micrathyria

Elongate-oval, light brown, contrasting pattern; eyes large, lateral; no middorsal hooks on abdomen; small, sharp posterolateral spines on segments 8 and 9



Micrathyria is a Neotropical genus of about 46 species, only two of which reach southern Florida.

Generic Notes:

Micrathyria nymphs are similar to *Pachydiplax*. In addition to the characters in couplet 20, the posterolateral spines on abdominal segment 9 of F-0 *Micrathyria* are shorter (0.45–0.75 mm) than in F-0 *Pachydiplax* (0.95–1.25 mm), and the paraprocts are more attenuate (Fig. 12.57).

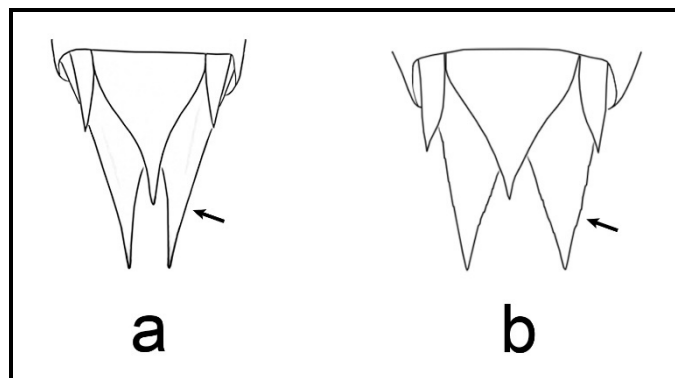


Figure 12.57. Libellulidae, anal appendages, dorsal view: a) *Micrathyria*; b) *Pachydiplax*. Arrow indicates right paraproct.

Key to *Micrathyria* Species

1. Posterolateral spines on abdominal segment 9 reaching level of tips of cerci (Fig. 12.58a); 10 palpal setae; ratio of antenna length:middorsal head length 1.2–1.3*aequalis*
- 1'. Posterolateral spines on abdominal segment 9 not reaching level of tips of cerci (Fig. 12.58b); 11 palpal setae; ratio of antenna length:middorsal head length 1.0–1.2*didyma*

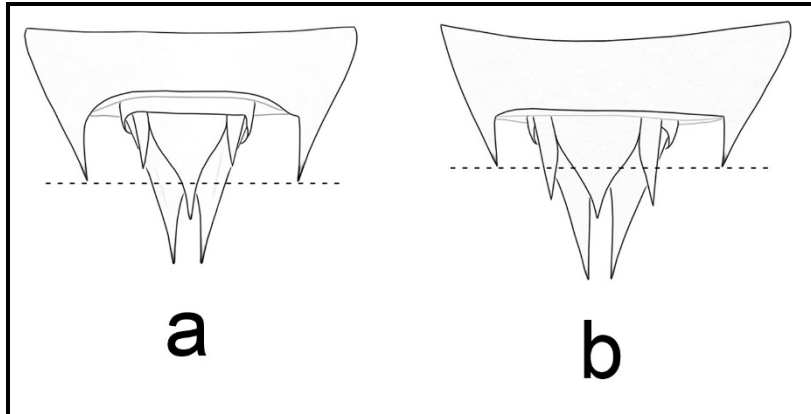


Figure 12.58. *Micrathyria*, posterolateral spines of abdominal segment 9 in relation to cerci, dorsal view: a) *M. aequalis*; b) *M. didyma*.

Diagnostic Remarks:

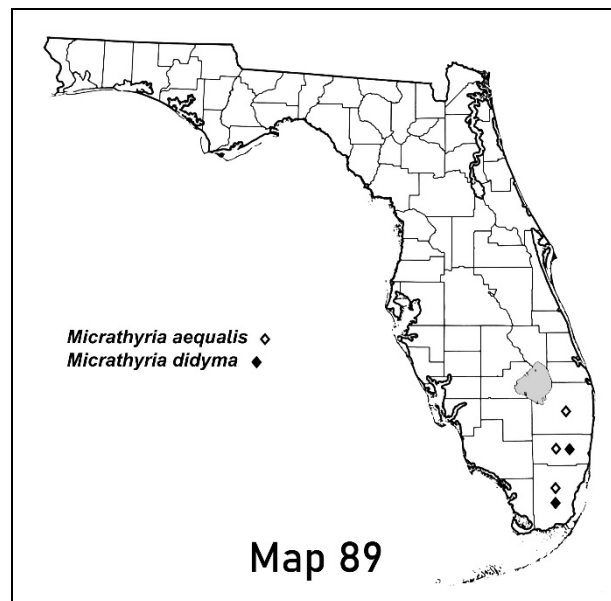
In addition to the key characters, the prementum and palpi of *M. aequalis* usually have small dark spots (sometimes faint or indiscernible, especially on exuviae) that are lacking in *M. didyma*.

Habitat, Distribution, Life Cycle:

Micrathyria nymphs are lentic, inhabiting open to shaded ponds, sloughs, and marshes with aquatic vegetation.

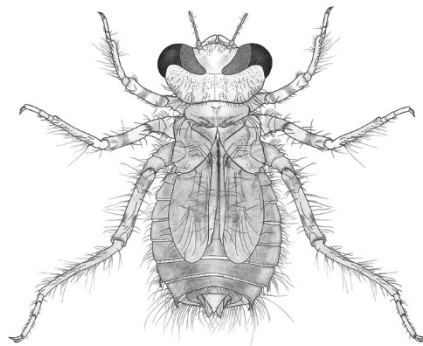
Micrathyria aequalis and *M. didyma* have been recorded in Florida only south of Lake Okeechobee (Map 89).

The flight season of both species of *Micrathyria* in southern Florida is year-long, although further north in the state it may be more restricted. *Micrathyria* is probably bivoltine.



Nannothemis

Very small, oval, green to brown; eyes round, bulging; no middorsal hooks on abdomen; small posterolateral spines on segments 8 and 9; apex truncate



Nannothemis is a monotypic North American endemic; the only species, *N. bella*, occurs in northern Florida.

Diagnosis:

Nannothemis is one of the smallest dragonflies in the world (F-0 total length 6.8–9.2 mm, head width 2.85–3.10 mm). The nymphs somewhat resemble *Erythemis*, as the body is compact.

Nannothemis has a small posterolateral spine on abdominal segment 8 which *Erythemis* lacks.

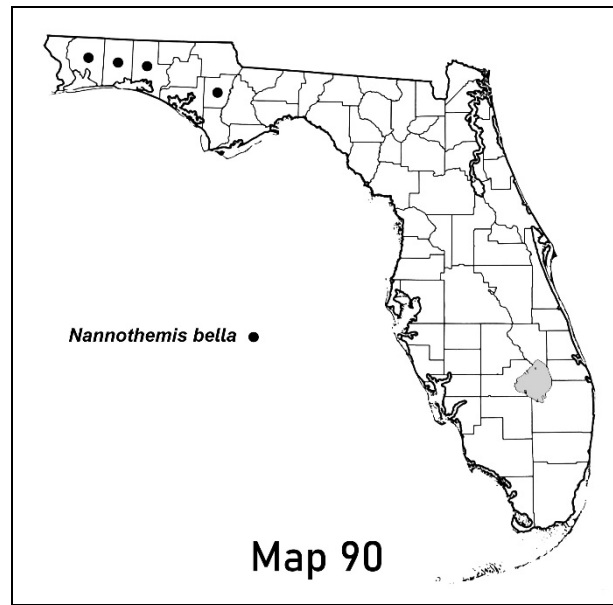
Nannothemis, full grown, is smaller than all *Erythemis* species. The only other species of Florida Libellulidae that approaches *Nannothemis bella* in size is *Erythrodiplax minuscula* (total length 9.2–10.7 mm, head width 3.45–3.75 mm).

Habitat, Distribution, Life Cycle:

Nannothemis nymphs inhabit shallow seeps and edges of bogs, typically hiding in small pockets of acidic water with *Sphagnum* moss.

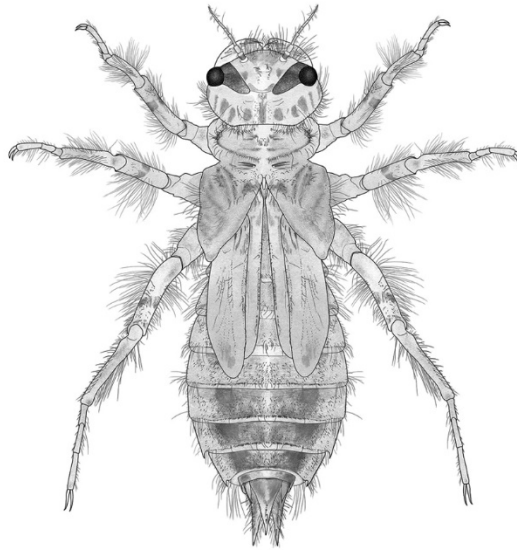
Nannothemis bella has been found in Florida only in the panhandle (Map 90).

The flight season of *Nannothemis bella* in Florida is from May 14 to July 29. The species is probably univoltine.



Orthemis

Elongate-oval, brown; eyes small, anteriorly positioned; no middorsal hooks on abdomen; small posterolateral spines on segments 8 and 9; apex pointed



Orthemis is a large Neotropical genus with two species in Florida; the identity of one of the species is yet to be resolved.

Generic Notes:

Orthemis is similar to *Ladona* and *Plathemis* in habitus. Both of the latter genera possess middorsal hooks on some of the middle abdominal segments, but *Orthemis* lacks middorsal hooks altogether. *Orthemis* also resembles *Libellula*, but all species of *Libellula* in Florida possess middorsal hooks and the ligula has numerous small crenulations between adjacent spiniform setae.

Key to *Orthemis* Species

1. Usually 9 palpal setae (each side), sometimes 8; prementum length 3.50–3.75 mm, basal width 1.50–1.60 mm; ratio of max head width:abdomen width 0.61–0.66 *ferruginea*
- 1'. 8 palpal setae (each side); prementum length 3.75–4.15 mm, basal width 1.60–1.75 mm; ratio of max head width:abdomen width 0.67–0.69 *Orthemis* sp.

Diagnostic Remarks:

The taxonomy of *Orthemis* as based on adults is unsettled. Numerous recent publications show that experts differ in their opinions on several species distinctions. Some researchers have argued that the species in southern Florida and the Keys (males are red, not purple as are *O. ferruginea* males) is *Orthemis schmidt* Buchholz, a widespread South/Central American species, whereas others argue that it is an undescribed species. Until the status of this species is resolved, I have designated it “*Orthemis* sp.”

There are several historic descriptions of the supposed nymph of *O. ferruginea* (Needham 1904, Calvert 1928, Geijskes 1934); nomenclatural changes since those descriptions appeared cast doubt on the specific identification, and furthermore the descriptions are inadequate to accurately diagnose the species. The most recent description of *O. ferruginea* nymph was by Carillo-Lara and

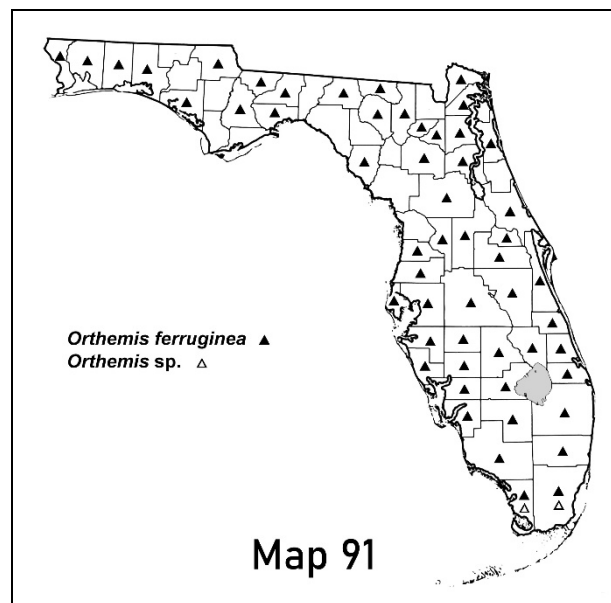
Novelo-Gutiérrez (2018), but it was not diagnosed with the species in southern Florida. In addition to the key characters, the distal palpal crenations have three setae per crenation in *O. ferruginea* compared to some with only two setae in *Orthemis* sp.

Habitat, Distribution, Life Cycle:

Orthemis nymphs inhabit mud-bottomed ponds and pools, also open marshes and ditches, and even muddy pools in trails and roads. They often occur where there is little or no bottom vegetation, and they can also exist in sizeable artificial containers.

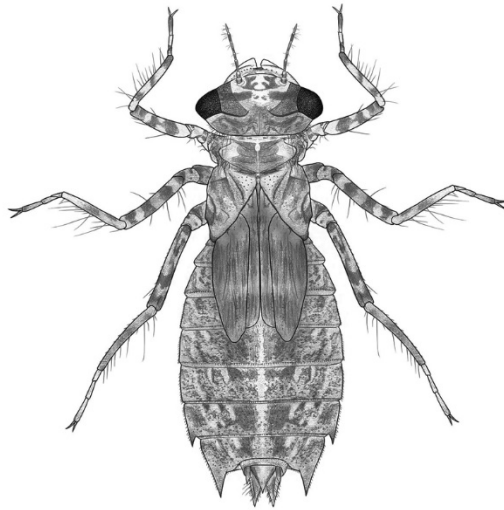
Orthemis ferruginea occurs throughout Florida (Map 91); the undetermined species has been found only in two southern Florida counties and the Keys (Map 91).

The flight season of *Orthemis* in Florida is throughout the year. The species are probably univoltine.



Pachydiplax

Elongate-oval, dark brown, patterned; eyes large; no middorsal hooks on abdomen; posterolateral spines on segments 8 and 9, long and stout on seg. 9; apex truncate



Pachydiplax is a monotypic North American endemic. The single species, *P. longipennis*, is extremely common in Florida.

Diagnosis:

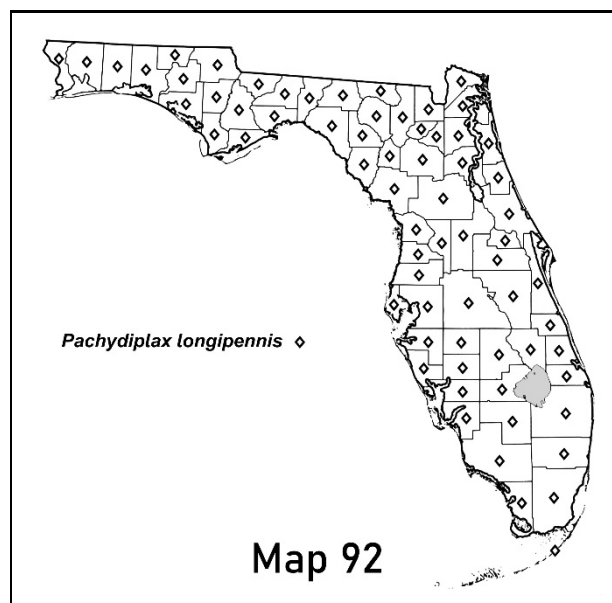
Pachydiplax is similar to *Micrathyria*. See diagnosis under that genus.

Habitat, Distribution, Life Cycle:

Pachydiplax nymphs inhabit lakes, ponds, marshes, swamps, reservoirs, canals, ditches, and slow portions of streams. It is one of the most abundant dragonflies where it occurs.

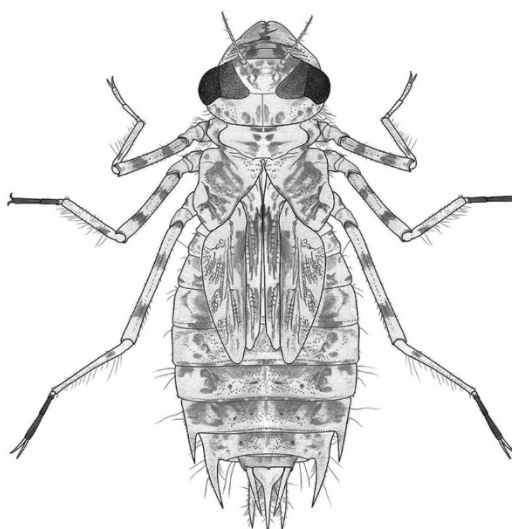
Pachydiplax longipennis occurs throughout the state (Map 92), south to Windley Key.

The flight season of *Pachydiplax longipennis* in Florida is throughout the year. The species is multivoltine as it can complete development (from egg to adult) in as little as 55 days.



Pantala

Elongate-oval, green with gray markings; eyes large; meso- and meta thoracic tarsi black; middorsal hooks on abdominal segments 2–4; long posterolateral spines on segments 8 and 9



Pantala comprises only two widely distributed species, both of which occur in Florida.

Generic Notes:

Pantala superficially resembles *Tramea*. However, *Pantala* has slender middorsal hooks on abdominal segments 2–4 (underneath the wing sheaths; in some specimens there is also a small middorsal hook on segment 5) whereas *Tramea* lacks middorsal hooks altogether. Note also that *Pantala* has a small middorsal projection on the posterior margin of abdominal segment 10. *Pantala* has a stout movable hook (slender in *Tramea*) and deep palpal crenations (shallow in *Tramea*). The posterolateral spine on abdominal segment 8 is shorter in *Pantala* than in *Tramea*, as the ratio of spine length:middorsal segment 8 length is 0.67–1.15 (1.57–2.25 in *Tramea*). In instars earlier than F-3, the middorsal hooks on segments 2–4 are vestigial to absent, but the tarsi are dark. *Pachydiplax* also resembles *Pantala* in having long posterolateral spines on segment 9, but middorsal hooks are entirely lacking and the meso- and meta-thoracic tarsi are mostly pale.

Previous keys to separate the two species used unreliable characters, as discussed by Landwer and Sites (2006).

Key to *Pantala* Species

1. Ratio of abdominal segment 9 posterolateral spine length:segment 9 midventral length 1.50–1.75; ratio of segment 8 posterolateral spine length:basal width of segment 9 posterolateral spine 1.90–2.60 (Fig. 12.59a); usually 13 or 14 palpal setae (each side), rarely 15...***flavescens***
- 1'. Ratio of abdominal segment 9 posterolateral spine length:segment 9 midventral length 1.09–1.32; ratio of segment 8 posterolateral spine length:basal width of segment 9 posterolateral spine 1.20–1.95 (Fig. 12.59b); usually 16 or more palpal setae (each side), sometimes 15
.....***hymenaea***

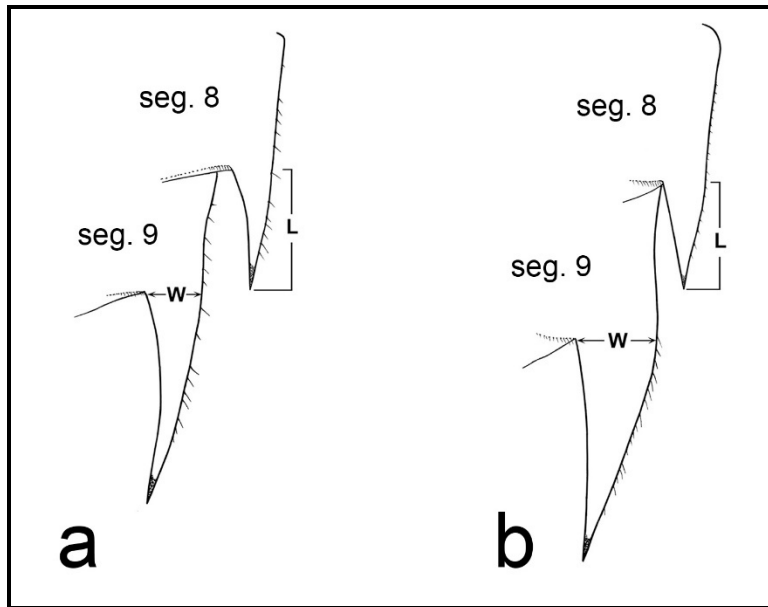


Figure 12.59. *Pantala*, posterolateral spines of abdominal segments 8 and 9, right side, dorsal view: a) *P. flavescens*; b) *P. hymenaea*. L = length, W = width.

Diagnostic Remarks:

There may be occasional specimens that cannot be determined based on the above key characters. Therefore, two additional differences are given here:

1. ratio of epiproct length:epiproct basal width 2.03–2.15 for *P. flavescens*, 1.64–1.91 for *P. hymenaea*.
2. head width 5.95–6.25 mm for *P. flavescens*, 6.25–6.75 mm for *P. hymenaea*.

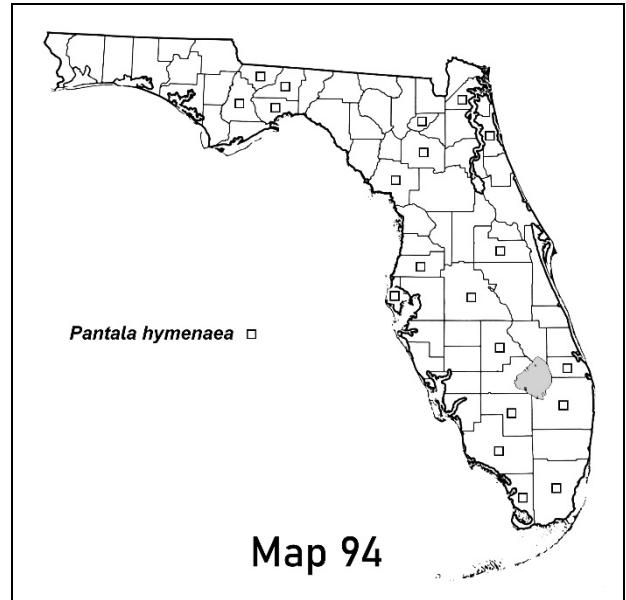
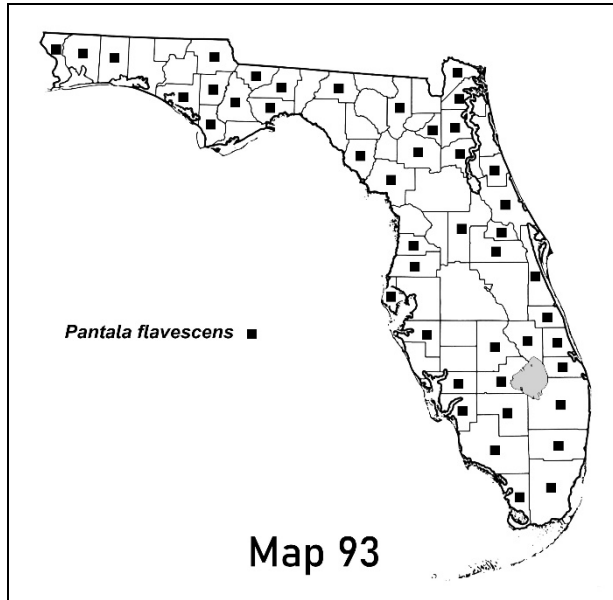
The combination of all these characters will separate most F-0s and F-1s of the two species; earlier instars should be determined as *Pantala* sp.

Habitat, Distribution, Life Cycle:

Pantala nymphs inhabit ponds, temporary rain pools, marshes, ditches, rice fields, and artificial tanks; the nymphs presumably cannot tolerate insectivorous fish.

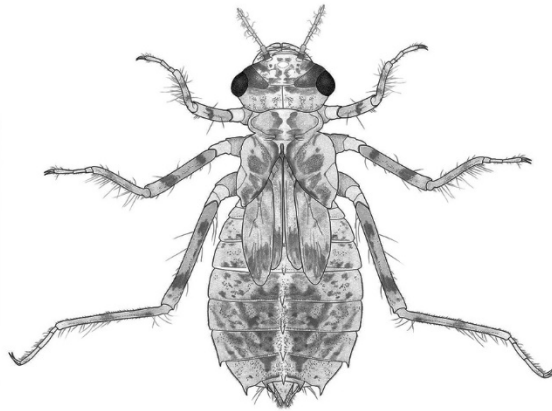
Both *Pantala* species occur throughout Florida (Maps 92 and 93), although *P. flavescens* appears to be more common.

The flight season of both *Pantala* species in Florida is throughout the year. The genus appears to be multivoltine as development from egg to adult can be completed in one to two months (Bick 1951). However, because *Pantala* adults migrate soon after emergence, Hawking and Ingram (1994) regarded them as univoltine.



Perithemis

Elongate-oval, dark brown; eyes lateral; femora patterned; abdomen with mid-dorsal hooks on segments 3–9; small posterolateral spines on segments 8 and 9



Perithemis is mainly a Neotropical genus; one species, *P. tenera*, occurs in Florida.

Diagnosis:

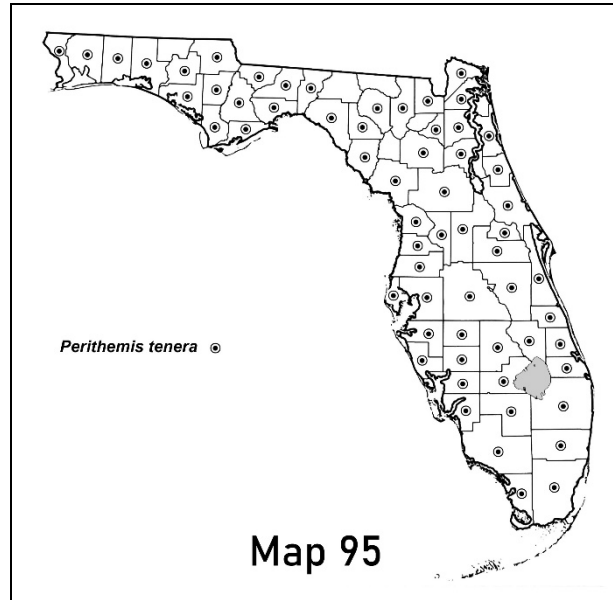
Perithemis is most similar to *Dythemis* in habitus, although the two genera may not be closely related. The number of palpal setae (per side) is usually 5 or 6 (rarely 7) in *Perithemis tenera* compared to 9 or 10 in *Dythemis velox*. F-0 *P. tenera* are much smaller than *D. velox* in total length (12.0–14.4 mm versus 15.5–17.2 mm) and head width (3.60–3.95 mm versus 5.05–5.30 mm). The subspecies *P. tenera seminole* Calvert of the Southeastern U.S. is considered an invalid taxon by some experts (Garrison et al. 2006); determining nymphs to *P. tenera* is recommended.

Habitat, Distribution, Life Cycle:

Perithemis nymphs inhabit permanent ponds, lakes, reservoirs, sloughs, and slow portions of streams. They coexist with insectivorous fish.

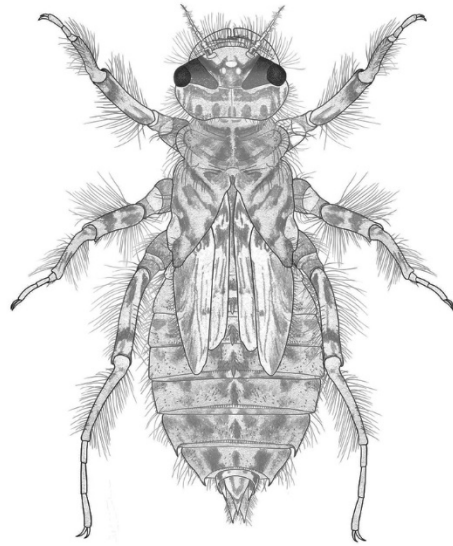
Perithemis tenera occurs throughout the state (Map 95).

The flight season of *Perithemis tenera* in Florida is throughout the year. The species is either bivoltine or univoltine according to Wissinger (1988).



Plathemis

Elongate-oval, dark brown; eyes small, anteriorly positioned; abdomen with mid-dorsal hooks on segments 3–6; small posterolateral spines on segments 8 and 9



Plathemis is a North American genus of only two species, one of which, ***P. lydia***, occurs in Florida.

Diagnosis:

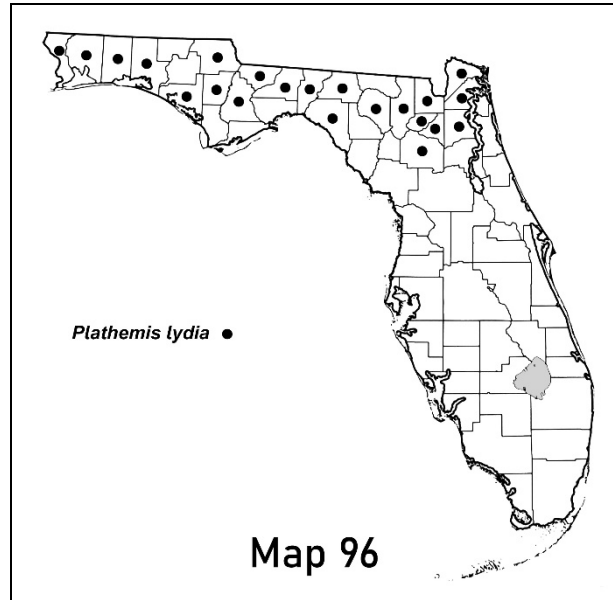
Plathemis is most similar to *Ladona*. In addition to the characters in couplet 4 of the generic key, there are 9–11 palpal setae per side in *P. lydia* versus only 5 or 6 (rarely 7) in *L. deplanata*. *Orthemis* also resembles *Plathemis* in habitus except it lacks middorsal hooks altogether.

Habitat, Distribution, Life Cycle:

Plathemis inhabits a wide variety of habitats including ponds, small lakes, ditches, and slow portions of streams. The nymphs can tolerate very low levels of dissolved oxygen.

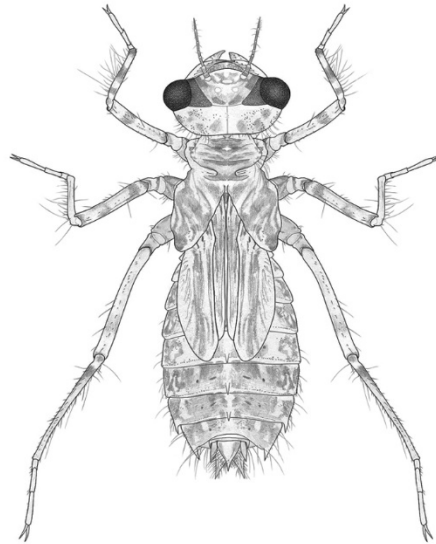
Plathemis lydia occurs in the northern portion of the state (Map 96).

The flight season of *Plathemis lydia* in Florida is from February 9 to November 16. The species is univoltine according to Wissinger (1988).



Sympetrum

Elongate-oval, tan to brown; eyes large; middorsal hooks on abdomen variable, present or absent; small posterolateral spines on segments 8 and 9



Sympetrum ranges worldwide, with most species at northern latitudes; three species occur in Florida.

Generic Notes:

In Florida, *Sympetrum* is most likely to be confused with *Celithemis* on one hand or with *Crocothemis* or *Erythrodiplax* on the other, depending on whether middorsal hooks are present or absent on some abdominal segments [Note: *Sympetrum* as a whole is highly variable in terms of middorsal hook development, both inter- and intra-specifically; in Florida, one species lacks middorsal hooks altogether while the other two species possess definite hooks on segments 4–8]. *Sympetrum* species in Florida that possess middorsal hooks can be distinguished from *Celithemis* by the presence of a prominent middorsal hook on segment 8; in *Celithemis*, middorsal hooks are present only on segments 4–7, sometimes only on 4–6. *Sympetrum* species that lack middorsal hooks can be distinguished from *Crocothemis* and *Erythrodiplax* by the lack of a cluster of erect stout setae on the prothorax (see Fig. 12.29 in the generic key).

Key to *Sympetrum* Species

1. Middorsal hooks absent on all abdominal segments; 13–15 palpal setae (each side); head width of F-0 > 5.0 mm, metathoracic femur length > 5.2 mm***corruptum***
- 1'. Middorsal hooks present on abdominal segments 4–8; 8–10 palpal setae (each side); head width and metathoracic femur length of F-0 < 5.0 mm2
2. Ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length 0.61–0.81 (Fig. 12.60a); ratio of abdominal segment 8 posterolateral spine length:segment 8 middorsal length 0.31–0.37***ambiguum***

- 2'. Ratio of abdominal segment 9 posterolateral spine length:segment 9 middorsal length 1.35–1.75 (Fig. 12.60b); ratio of abdominal segment 8 posterolateral spine length:segment 8 middorsal length 0.66–0.82..... *vicinum*

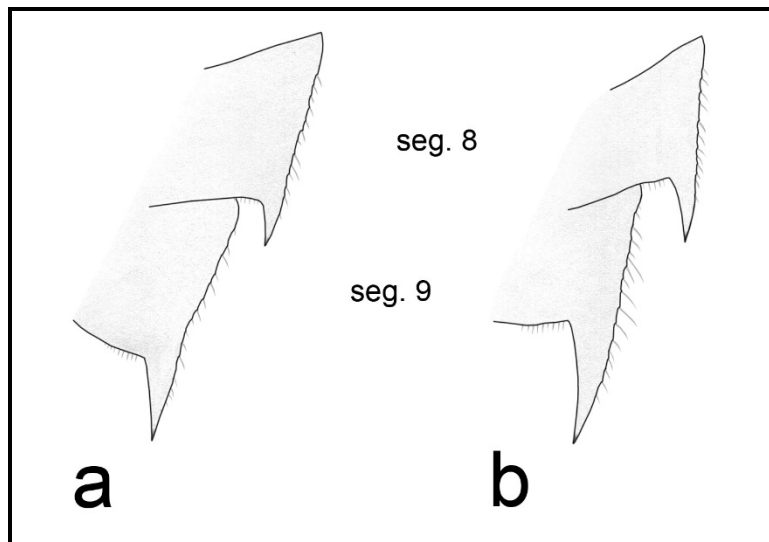


Figure 12.60. *Sympetrum*, posterolateral spines of abdominal segments 8 and 9, dorsal view: a) *S. ambiguum*; b) *S. vicinum*.

Diagnostic Remarks:

The most reliable differences between *S. ambiguum* and *S. vicinum* involve the longer posterolateral spines of *S. vicinum*. Absolute lengths of segment 9 spines (for F-0) that I obtained were 0.67–1.10 mm for *S. vicinum* versus 0.43–0.57 mm for *S. ambiguum*, and of segment 8 spines 0.40–0.59 mm for *S. vicinum* and 0.24–0.32 mm for *S. ambiguum*. I calculated ratios comparing the spine lengths to the respective segment lengths, as expressed in the key to species, so that instars earlier than F-0 might be identified. Another difference based on spine dimensions is segment 9 spine length:basal width — the ratio for *S. vicinum* was 2.68–2.94 compared to 1.79–2.28 for *S. ambiguum*.

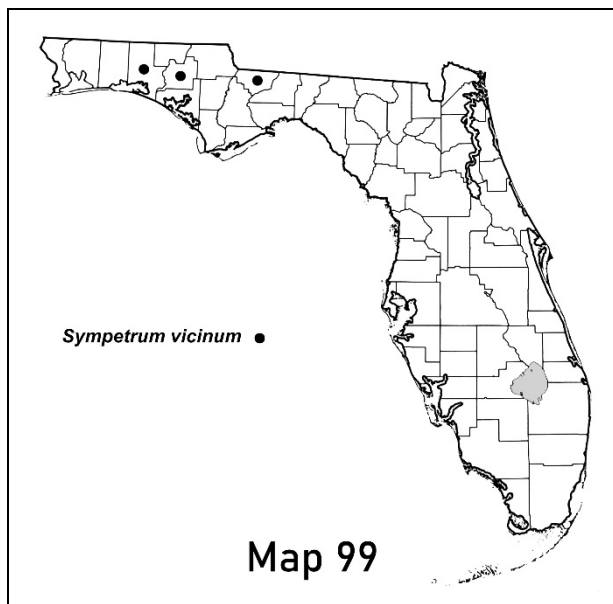
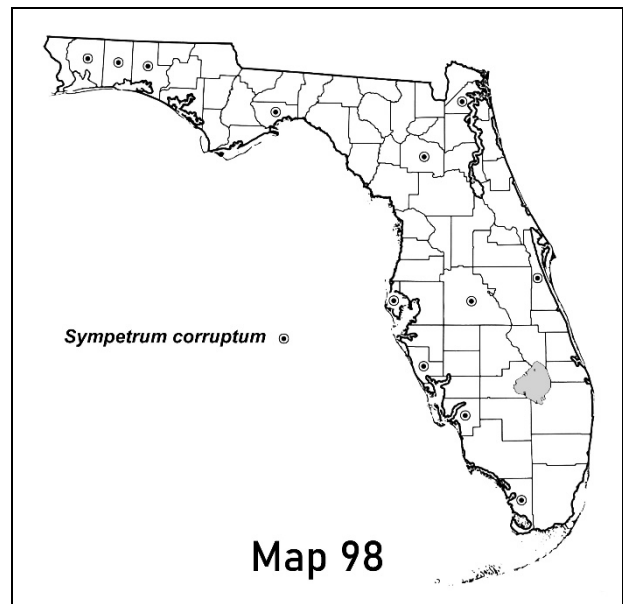
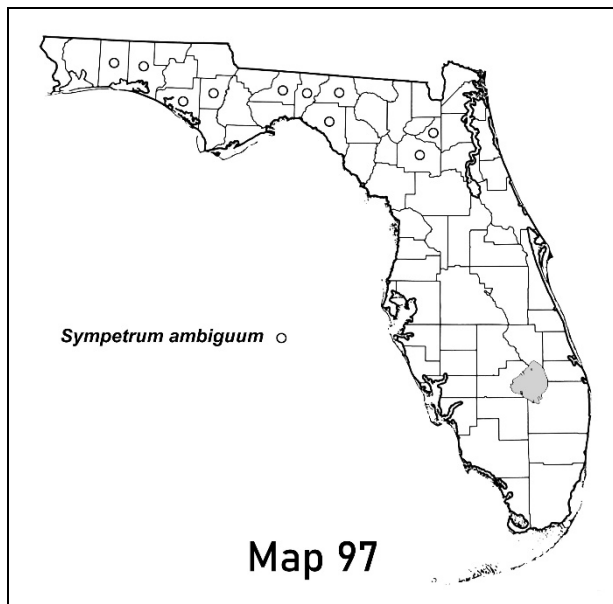
Habitat, Distribution, Life Cycle:

Sympetrum nymphs are predominantly lentic, inhabiting a wide variety of habitats, including lakes and ponds, shaded swales, marshes (including temporary marshy habitats), backwaters of streams, and fens; a few species are considered partly lotic, as they can inhabit slow portions of streams.

Sympetrum ambiguum and *S. vicinum* appear restricted to northern Florida (Maps 97 and 99). *Sympetrum corruptum* has a wider range in the state but it occurs sporadically (Map 98); this species is a known migrant (Paulson 2011).

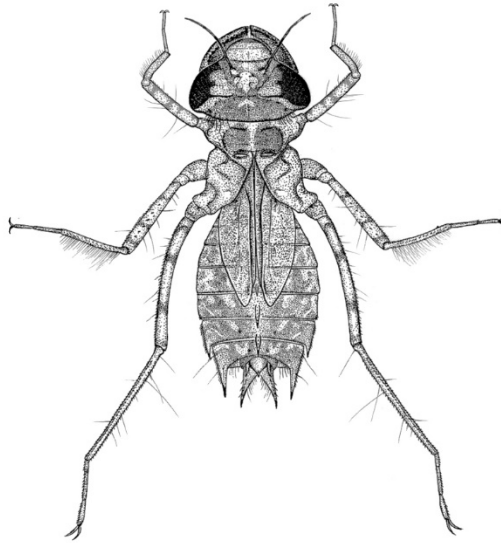
Sympetrum corruptum has been sighted throughout the year in Florida, although it has been observed mainly in the fall, winter, and spring months. Whether it breeds in Florida is uncertain; I have seen it oviposit in October. The flight season of most *Sympetrum* species begins slightly later than most other libellulids. *Sympetrum ambiguum* has been recorded from May 3 to November 20 in Florida, *S. vicinum* from May 27 to August 22. *Sympetrum vicinum* has one of the latest flight

seasons outside of Florida — I have seen adults as late as December in northern Alabama. *Sympetrum* species are probably univoltine in Florida.



Tauriphila

Elongate-oval, brown, body patterned; eyes large, sloping posteriorly; middorsal hooks on abdominal segments 4–8 large and sharp; posterolateral spines on segments 8 and 9, long on segment 9



Tauriphila is a small Neotropical genus with two species, *T. argo* and *T. australis*, recorded in Florida.

Diagnosis:

Tauriphila is most similar to *Miathyria* in habitus although *Miathyria* is smaller (see Table 12.1), the epiproct is more elongate (compare Figs. 12.18b and c), and the number of palpal setae is 6 or 7 per side compared to 8 or 9 in *Tauriphila*. *Tauriphila* superficially resembles *Tramea* but that genus lacks middorsal hooks altogether and has a very elongate epiproct.

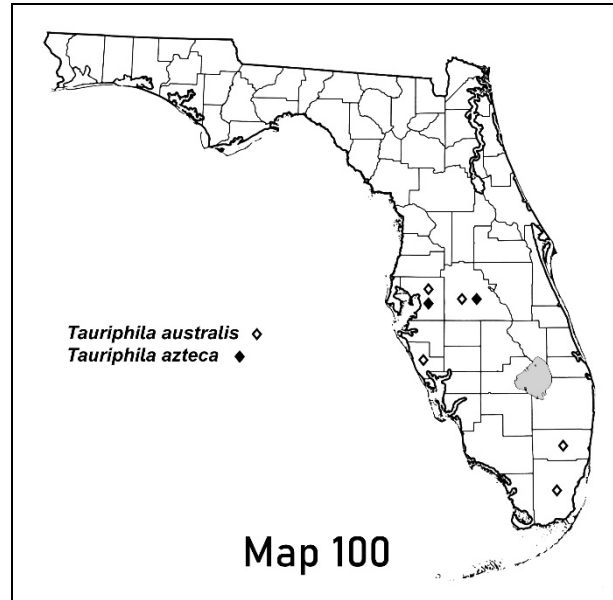
A key to separate the two Florida species is not possible as the nymph of *T. azteca* is unknown. The character states for the genus are based upon the two species known to occur in the United States, *T. argo* and *T. australis*.

Habitat, Distribution, Life Cycle:

Tauriphila nymphs are lentic, inhabiting permanent ponds; specific localities and habitats of nymphs in Florida have not been identified.

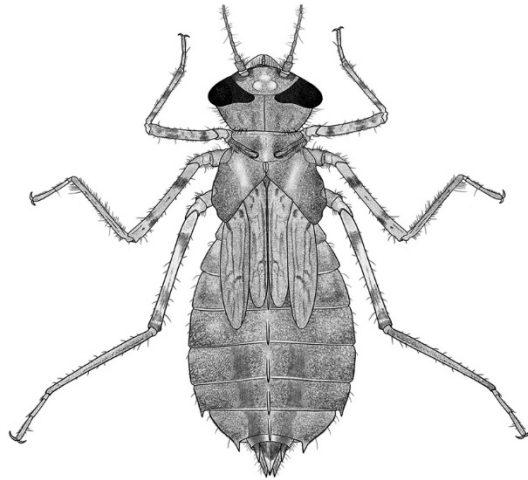
Both *Tauriphila* species in Florida appear to be restricted to the southern half of the peninsula (Map 100).

Based on the little information available, the flight season of *Tauriphila* in Florida is mainly summer, dates ranging from late June through August, although Dunkle (1992) gave October 21 as the late date for *T. australis*. No data on life history are available.



Tholymis

Elongate-oval, dark brown; eyes large; tip of antenna bulbous; middorsal hooks on abdominal segments 4–10; small postero-lateral spines on segments 8 and 9



Tholymis comprises only two species (one New World, one Old World); the New World species, *T. citrina*, is mainly Neotropical but occurs in extreme southern Florida.

Diagnosis:

Tholymis is unique among known Libellulidae nymphs in the shape of the tip of the 7th antennal segment, which is bulbous. In habitus, the genus is somewhat similar to *Dythemis* and *Perithemis*, although these genera are probably not closely related as indicated by the character states in couplet 9 of the generic key.

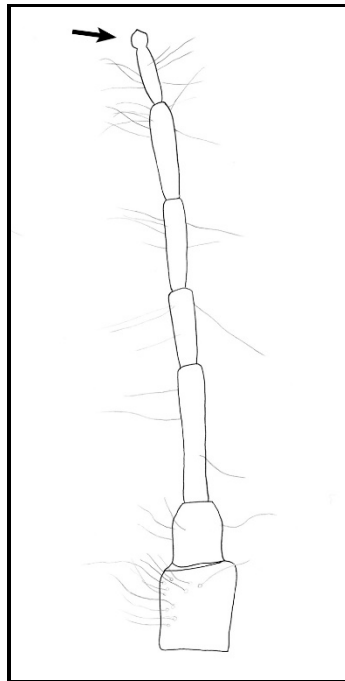


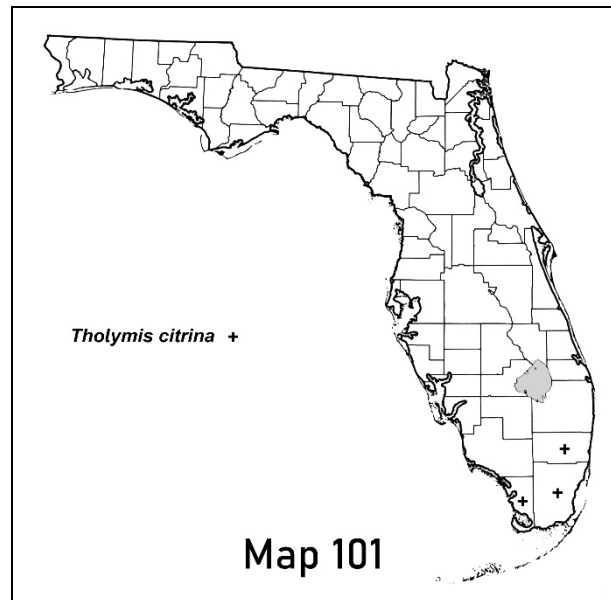
Fig. 12.61. *Tholymis*, antenna. Arrow indicates tip of 7th segment.

Habitat, Distribution, Life Cycle:

Tholymis nymphs inhabit shallow pools and marshes, usually near forest edges; they are probably capable of completing development in temporary rain pools.

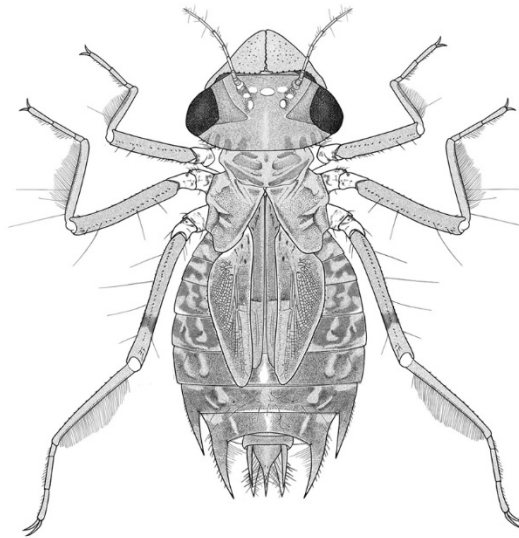
Tholymis citrina has been recorded in Florida in only three counties south of Lake Okeechobee, including the Keys (Map 101).

In Florida, *Tholymis citrina* has been recorded flying in March, June, and December. The exact flight season is uncertain, as few records are available. The species is probably univoltine in south Florida.



Tramea

Elongate-oval, green to brown; eyes large, sloping posteriorly; tarsi fringed with setae; no middorsal hooks on abdomen; long, sharp posterolateral spines on segments 8 and 9



Tramea is a species-rich genus that ranges worldwide; seven species occur in Florida.

Generic Notes:

Tramea resembles *Pantala* and *Tauriphila* in habitus but lacks middorsal hooks on all abdominal segments — see Generic Notes under the latter two genera for further distinction. As a precaution, carefully inspect the segments underneath the wing sheaths to make sure no middorsal hooks are present on those segments. *Pachydiplax* also superficially resembles *Tramea* but the posterolateral spine on segment 9 is much shorter than in *Tramea* and the epiproct and paraprocts are shorter and less attenuate.

In the following key, for couplet 2, the total number of palpal and premental setae includes both palps and both sides of the prementum.

Key to *Tramea* Species

1. Middorsum of abdominal segments 7 and 8 with numerous closely-spaced, minute setae, density roughly 25–40 per square mm, and posterior margins usually with only 3–6 long piliform setae, the bases pale (Fig. 12.62a); 7–10 palpal setae (each side), rarely 10.....2
- 1'. Middorsum of abdominal segments 7 and 8 with few closely-spaced, minute setae, density between 0–15 per square mm, and posterior margins usually with 10–20 long piliform setae, the bases dark (Fig. 12.62b); 10–12 palpal setae (each side).....4

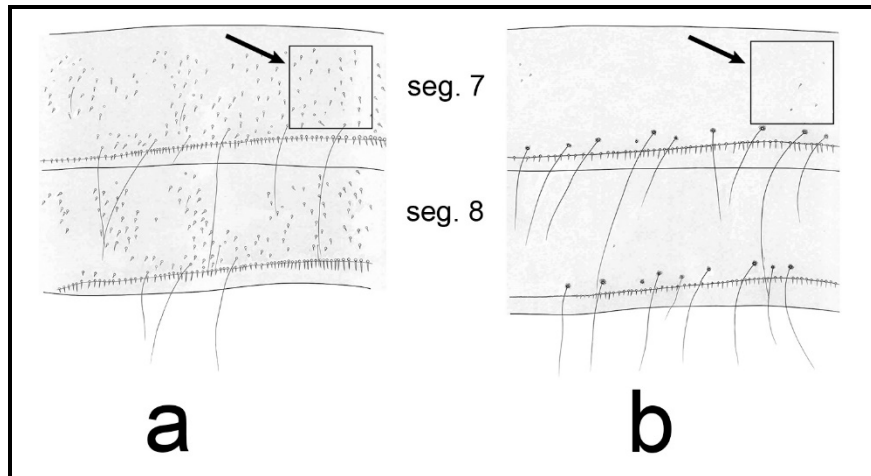


Figure 12.62. *Tramea*, dorsum of abdominal segments 7 and 8, left side, dorsal view: a) *T. insularis*; b) *T. lacerata*. Arrow indicates imaginary 1 mm² box.

2. Total number of palpal and premental setae 30–37; antenna length > 5.0 mm; ratio of prementum length:max width 1.11–1.31 ***binotata***
- 2'. Total number of palpal and premental setae 39–48; antenna length < 5.0 mm; ratio of prementum length:max width 0.95–1.08 **3**

See note on *Tramea basilaris* in the Diagnosis section of p. 256.

3. Ratio of antennal segment 4 length:segment 3 length ≤ 0.70 (Fig. 12.63a); premental setae usually 12–14 (each side); epiproct length 1.85–2.55 mm ***calverti***
- 3'. Ratio of antennal segment 4 length:segment 3 length ≥ 0.70 (Fig. 12.63b); premental setae usually 11 or 12 (each side); epiproct length 2.45–2.80 mm ***insularis***

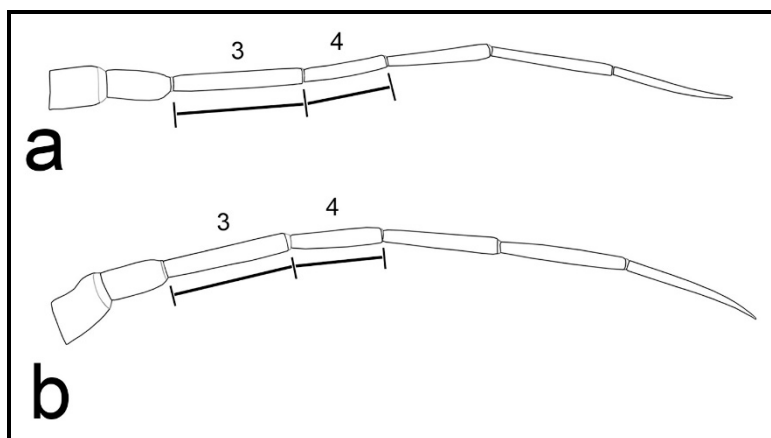


Figure 12.63. *Tramea*, antenna: a) *T. calverti*; b) *T. insularis*.

4. Ratio of antennal segment 4 length:segment 3 length ≥ 0.70 ; abdominal segments 8 and 9 with pale middorsal mark a narrow line (Fig. 12.64a); antenna of F-0 > 5.0 mm long.....*carolina*
- 4'. Ratio of antennal segment 4 length:segment 3 length < 0.70 ; abdominal segments 8 and 9 with pale middorsal mark oval, nearly as wide as length of segment (Fig. 12.64b); antenna of F-0 < 5.0 mm long5

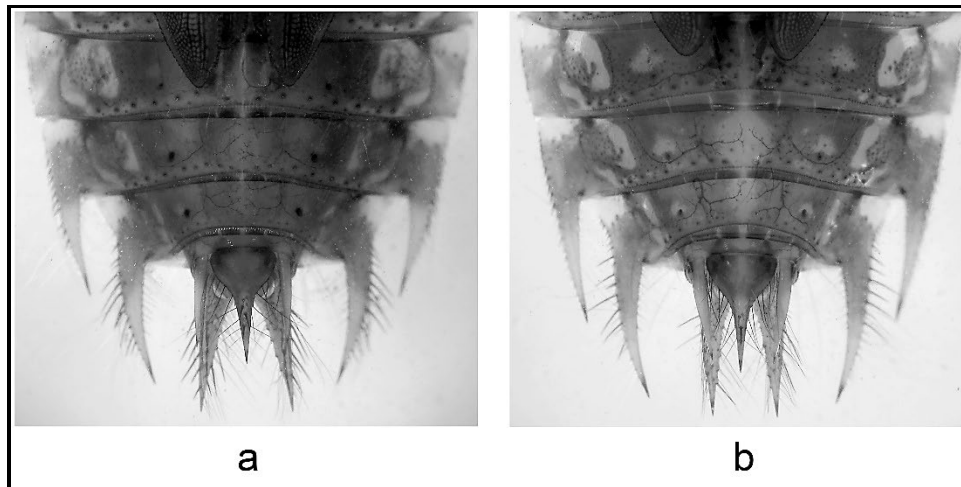


Figure 12.64. *Tramea*, color pattern on abdominal segments 7–10, dorsal view: a) *T. carolina*; b) *T. onusta*.

5. Epiproct length > 2.30 mm; ratio of epiproct length:ventral paraproct length 0.95–1.08; ratio of abdominal segment 8 posterolateral spine length:segment 9 posterolateral spine length 0.73–0.89*lacerata*
- 5'. Epiproct length ≤ 2.30 mm; ratio of epiproct length:ventral paraproct length 0.76–0.90; ratio of abdominal segment 8 posterolateral spine length:segment 9 posterolateral spine length 0.85–0.95.....6
6. Ratio of cercus length:segment 9 posterolateral spine length 0.81–1.00; stout setae on medial margin of segment 9 posterolateral spine as stout and as long as or longer than setae on lateral margin and much longer than stout setae on posterior margin of segment (Fig. 12.65a)*abdominalis*
- 6'. Ratio of cercus length:segment 9 posterolateral spine length 0.69–0.80; stout setae on medial margin of segment 9 posterolateral spine less stout and much smaller than setae on lateral margin and about twice as long as stout setae on posterior margin of segment (Fig. 12.65b)*onusta*

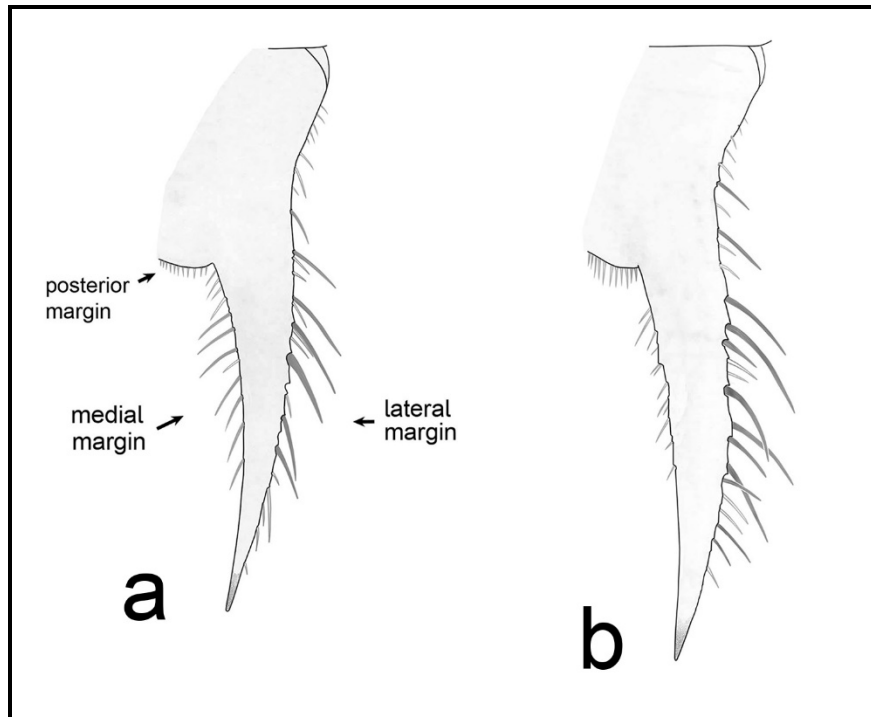


Figure 12.65. *Tramea*, posterolateral spine of abdominal segment 9, right side, dorsal view, showing spiniform setae on medial and lateral margins: a) *T. abdominalis*; b) *T. onusta*. Long piliform setae omitted.

Diagnostic Remarks:

Previous keys used several unreliable and variable characters (see Landwer and Sites 2005, 2010 for an analysis of anal appendage and posterolateral spine characters), and some species were not included in the keys. The above key includes all species of *Tramea* known to occur in the United States, introduces several new characters, and considers intraspecific variation. However, identifying *Tramea* nymphs to species is still difficult.

The species that key to couplets 2 and 3 (*binotata*, *calverti* and *insularis*, all uncommon and restricted in their distribution in Florida) have numerous tiny setae also on the venter of abdominal segments 4–6 whereas the remaining four more common species have few to no setae on the venter of these segments. The former three uncommon species are extremely similar to each other and no outstanding differences (as is clear in couplets 2 and 3) between them are known.

The four more common species, *T. abdominalis*, *T. carolina*, *T. lacerata*, and *T. onusta*, are also difficult to distinguish. The character states in couplets 4 to 6 that distinguish these species are minimal. Furthermore, the pale median stripe on abdominal segments 7 and 8 of *T. abdominalis* and *T. onusta* is sometimes narrow; although the pale area in such specimens is still slightly widened at mid-length, they can be confused with *T. carolina*. Therefore, accurate measurement of antennal segments 3 and 4 is crucial to obtain the ratios necessary to separate *T. carolina* as per couplet 4. Absolute length of antennal segment 4 also helps separate *T. carolina*: 0.55–0.75 mm compared to 0.45–0.59 mm for *T. lacerata* and 0.45–0.55 mm for *T. onusta*; unfortunately, the length of antennal segment 4 for *T. abdominalis* (0.45–0.63 mm) greatly overlaps that of *T. carolina*. As a further note, pond benthic samples in much of Florida more likely will contain nymphs of *T. carolina* and *T. lacerata* than the other species.

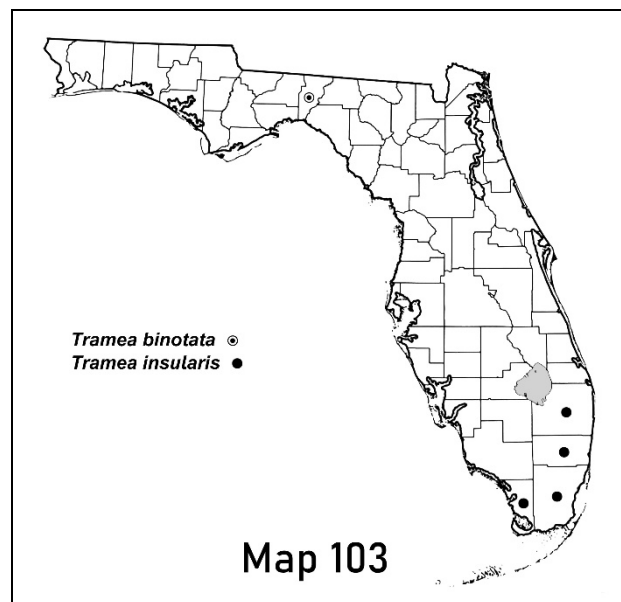
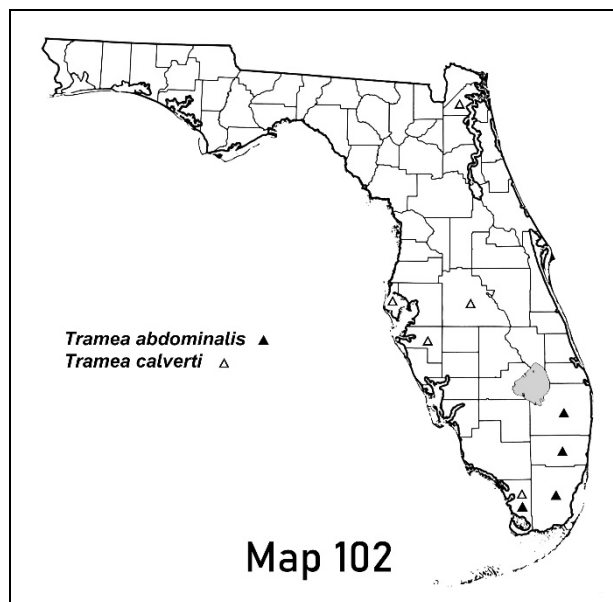
As a final consideration, there is a possibility that an eighth species of *Tramea* will be found in Florida. An African species, *Tramea basilaris* (Palisot de Beauvois), has been recorded recently in the Lesser Antilles (Meurgey and Picard 2011) and in Cuba (Meurgey 2012). This species is migratory and could invade Florida in the future. The nymph of *T. basilaris* will key to couplet 2 as it has numerous spiniform setae on the dorsum and venter of the abdomen. However, there are 10 palpal setae per side and 15 or 16 premental setae per side.

Habitat, Distribution, Life Cycle:

Tramea nymphs inhabit a wide variety of lentic habitats, including lakes, ponds, marshes, ditches, and drainage canals with abundant emergent and floating vegetation, but they are also found in slow portions of streams. The nymphs of two species, *T. binotata* and *T. calverti*, have not been collected in Florida and it is unknown if these species breed and complete development within the state.

Three species of *Tramea* occur statewide, *T. carolina*, *T. lacerata*, and *T. onusta* (Maps 104–106). The other four species are restricted mainly to the southern part of the peninsula (Maps 102 and 103). Several species of *Tramea*, including *T. calverti* and *T. lacerata*, are known migrants (May 2013).

The flight season of most *Tramea* species appears to continue throughout the year in Florida. However, the season of several species is probably underestimated, including *T. binotata* (September 20) and *T. calverti* (August 7 to November 22), as they have been sighted infrequently. *Tramea* species are either univoltine or bivoltine, depending on location (Morin 1984, Wissinger 1988).



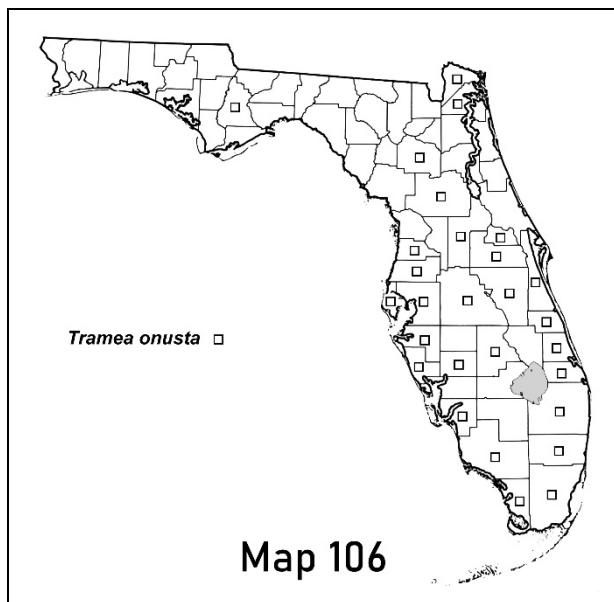
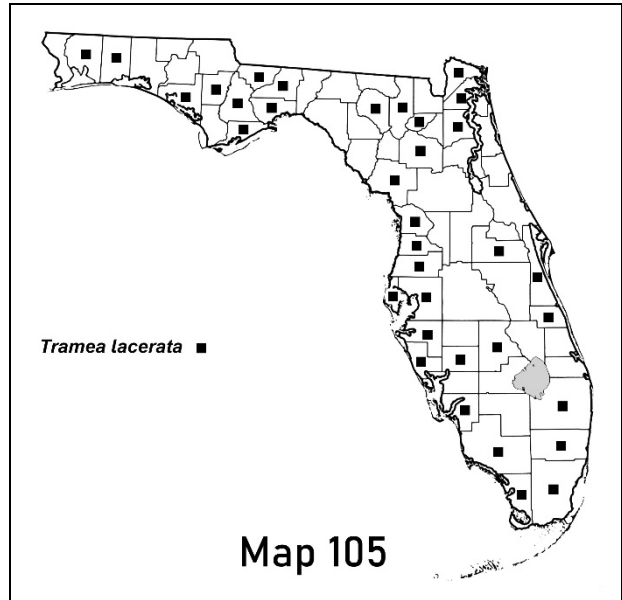
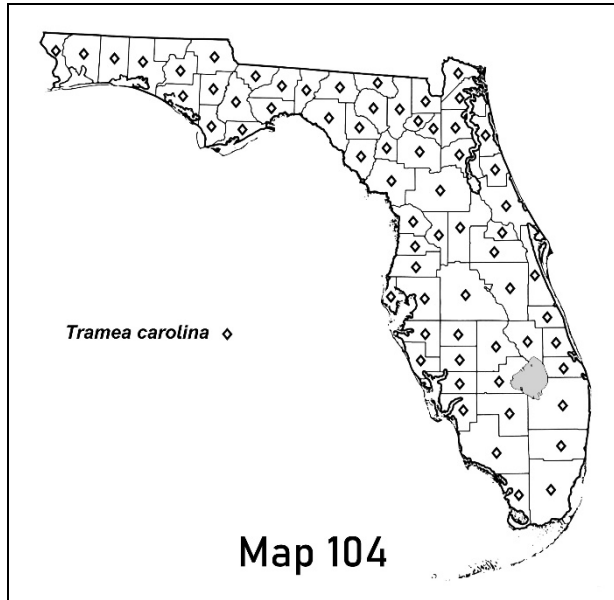
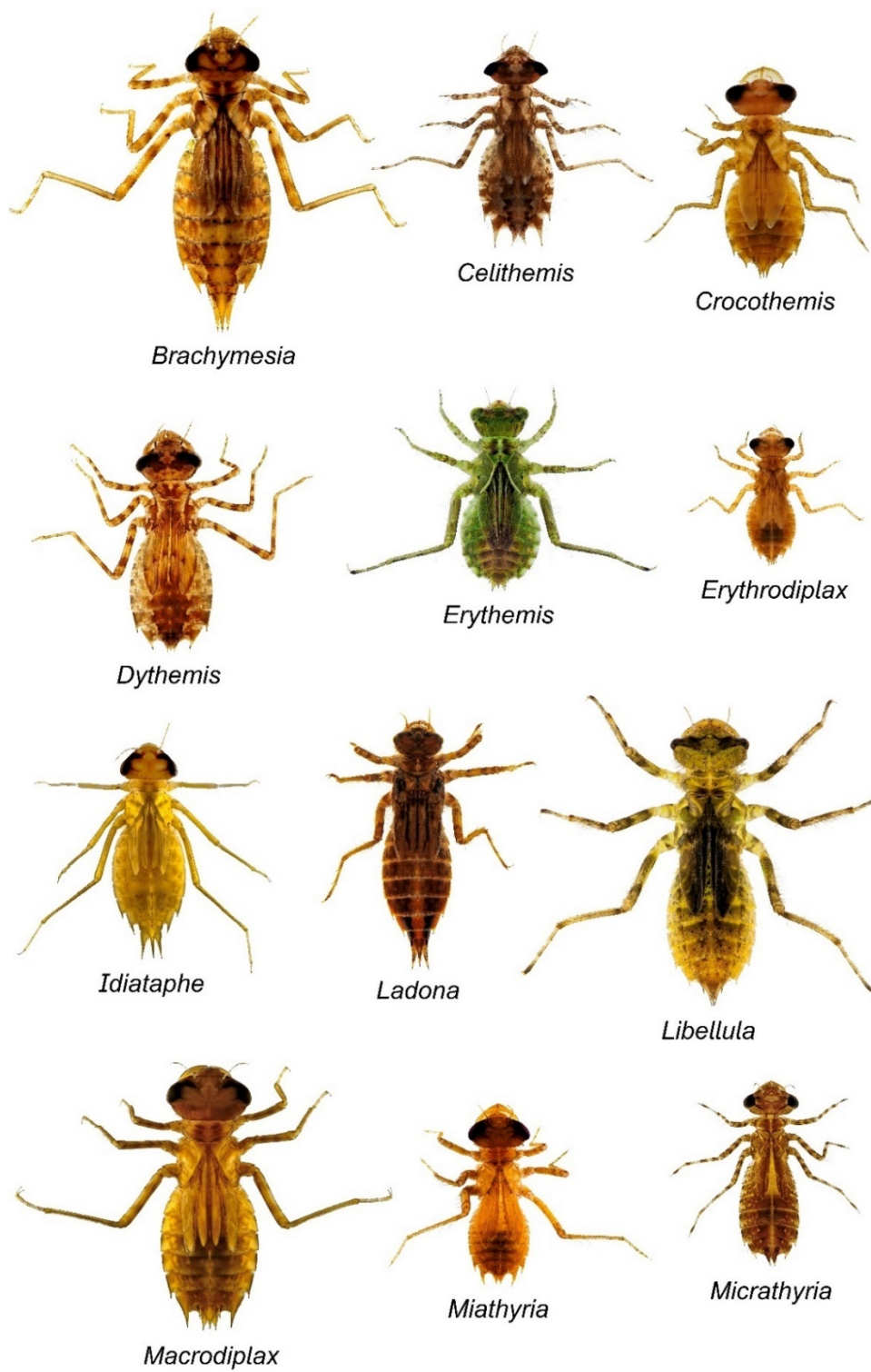
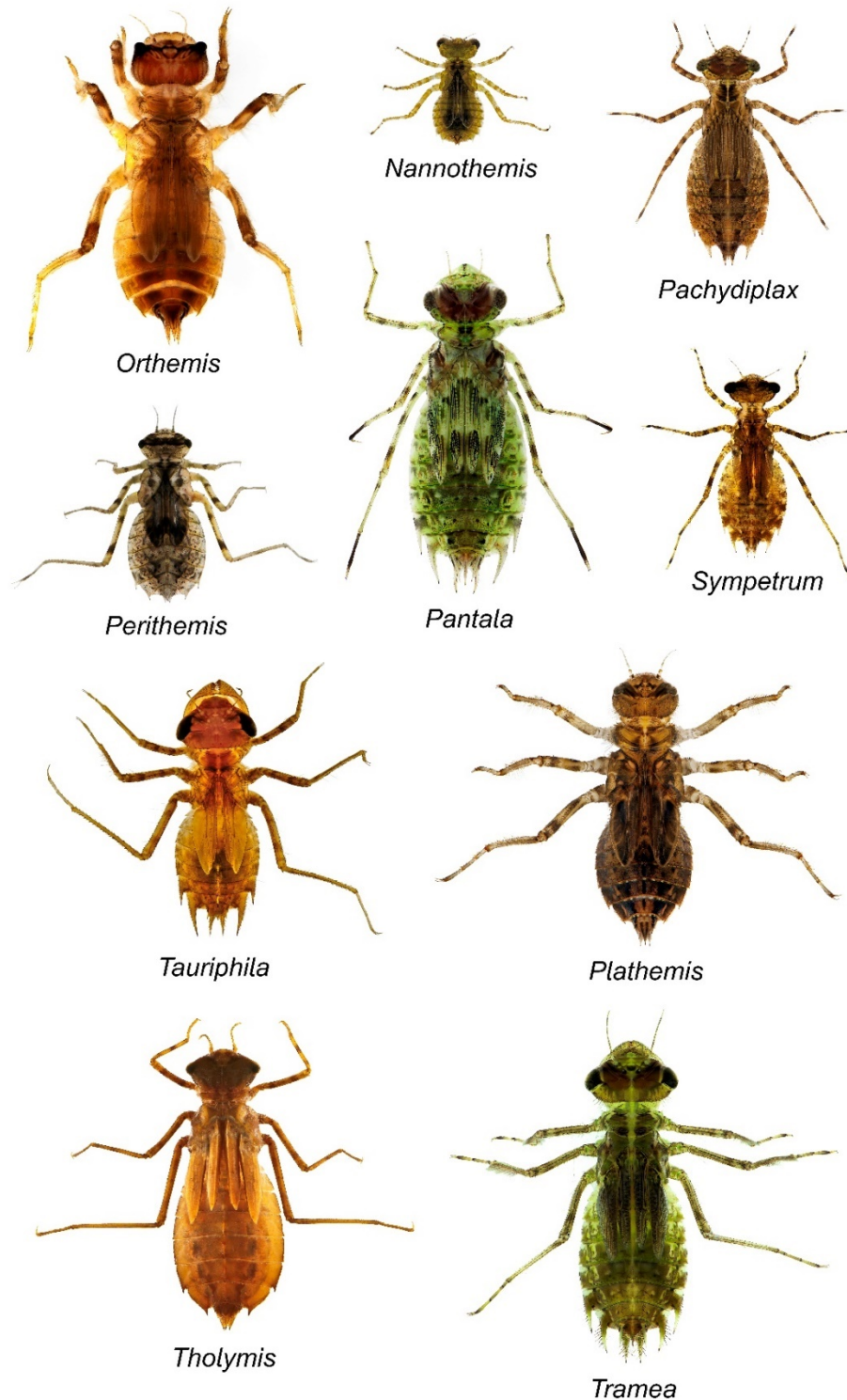


Plate 9. Representatives* of 22 Libellulidae genera of Florida (photographs by Marla C. Garrison).





* The species represented in Plate 9 are *Brachymesia gravida*, *Celithemis fasciata*, *Crocothemis servilia*, *Dythemis velox*, *Erythemis simplicicollis*, *Erythrodiplax minuscula*, *Idiataphe cubensis*, *Ladona deplanata*, *Libellula semifasciata*, *Macrodiplax balteata*, *Miathyria marcella*, *Micrathyria aequalis*, *Orthemis ferruginea*, *Nannothemis bella*, *Pachydiplax longipennis*, *Pantala flavescens*, *Perithemis tenera*, *Plathemis lydia*, *Sympetrum vicinum*, *Tauriphila australis*, *Tholymis citrina*, *Tramea onusta*.

13. CALOPTERYGIDAE

Calopterygid nymphs are adapted for clinging to substrates in the water column, mainly plant stems, sticks, and roots. They have elongated, stick-like bodies with long, slender legs. There is little variability in general body shape within the family.

The family is characterized by: 1) antennae with first segment greatly elongate, approximately as long as segments 2–7 combined; 2) posterolateral corners of head angulate; 3) ligula deeply cleft, forming two elongate projections, opening between the projections extending proximally into prementum; 4) a single straight seta on ental surface of each elongate projection of the ligula; 5) palpal base without prominent long setae but distal end with three spiniform setae (two very short and one longer); 6) venter of pterothorax with a transverse suture; 7) caudal lamellae rigid, lateral lamellae triquetral.

Two genera occur in Florida, *Calopteryx* Leach and *Hetaerina* Hagen, each with two species in the state. Identifying calopterygid nymphs to genus under low magnification is easy; however, species determinations are more difficult, especially in *Calopteryx*, and attention must be paid to microscopic details.

Key to Genera of Calopterygidae

1. Ligula cleft extending proximally far beyond base of palps (Fig. 13.1a); dorsolateral margins of prothorax in dorsal view slightly incurved to straight (Fig. 13.2a); abdominal segment 9 without a posterolateral spine (Fig. 13.3a)*Calopteryx*
- 1'. Ligula cleft extending to base of palps or only slightly beyond (Fig. 13.1b); dorsolateral margins of prothorax in dorsal view prominently angulate (Fig. 13.2b); abdominal segment 9 with a posterolateral spine (Fig. 13.3b)*Hetaerina*

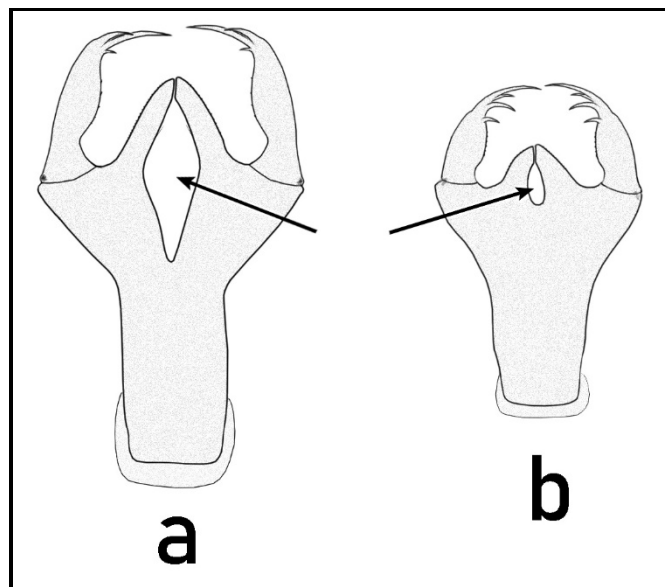


Fig. 13.1. Calopterygidae, prementum, ventral view: a) *Calopteryx dimidiata*; b) *Hetaerina americana*.

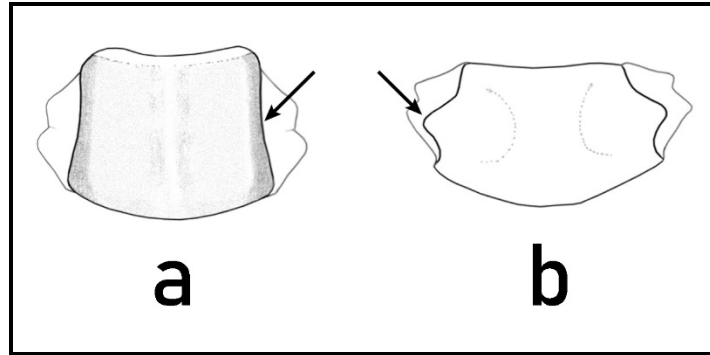


Fig. 13.2. Calopterygidae, prothorax, dorsal view: a) *Calopteryx dimidiata*; b) *Hetaerina americana*.

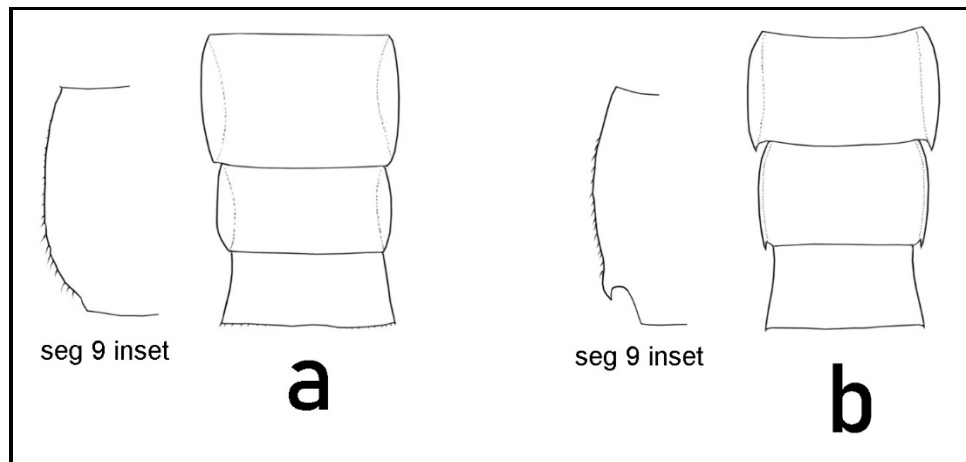


Fig. 13.3. Calopterygidae, posterolateral margins of abdominal segments 8–10, dorsal view: a) *Calopteryx dimidiata*; b) *Hetaerina titia*. Insets are enlarged views of the margin of abdominal segment 9 in dorsolateral view to clearly show the posterolateral aspect of the segment.

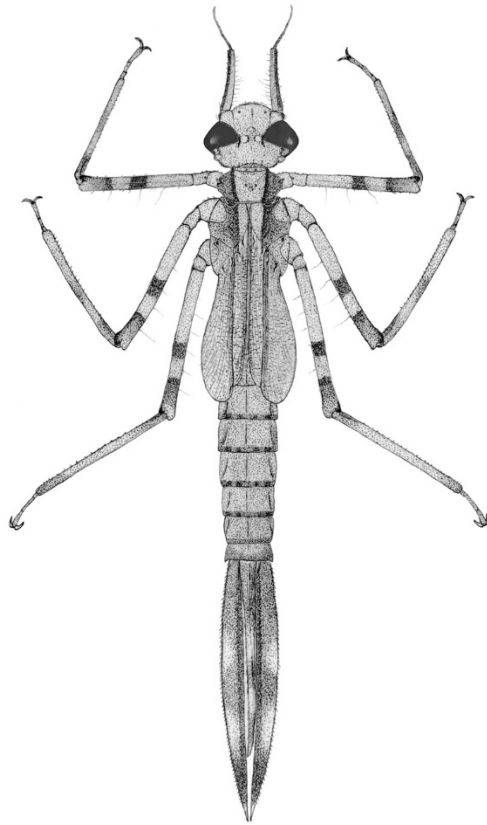
Generic Notes:

The large cleft in the prementum is diamond-shaped in *Calopteryx* versus teardrop shaped in *Hetaerina*. The differences between the two genera, including the depth of the cleft, the shape of the pronotum, and the presence/absence of posterolateral spines on segment 9, are present in instars as early as F-2; however, these character states have not been studied in earlier instars. An additional generic difference is in the length to width ratio of the lateral caudal lamella; this ratio is approximately 10 in *Calopteryx* compared to 3–5 in *Hetaerina*.

Calopterygidae Generic Treatments

Calopteryx

Elongate, stick-like, variable in color (tan to dark brown); head angulate on posterior corners; ligula cleft extending to half length prementum; abd. seg. 9 w/o lateral spine; lateral caudal lamella about 10 X longer than wide



Key to *Calopteryx* Species

1. Median lamella < 4.0 times as long as max width, with dorsal curvature prominent and banding definite (Fig. 13.4a); stout spines prominent on margins of caudal lamellae and numerous on lateral margin of abdominal segment 9 (Fig. 13.5a)*dimidiata*
- 1'. Median lamella > 5.0 times as long as max width, with dorsal curvature less pronounced and banding less definite (Fig. 13.4b); stout spines small on margins of caudal lamellae and sparse on lateral margin of abdominal segment 9 (Fig. 13.5b).....*maculata*

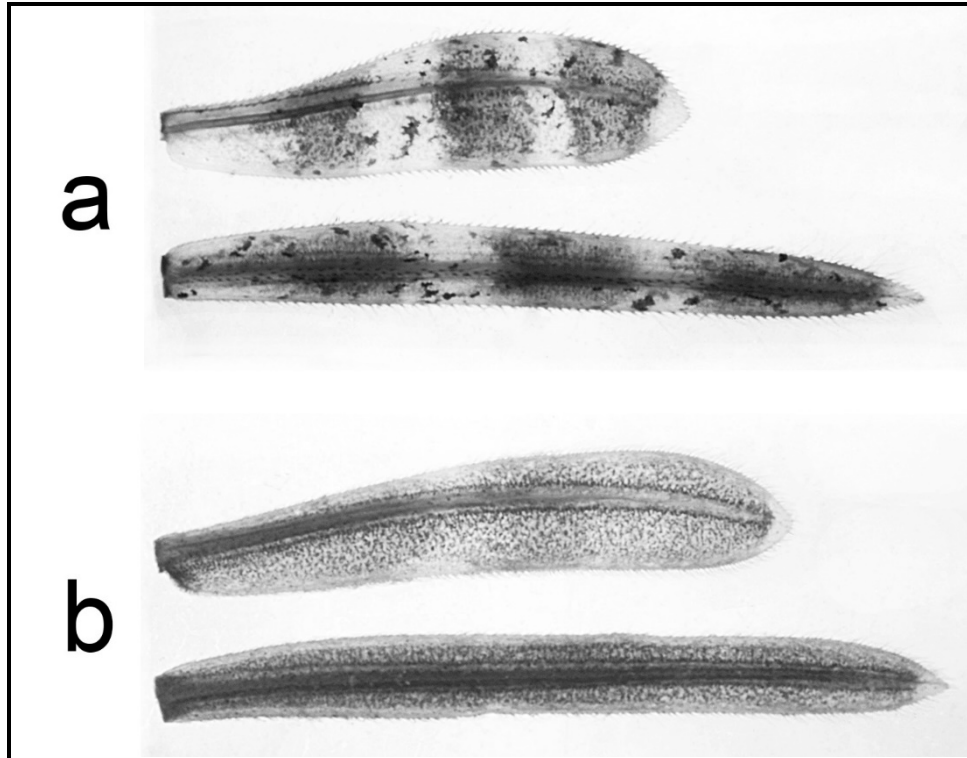


Fig. 13.4. *Calopteryx*: median and left caudal lamellae, lateral view: a) *C. dimidiata*; b) *C. maculata*.

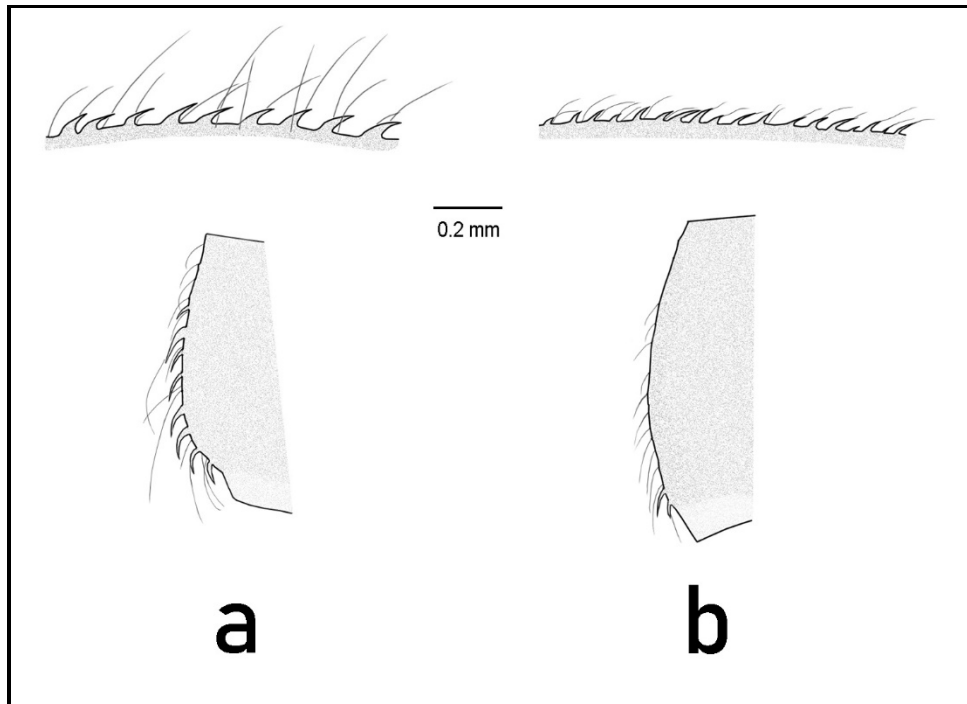


Fig. 13.5. *Calopteryx*: spines and setae on dorsal margin of median caudal lamellae (upper figures) and lateral margin of abdominal segment 9 (lower figures): a) *C. dimidiata*; b) *C. maculata*.

Diagnostic Remarks:

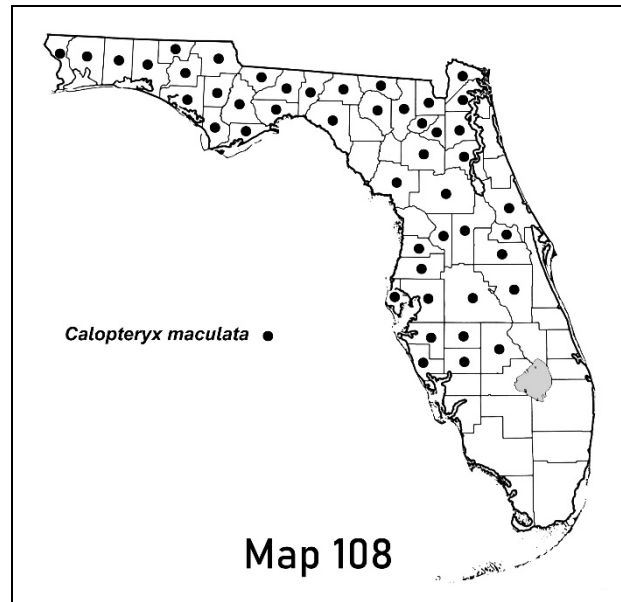
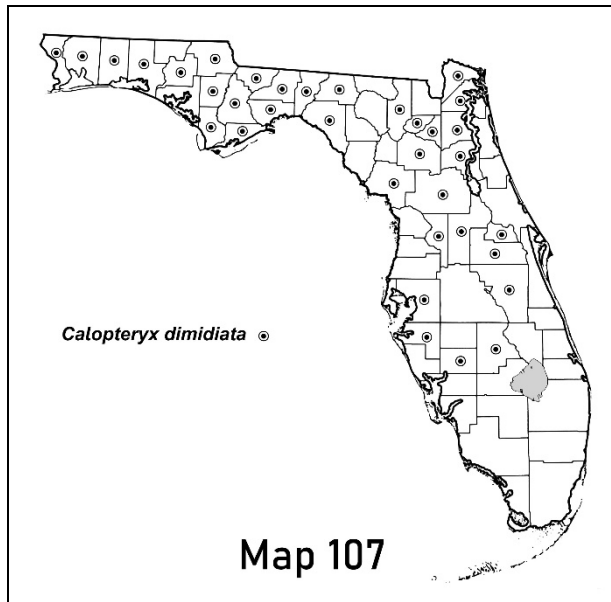
No characters other than those provided in the above key were found to reliably separate the two *Calopteryx* species.

Habitat, Distribution, Life Cycle:

Calopteryx nymphs inhabit streams with rooted aquatic vegetation, usually in wooded to partly open areas.

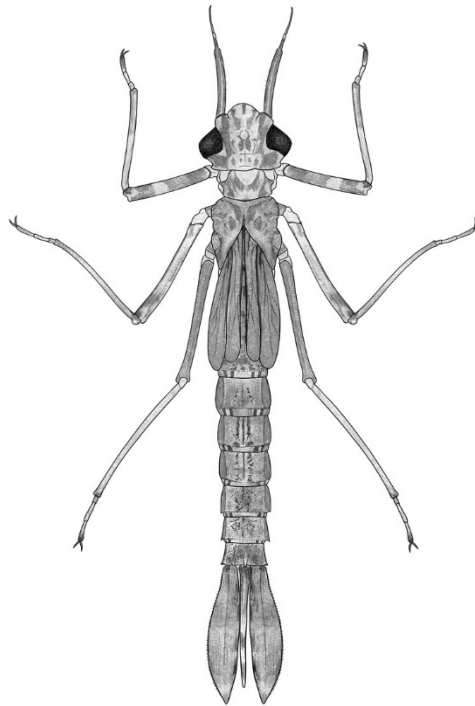
Both species of *Calopteryx* are widely distributed in Florida, although neither has been found south of Lake Okeechobee (Maps 107 and 108).

Adults of *C. dimidiata* have been recorded from February 15 to November 11 in Florida; *C. maculata* has a slightly longer flight season recorded in the state, from February 7 to December 3. *Calopteryx* nymphs are probably univoltine in Florida.



Hetaerina

Elongate, stick-like,
variable in color (tan
to dark brown); head
angulate at corners;
ligula cleft extending
to base of palps; abd.
seg. 9 w/ lateral spine;
lateral caudal lamella
about 3–5 X longer
than wide



Key to *Hetaerina* Species

1. Posterolateral corners of head with obtuse tubercle (Fig. 13.6a); ligula projections about twice as long as their width at level of setal base (Fig. 13.7a); abdominal segment 10 without a middorsal posterior spine.....*americana*
- 1'. Posterolateral corners of head with acute tubercle (Fig. 13.6b); ligula projections about 4 times as long as their width at level of setal base (Fig. 13.7b); abdominal segment 10 with a middorsal posterior spine.....*titia*

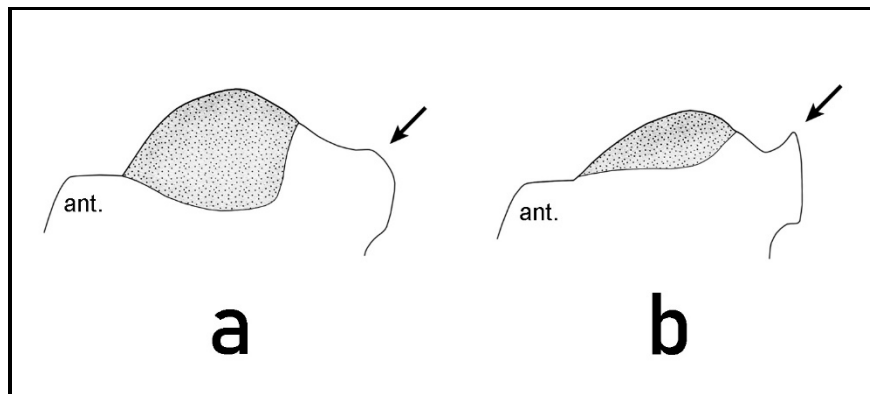


Fig. 13.6. *Hetaerina*: tubercle on posterolateral corner, right side of head, dorsolateral view: a) *H. americana*; b) *H. titia*; ant. = base of antenna.

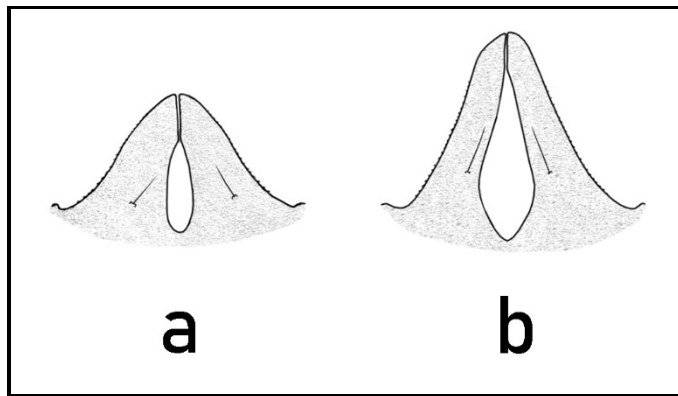


Fig. 13.7. *Hetaerina*: distal lobes of ligula: a) *H. americana*; b) *H. titia*.

Diagnostic Remarks:

Hetaerina nymphs are identifiable to species in F-0 to F-2 using the key characters presented above; instars earlier than F-2 have not been studied. An additional specific difference involves the shape of the median caudal lamella: in *H. americana*, the lamella is not widened in the distal half and the apex is obtusely pointed (Fig. 13.8a); in *H. titia*, the lamella is widened in the distal half and the apex truncate (Fig. 13.8b).

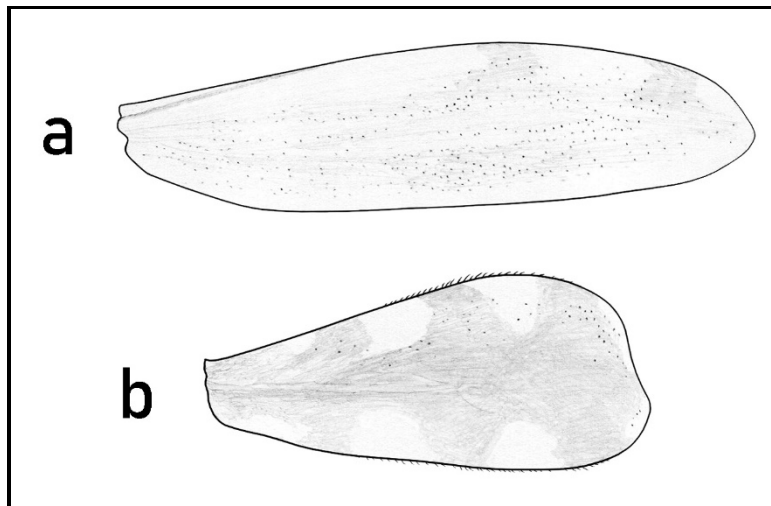


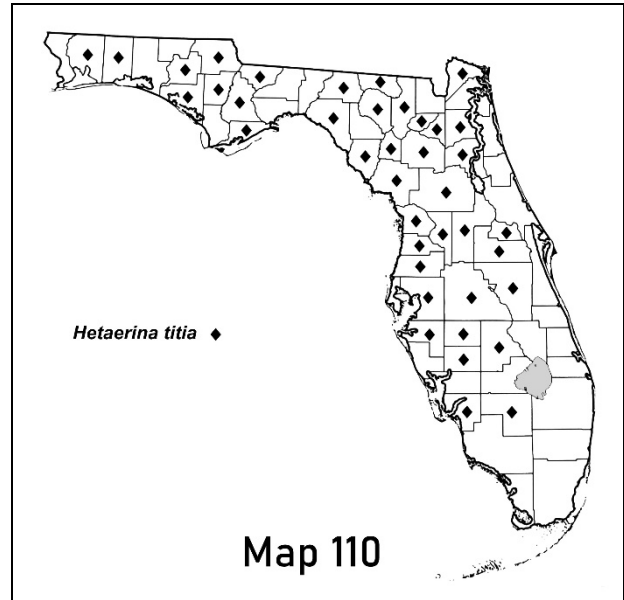
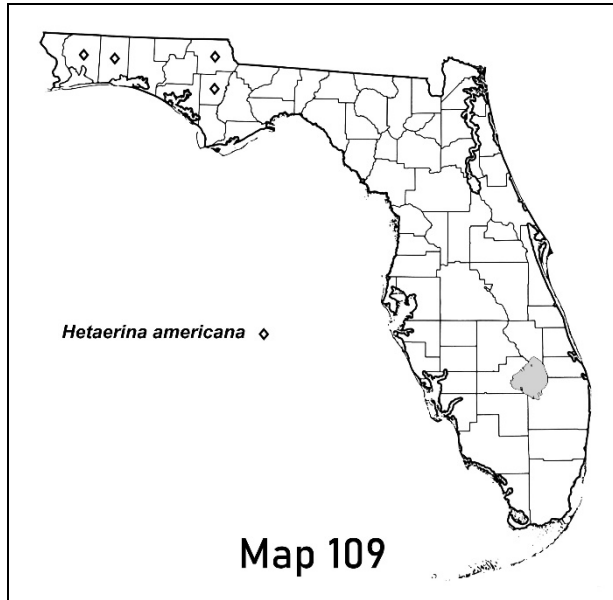
Fig. 13.8. *Hetaerina*: median lamella: a) *H. americana*; b) *H. titia*.

Habitat, Distribution, Life Cycle:

Hetaerina nymphs are lotic, hiding in detritus and rooted aquatic vegetation, usually along stream banks.

Hetaerina americana is restricted in Florida as it has been recorded in only four counties in the panhandle, all west of the Apalachicola River (Map 109). *Hetaerina titia* is much more common and widely distributed in the state, from the panhandle to Lake Okeechobee (Map 110).

Adults of *H. americana* fly from April 12 to August 15 in Florida. *Hetaerina titia* has a yearlong flight season. *Hetaerina* nymphs are probably univoltine in Florida.



14. COENAGRIONIDAE

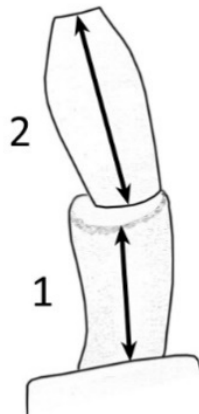
Coenagrionid nymphs are found in many kinds of habitats, including lentic and lotic conditions. Some groups cling to substrates such as stems, roots, rocks, or sunken logs whereas others hide in detritus at the bottom. Body shape within the family is variable, from stocky to slender, but most genera are usually more compact than Calopterygidae and Lestidae, and their legs are not as long and slender. When full-grown, coenagrionids are generally smaller than calopterygids and lestids.

The family is characterized by: 1) antenna six- or seven-segmented, segment lengths variable but first segment shorter than segments 2 and 3 combined; 2) posterolateral corners of head variable, rounded in all Florida genera; 3) prementum flat, short, subquadrate; 4) ligula without remnant of a medial cleft; 5) movable hook without setae, basal portion of palp usually with one or more prominent setae; 6) palp bilobed; 7) venter of pterothorax with a transverse suture; 8) caudal lamellae usually flat, pattern of extratracheal pigment variable, apices usually pointed.

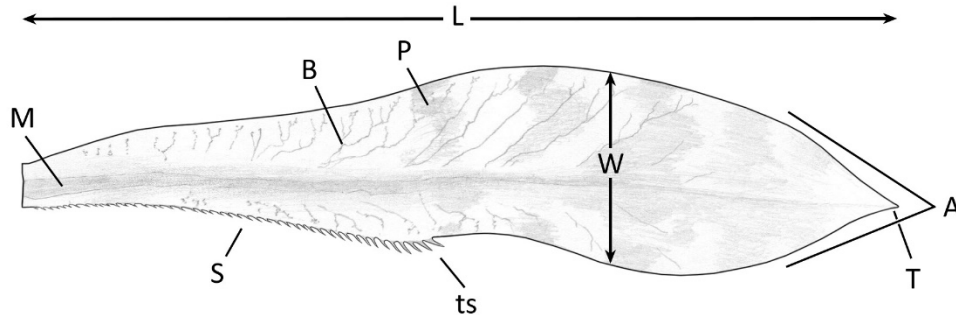
This is the largest family of Zygoptera in Florida with a total of 35 species in seven genera: *Argia* Rambur, *Enallagma* Charpentier, *Ischnura* Charpentier, *Leptobasis* Selys, *Nehalennia* Selys, *Neoerythromma* Kennedy, and *Telebasis* Selys. Identifying certain Coenagrionidae is difficult, especially differentiating the genera *Enallagma*, *Ischnura* and *Leptobasis*. Specific determination within *Enallagma* and *Ischnura* is challenging; in most instances, only F-0s can be determined with certainty. The coenagrionid genera most likely to show up in benthic samples from lotic habitats are *Argia* and *Enallagma*; the other genera are predominantly lentic although *Ischnura* and *Telebasis* are found occasionally in slow or pooled areas of slow-flowing waters.

Notes for using the following generic and specific keys:

- Detecting the small setae on the lateral carinae of the abdominal segments requires high magnification (at least 20X) and good lighting; viewing the abdomen from a dorsal perspective is sometimes necessary to detect that setae are present on the lateral margins, and then a lateral view is most convenient to determine the arrangement of the setae.
- Antennal segments 1 and 2 were measured in dorsal view as shown here:



- The main features of the caudal lamellae are length (L), max width (W), main trachea (M), branched tracheae (B), extratracheal pigment (P), marginal setae (S), terminal antenodal spiniform setae (ts), tip (T), and apical angle (A), shown below for a lateral lamella of *Enallagma pollutum*:



Key to the Genera of Coenagrionidae of Florida

1. Prementum without long prominent setae and palpal setae difficult to detect (Fig. 14.1a), sometimes absent, bases inconspicuous; palp with upper and lower lobes pointed (Fig. 14.2a); basal width of prementum > 0.35 times length of prementum, usually $0.4\text{--}0.5$ times (Fig. 14.1a)..... *Argia*
- 1'. Prementum with at least 1 long prominent seta on each side and palpal setae prominent, bases conspicuous (Fig. 14.1b); palp with upper lobe usually truncate and lower lobe pointed (Fig. 14.2b), though note exception, *Telebasis byersi* (see Fig. 14.4); basal width of prementum usually $0.25\text{--}0.35$ times length of prementum (Fig. 14.1b), with *T. byersi* again an exception, at $0.43\text{--}0.55$ 2

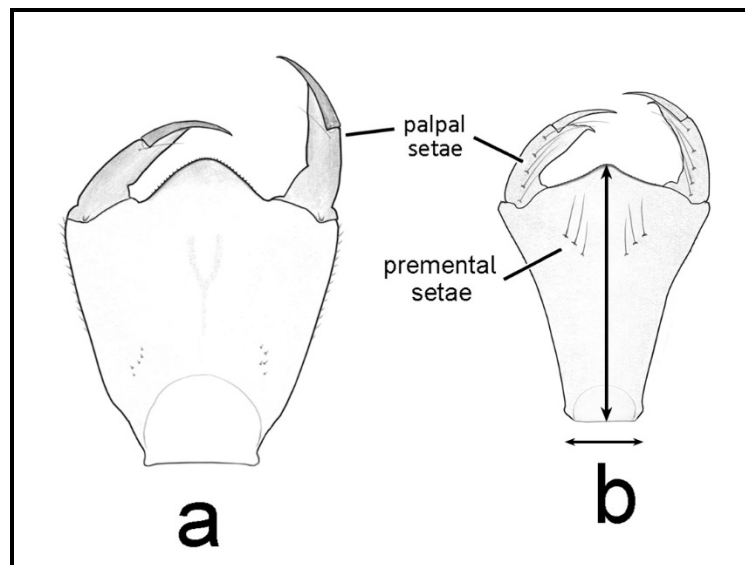


Fig. 14.1. Coenagrionidae, prementum, ental view: a) *Argia moesta*; b) *Enallagma signatum*; (not same scale, b enlarged).

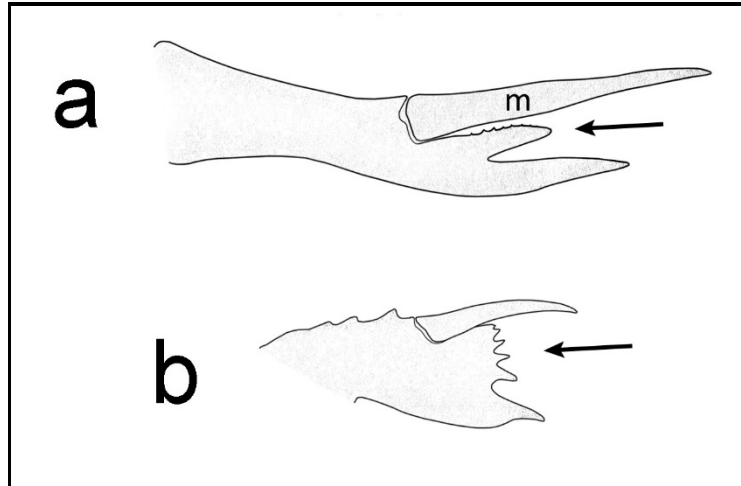


Fig. 14.2. Coenagrionidae, right palp, ectal view: a) *Argia moesta*; b) *Enallagma signatum*; arrow indicates upper lobe; m = movable hook.

2. Lateral caudal lamellae at most 3 times as long as max width, markedly widened in apical third (Fig. 14.3a); abdominal segments 1–8 pale laterally but without a lateral carina; upper palpal lobe tapered to acute apex (Fig. 14.4) ***Telebasis***
- 2'. Lateral caudal lamellae at least 4 times as long as max width, slightly widened in apical third (Fig. 14.3b); abdominal segments 1–8 with a moderate to prominent lateral carina; upper palpal lobe truncate (Figs. 14.2b, 14.5a,b).....**3**

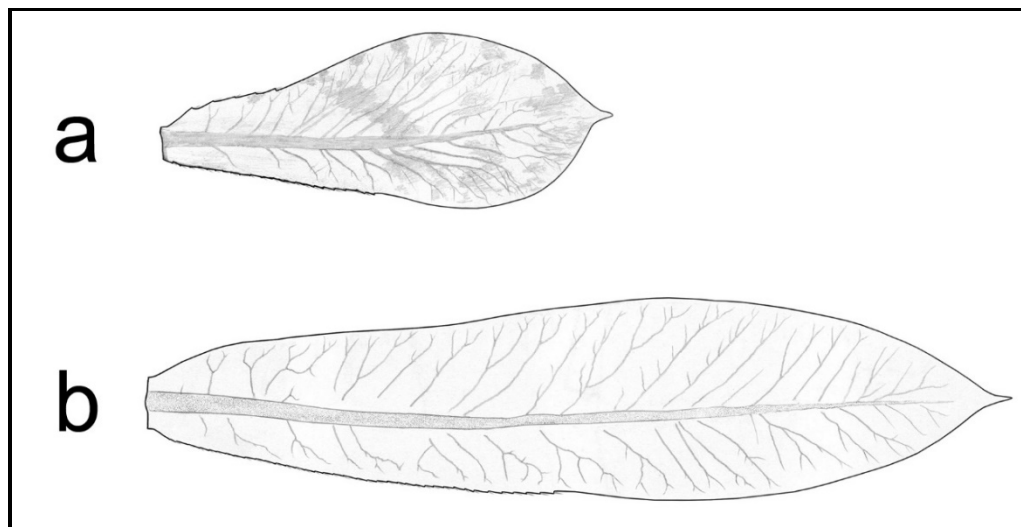


Fig. 14.3. Coenagrionidae, left lateral lamella, lateral view: a) *Telebasis byersi.*; b) *Enallagma doubledayi.*

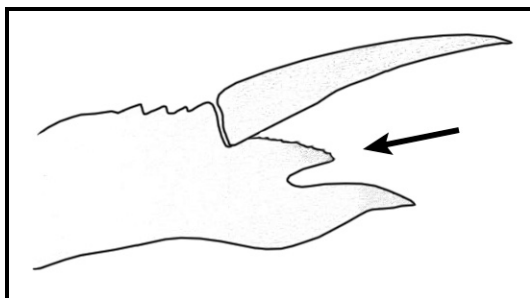


Fig. 14.4. Coenagrionidae, right palp, ectal view, *Telebasis byersi*.

3. Truncate lobe of palp with extremely tiny denticles, barely detectable in some species (Fig. 14.5a); lateral carinae of abdominal segments 2–5 usually with only 1 or 2 inconspicuous spiniform setae on posterolateral corner (Fig. 14.6a) *Nehalennia*
- 3'. Truncate lobe of palp with distinct denticles (Fig. 14.5b); lateral carinae of abdominal segments 2–5 usually with several either long stiff setae, short stout setae, or both on posterolateral corner (Fig. 14.6b).....4



Fig. 14.5. Coenagrionidae, right palp, ectal view: a) *Nehalennia gracilis*; b) *Ischnura ramburii*; denticles on truncate process indicated by arrow.

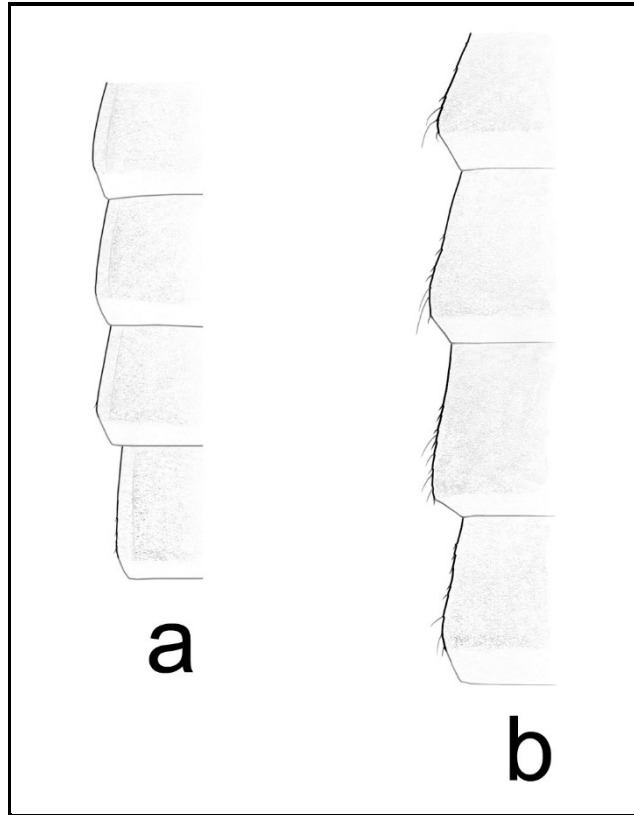


Fig. 14.6. Coenagrionidae, right side of abdominal segments 2–5, ventral view: a) *Nehalennia integricollis*; b) *Enallagma cardenium*.

4. Antennal segment 1 longer than segment 2; abdominal segment 9 with a prominent posterolateral spine-like seta (Fig. 14.7a); dorsal margin of median lamella and ventral margin of lateral lamellae with antenodal row of spiniform setae terminating in 1 or 2 stout, curved setae larger than preceding setae (Fig. 14.8a) ***Neoerythromma***
- 4'. Antennal segment 1 equal in length or shorter than segment 2; abdominal segment 9 without a posterolateral spine (Fig. 14.7b); dorsal margin of median lamella and ventral margin of lateral lamellae with antenodal row of spiniform setae usually terminating in setae approximately equal in size to preceding setae (Fig. 14.8b), sometimes with slightly larger setae in a few *Enallagma* species **5**

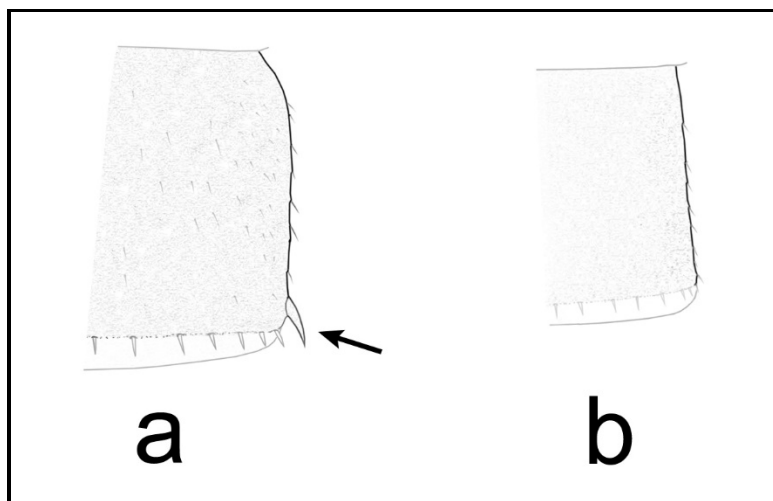


Fig. 14.7. Coenagrionidae, right side of abdominal segment 9, dorsolateral view: a) *Neoerythromma cultellatum* (arrow indicates stout posterolateral seta); b) *Enallagma signatum*.

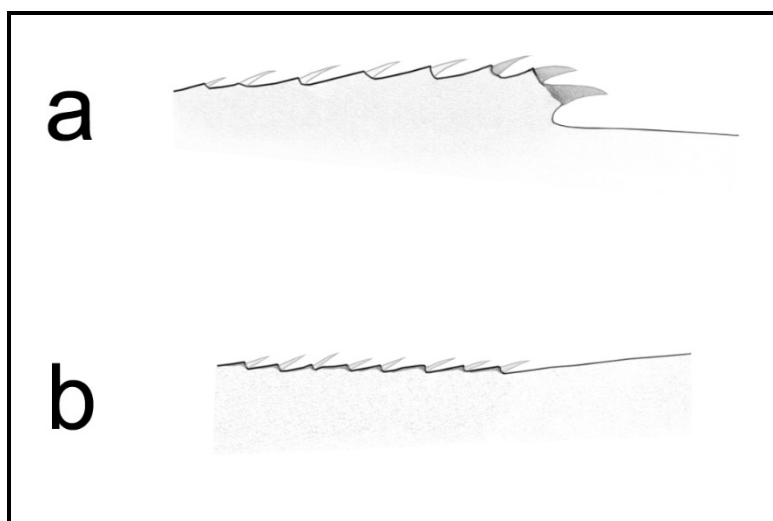


Fig. 14.8. Coenagrionidae, terminal marginal setae at midlength of median lamella, lateral view: a) *Neoerythromma cultellatum*; b) *Ischnura posita*.

5. Lateral carinae of abdominal segments 3–8 with spiniform setae in a single row (Fig. 14.9a), rarely a few staggered setae above the row on segments 5 and/or 6; antennae 6-segmented (Fig. 14.10a); eyes completely dark (Fig. 14.11a) or with a lattice-like pattern (Fig. 14.11b)..... ***Enallagma***
- 5'. Lateral carinae of abdominal segments 3–8 with spiniform setae usually in staggered rows (Fig. 14.9b), the exception being *Leptobasis*; antennae 7-segmented (Fig. 14.10b); eyes with one or more horizontal pale bands (Fig. 14.11c)**6**

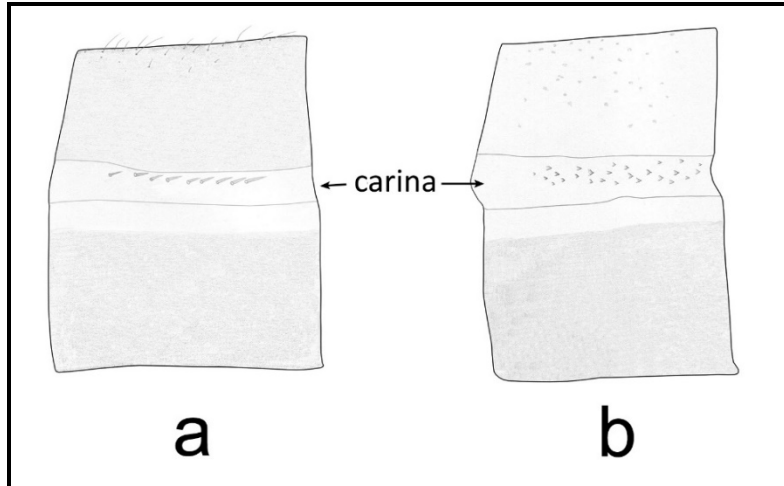


Fig. 14.9. Coenagrionidae, abdominal segment 5, lateral view, showing arrangement of setae on lateral carina: a) *Enallagma doubledayi*; b) *Ischnura ramburii*.

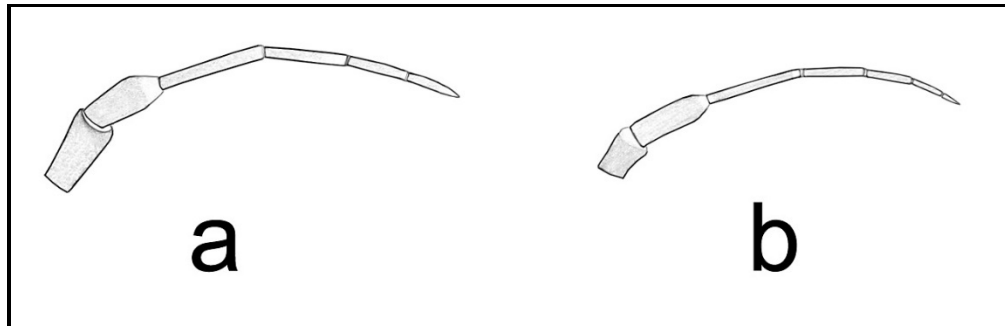


Fig. 14.10. Coenagrionidae, right antenna, lateral view (setae omitted): a) *Enallagma signatum*; b) *Ischnura posita*.

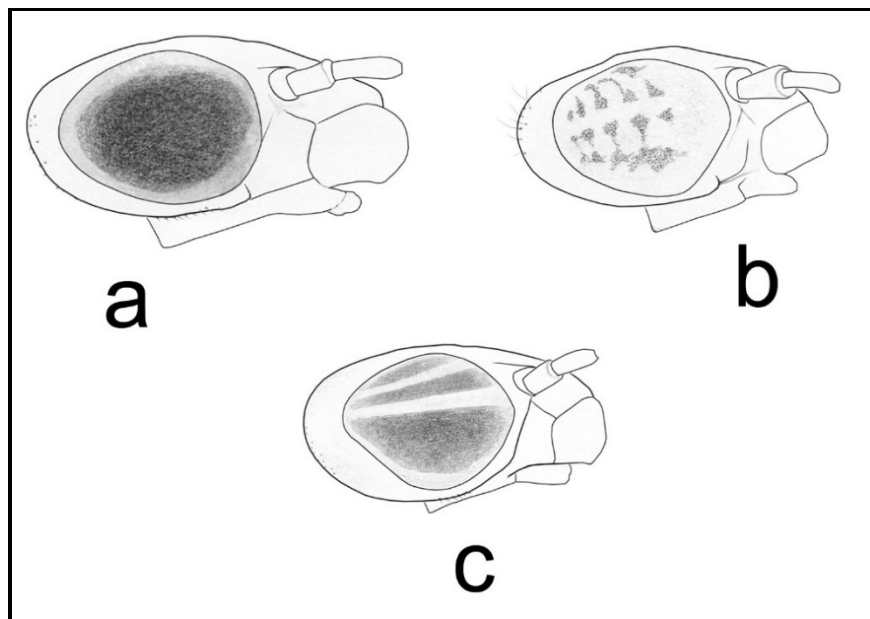


Fig. 14.11. Coenagrionidae, head in lateral view, showing compound eye: a) *Enallagma civile*; b) *Enallagma concisum*; c) *Ischnura posita*.

6. Lateral carinae of abdominal segments 3–6 with spiniform setae staggered, at least on some segments (Fig. 14.12a); male cercus in lateral view with apex obtuse (truncate or rounded; Fig. 14.13a); female ovipositor extending to distal margin of abdominal segment 10 or slightly beyond (Fig. 14.14a) *Ischnura*
- 6'. Lateral carinae of abdominal segments 3–6 with spiniform setae in a single row on all segments (Fig. 14.12b); male cercus in lateral view with apex bluntly pointed (Fig. 14.13b); female ovipositor extending beyond distal margin of abdominal segment 10 by a distance equal to segment 10 length (Fig. 14.14b) *Leptobasis*

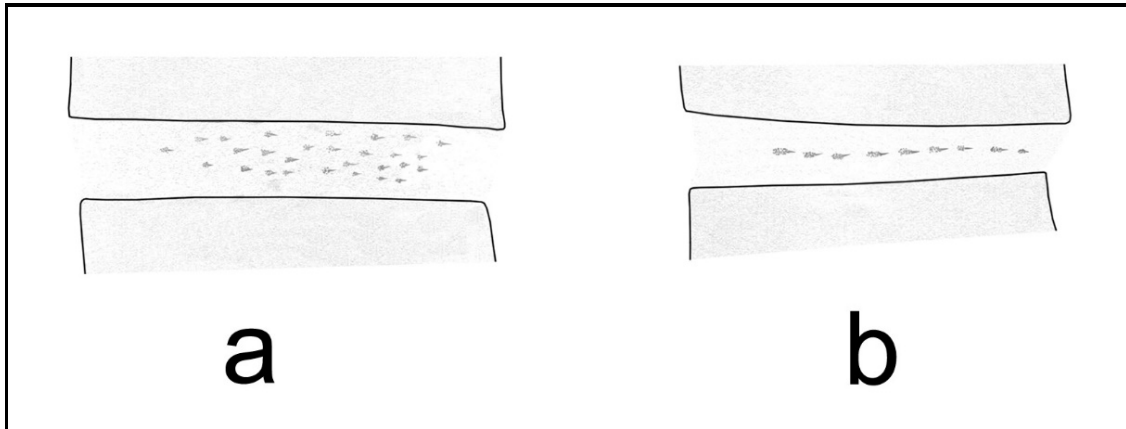


Fig. 14.12. Coenagrionidae, lateral carina of abdominal segment 6, lateral view, showing arrangement of spiniform setae: a) *Ischnura posita*; b) *Leptobasis lucifer*.

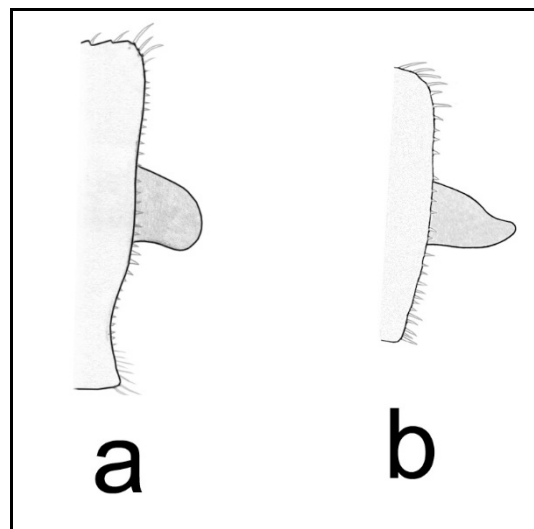


Fig. 14.13. Coenagrionidae, male cercus, lateral view: a) *Ischnura posita*; b) *Leptobasis lucifer*.

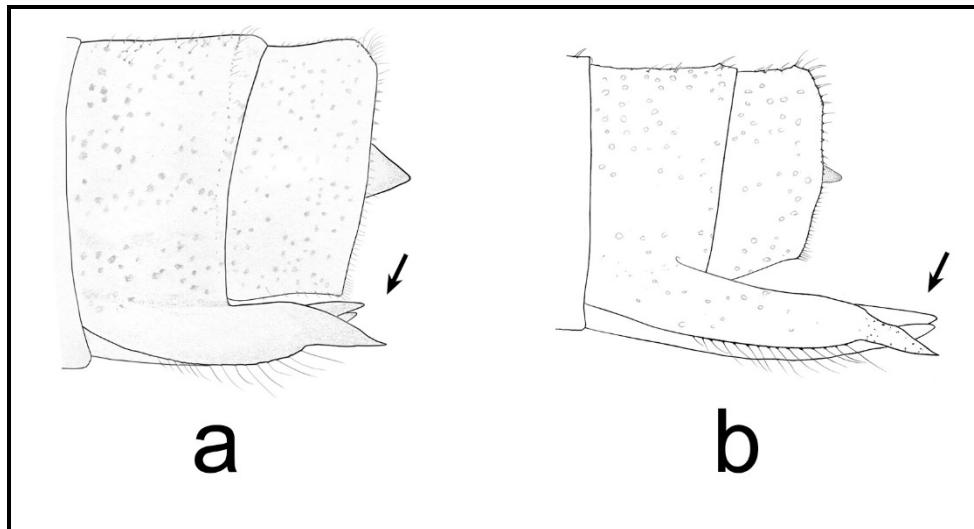


Fig. 14.14. Coenagrionidae, female abdominal segments 9 and 10 in lateral view, showing ovipositor length relative to segment 10: a) *Ischnura posita*; b) *Leptobasis lucifer*.

Diagnostic Remarks:

Caudal lamellae characters are utilized sparingly in the generic key and those that are presented are supplemented with characters based on other morphological features in case the lamellae are missing or are partly regenerated; regenerated lamellae usually do not exhibit the full characteristics of normally developed lamellae.

Telebasis, like *Argia*, differs from the other genera in the dimensions of the prementum: the ratio of the basal width of the prementum compared to the length of the prementum is about 0.45, within the range for *Argia*; all other coenagrionid genera in Florida have a much narrower base relative to prementum length (≤ 0.35). Also, the upper palpal lobe of *Telebasis byersi* resembles that of *Argia* and is an exception compared to the truncate lobe in the other coenagrionid genera.

Nehalennia nymphs are characteristically small (F-0 head width 2.30–2.90 mm, hind femur length 1.90–2.85 mm), separating them from most species in other coenagrionid genera. However, *Leptobasis lucifer* and at least one species of both *Enallagma* and *Ischnura* overlap in these measurements. The femora of *Nehalennia* usually have two dark bands whereas there is only dark band in the other remaining four genera, and the tips of the caudal lamellae of *Nehalennia* are usually filamentous compared to attenuated to nearly rounded tips of species in the other genera.

Neoerythromma cultellatum resembles some *Enallagma* species. The lamellae of the majority of *Enallagma* species have the terminal marginal spiniform setae subequal in stature to the preceding setae; these are the species in which the adults are predominantly blue. Among the *Enallagma* species in which the adults have orange, red or purple markings (pale markings not predominantly blue), the terminal spiniform setae on the lamellae are usually slightly larger (stouter and longer) than the preceding setae (Fig. 14.15a), although the difference is not as pronounced as in *Neoerythromma* (Fig. 14.15b).

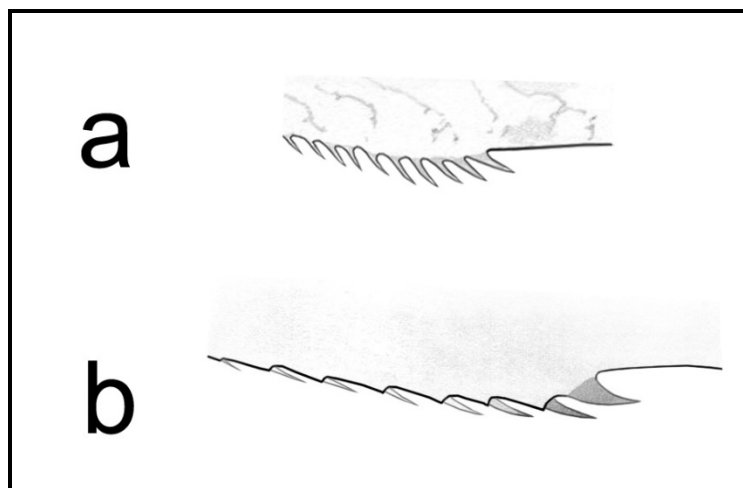


Fig. 14.15. Coenagrionidae, terminal setae on ventral margin of left lateral lamella, near midlength of lamella: a) *Enallagma pollutum*; b) *Neoerythromma cultellatum*.

All Florida species of *Enallagma* have 6-segmented antennae. However, the sixth segment in some species has a slightly perceptible constriction near or just beyond its midlength (Fig. 14.16a); if a faint constriction is present, a few fine pale setae may also be present around the constriction. Therefore, the terminal antennal segment must be examined carefully under high magnification and proper lighting to determine whether or not a joint is present. The joint between segments 6 and 7 in *Ischnura* and *Leptobasis* is clearly defined (Fig. 14.16b,c). In addition, the relative lengths of antennal segments 1 and 2 will separate most *Enallagma* species from *Ischnura* and *Leptobasis*: the ratio of seg. 2 length:seg. 1 length ranged from 1.00–1.70 (average 1.20) in the 17 species of *Enallagma* as opposed to 1.60–1.95 (average 1.75) in the five *Ischnura* and one *Leptobasis* species. Only two species of *Enallagma* had a ratio that approached or was greater than 1.60 (*E. doubledayi* and *E. civile*). Therefore, the ratio is helpful in most cases although not totally reliable.

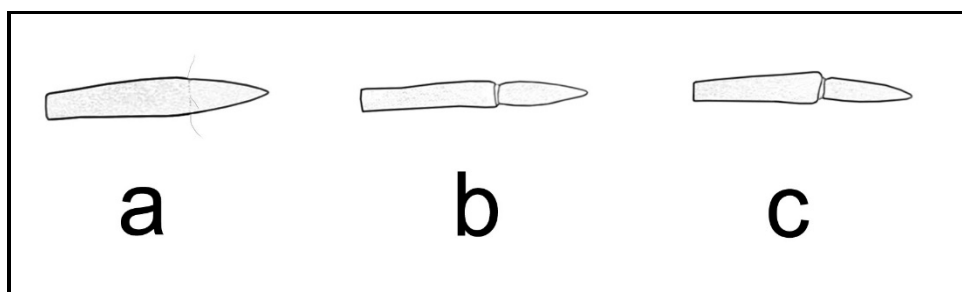
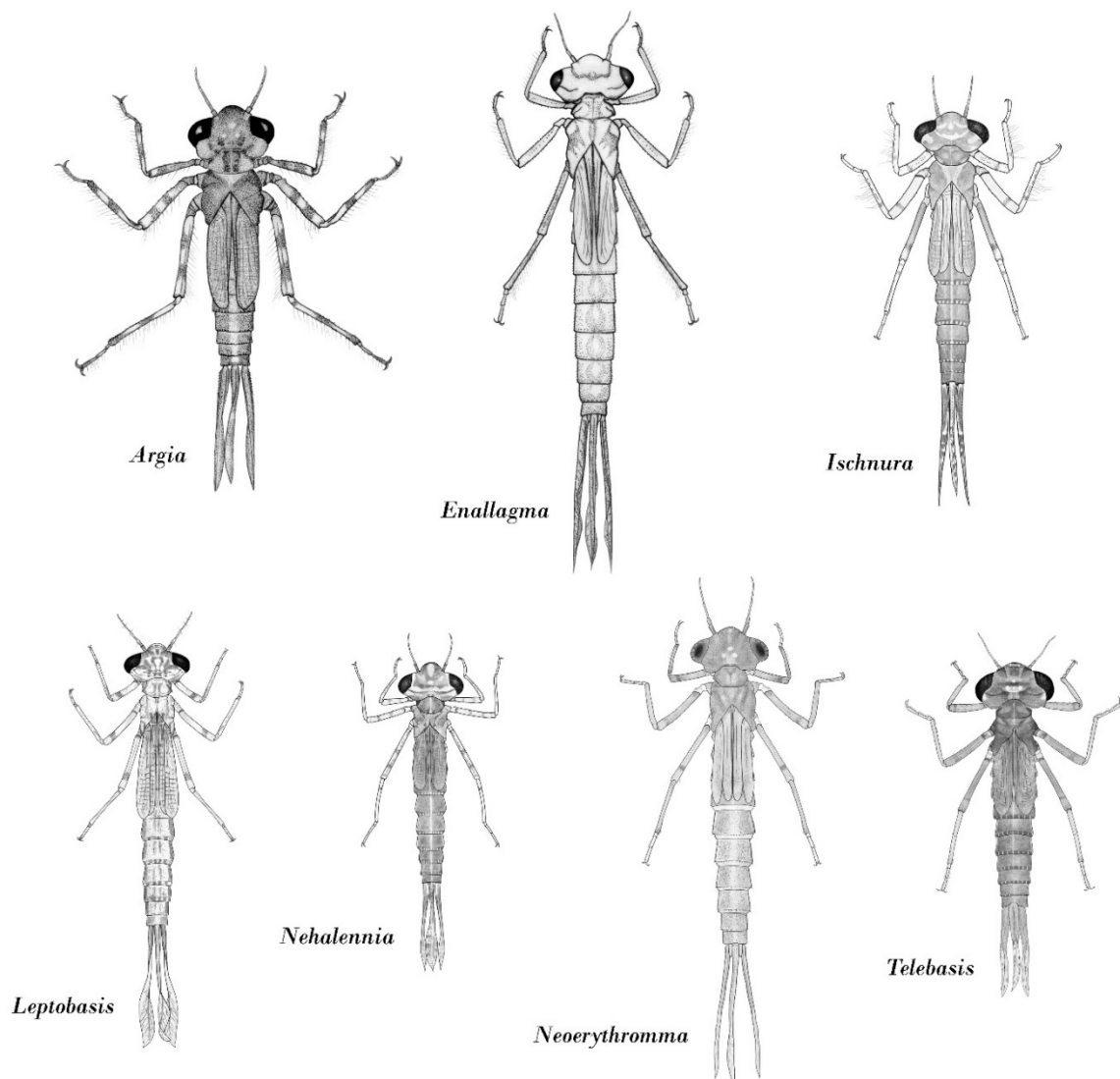


Fig. 14.16. Coenagrionidae, terminal antennal segment(s): a) *Enallagma doubledayi*; b) *Ischnura posita*; c) *Leptobasis lucifer*.

Eye color pattern (as presented in couplet 5) readily differentiates *Enallagma* from *Ischnura/Leptobasis*, especially with living or freshly preserved nymphs. However, eye pattern in preserved specimens is sometimes obscured, in which case the last character in couplet 5 would be doubtful. Eyes that are completely dark could be *Enallagma*, *Ischnura* or *Leptobasis*, and reliance on the other characters is necessary.

The small spiniform setae on the lateral carinae of abdominal segments 3–8 of *Ischnura* are variable. Although the setal arrangement on the lateral carinae of segments 7 and 8 is usually similar to the setae on segments 3–6, in a few exceptional species the setae are in a rather straight row. Furthermore, the lateral carinae of segment 5 and 6 in a few species of *Enallagma* in Florida have a few staggered setae. Reliance on this character alone is not advised.

Plate 10. Representatives* of the seven Coenagrionidae genera of Florida.

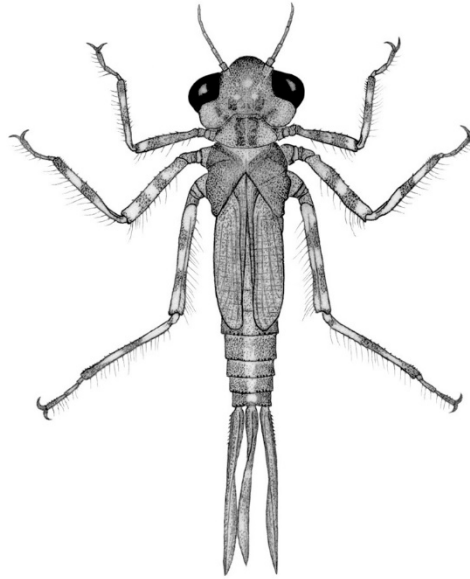


* The species presented in Plate 10 are *Argia apicalis*, *Enallagma civile*, *Ischnura posita*, *Leptobasis lucifer*, *Nehalennia integricollis*, *Neoerythromma cultellatum*, and *Telebasis byersi*.

Coenagrionidae Generic Treatments

Argia

Stocky, flattened, head pentagonal; prementum without prominent setae; palpal lobes w/ 2 pointed hooks, 0–4 palpal setae; legs often patterned; caudal lamellae lack nodus, main trachea thick, apical half of lamellae flat



Argia is the largest genus of Odonata in the New World, with 135 valid species and at least a dozen still undescribed species (R. W. Garrison, pers. comm., Nov. 16, 2020); its highest diversity is in the Neotropics. Thirty nine species occur in the United States, six of which are found in Florida.

Diagnosis:

Argia nymphs resemble *Telebasis* in general appearance and in the wide base of the prementum (though *Argia* is typically larger in overall size). Furthermore, the lone species of *Telebasis* that occurs in Florida (*T. byersi*) has a pointed upper palpal process much like that of *Argia*. The most reliable differences are: 1) *Argia* prementum lacks long prominent setae (*Telebasis* has at least 1 on each side); 2) *Argia* palpal setae and their bases are inconspicuous (in *Telebasis* prominent).

Key to *Argia* Species

Note: because the palpal setae of *Argia* are fine and often very pale, they can be relatively difficult to detect and count; rotating the palps from an ental view to a dorsolateral view and changing the angle of lighting can help reveal the setae and make counting them easier.

1. Margins of caudal lamellae fringed with spiniform setae for nearly entire length, few long hair-like setae present (Fig. 14.17a); tarsal claws on metathoracic leg slightly curved, length over one-half length of 3rd tarsal segment (Fig. 14.18a).....2

- 1'. Margins of caudal lamellae fringed with white hair-like setae for entire length (Fig. 14.17b), lacking spiniform setae except for a few at extreme base of lamella; tarsal claws on metathoracic leg strongly curved, length less than one-half length of 3rd tarsal segment (Fig. 14.18b).....4

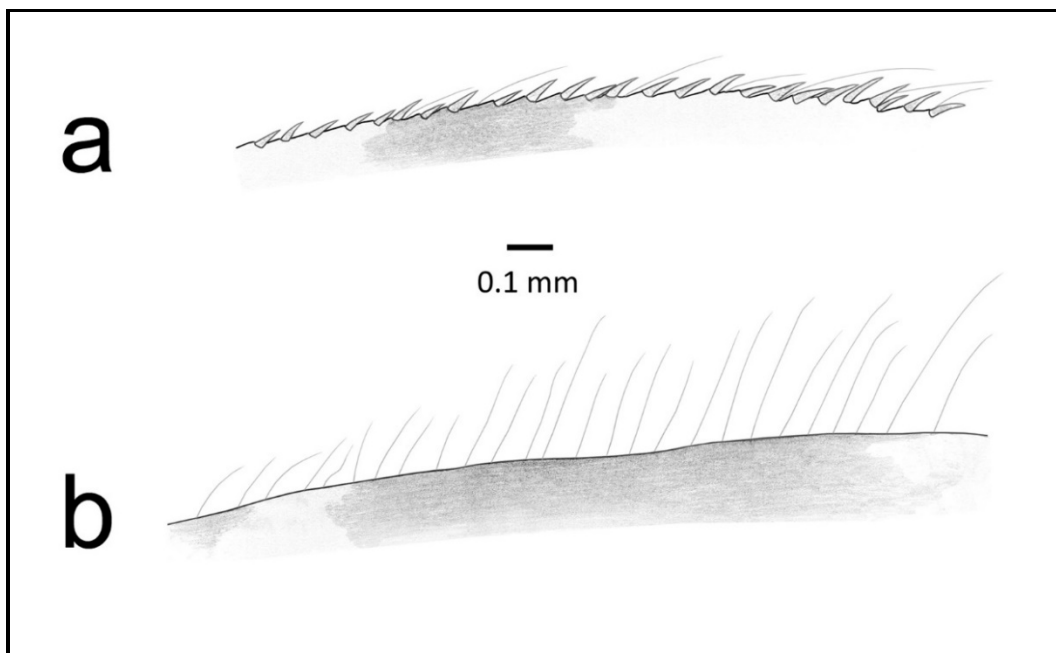


Fig. 14.17. *Argia*, portion of dorsal margin of lateral caudal lamella near midlength, lateral view: a) *A. sedula*; b) *A. tibialis*.

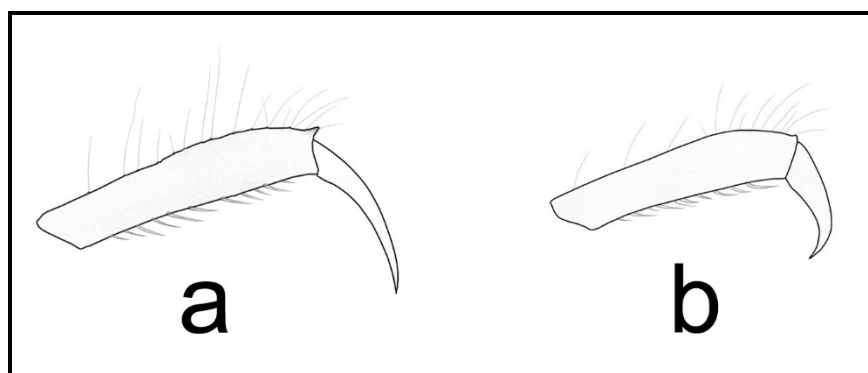


Fig. 14.18. *Argia*, third tarsal segment of left leg, lateral view: a) *A. fumipennis*; b) *A. tibialis*.

2. Ligula nearly straight medially, prementum without basal short setae (Fig. 14.19a); F-0 caudal lamellae < 4 mm long, < 1.2 mm wide; lamellae in dorsal view thick beyond midlength (Fig. 14.20a); antennae 6-segmented.....***bipunctulata***
- 2'. Ligula rounded medially, prementum with 3–5 basal short setae on each side (Fig. 14.19b); F-0 caudal lamellae > 4mm long, > 1.4 mm wide; lamellae in dorsal view slender beyond midlength (Fig. 14.20b); antennae 7-segmented.....3

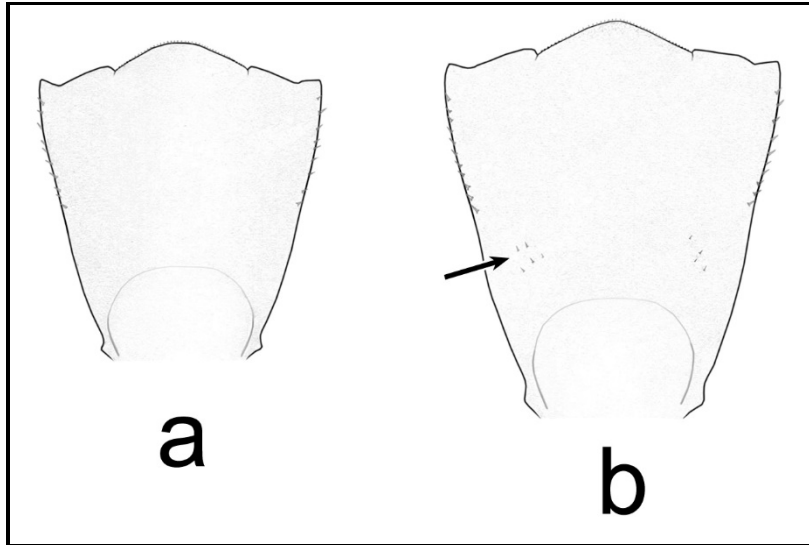


Fig. 14.19. *Argia*, prementum, ental view: a) *A. bipunctulata*; b) *A. fumipennis*; arrow indicates small basal setae.

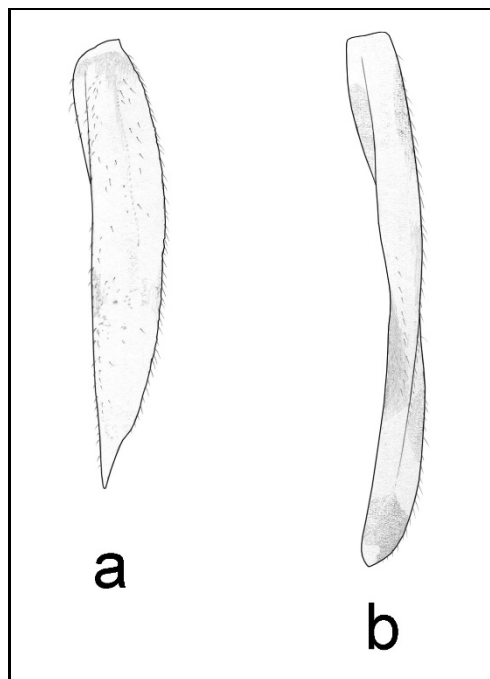


Fig. 14.20 *Argia*, right lateral caudal lamella, dorsal view: a) *A. bipunctulata*; b) *A. fumipennis*.

3. Antennal segments 1 and 2 mostly dark, not contrasting with segment 3 (Fig. 14.21a); median caudal lamella length:width ratio 0.35–0.46, lateral lamella length:width ratio 0.30–0.40; median caudal lamella with slightly produced baso-ventral corner, and dark markings weakly contrasting with pale areas (Fig. 14.22a)*fumipennis*
- 3'. Antennal segments 1 and 2 pale, contrasting with slightly darker segment 3 (Fig. 14.21b); median caudal lamella length:width ratio 0.45–0.50, lateral lamella length:width ratio

usually 0.40–0.45; median caudal lamella with strongly produced baso-ventral corner, and dark markings usually strongly contrasting with pale areas (Fig. 14.22b)*sedula*

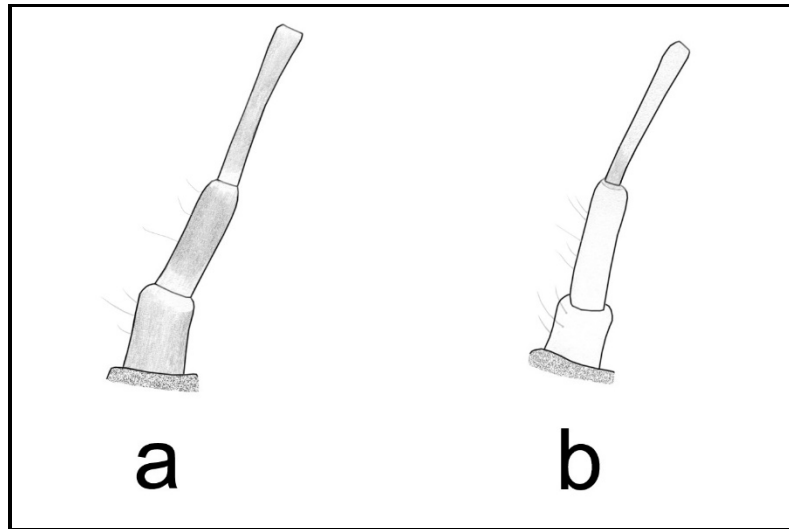


Fig. 14.21. *Argia*, antennal segments 1–3, dorsal view: a) *A. fumipennis*; b) *A. sedula*.

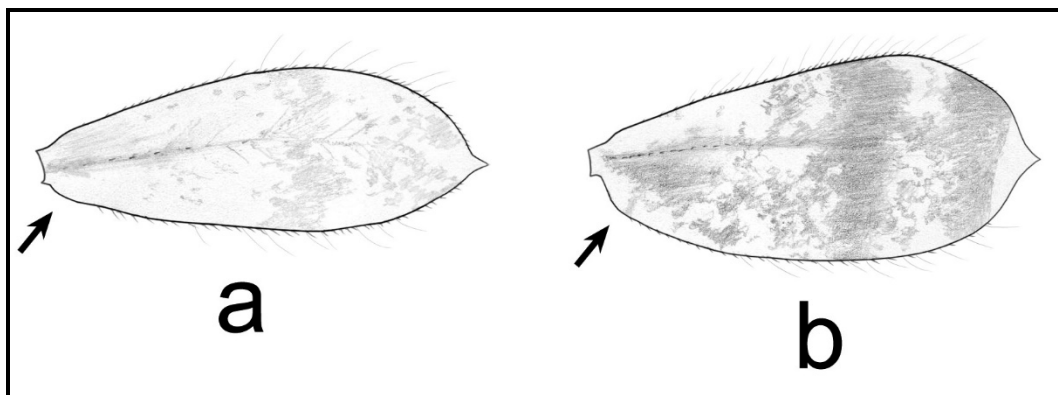


Fig. 14.22. *Argia*, median caudal lamella, lateral view: a) *A. fumipennis*; b) *A. sedula*; arrow indicates baso-ventral corner.

4. Lateral caudal lamellae with numerous long hair-like setae on main trachea, usually a few small, darker setae in basal tenth, best seen in dorsal view (Fig. 14.23a); caudal lamellae uniformly dark except apical tenth pale; ligula strongly produced, about 1/5 as long as main portion of prementum (Fig. 14.24a); 1 palpal seta.....*moesta*
- 4'. Lateral caudal lamellae with a row of small, dark stout setae in basal four-tenths, few long hair-like setae present, best seen in dorsal view (Fig. 14.23b); caudal lamellae patterned with pale and dark areas, usually with 2 wide dark bands, one near midlength, one apical; ligula moderately produced, about 1/6 as long as main portion of prementum (Fig. 14.24b); 1 or more palpal setae5

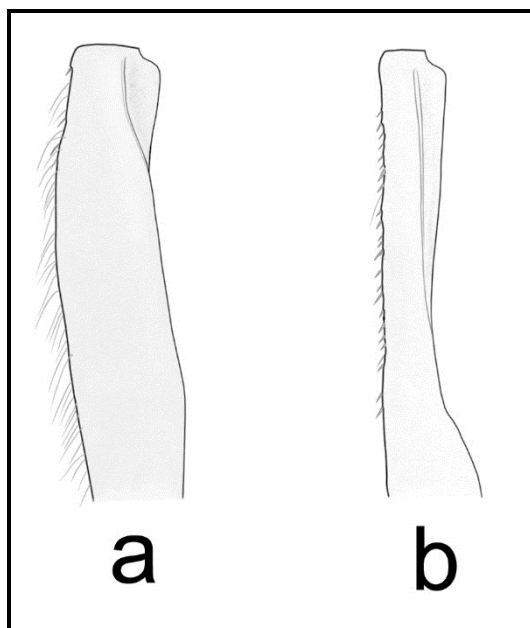


Fig. 14.23. *Argia*, basal half of left lateral caudal lamella, dorsal view, showing setae on main trachea: a) *A. moesta*; b) *A. apicalis*.

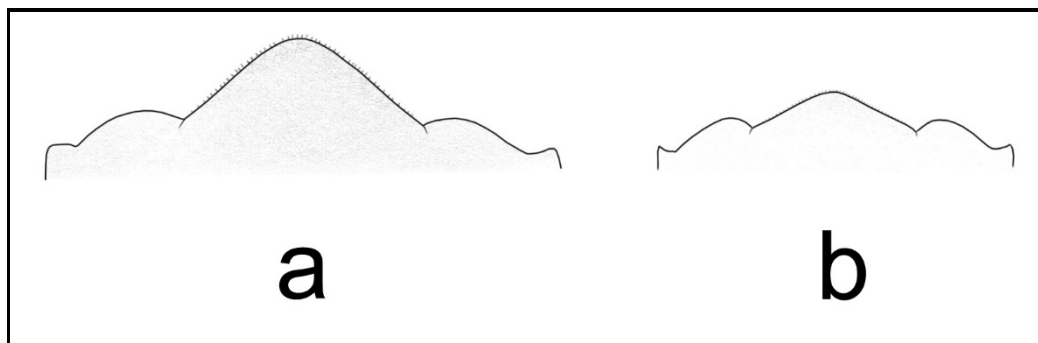


Fig. 14.24. *Argia*, ligula, ectal view: a) *A. moesta*; b) *A. apicalis*.

5. Palpal setae 2–4; femora with pale central band narrower than adjacent dark bands (Fig. 14.25a); median caudal lamella with 0–4 small stout setae confined to basal tenth, best seen in dorsal view (Fig.14.26a) ***apicalis***
- 5'. Palpal setae usually 1, close to base of movable hook (sometimes a second more proximal seta present); femora with pale central band as wide as or wider than dark adjacent bands (Fig. 14.25b); median caudal lamella with 4–10 small, dark, stout setae in basal fifth (Fig.14.26b)..... ***tibialis***

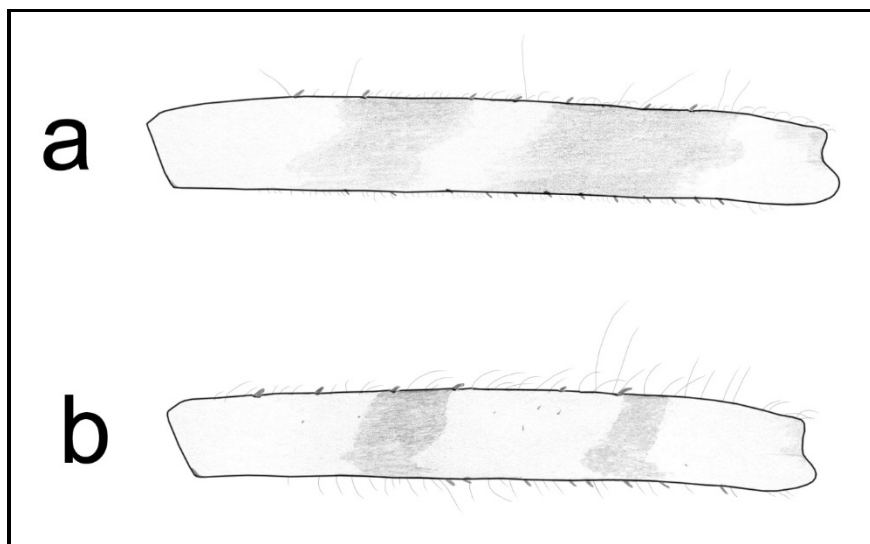


Fig. 14.25. *Argia*, metathoracic femur, lateral view: a) *A. apicalis*; b) *A. tibialis*.

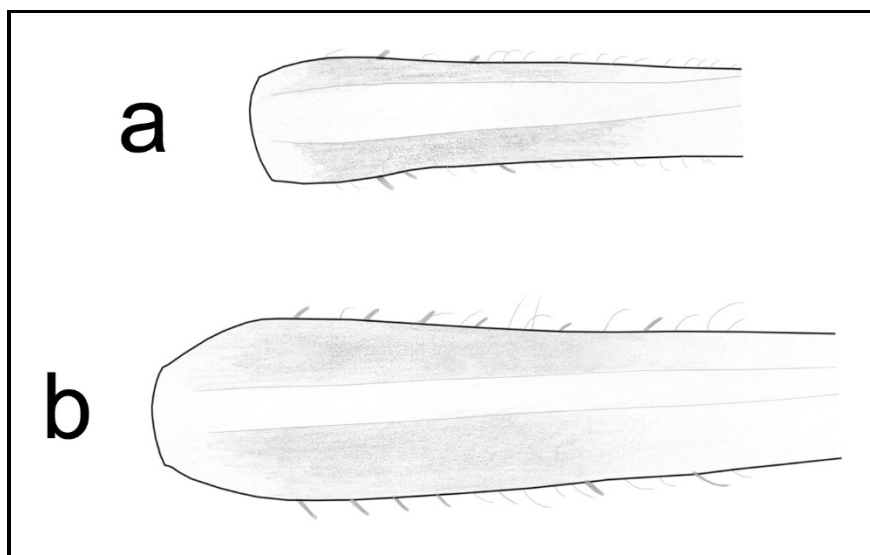


Fig. 14.26. *Argia*, median lamella, dorsal view: a) *A. apicalis*; b) *A. tibialis*.

Diagnostic Remarks:

Most of the key characters are reliable for instar F-1, but for instars earlier than F-1 it is probably best to leave identification at genus level.

Argia bipunctulata is the most distinctive of all the Florida *Argia* species. In addition to the key characters, it is the smallest (F-0 head width 2.70–3.00 mm versus 3.10–4.20 mm for the other five species combined). Also, the legs of *A. bipunctulata* are completely pale; the other five species have various dark markings on the femora and tibiae though they may be diffuse.

Argia fumipennis and *A. sedula* are remarkably similar. The number of palpal setae, used previously to separate these species, is not totally reliable as some *A. fumipennis* have 3 palpal setae. The only characters thus far discovered are included in couplet 3. The caudal lamella are shown in Plate 11; lamella patterning is variable; some *A. sedula* have paler lamellae than shown in Fig. 14.22b and Plate 11. No key characters to separate the two subspecies of *Argia fumipennis*

have been published. *Argia f. fumipennis* has two palpal setae, as in the more northerly distributed *A. f. violacea*, whereas *A. f. atra* can have two or three palpal setae.

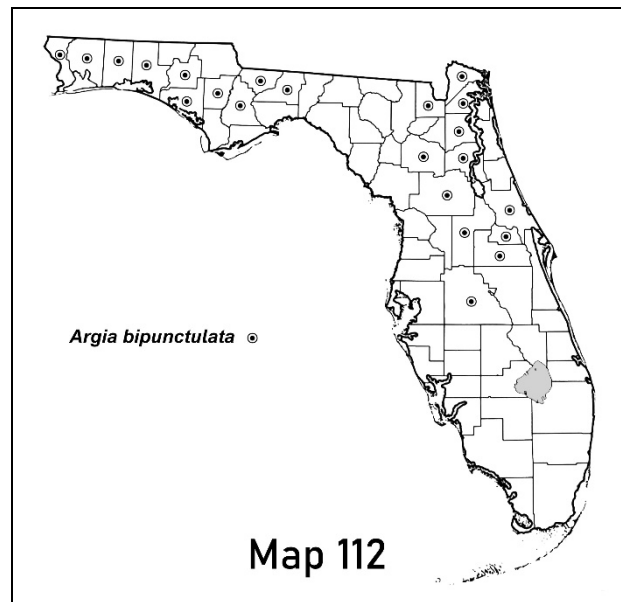
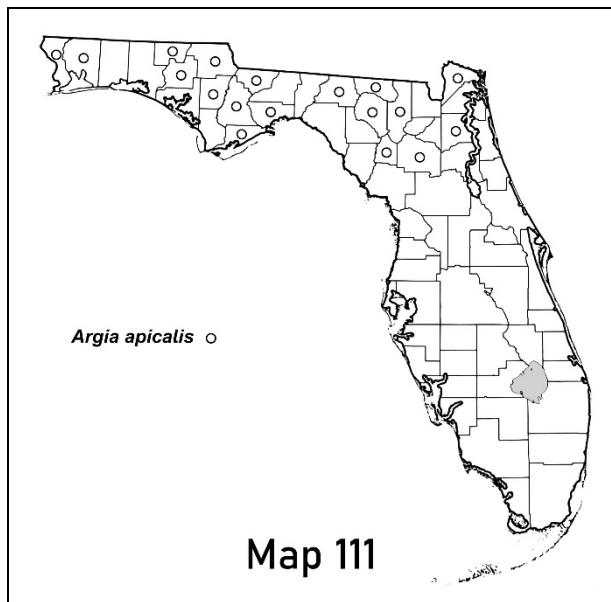
In addition to the characters in couplet 4, the setae on the dorsoposterior margins of abdominal segments 6–9 in *Argia moesta* are pale, slender, and inconspicuous; in *A. apicalis* and *A. tibialis* the setae are much more conspicuous, being stout and dark, and many of the setae are bluntly tipped. The latter two species are more difficult to distinguish. The lateral caudal lamellae of *A. apicalis* are less attenuate apically and wider relative to their length than are those of *A. tibialis* (see Plate 11).

Habitat, Distribution, Life Cycle:

Argia nymphs are mainly lotic although a few species are both lotic and lentic. Habitats include rivers, small streams, slow-flowing canals, seeps and bogs, and lakes. *Argia apicalis*, *A. moesta*, *A. sedula* and *A. tibialis* are typically lotic, inhabiting small to large streams, the former two species in larger more open streams, *A. sedula* in slow-flowing streams and canals, and *A. tibialis* in smaller, sandy, more forested streams. In some regions of the U.S., *A. apicalis* inhabits lakes, but it appears to be lotic in Florida. *Argia bipunctulata* is unusual in inhabiting seepage trickles and boggy spots along small, wooded streams. *Argia fumipennis* occupies slow streams, canals and open ponds and lakes.

Argia apicalis has been recorded only in the northern third of the state (Map 111). *Argia bipunctulata* and *A. tibialis* occur south to Polk County (Maps 112 & 116). *Argia fumipennis* and *A. moesta* occur south to at least Lake Okeechobee (Maps 113 & 114) whereas *A. sedula* occurs further south to Miami-Dade County (Map 115).

Recorded flight seasons are long, beginning in early spring and lasting at least until late summer. The dates for *A. apicalis* are from April 12 to August 22, and for *A. bipunctulata* from March 3 to August 17. The dates for *A. moesta* are from March 27 to November 15, and for *A. tibialis* from March 3 to October 26. Two species, *A. fumipennis* and *A. sedula* fly yearlong in the southern part of the peninsula. *Argia* species appear to be univoltine in Florida.



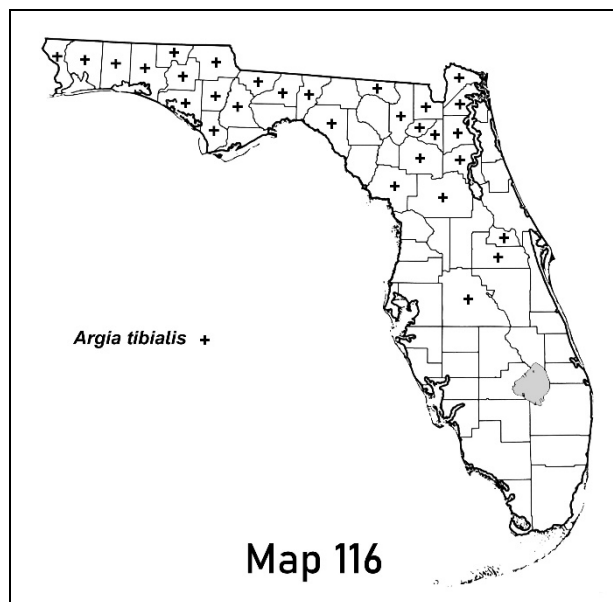
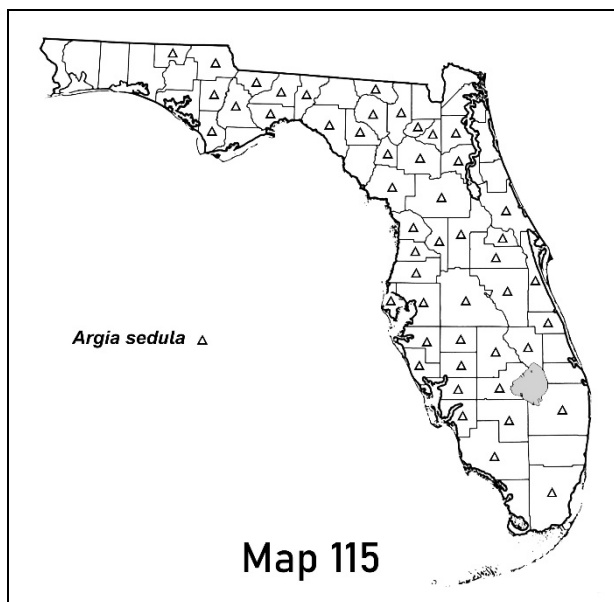
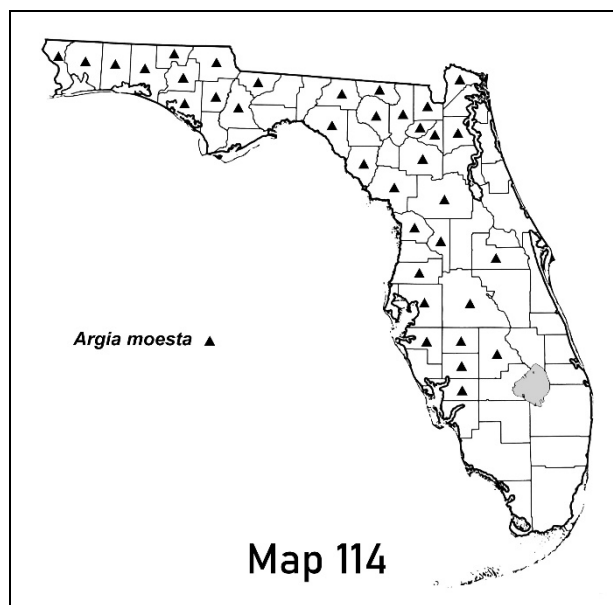
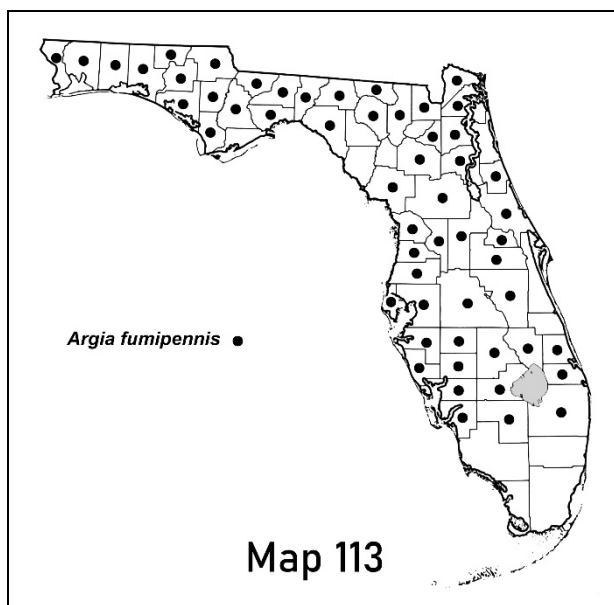
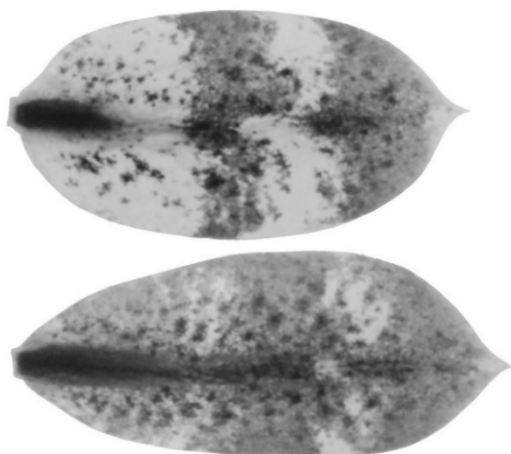
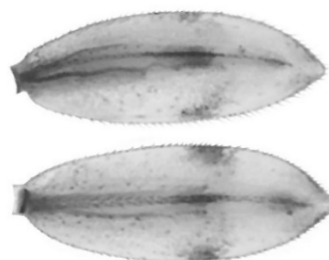


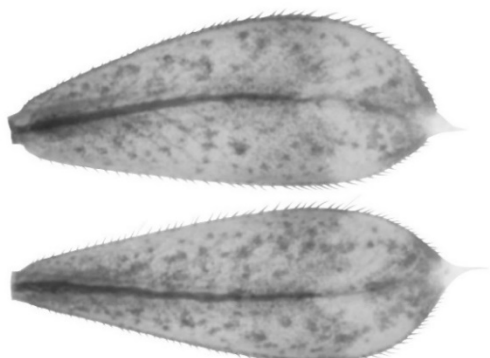
Plate 11. Caudal lamellae of *Argia* in Florida (for each species, the upper photograph is the median lamella, lower photograph is the left lateral lamella; many fine setae are not visible).



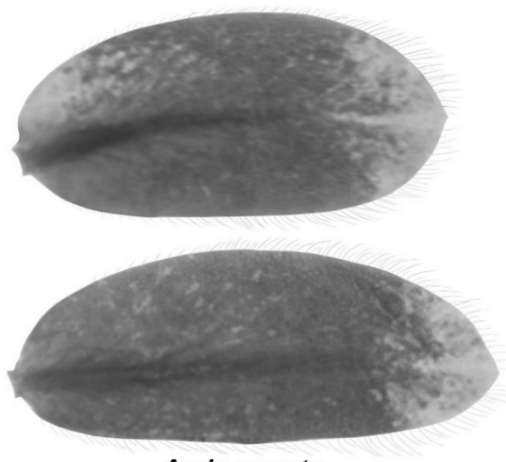
Argia apicalis



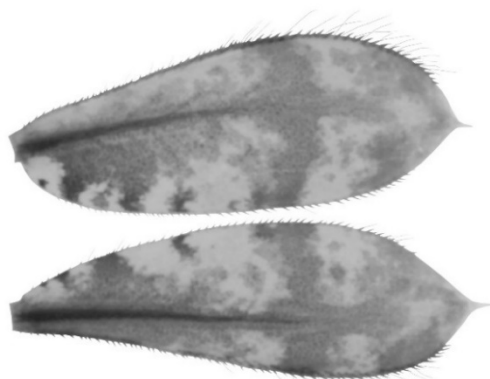
Argia bipunctulata



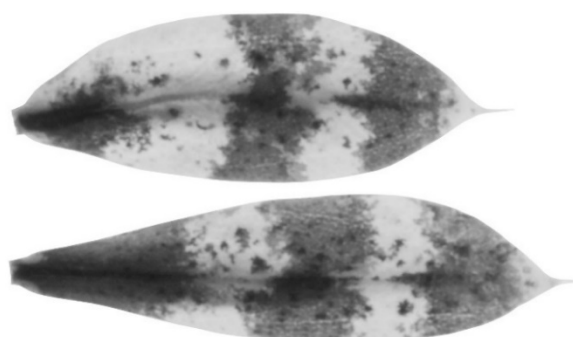
Argia fumipennis



Argia moesta



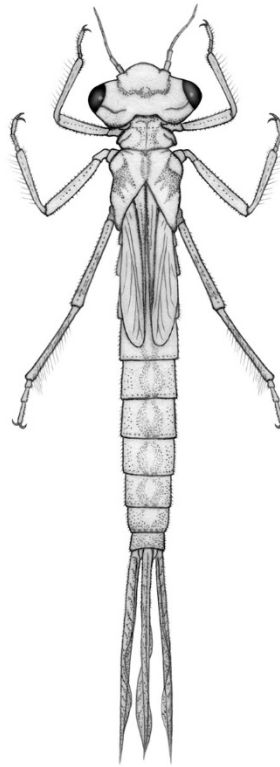
Argia sedula



Argia tibialis

Enallagma

Slender, elongate, head wider than long; antenna 6-segmented; prementum with 1–5 prominent setae; palpal lobes with truncate upper process, 3–6 palpal setae; caudal lamellae flat, tracheae distinct, nodus and patterning variable



Enallagma is a relatively large genus with its highest diversity (37 species) in the United States. Seventeen species are recorded in Florida.

Diagnosis:

Enallagma nymphs can be difficult to distinguish from *Ischnura*. The most reliable differences are presented in the key to the genera (pages 272–274) and diagnosis (page 276). The apical angle of the caudal lamellae of most *Enallagma* species, as in Fig. 14.34, is wide compared to *Ischnura*. However, the apical angle is variable and difficult to quantify, and a few *Enallagma* species, such as *E. divagans* and *E. pallidum*, have lamellae tips as acute as those of *Ischnura* (Fig. 15.44a); therefore, the tips are not reliable to routinely distinguish the two genera. *Leptobasis* is distinguished by having 7-segmented antennae, and the only species known in Florida, *L. lucifer*, has been found only in swamps in extreme southern tip of the state.

Key to *Enallagma* Species

1. Movable hook longer than palpal base (Fig. 14.27a); upper lobe of palp narrow, about as wide as gap between lobes (Fig. 14.27a); F-0 metathoracic femur length 3.75–4.55 mm, greater than width of head..... ***durum***
- 1'. Movable hook shorter than palpal base (Fig. 14.27b); upper lobe of palp wide, much wider than gap between lobes (Fig. 14.27b); F-0 metathoracic femur length 2.05–3.65 mm, usually less than width of head**2**

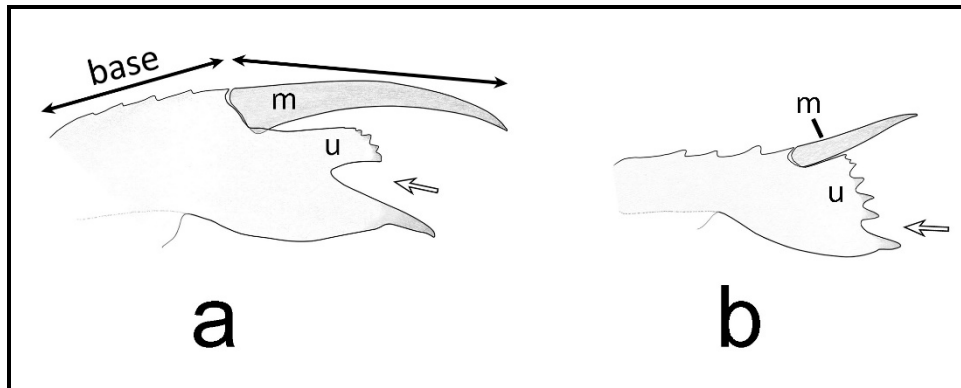


Fig. 14.27. *Enallagma*, right palp, ectal view, showing movable hook (m) and truncate upper lobe (u): a) *E. durum*; b) *E. divagans*; arrow indicates gap between upper and lower lobes.

2. Dorsum of abdominal segments 2–3 with long pale setae from base to posterior margin (Fig. 14.28a); eyes totally dark, not patterned; second antennal segment distinctly longer (1.4–1.9 times) than first segment (Fig. 14.29a).....3
- 2'. Dorsum of abdominal segments 2–3 either with long pale setae only near posterior margin (Fig. 14.28b) or without long setae (Fig. 14.28c); eyes patterned with spots or stripes; second antennal segment subequal in length to slightly longer (0.9–1.4 times) than first segment (Fig. 14.29b)6

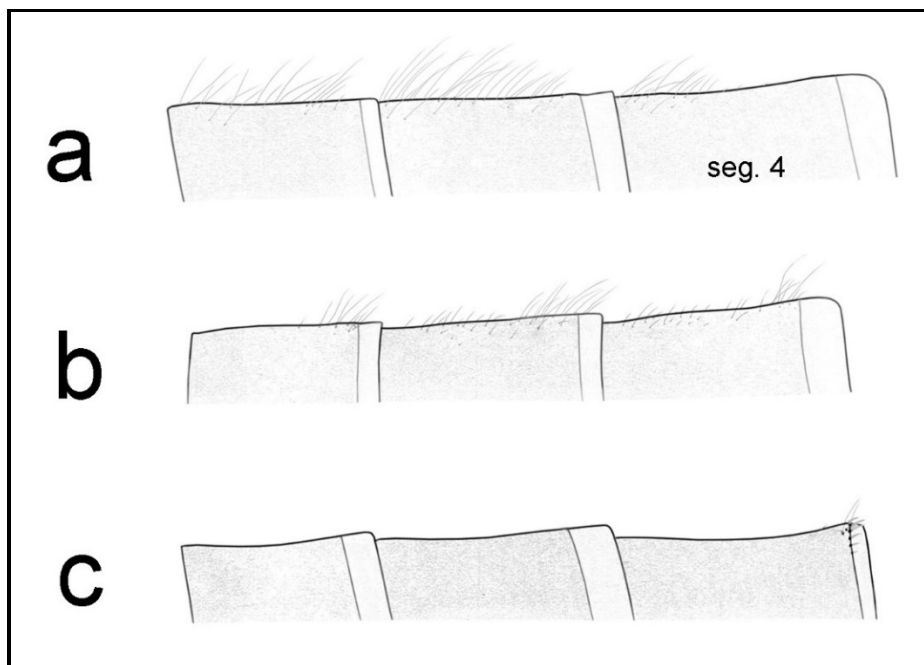


Fig. 14.28. *Enallagma*, dorsum of abdominal segments 2–4, lateral view: a) *E. civile*; b) *E. basidens*; c) *E. signatum*; the long pale setae are depicted dark for clarity.

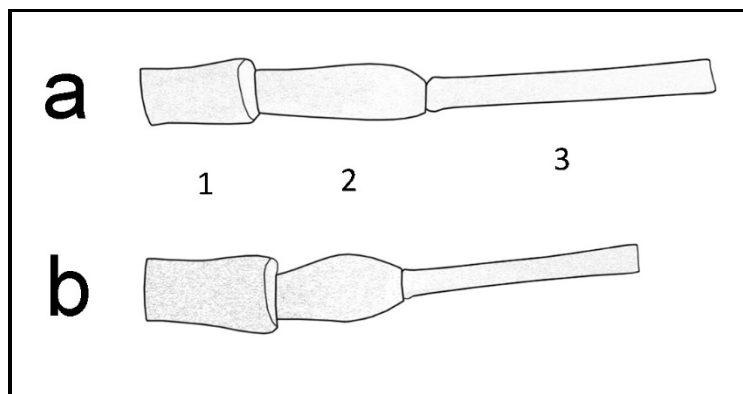


Fig. 14.29. *Enallagma*, basal antennal segments 1–3, dorsal view, setae omitted: a) *E. civile*; b) *E. signatum*.

3. Row of spiniform antenodal setae on dorsal margin of median lamella less than $\frac{3}{4}$ as long as row of similar setae on ventral margin of lateral lamellae (Fig. 14.30a); apex of caudal lamellae usually rounded (Fig. 14.30a); ligula triangular, anterior portion of prementum markedly projecting anteriorly (Fig. 14.31a).....*davisi*
- 3'. Row of spiniform antenodal setae on dorsal margin of median lamella at least $\frac{8}{10}$ to $\frac{9}{10}$ as long as row of same setae on ventral margin of lateral lamellae (Fig. 14.30b); apex of caudal lamellae pointed (Fig. 14.30b); ligula broadly rounded, anterior portion of prementum slightly to moderately projecting anteriorly (Fig. 14.31b)4

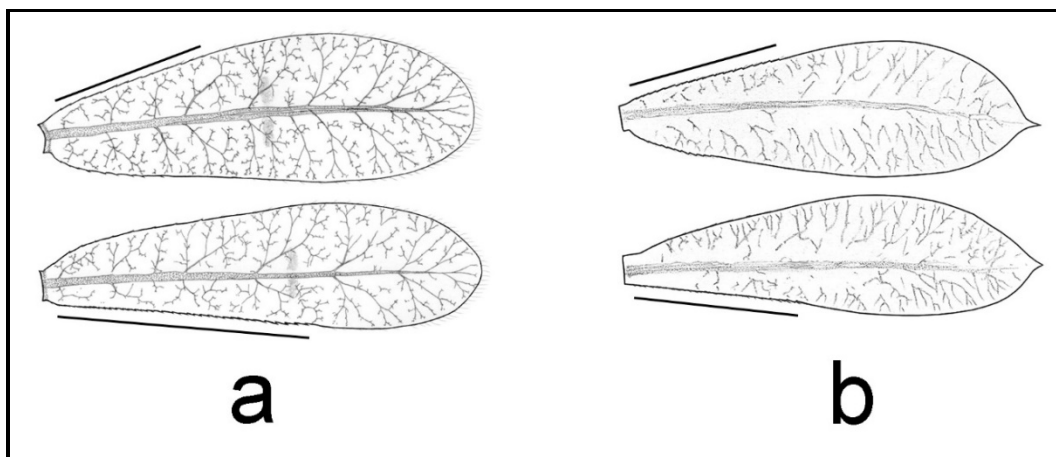


Fig. 14.30. *Enallagma*, caudal lamellae, lateral view: a) *E. davisi*; b) *E. geminatum*. Median lamella above, lateral lamella below; lines indicate length of dorsal and ventral series of spiniform setae.

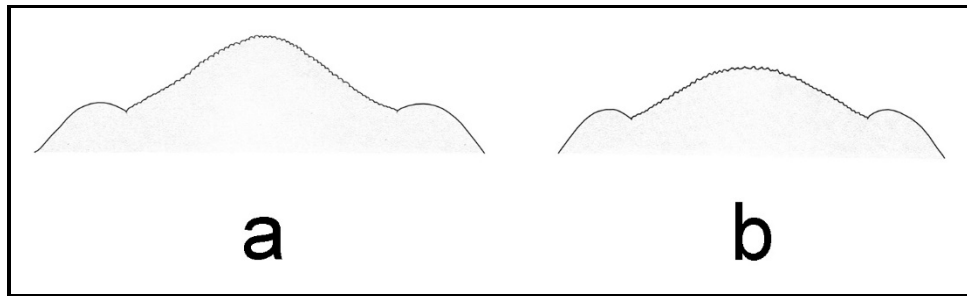


Fig. 14.31. *Enallagma*, ligula, ectal view: a) *E. davisii*; b) *E. geminatum*.

- 4. Fewer than 20 spiniform antenodal setae on dorsal margin of median lamella (Fig. 14.32a);
F-0 median lamella length 3.8–4.6 mm***geminatum***
- 4'. More than 20 spiniform antenodal setae on dorsal margin of median lamella (Fig. 14.32b);
F-0 median lamella length 5.3–6.6 mm**5**

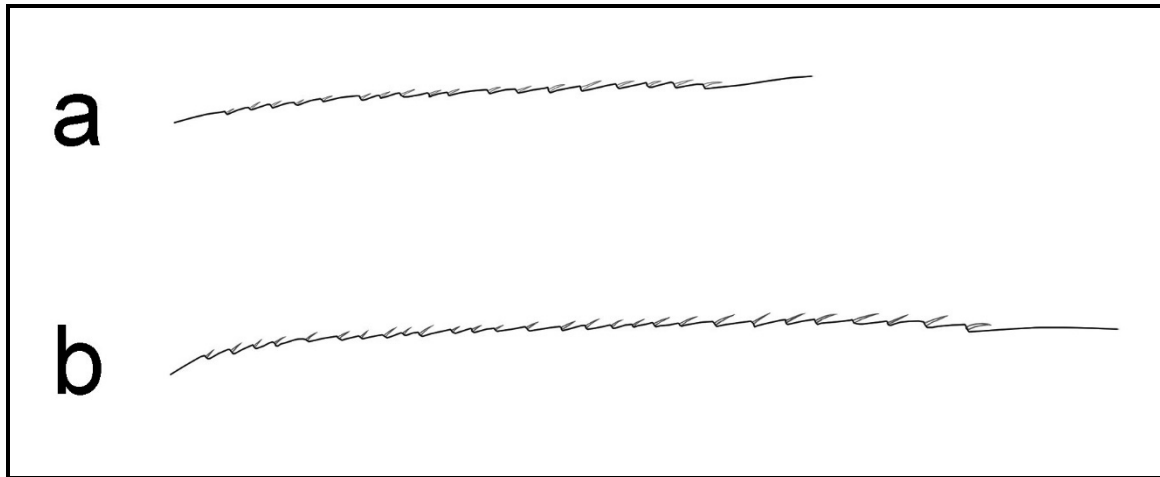


Fig. 14.32. *Enallagma*, proximal portion of median caudal lamella, showing spiniform setae on dorsal margin: a) *E. geminatum*; b) *E. civile*.

- 5. Ligula moderately rounded medially, moderately projecting anteriorly (Fig. 14.33a); lateral caudal lamellae with tracheae mostly dark but central trachea and some branches with intermittent pale intervals (Fig. 14.34a).....***civile***
- 5'. Ligula broadly rounded medially, barely projecting anteriorly (Fig. 14.33b); lateral caudal lamellae with tracheal branches completely dark (Fig. 14.34b)***doubledayi***

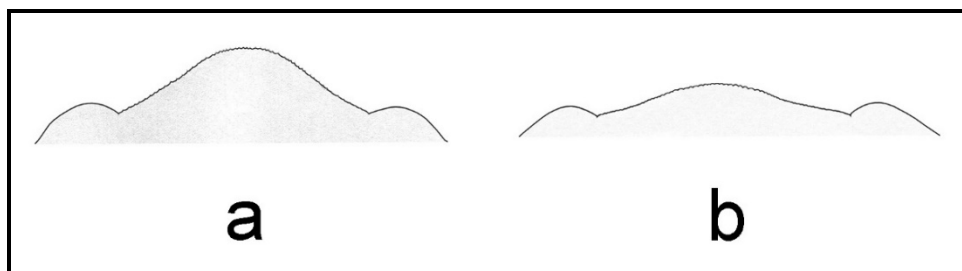


Fig. 14.33. *Enallagma*, ligula, ectal view: a) *E. civile*; b) *E. doubledayi*.

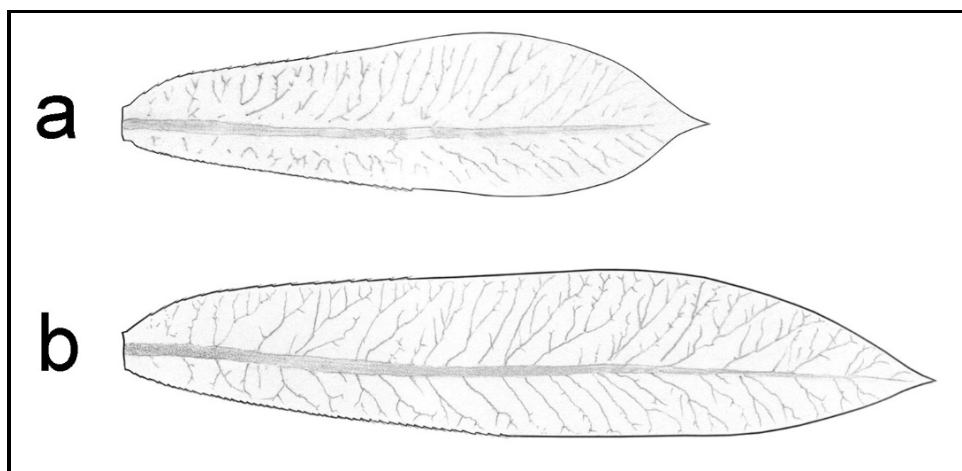


Fig. 14.34. *Enallagma*, left lateral caudal lamella: a) *E. civile*; b) *E. doubledayi*.

6. Lateral carinae of abdominal segments 2–8 with a prominent group of 3–5 large spiniform setae on posterior corners, in contrast to smaller more proximal setae (Fig. 14.35a); ventral margin of lateral caudal lamellae distal to nodus concave (Fig. 14.36a); head width across eyes more than twice head length (2.1–2.3) from base of antenna to posterolateral margin (Fig. 14.37a).....7
- 6'. Lateral carinae of abdominal segments 2–8 with few or no spiniform setae on posterior corners, if 1 or 2 such setae present about same size as more proximal setae (Fig. 14.35b); ventral margin of lateral caudal lamellae distal to nodus straight or slightly indented (Fig. 14.36b); head width slightly less to slightly more than twice head length (1.9–2.1) from base of antenna to posterolateral margin (Fig. 14.37b)12

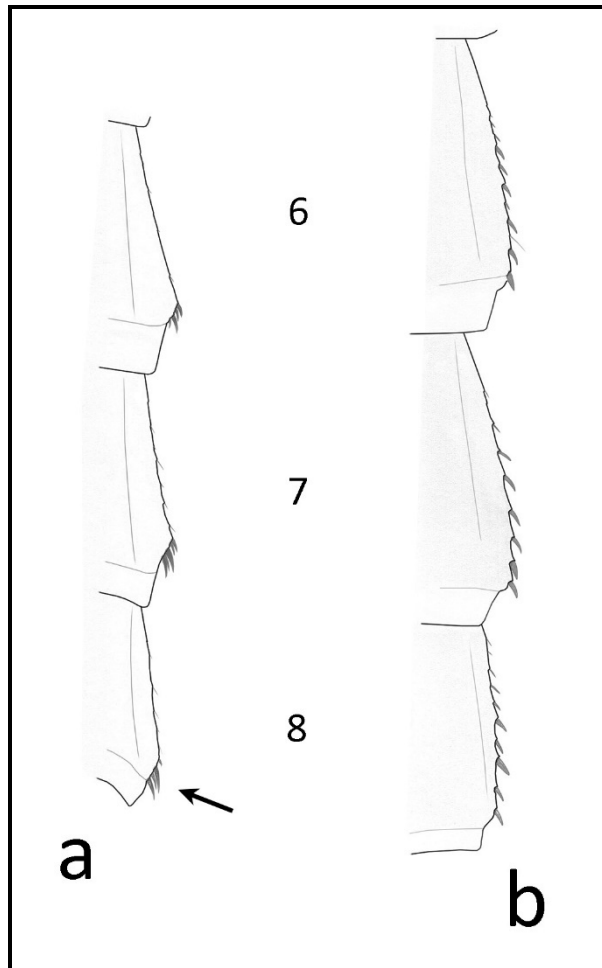


Fig. 14.35. *Enallagma*, lateral margin of abdominal segments 6–8, right side, dorsal view: a) *E. pollutum* (arrow indicates group of spiniform setae on posterolateral corner); b) *E. cardenium*.

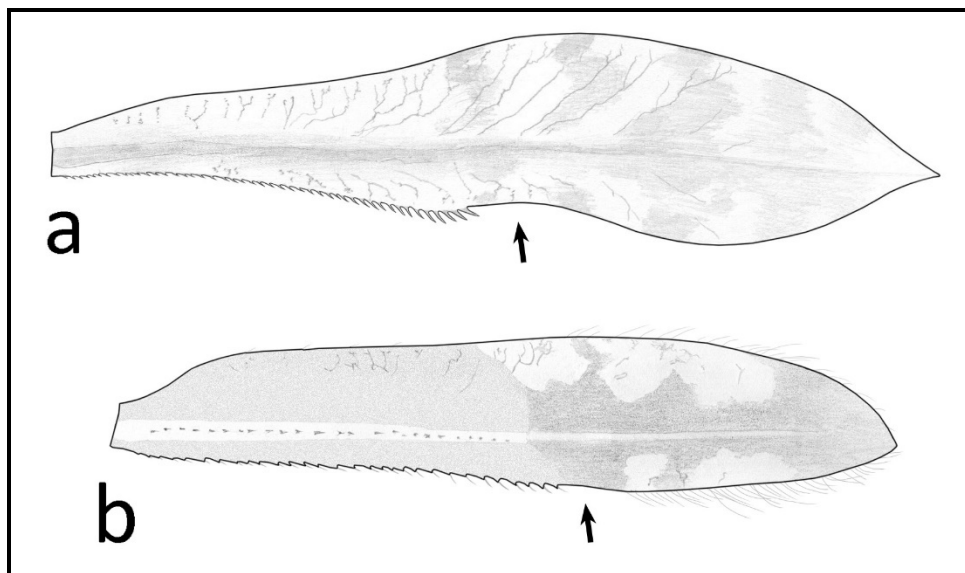


Fig. 14.36. *Enallagma*, ventral margin of lateral lamella: a) *E. pollutum*; b) *E. cardenium*; arrow indicates contour of margin distal to nodus.

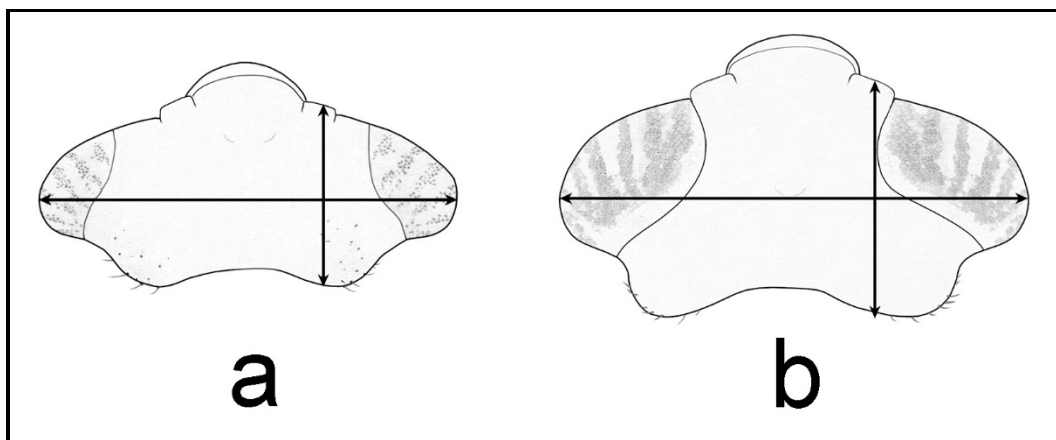


Fig. 14.37. *Enallagma*, head, showing width and length measurements in dorsal view: a) *E. pollutum*; b) *E. cardenium*.

- 7. Dorsal margin of median caudal lamella strongly convex (Fig. 14.38a); median lamella width:length ratio 2.7–3.0; lateral lamellae without spiniform antenodal setae on ventral margin ***vesperum***
- 7'. Dorsal margin of median caudal lamella moderately convex (Fig. 14.38b); median lamella width:length ratio 3.3–4.6; lateral lamellae with numerous spiniform antenodal setae on ventral margin **8**

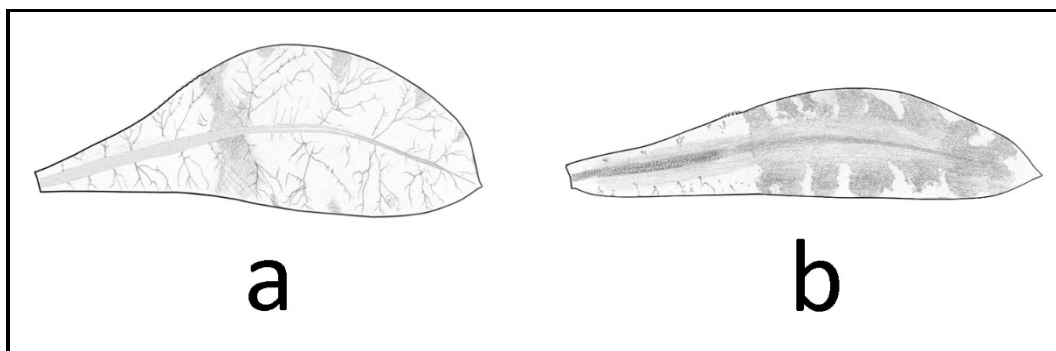


Fig. 14.38. *Enallagma*, median caudal lamella: a) *E. vesperum*; b) *E. signatum*.

- 8. Prementum not projecting anteriorly, ligula slightly concave medially (Fig. 14.39a); venter of abdominal segments 1–7 with spiniform setae on posterior margin ***sulcatum***
- 8'. Prementum projecting anteriorly, ligula convex medially (Fig. 14.39b); venter of abdominal segments 1–7 without spiniform setae on posterior margin **9**

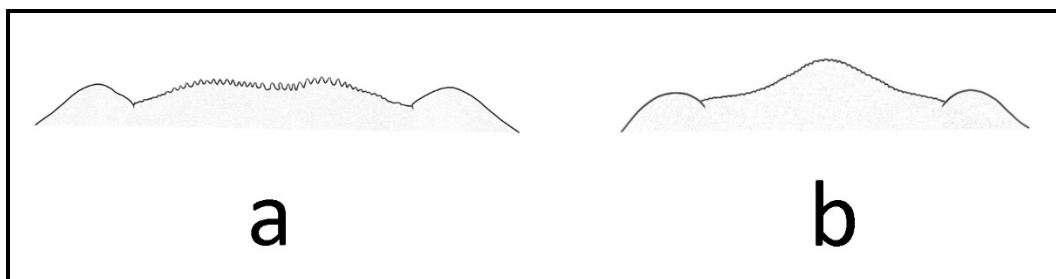


Fig. 14.39. *Enallagma*, ligula, ectal view: a) *E. sulcatum*; b) *E. pollutum*.

- 9. Lateral caudal lamellae with more than 40 stout sharp antenodal setae on ventral margin; metathoracic femur length usually greater than head width**10**
- 9'. Lateral caudal lamellae with fewer than 30 stout sharp antenodal setae on ventral margin; metathoracic femur length less than head width**11**

- 10. Lateral caudal lamellae with 35–46 spiniform antenodal setae on ventral margin and 20–30 spiniform setae laterally along proximal portion of main trachea; median lamella width:length ratio 3.5–3.6***pollutum***
- 10'. Lateral caudal lamellae with 45–55 spiniform antenodal setae on ventral margin and 30–40 spiniform setae laterally along proximal portion of main trachea; median lamella width:length ratio 4.0–4.6***signatum***

- 11. Tracheal branches in proximal half of caudal lamellae numerous, most with 2 or 3 branches (Fig. 14.40a); posterolateral corners of abdominal segments 3–5 with 4–6 spiniform setae; F-0 head width > 3.0 mm, metathoracic femur length > 2.9 mm***concisum***
- 11'. Tracheal branches in proximal half of caudal lamellae few, unbranched or with 1 branch (Fig. 14.40b); posterolateral corners of abdominal segments 3–5 with 2 or 3 spiniform setae, rarely 4; F-0 head width < 3.0 mm, metathoracic femur length < 2.8 mm***dubium***

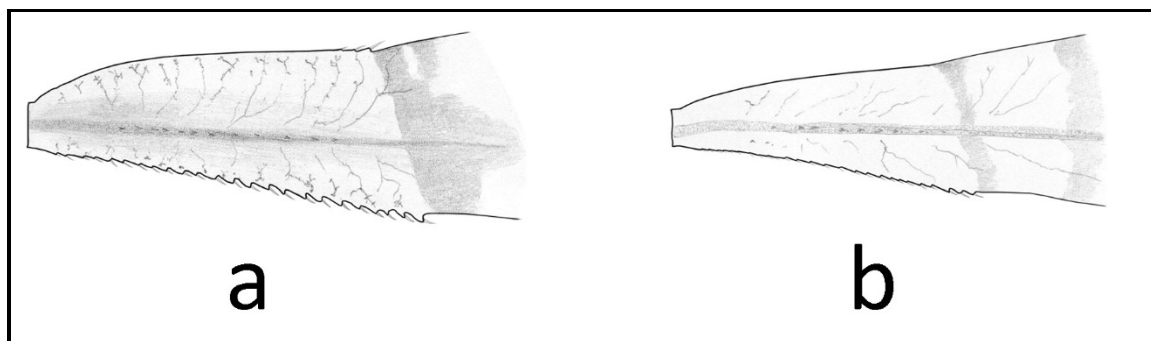


Fig. 14.40. *Enallagma*, proximal portion of left lateral caudal lamella: a) *E. concisum*; b) *E. dubium*.

12. Prementum with 1 prominent seta on each side, sometimes a small, second seta present medially (Fig. 14.41a); abdominal segment 9 with 3–6 spiniform setae on lateral margin (Fig. 14.42a); 3 palpal setae per side*cardenium*
- 12'. Prementum with 2 or more prominent setae on each side (Fig. 14.41b); abdominal segment 9 usually without spiniform setae on lateral margin, sometimes a few small sharp setae present (Fig. 14.42b); 4 or 5 palpal setae per side13

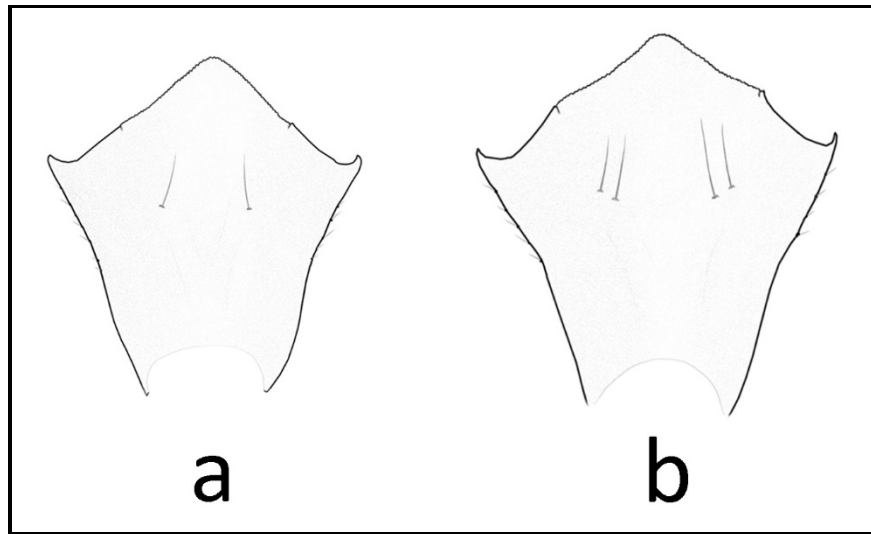


Fig. 14.41. *Enallagma*, prementum, ental view: a) *E. cardenium*; b) *E. weewa*.

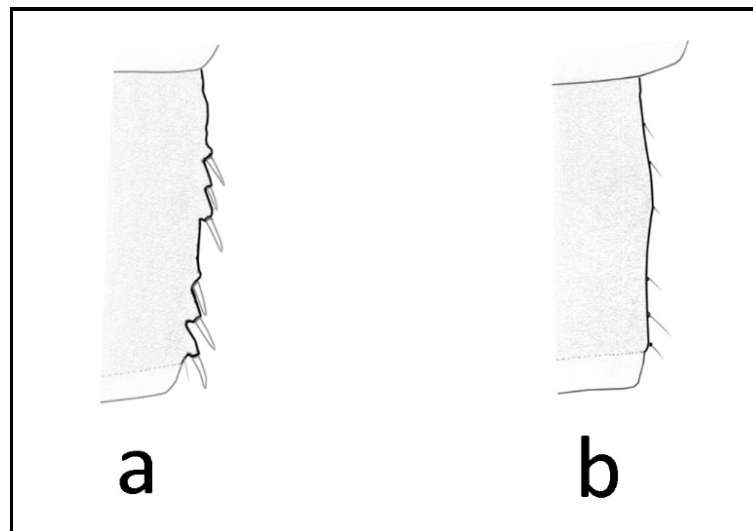


Fig. 14.42. *Enallagma*, abdominal segment 9, right side, dorsal view (slightly oblique): a) *E. cardenium*; b) *E. weewa*.

13. Dorsum of abdominal segments 2–4 with scattered to clustered pale piliform setae, mostly near posterior margin (Fig. 14.28b); caudal lamellae with 3–5 dark bands in distal half (Fig. 14.43a); F-0 metathoracic femur length 2.05–2.25 mm *basidens*
- 13'. Dorsum of abdominal segments 2–4 with few if any long setae, if present only near posterior margin (Fig. 14.28c); caudal lamellae with at most 1 or 2 dark bands in distal half (Fig. 14.43b); F-0 metathoracic femur length 2.35–2.85 mm14



Fig. 14.43. *Enallagma*, left lateral lamella: a) *E. basidens*; b) *E. divagans*.

14. Posterolateral corner of head without spiniform setae, instead with long, pale piliform setae (Fig. 14.44a); caudal lamellae with a chevron-shaped dark spot near midlength (Fig. 14.45a); 5 palpal setae per side *daeckii*
- 14'. Posterolateral corner of head with some spiniform setae (Fig. 14.44b); caudal lamellae with variable dark extra-tracheal pigmentation but without a chevron-shaped spot near midlength (Fig. 14.45b); 4 palpal setae per side15

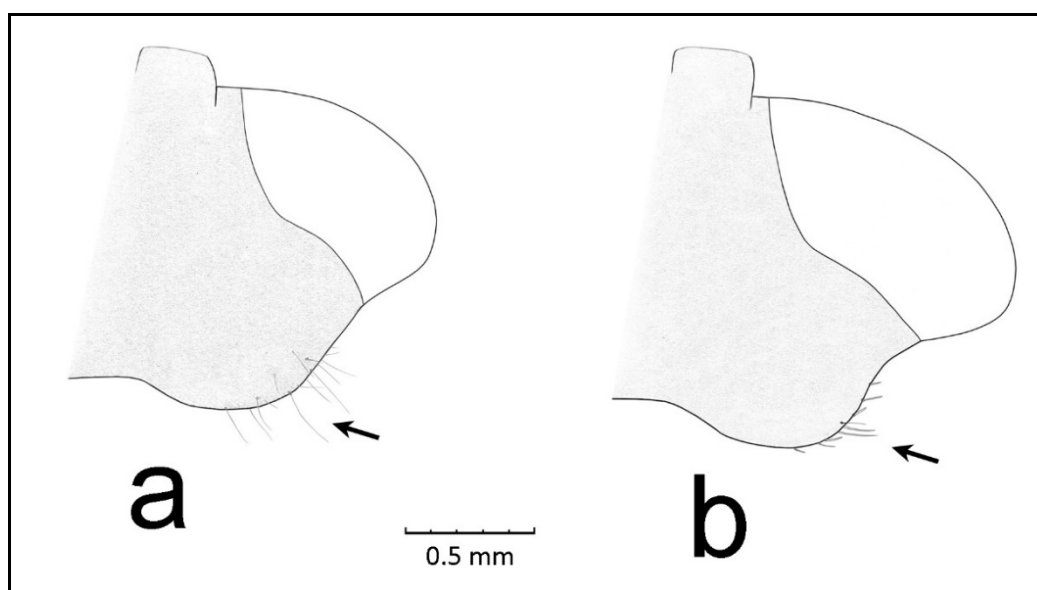


Fig. 14.44. *Enallagma*, posterolateral corner of head: a) *E. daeckii*; b) *E. weewa*.

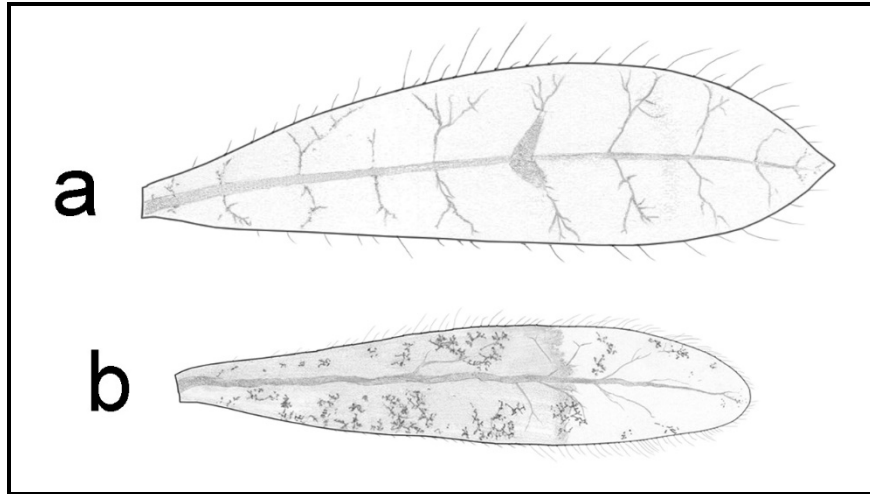


Fig. 14.45. *Enallagma*, median caudal lamella,: a) *E. daeckii*; b) *E. weewa*.

15. Caudal lamellae without a discernible nodus, dorsal and ventral margins minutely serrulate along entire length, tips acutely pointed (Fig. 14.46a); ratio of lateral lamella length:max width > 7.0 ; usually 3 premental setae per side.....*divagans*
- 15'. Caudal lamellae with a discernible nodus, indicated either by an abrupt color change at about 2/3 lamella length from brown proximally to pale distally, or by termination of series of spiniform setae on margins (Fig. 14.46b), tips variable; ratio of median lamella length:max width < 6.0 ; 2 premental setae per side.....16

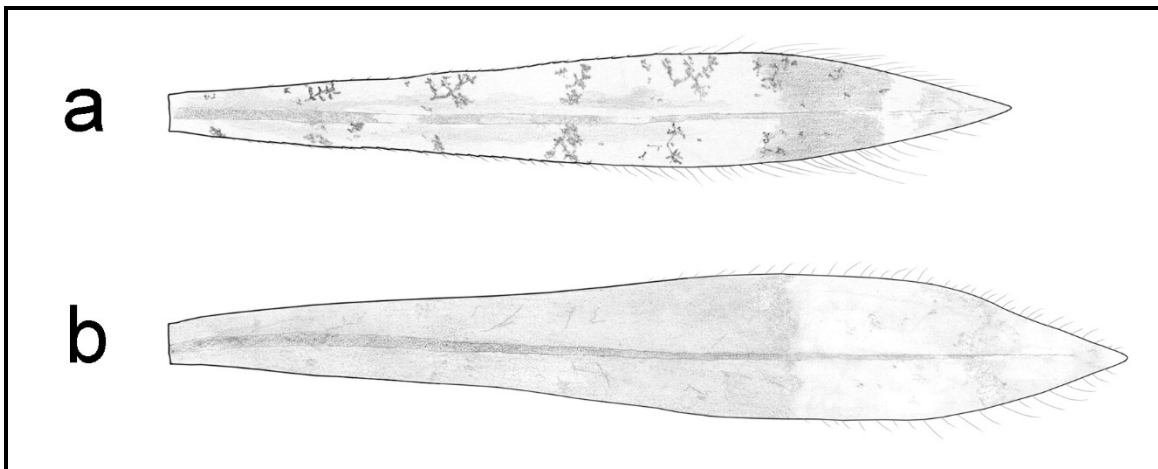


Fig. 14.46. *Enallagma*, left lateral caudal lamella,: a) *E. divagans*; b) *E. pallidum*.

16. Tips of caudal lamellae acutely pointed, lamellae with abrupt color change from tan in proximal 2/3 to pale in distal 1/3, at position of nodus (Fig. 14.46b); ventral margin of lateral lamellae, proximal to nodus, without spiniform antenodal setae, instead with slender, pale hair-like setae (Fig. 14.47a).....*pallidum*
- 16'. Tips of caudal lamellae rounded to obtusely pointed (Fig. 14.45b), lamellae with or without notable color change, nodus detectable by termination of series of sharp setae on margins; ventral margin of lateral lamellae, proximal to nodus, with a few spiniform setae intermittent with slender, pale hair-like setae (Fig. 14.47b)*weewa*

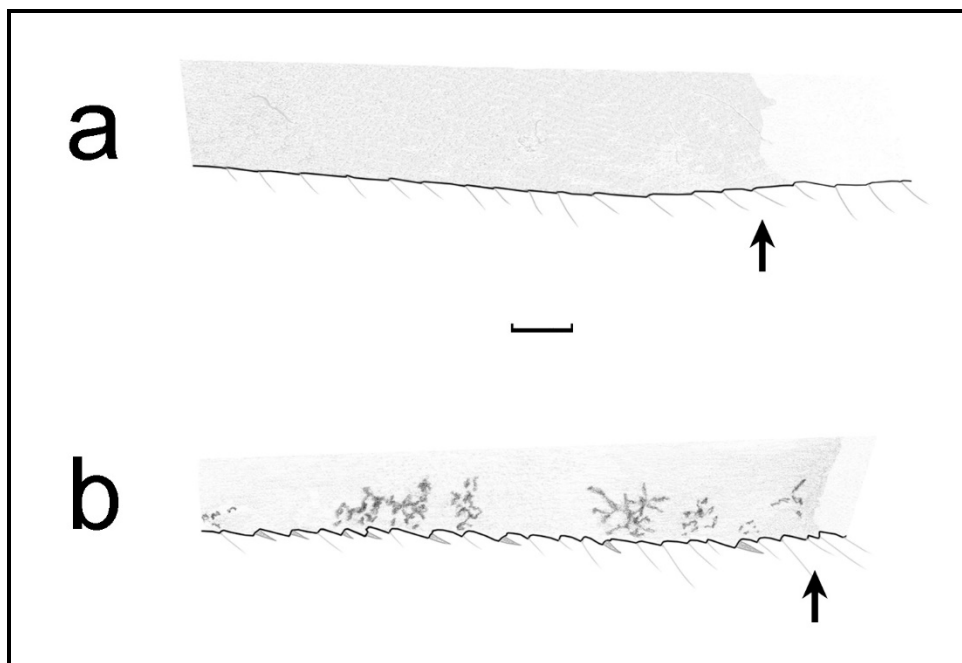


Fig. 14.47. *Enallagma*, ventral margin of left lateral caudal lamella, proximal to nodus: a) *E. pallidum*; b) *E. weewa*. Scale bar = 0.2 mm; arrow indicates position of nodus.

Diagnostic Remarks:

The key to species is applicable only for the *Enallagma* fauna of Florida; several species that occur in other southeastern states complicate the characters presented here and can lead to misdeterminations. Regarding instars earlier than F-0, a few key characters will work for instar F-1, whereas others, especially size measurements, will not; therefore, it is advised to leave most F-1 and earlier instars identified to genus level only.

The long movable hook and narrow upper palpal lobe of *E. durum* are unique within the genus (Fig. 14.27a). Although *E. durum* is the largest species of *Enallagma* on average, two other highly variable species may overlap in size: minimum head width in *E. durum* is about 3.55 mm whereas maximum head width in *E. doubledayi* is about 3.60 mm and in *E. civile* about 3.50 mm; minimum metathoracic femur length in *E. durum* is about 3.80 mm, whereas the maximum length in *E. doubledayi* is about 3.80 mm and in *E. civile* about 3.65 mm.

The marginal spiniform setae on the caudal lamellae of some *E. davisii* individuals are extremely small and almost undetectable compared to *E. civile*, *E. doubledayi*, and *E. geminatum*. Besides the key characters in couplets 4 and 5, no other differences between the latter three species

were found. *Enallagma civile* and *E. doubledayi* are the most difficult to distinguish from each other in this group of species.

Enallagma vesperum has a few prominent spiniform setae on the lateral carinae of abdominal segment 1, whereas the other species in its group lack such setae. *Enallagma pollutum* and *E. signatum* are the most similar, which is to be expected as they are considered sibling species based on adult likeness; without caudal lamellae, they are indistinguishable.

Enallagma basidens and *E. dubium* are similar in size and banding pattern on the caudal lamellae, though the two species are not closely related; paying close attention to the characters in couplet 6 will prevent confusing the two. Distinguishing *E. daeckii*, *E. divagans*, *E. pallidum* and *E. weewa* depends almost totally on the presence and integrity of the caudal lamellae, as presented in couplets 14–16.

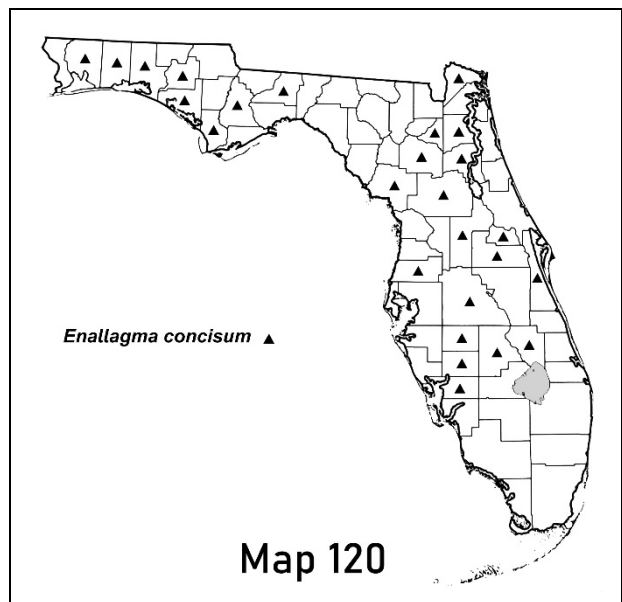
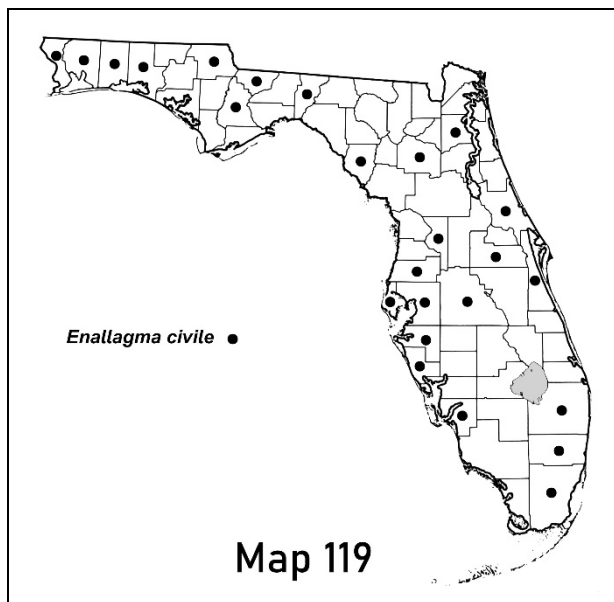
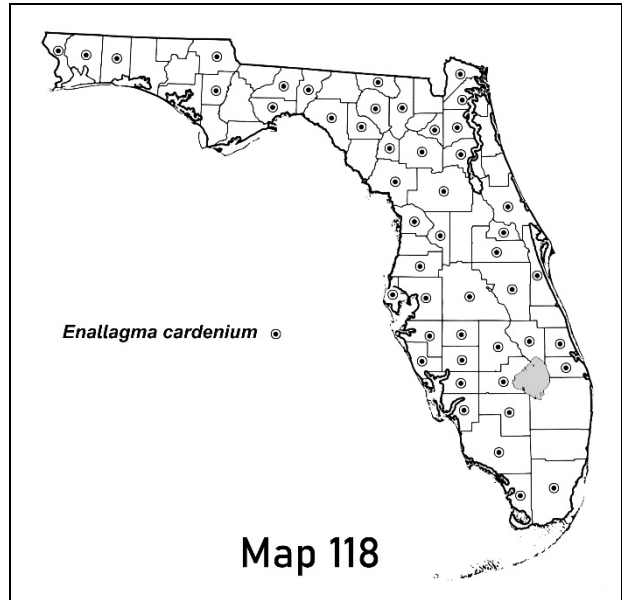
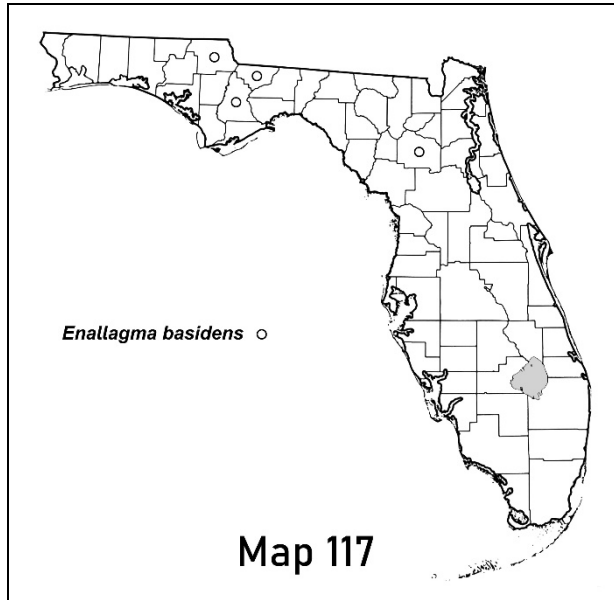
It is possible that an additional species of *Enallagma* occurs in Florida — *E. traviatum* Selys ranges into southern Alabama and Georgia. The nymph of this species is similar to that of *E. divagans* and *E. pallidum*; the caudal lamellae have a distinct nodus (unlike *E. traviatum*), located proximal to 2/3 lamella length (unlike *E. pallidum*); for further characterization, see Westfall & May (2006).

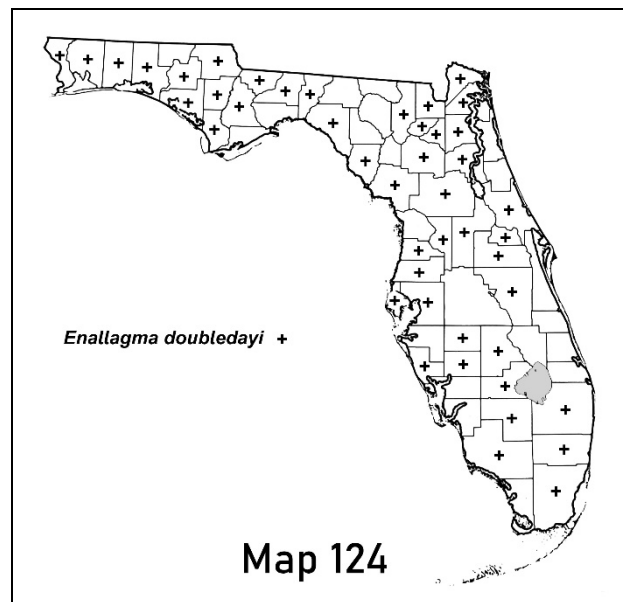
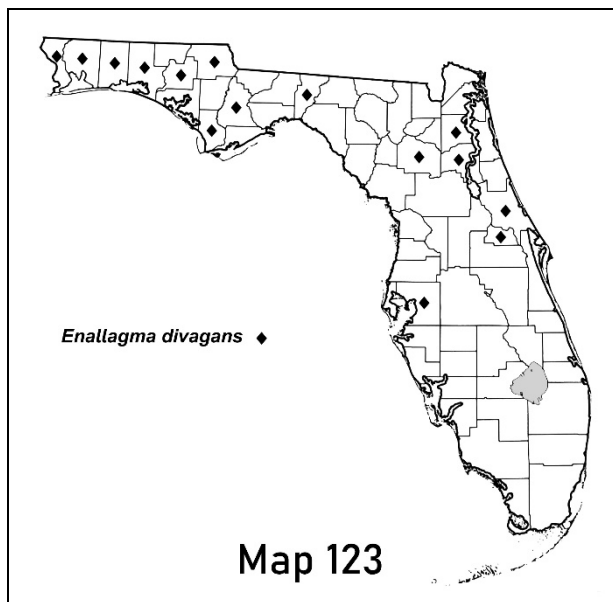
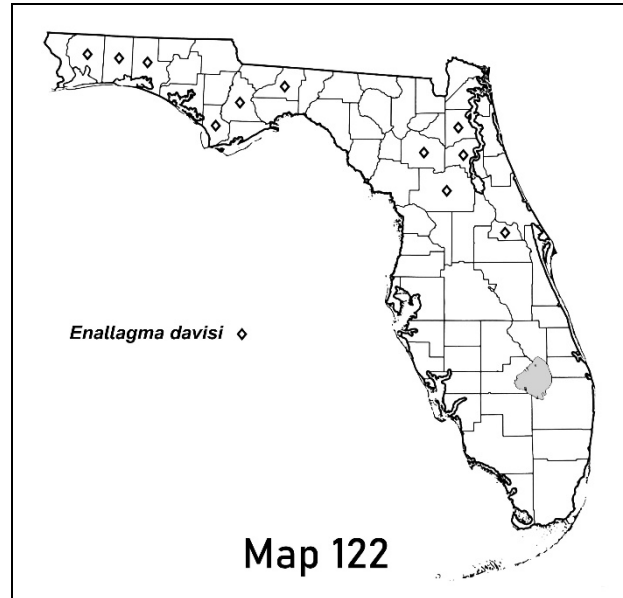
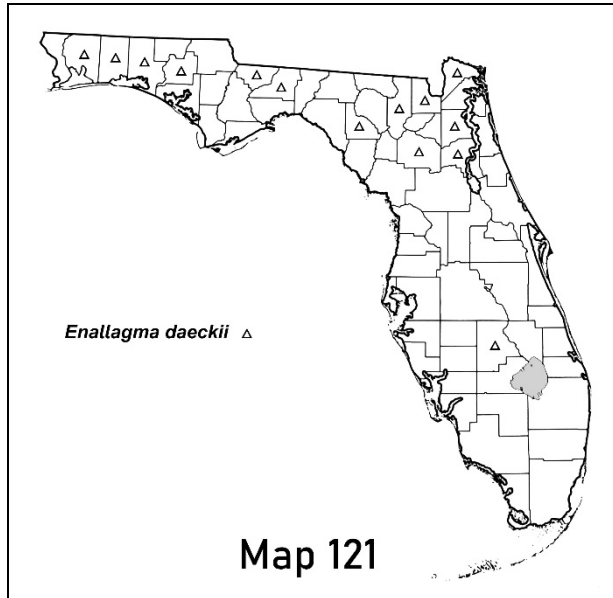
Habitat, Distribution, Life Cycle:

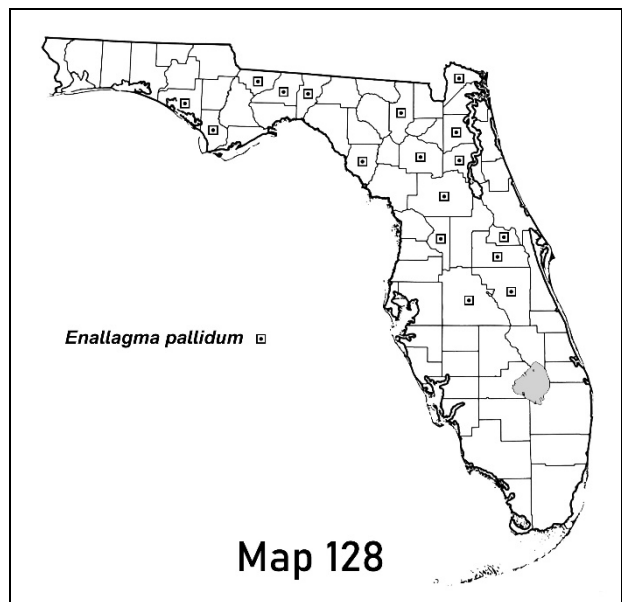
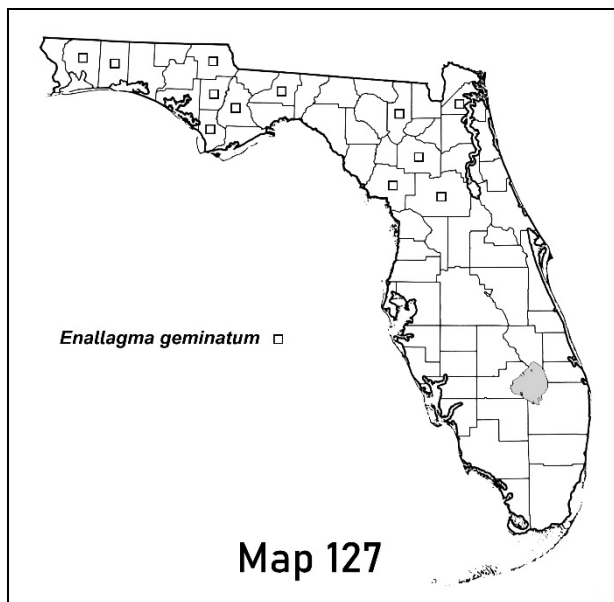
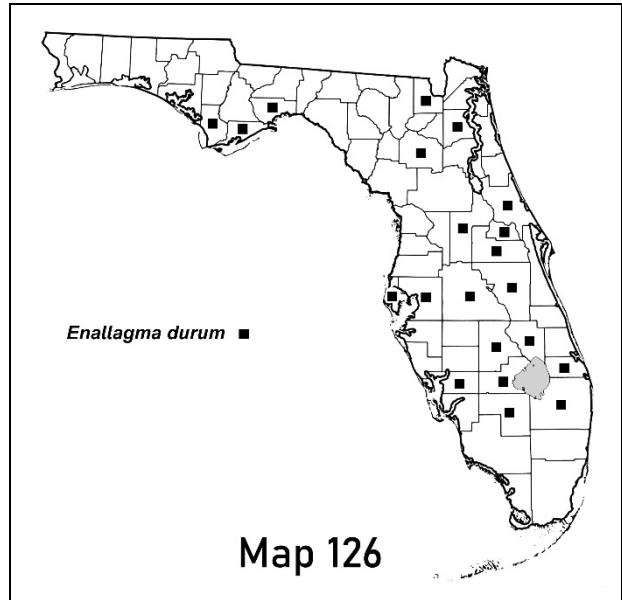
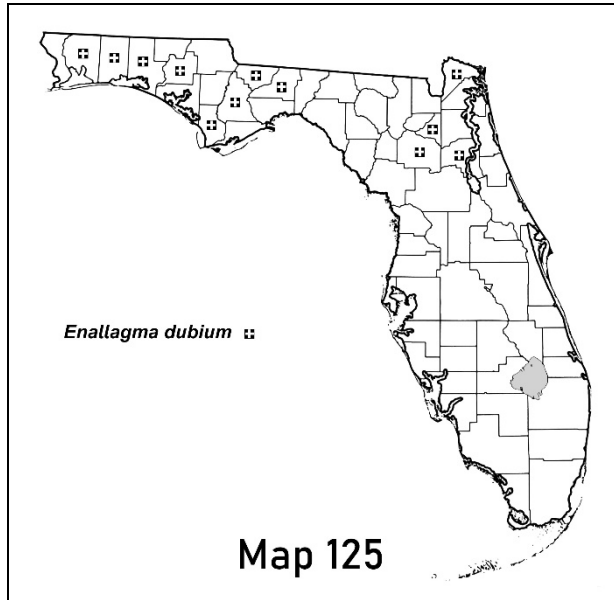
Most species of *Enallagma* are lentic although a few species are strictly lotic (e.g., *E. cardenium* and *E. weewa*). Habitats include lakes, ponds, marshes, streams, slow-flowing canals, all with emergent and/or floating vegetation. Some lentic species, such as *E. dubium*, *E. pollutum* and *E. signatum*, also inhabit heavily vegetated areas of slow streams. The smallest species, *E. basidens*, has broad habitat requirements, including mid-sized streams, rivers, lakes, reservoirs, ponds, strip mine pits, spring runs and backwater sloughs (Huggins 1978). A few species, such as *E. divagans* and *E. weewa*, inhabit woodland areas, including swamps and small streams.

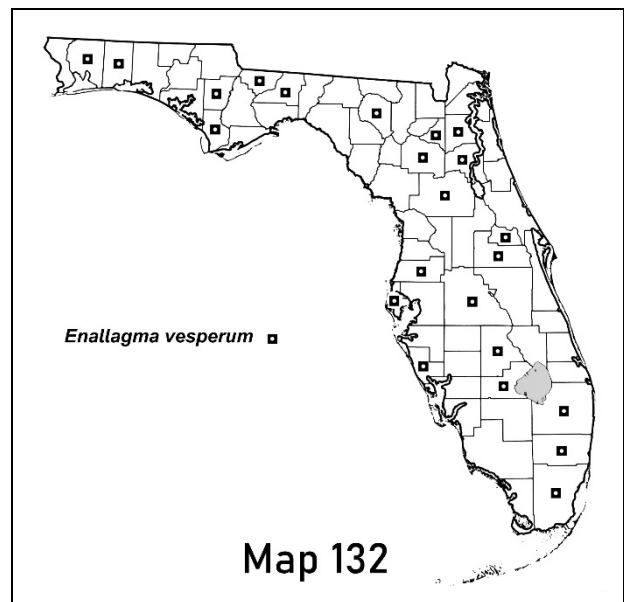
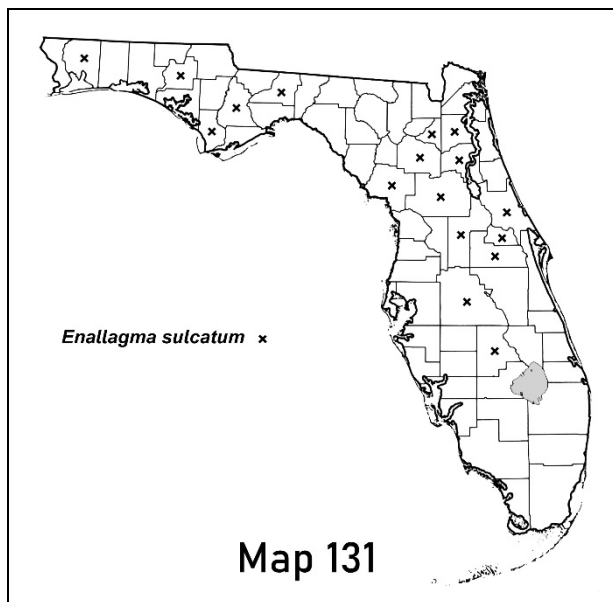
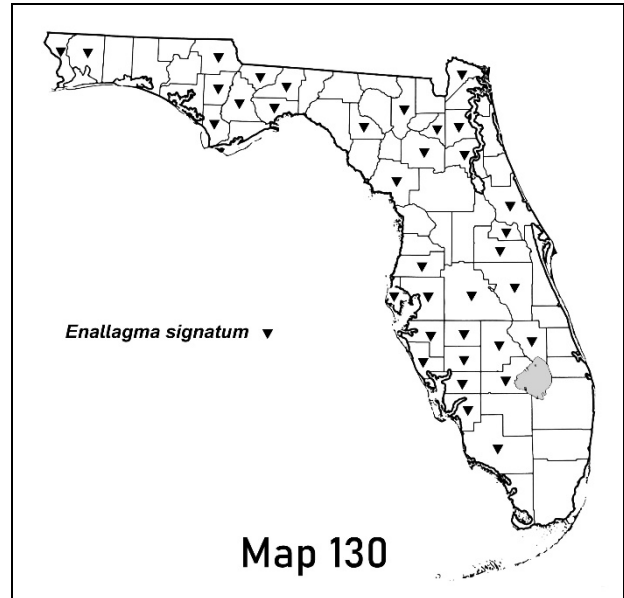
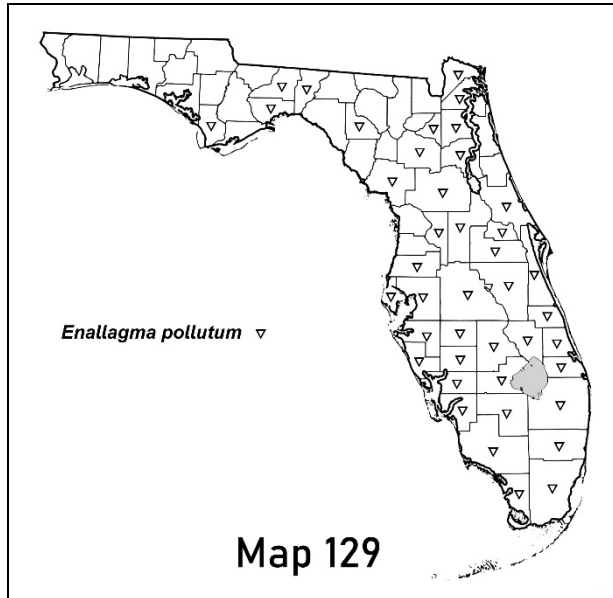
Enallagma basidens has been recorded in only four counties in the northern third of the state (Map 117); this small species has expanded its range in recent decades (Cannings 1989, Westfall & May 2006) and probably will be found in additional north Florida counties. Three species are restricted to the northern third or half of the state, including *E. davisii*, *E. dubium* and *E. geminatum* (Maps 122, 125 & 127). Six species (*E. concisum*, *E. daeckii*, *E. divagans*, *E. pallidum*, *E. sulcatum* and *E. weewa*) occur nearly throughout the state but have not been found south of Lake Okeechobee (Maps 120, 121, 123, 128, 131 & 133). The remaining seven species occur statewide except none is known from the Keys (Maps 118, 119, 124, 126, 129, 130 & 132).

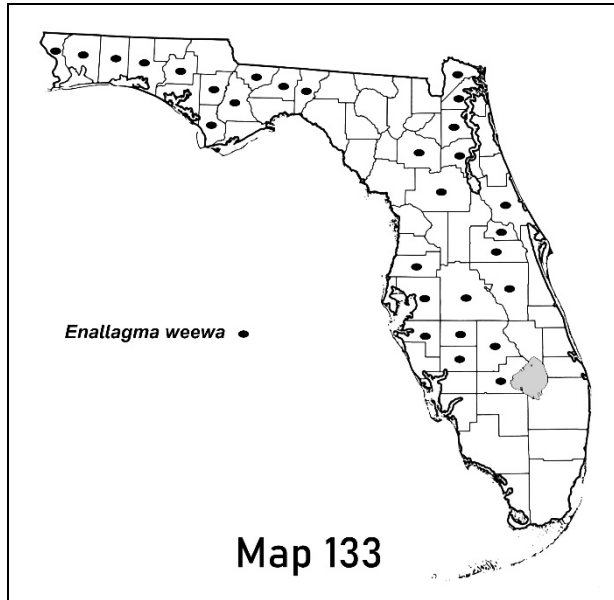
The flight seasons of *E. davisii* (January 23 to April 12) and *E. divagans* (March 18 to May 22) in Florida begin early and appear to be relatively short. The other species of *Enallagma* have long flight seasons, beginning in early spring and lasting at least until late summer. Seven species, *E. cardenium*, *E. concisum*, *E. civile*, *E. doubledayi*, *E. durum*, *E. pollutum* and *E. signatum*, have been recorded every month of the year. The dates for the other eight species are as follows: *E. basidens* April 5 to September 28; *E. daeckii* April 6 to September 11; *E. dubium* March 20 to September 11; *E. geminatum* February 23 to October 18; *E. pallidum* April 6 to August 30; *E. sulcatum* February 25 to November 15; *E. vesperum* February 25 to November 7; *E. weewa* February 25 to November 7. Most species appear to have long emergence periods in Florida and may be either bivoltine or univoltine.





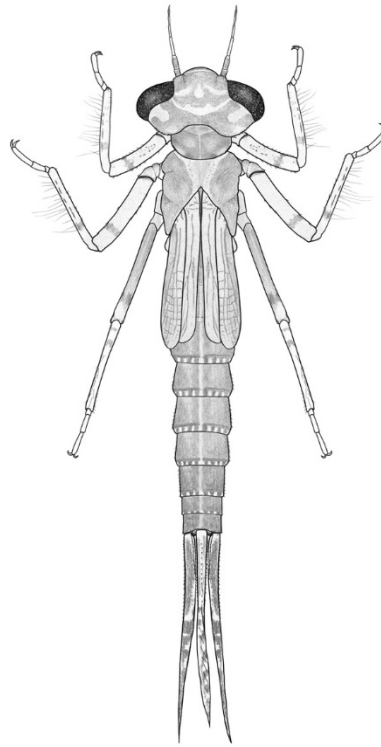






Ischnura

Slender, elongate, head wider than long; antennae 7-segmented; prementum with 3 or 4 prominent setae; palpal lobes with truncate upper process, 4–6 palpal setae; caudal lamellae flat, tracheae distinct, nodus and patterning variable



Ischnura is a cosmopolitan genus with 14 species in the United States, five of which occur in Florida. Several species are common to abundant in lentic waters and are important components of aquatic ecosystems.

Diagnosis:

Ischnura nymphs resemble *Enallagma* and *Leptobasis*. They are more likely to be confused with *Enallagma* throughout most of the state except in a few localities in extreme southern Florida where *Leptobasis* and *Ischnura* may be found together. The characters presented in couplets 5 and 6 in the key to coenagrionid genera (pages 272–274) are best considered in combination; relying on a single character can lead to misdetermination. The arrangement of spiniform setae on the lateral carinae of abdominal segments 3–8 is somewhat variable in both *Enallagma* and *Ischnura*, and the setae can be difficult to discern. Eye patterns are diagnostic in well-preserved specimens: in *Ischnura* and *Leptobasis*, one or two horizontal pale bands are usually present; in *Enallagma*, the eyes are either completely dark or a pattern of dark and pale spots is present. Unfortunately, the eyes can be totally dark in some preserved *Ischnura* specimens. Relative antennal segment length will help separate *Ischnura* from the majority of *Enallagma*: in all five *Ischnura* species known in Florida, antennal segment 2 is distinctly longer than segment 1, and segment 3 is at least twice as long as segment 1; this contrasts with most *Enallagma* species in which segment 2 is subequal in length to segment 1, and segment 3 is usually less than twice as long as segment 1 (see Fig. 14.10, page 273). However, five species of *Enallagma* (*civile*, *davisi*, *doubledayi*, *durum*, and *geminatum*) are similar to *Ischnura* in the relative lengths of antennal segments 1 and 2; the latter *Enallagma* species have long, pale setae on the dorsum of abdominal segments 2–4 that *Ischnura* lacks.

As in *Ischnura*, *Leptobasis* nymphs have 7-segmented antennae and horizontally banded eyes. The best way to distinguish *Ischnura* from *Leptobasis* is by shape of the male cerci (broadly rounded in *Ischnura*, acuminate in *Leptobasis*) and the female ovipositor (extending barely to posterior margin of segment 10 in *Ischnura*, extending well beyond posterior margin of segment 10 in *Leptobasis*), as presented in couplet 6 on page 274.

Key to *Ischnura* Species

1. Caudal lamellae with extratracheal dark pigment in form of 4–6 transverse bands (Fig. 14.48a); apical angle of caudal lamellae $> 50^\circ$ 2
- 1'. Caudal lamellae with extratracheal dark pigment, if present, in form of one or two slightly darkened, diffuse transverse markings (Fig. 14.48b); apical angle of caudal lamellae variable, $25\text{--}45^\circ$ 3

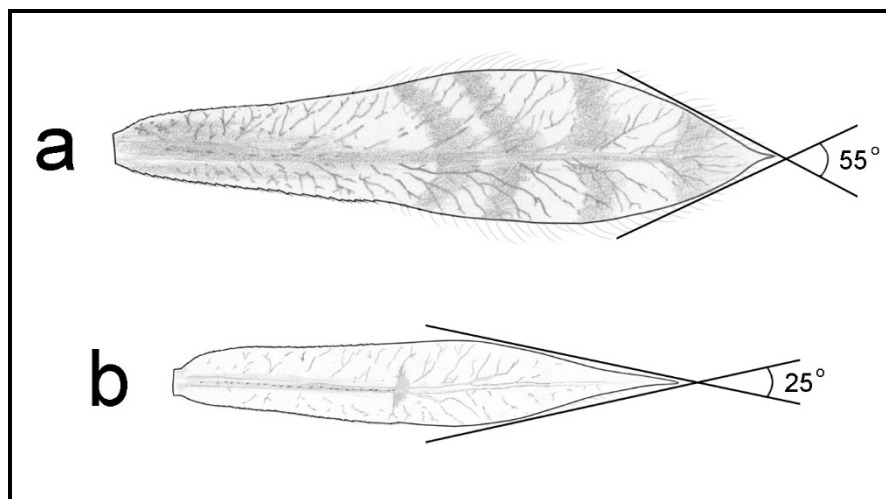


Fig. 14.48. *Ischnura*, left lateral caudal lamella: a) *I. posita*; b) *I. hastata*.

2. Caudal lamellae oblanceolate (Fig. 14.49a); median caudal lamella with < 30 antenodal spiniform setae on dorsal margin, the series terminating proximal to $2/5$ lamella length (Fig. 14.49a); ratio of median caudal lamella length: max width 3.4–4.2, ratio for lateral lamella 4.1–5.2*posita*
- 2'. Caudal lamellae lanceolate (Fig. 14.49b); median caudal lamella with > 30 antenodal spiniform setae on dorsal margin, the series terminating distal to $2/5$ lamella length (Fig. 14.49b); ratio of median caudal lamella length: max width 4.8–5.2, ratio for lateral lamella 5.7–5.9*prognata*

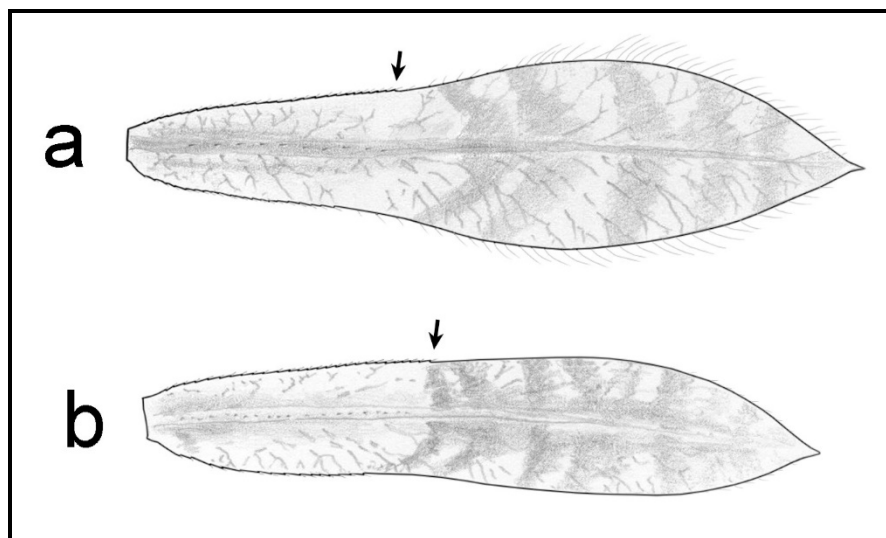


Fig. 14.49. *Ischnura*, median caudal lamella: a) *I. posita*; b) *I. prognata*; arrow indicates position of nodus.

3. Lateral caudal lamellae with antenodal series of spiniform setae on dorsal margin about 1/3 as long as ventral series (Fig. 14.50a); lateral caudal lamellae acuminate only in apical 1/10; F-0 caudal lamellae > 5.8 mm long, metathoracic femur length usually > 3.0 mm.....***ramburii***
- 3'. Lateral caudal lamellae with antenodal series of spiniform setae on dorsal margin at least 3/4 as long as ventral series (Fig. 14.50b); lateral caudal lamellae acuminate in distal 1/3; F-0 caudal lamellae < 5.8 mm long, metathoracic femur length < 3.0 mm.....4

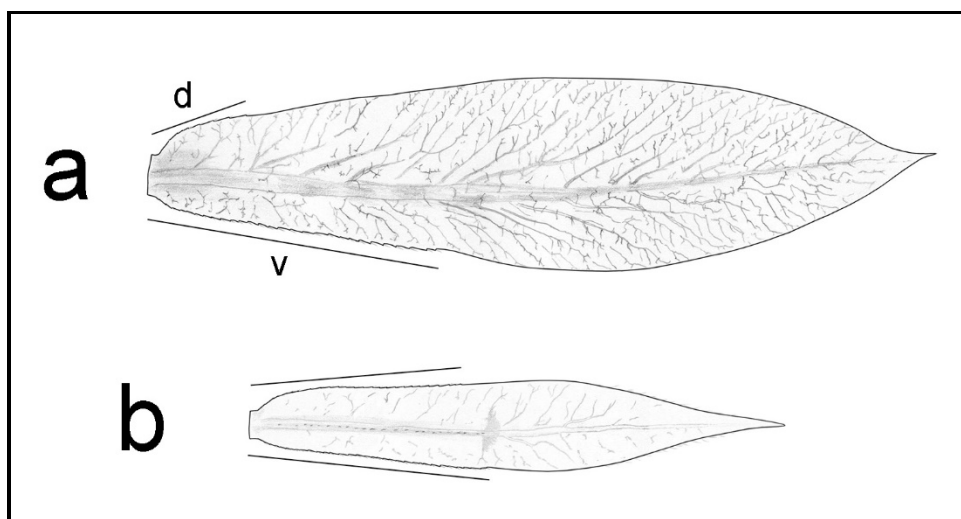


Fig. 14.50. *Ischnura*, lateral caudal lamella, comparing lengths of dorsal and ventral series of antenodal spiniform setae: a) *I. ramburii*; b) *I. hastata*; d = dorsal series, v = ventral series.

4. Dorsal and ventral surfaces of abdominal segments with numerous dark setal bases, appearing spotted (Fig. 14.51a); 5 palpal setae on each palp*hastata*
- 4'. Dorsal and ventral surfaces of abdominal segments without dark setal bases or with so few appearing smooth (Fig. 14.51b); 6 palpal setae on each palp *kellicotti*

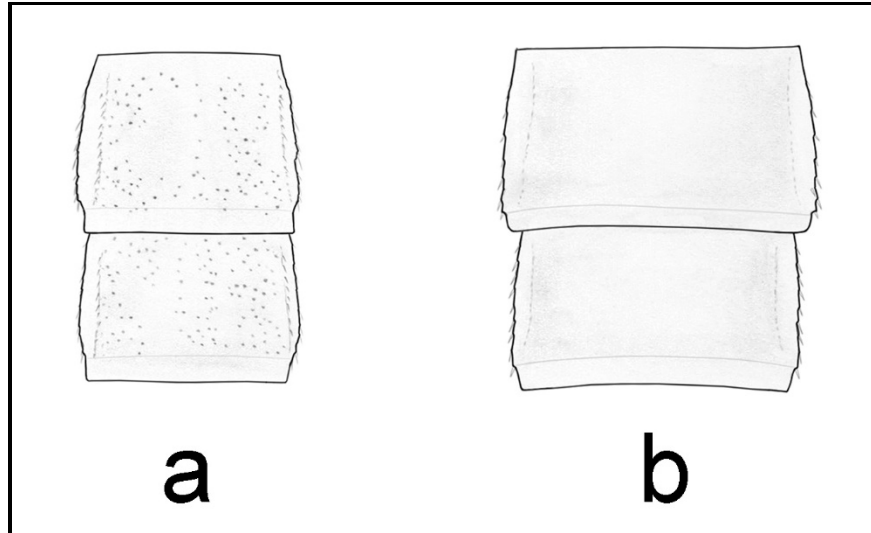


Fig. 14.51. *Ischnura*, abdominal segments 6 and 7, dorsal view: a) *I. hastata*; b) *I. kellicotti*.

Diagnostic Remarks:

In instars earlier than F-0, the caudal lamellae are much narrower relative to their length than in F-0 and therefore, ratios of length:max width do not apply to early instars. Also, the tips are more acuminate. Most *I. posita* and *I. prognata* F-1 and F-2 have definite dark bands on the caudal lamellae, separating them from the other three species. However, few other key characters apply to early instars, especially size measurements; therefore, it is advised to leave most F-1 and earlier instars identified to genus level only.

Metathoracic femur length is not a reliable character to separate *I. posita* and *I. prognata*. *Ischnura posita* is highly variable in size; metathoracic femur length varies from 2.50 to 2.95 mm, overlapping with *I. prognata* (2.80 to 3.00 mm). The nodus of the median lamella (measured along dorsal margin) is proximal to 2/5 of lamella total length in *I. posita* compared to distal to 2/5 lamella length in *I. prognata* (Fig. 14.49). Also, the margins of the lamellae in *I. prognata* have very few fine, inconspicuous setae and any existing setae are located distally; the lamellae of *I. posita* have many fine, longer, conspicuous setae along the margins from the nodus to the tip. Lastly, the shape of the male cerci (in lateral view) is diagnostic, *I. posita* rounded apically, *I. prognata* truncate and slightly indented apically (Fig. 14.52).

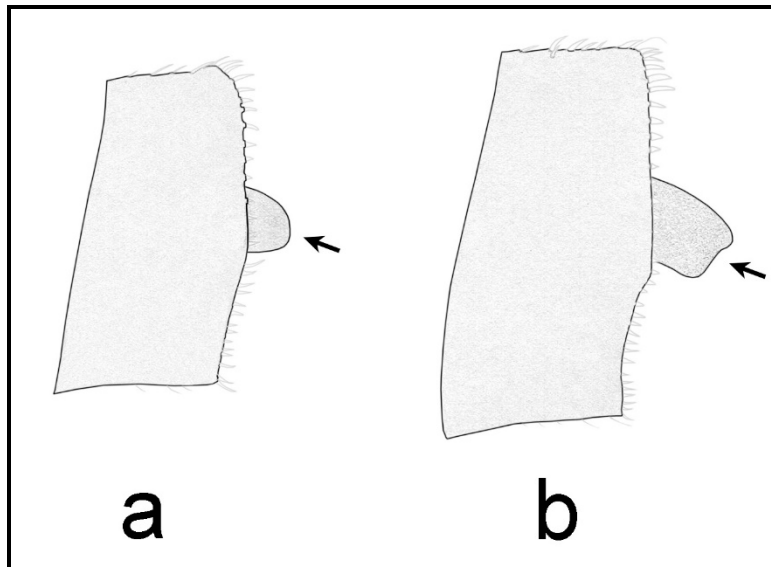


Fig. 14.52. *Ischnura*, male left cercus, lateral view: a) *I. prognata*; b) *I. posita*.

Of the remaining three species, *I. ramburii* is larger than *I. hastata* and *I. kellicotti*; F-0 lateral caudal lamella length is > 6.0 mm in *I. ramburii* versus < 5.6 mm in the other two species. Metathoracic femur length varies from 2.95–3.20 mm in *I. ramburii* compared to 1.80–2.95 mm, and head width is > 3.1 mm for *I. ramburii* versus 2.4–2.8 mm for *I. hastata* and 3.00–3.10 mm for *I. kellicotti*. The length:maximum width ratio for the median caudal lamella varies from 0.26–0.30 for *I. ramburii* versus 0.15–0.22 for *I. hastata* and 0.22–0.24 for *I. kellicotti*. Also, the lamellae of *I. ramburii* have many more tracheae than the other species (see Fig. 14.50). The number of palpal setae for *I. ramburii* has been reported as 6 but 5 is about as common and one specimen had 4 on one palp. *Ischnura kellicotti* is slightly larger than *I. hastata* but the two species probably overlap in most measurements.

The nymph of *I. kellicotti* is known but is undescribed. Previous keys that include *I. kellicotti* stated that the marginal spiniform setae on the lamellae extend nearly the entire length of the lamellae. However, examination of numerous specimens by myself and three other colleagues (D. R. Denson, R. DuBois, R. S. Krotzer, pers. comm.) confirm that the series of spiniform setae extends at most to midlength of the lamellae, and distal to the midlength there is a transition to longer, slender, pale piliform setae; it is possible that the earlier characterization of *I. kellicotti* was based on instars earlier than F-0, in which spiniform setae do extend nearly to the tip of the lamellae. In addition to the key, another difference between *I. hastata* and *I. kellicotti* is the relative dimensions of the abdominal segments; in *I. hastata* most middle segments are about 1.2–1.3 times as wide as long compared to 1.6–1.8 times as wide as long in *I. kellicotti* (see Fig. 14.51).

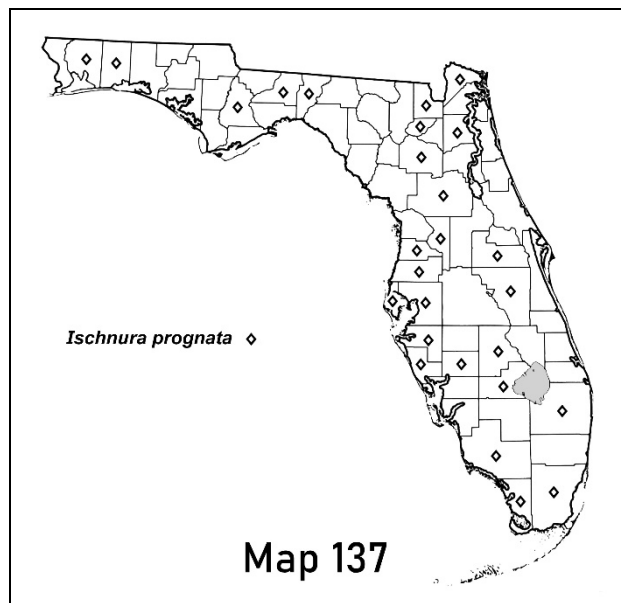
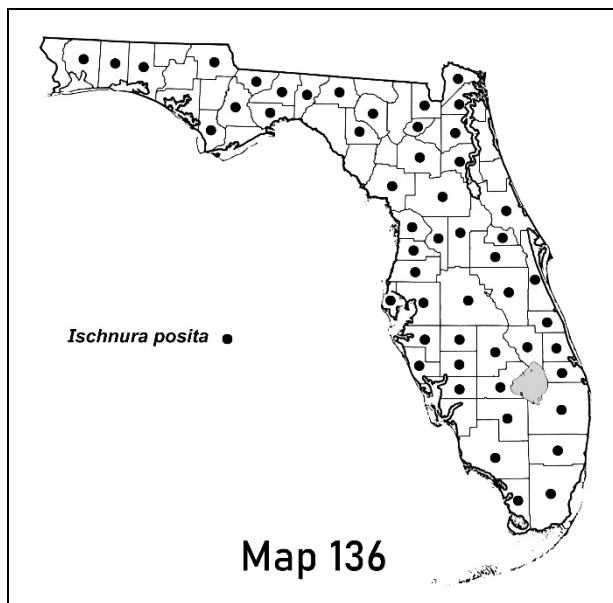
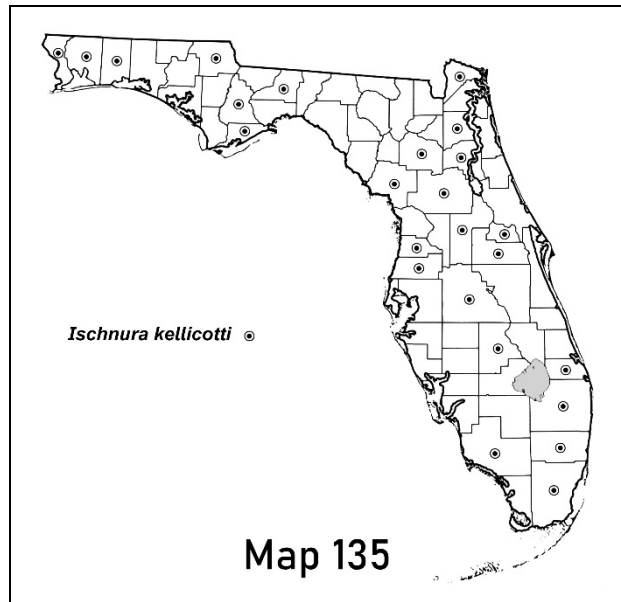
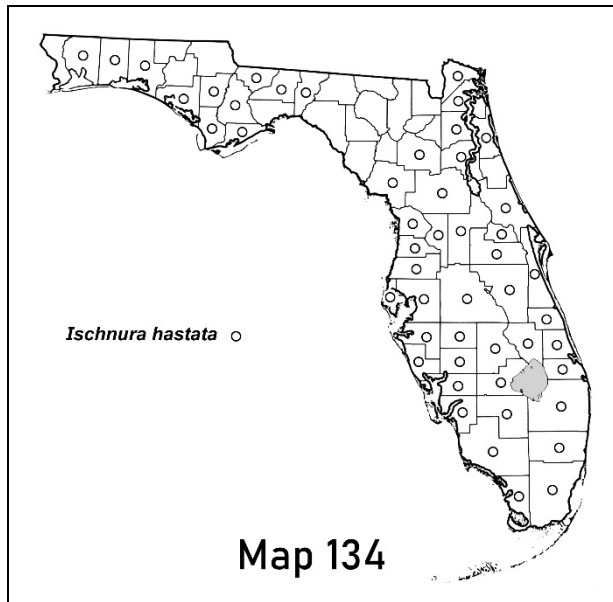
Habitat, Distribution, Life Cycle:

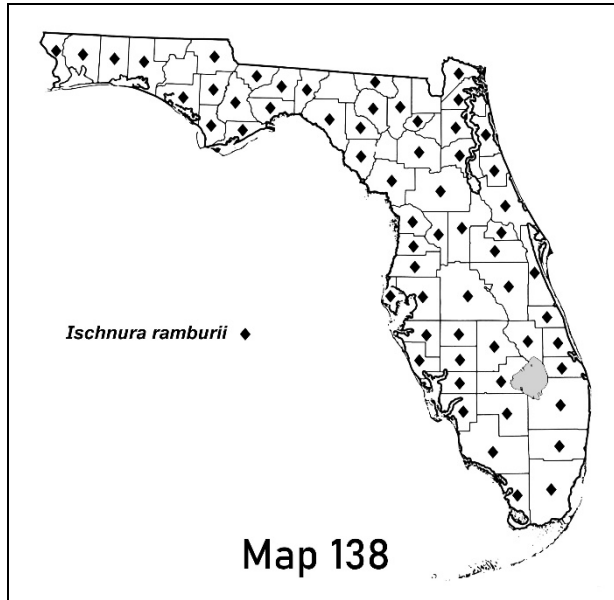
Ischnura nymphs are typically lentic although a few species inhabit slow flowing waters (e.g., *I. posita*). Habitats include lakes, ponds, marshes, ditches, slow-flowing canals, all with emergent and/or floating vegetation. The nymphs typically hide among plant stems and vegetative debris. However, *Ischnura kellicotti* is a microhabitat specialist, as it clings to the underside of lily pads in open ponds and lakes. *Ischnura prognata* is restricted to shady swamps and wooded

margins of slow streams. *Ischnura hastata*, *I. posita* and *I. ramburii* have broader habitat requirements.

All five species of *Ischnura* have been recorded throughout the state (Maps 134–138). The only species known from the Keys are *I. hastata* and *I. ramburii*.

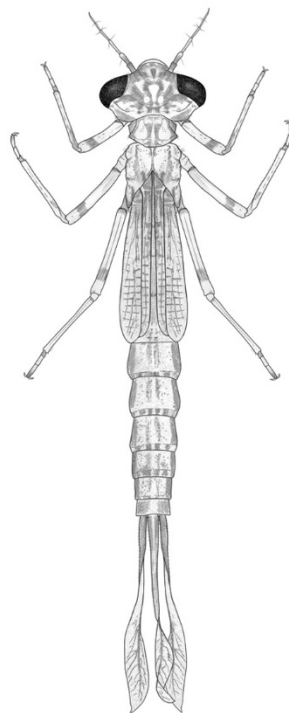
The flight seasons of all five *Ischnura* species in Florida continue throughout the year, although in northern Florida adults are absent in the colder periods of winter. Most species appear to have long emergence periods in Florida and appear to be bivoltine or multivoltine.





Leptobasis

Slender, elongate; antennae 7-segmented; prementum with 4 or 5 prominent setae; upper process of palpal lobe truncate with 4 or 5 definite denticles; 5 palpal setae; caudal lamellae flat, without extratracheal pigment



Leptobasis is a New World genus comprising nine species, one of which occurs in south Florida, *Leptobasis lucifer*. This species was one of two species placed in *Chrysobasis* Rácenis, a name that has been synonymized with *Leptobasis* (Garrison et al. 2010).

Diagnosis:

Leptobasis nymphs resemble *Ischnura*, mainly in the horizontally banded eyes and 7-segmented antennae. The most reliable differences are based on sexual features: 1) cerci of *Leptobasis* males are acuminate in lateral view (rounded in *Ischnura*); 2) ovipositor of *Leptobasis* females has the apices extending beyond posterior margin of abdominal segment 10 (not beyond in *Ischnura*); see Fig. 14.14 on page 275. Also, the lateral carinae of abdominal segments 3–8 have spiniform setae set in a single row (scattered on most segments in *Ischnura*).

To a lesser extent, *Leptobasis* also resembles *Enallagma*, but all Florida species in that genus have antennae that are 6-segmented and eyes that are either completely dark or have a spotted pattern. The caudal lamellae of *Leptobasis* (Fig. 14.53) are similar to the lamellae of several species of *Enallagma* and *Ischnura*.



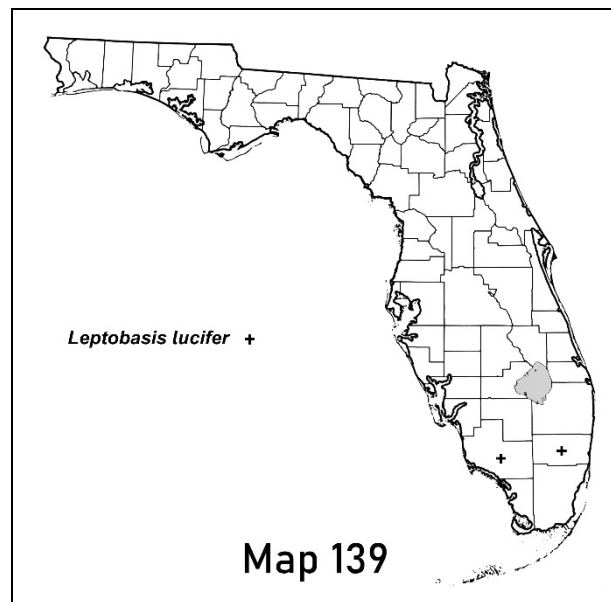
Fig. 14.53. Caudal lamellae, *Leptobasis lucifer*; upper image is the median lamella, lower image is the left lateral lamella.

Habitat, Distribution, Life Cycle:

Leptobasis nymphs are primarily lentic; *L. lucifer* inhabits cypress swamps with sparse to moderate woody understory that flood seasonally. The nymphs cling to stems of rooted aquatic plants.

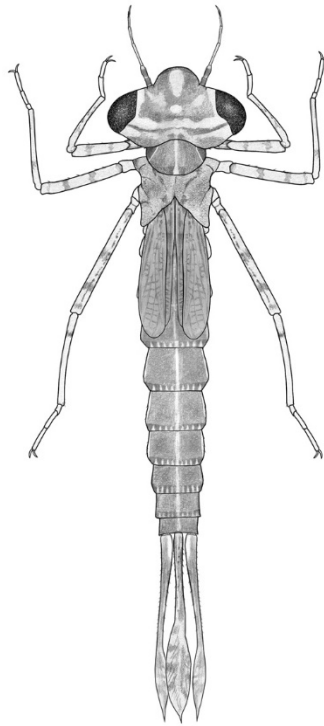
Leptobasis lucifer has been found only in the extreme southern part of the state (Map 139).

The recorded flight season of *L. lucifer* is from October 20 into March; this species appears to be univoltine.



Nehalennia

Slender, small; antennae 7-segmented; prementum with 1–4 prominent setae; upper process of palpal lobe truncate with minute denticles; femora w/ 2 dark bands; caudal lamellae flat, patterning variable, with or without extratracheal spots



Nehalennia is a small genus, with four of the five New World species occurring in Florida. These small damselflies are rarely collected as their small size, reclusive habits, and cryptic coloration aid in escaping detection both as adults and nymphs.

Diagnosis:

Nehalennia nymphs are among the smallest damselflies in Florida (F-0 head width 2.2–2.7 mm), and as such they can be mistaken for small *Ischnura*. The most notable differences are: 1) in *Nehalennia*, the truncate upper process of the palpal lobe has minute, almost imperceptible denticles versus 4 or 5 distinct denticles in *Ischnura* (see Fig. 14.5); 2) *Nehalennia* has only about 9–20 spiniform antenodal setae on the dorsal margin of the median lamella compared to 21–40 in *Ischnura*; 3) the tips of *Nehalennia* caudal lamellae are often filamentous (slender and elongate) versus usually attenuate and shorter, though variable, in *Ischnura* (Fig. 14.54); 4) the femora of *Nehalennia* usually have two dark bands, which may be faint, whereas there is only dark band in *Ischnura*; and 5) in *Nehalennia*, the spiniform setae on the lateral carinae of the abdomen are so small and inconspicuous that they can be overlooked, especially compared to the darker and more conspicuous setae of *Ischnura*.

Two of the four species of *Nehalennia* in Florida have only one prominent seta on each side of the prementum, as do *Enallagma cardenium* and *Telebasis byersi*. Besides the characters in the generic key to differentiate these genera/species, *Nehalennia* usually has two dark bands on the femora (one at midlength, another at about 3/4 length, shown in the habitus drawing above) compared to one for most other coenagrionids; however, the bands can be indiscernible in some specimens and thus are not always reliable.

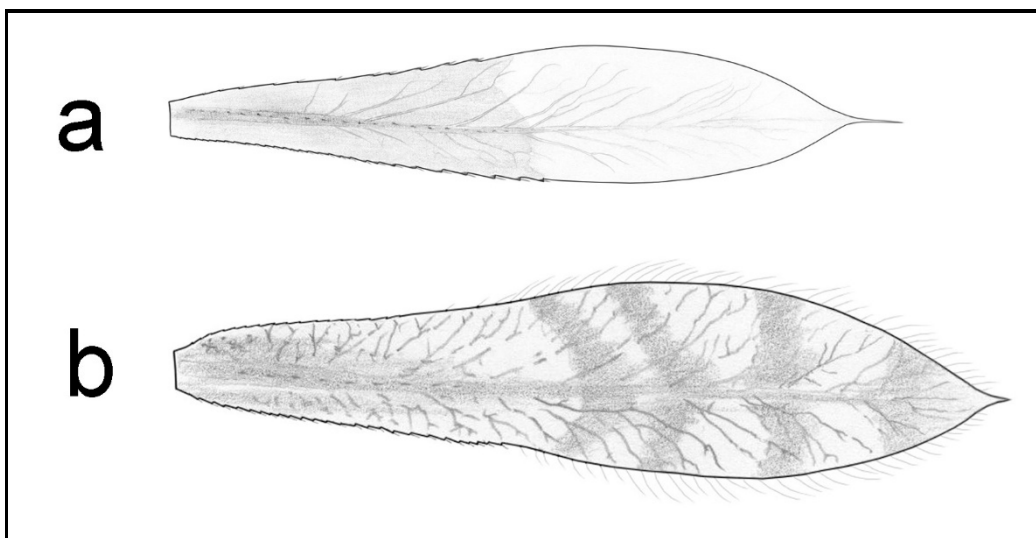


Fig. 14.54. Left lateral caudal lamella: a) *N. integricollis*; b) *Ischnura posita*.

Key to *Nehalennia* Species

1. Prementum with 1 prominent seta per side, although 1 or 2 smaller setae sometimes present medially (Fig. 14.55a); median caudal lamella with 14 or fewer antenodal spiniform setae on dorsal margin (Fig. 14.56a).....2
- 1'. Prementum with 3 or 4 prominent setae per side (Fig. 14.55b); median caudal lamella with 16 or more antenodal spiniform setae on dorsal margin (Fig. 14.56b).....3

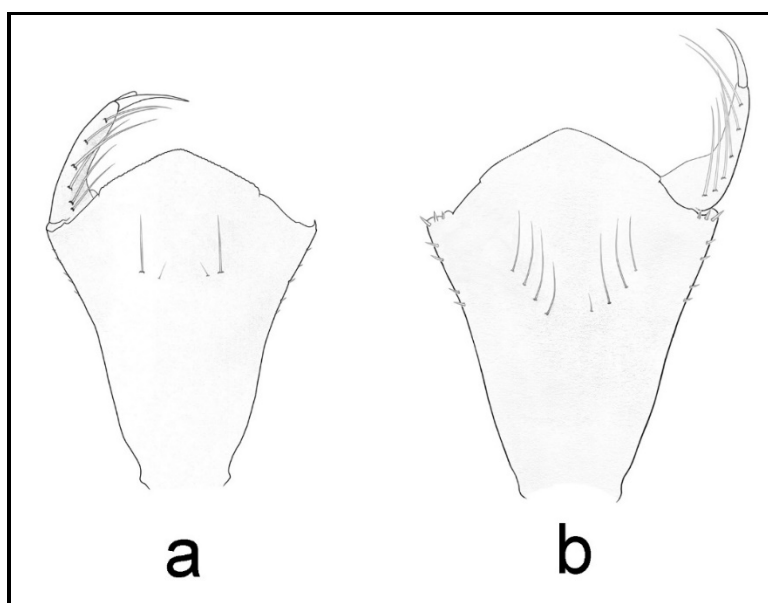


Fig. 14.55. *Nehalennia*, prementum, ental view: a) *N. integricollis*; b) *N. pallidula*.

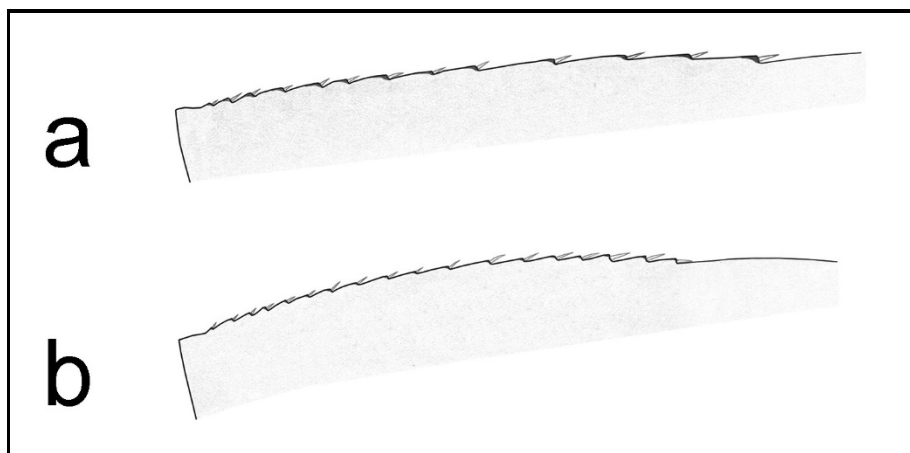


Fig. 14.56. *Nehalennia*, proximal portion of median caudal lamella, showing dorsal margin and antenodal spiniform setae: a) *N. integricollis*; b) *N. pallidula*.

2. Caudal lamellae not darker proximal to nodus; median caudal lamella max width 0.70–0.90 mm, lateral lamellae width 0.60–0.80 mm; ratio of metathoracic femur length:head width ≤ 0.88 ; spiniform setae on posterolateral corner of head with pale bases (Fig. 14.57a); 5 palpal setae per side ***gracilis***
- 2'. Caudal lamellae darker proximal to nodus; median caudal lamella max width 1.05–1.25 mm, lateral lamellae width 0.85–1.10 mm; ratio of metathoracic femur length:head width ≥ 0.88 ; spiniform setae on posterolateral corner of head with dark bases (Fig. 14.57b); 6 palpal setae per side ***integracollis***

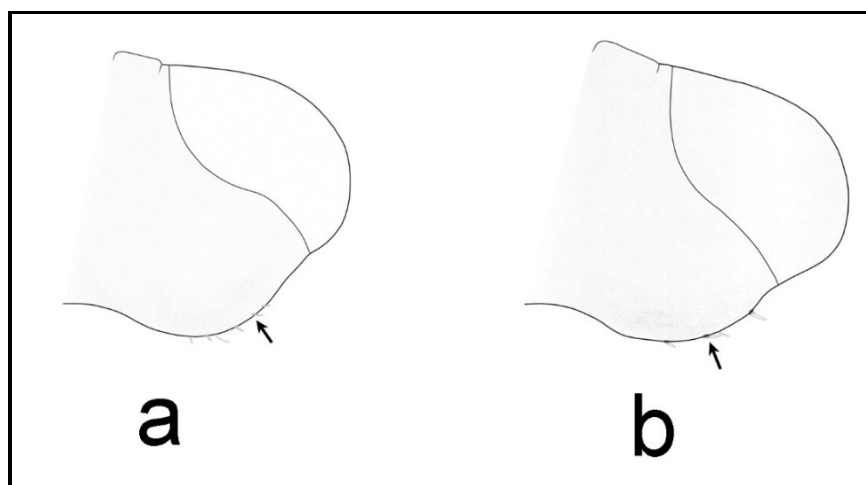


Fig. 14.57. *Nehalennia*, right side of head, dorsal view: a) *N. gracilis*; b) *N. integracollis*.

3. F-0 metathoracic femur length < 2.50 mm; caudal lamellae with 3 dark bands distal to nodus; 3 prominent palpal setae plus 1 smaller medial seta on each side ***minuta***
- 3'. F-0 metathoracic femur length ≥ 2.50 mm; caudal lamellae with 4 dark bands distal to nodus; 3 or 4 prominent palpal setae plus 1 smaller medial seta on each side ***pallidula***

Diagnostic Remarks:

The key is constructed based on F-0 only; earlier instars have not been studied. Of the four species, *N. integricollis* is the most likely of this genus to be encountered; it can be common in sand-bottomed ponds and lakes. The other three species are restricted in their distribution and are found much less frequently.

Nehalennia minuta and *N. pallidula* are remarkably similar. The developing ovipositor of *N. minuta* extends beyond the posterior margin of abdominal segment 10 by about 0.15 to 0.25 mm compared to extending beyond the posterior margin of segment 10 by at most 0.10 mm in *N. pallidula*. The number of prominent palpal setae is 3 in *N. minuta*, and usually a small medial seta is present, whereas *N. pallidula* has either 3 or 4 prominent setae and usually a small medial seta also. *Nehalennia minuta* has not been recorded from mainland Florida.

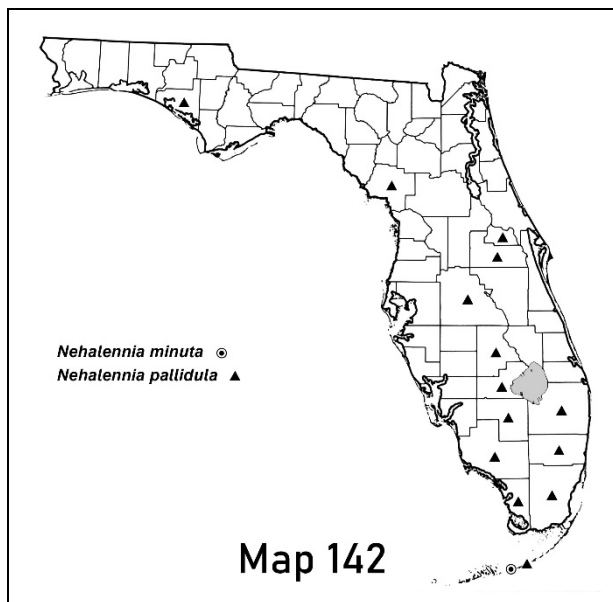
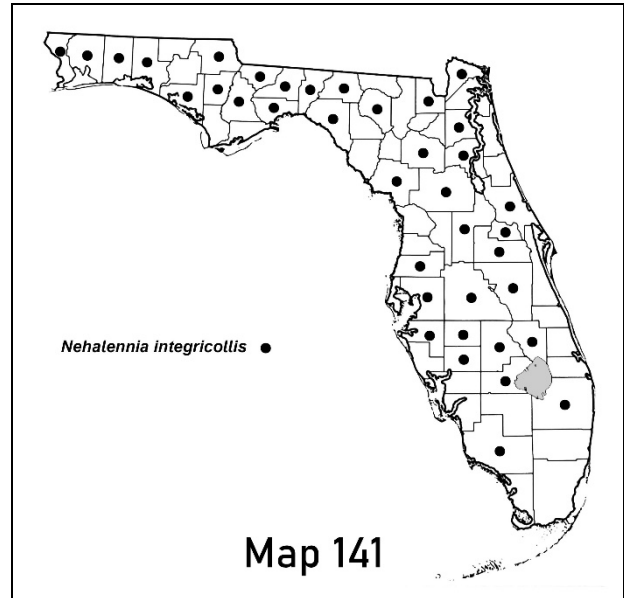
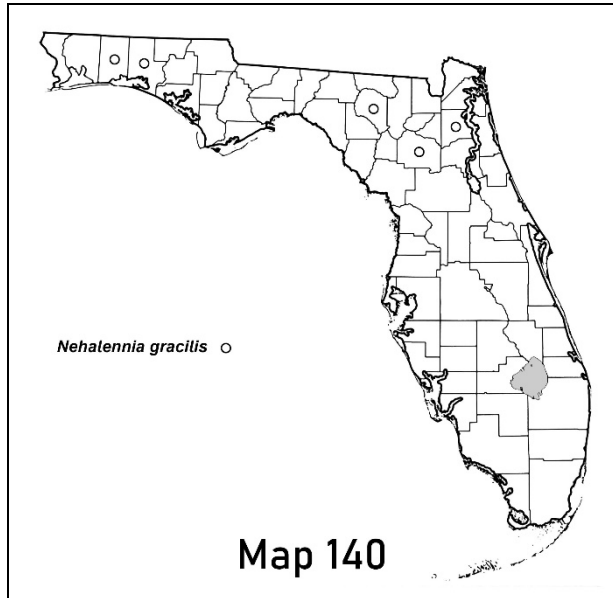
The nymphs of *N. integricollis* and *N. pallidula* have not been described in detail though specimens of both have been reared and are awaiting description.

Habitat, Distribution, Life Cycle:

Nehalennia nymphs are typically lentic. In general, habitats include lakes, ponds, marshes, and ditches with emergent and/or floating vegetation. However, *N. gracilis* adults have been found in northern Florida near seepage areas along small, wooded streams, and nymphs have been collected and reared from a seep (in South Carolina); further north in its range, nymphs of *N. gracilis* occupy shallow edges of bogs and fens. *Nehalennia* nymphs cling to plant stems and roots.

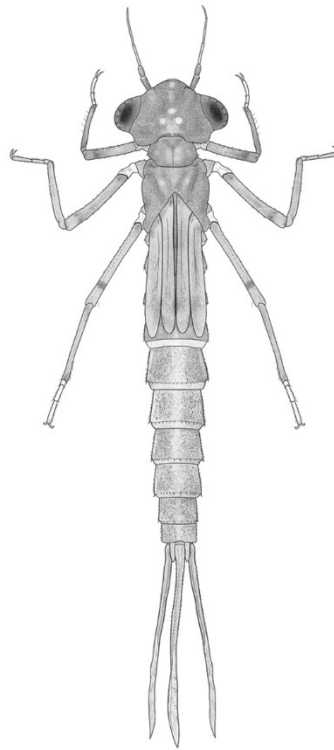
Two species, *N. integricollis* and *N. pallidula* are fairly widespread in the state (Maps 141 & 142). *Nehalennia gracilis* has been recorded only in the northwestern part of the state (Map 140). *Nehalennia minuta* is known only from the Keys (Map 142) but adults have not been seen there in recent years due to saltwater inundation of its only known locality (J. J. Daigle, pers. comm.).

The flight seasons of *Nehalennia* in Florida are variable. *Nehalennia integricollis* and *N. pallidula* continue from March to November. *Nehalennia minuta* has been found from September to February on Big Pine Key (Paulson 2011, J. J. Daigle pers. comm.), although its status there is now uncertain; it is reported to fly year-round outside the U.S., in more tropical parts of its range. The flight season of *Nehalennia gracilis* is early and apparently short, from April 28 to May 18. The other species appear to have long emergence periods in Florida and are probably bivoltine.



Neoerythromma

Slender, elongate; antennae 7-segmented, seg. 1 longer than seg. 2; prementum with 3 or 4 prominent setae; upper process of palpal lobe truncate; 5 palpal setae; abd. seg. 9 with prominent posterolateral spine; caudal lamellae flat, without extratracheal pigment



Neoerythromma is restricted to the New World and contains only two species, one of which occurs in south Florida, *N. cultellatum*.

Diagnosis:

Neoerythromma nymphs closely resemble *Enallagma* and to a lesser extent *Ischnura*. The most reliable differences are 1) antennal segment 1 about 1.15–1.30 times as long as segment 2 [shorter than or subequal in *Enallagma* (ratio 0.52–1.07) and much shorter in *Ischnura* (ratio 0.50–0.65)], 2) abdominal segment 9 with a prominent posterolateral spine (without a prominent spine in *Enallagma* and *Ischnura*); and 3) terminal spiniform seta at nodus on dorsal margin of median lamella and ventral margin of lateral lamella distinctly larger than more proximal setae (at most slightly larger in *Enallagma*, usually about same size as more proximal setae). *Neoerythromma cultellatum* has 5 palpal setae per side and usually 3 premental setae (often a smaller medial seta is present), although some specimens have 4 prominent premental setae; these setal counts do not differ from many species of *Enallagma* and *Ischnura*. The posterolateral corners of the head of *N. cultellatum* are slightly more squarish than in *Enallagma* and *Ischnura*, and the eyes have small dark dashes along the anterior margin (Fig. 14.58a). The male cercus of *N. cultellatum* is longer and more acuminate apically (Fig. 14.58b) than the cerci of nearly all *Enallagma* or *Ischnura* (0.47–0.52 mm compared to 0.15–0.45 mm for all *Enallagma* and *Ischnura* combined). These main distinguishing characteristics of *Neoerythromma* are present in F-1.

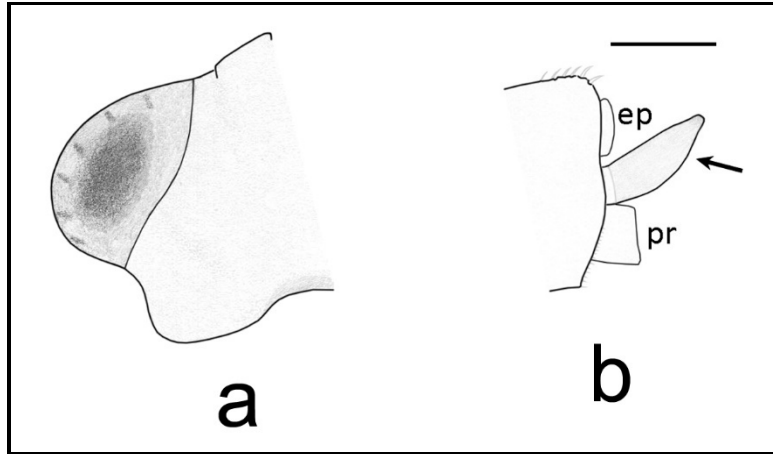


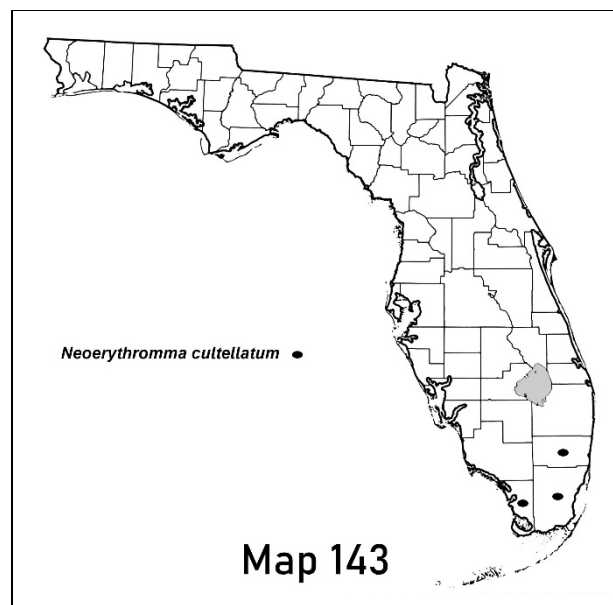
Fig. 14.58. *Neoerythromma cultellatum*: a) left side of head; b) male cercus (indicated by arrow); ep = base of epiproct and pr = base of paraprot (lamellae omitted); scale bar = 0.5 mm.

Habitat, Distribution, Life Cycle:

Neoerythromma nymphs are lentic; *N. cultellatum* inhabits open ponds and lakes with emergent aquatic vegetation. Paulson (2011) suggested this species may tolerate brackish water. The nymphs cling to stems of rooted aquatic plants.

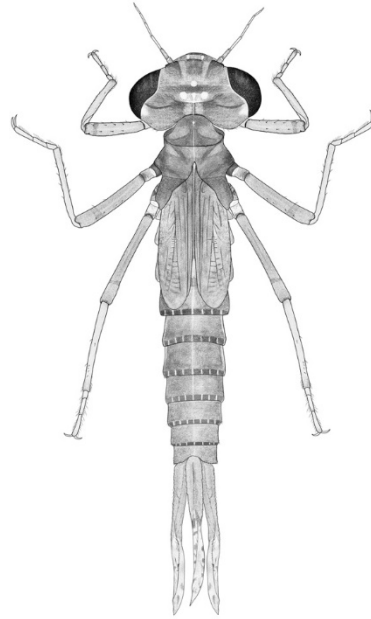
Neoerythromma cultellatum has been found in only three counties in the extreme southern part of the state (Map 143). It has been present on Big Pine Key in past years although its status is unknown.

The recorded flight season of *N. cultellatum* is long, from March 15 to December 24. The species is probably multivoltine, although no life history data are available.



Telebasis

Stocky, small; antennae 7-segmented; prementum with one prominent seta; upper process of palpal lobe usually truncate but pointed in *T. byersi*; usually 6 palpal setae; prothoracic coxal cavities large; caudal lamellae flat, with extra-tracheal spots



Telebasis is a large Neotropical genus; only one species occurs in Florida, *T. byersi*.

Diagnosis:

Telebasis nymphs possess an unusual trait among the genera of North American Coenagrionidae. On the venter of the prothorax, between the coxal cavities, the medial portion of the prosternum is lightly sclerotized and appears as a pale oval (Fig. 14.59a); in other genera, the medial portion of the prosternum is as dark as the surrounding sclerotized parts (Fig. 14.59b). [Note: the venter of the prothorax is overlain by the labium, which must be pushed forward in order to expose the prosternum on the venter]. The eyes of some *T. byersi* specimens have two or three narrow, pale longitudinal stripes on the anterior half of the eyes; these stripes are another unusual feature in Coenagrionidae, although they are often obscured.

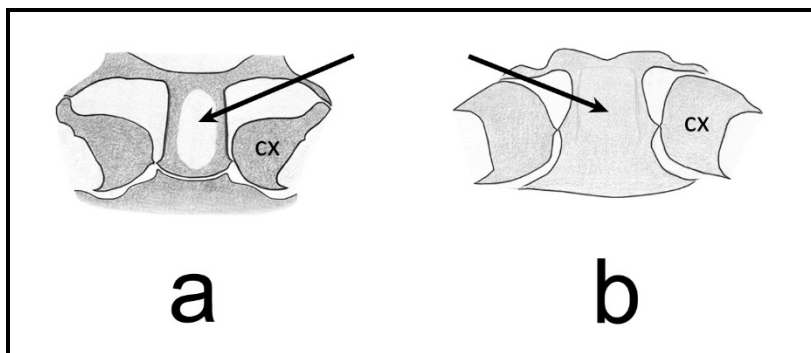


Fig. 14.59. Venter of prothorax: a) *Telebasis byersi*; b) *Ischnura posita*; prosternum indicated by arrow; cx = coxa.

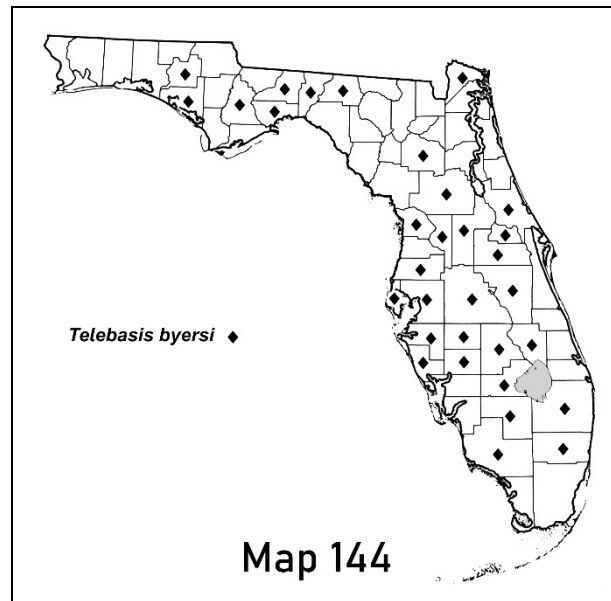
In general habitus, *Telebasis* resembles *Argia* but differs by 1) *Telebasis* palps with 5–7 prominent setae (0–4 inconspicuous setae in *Argia*), 2) *Telebasis* prementum with at least 1 prominent palpal seta, some species with additional setae present medially which may be same size or smaller (none in *Argia*), 3) ligula nearly straight (convex in *Argia*). The only species of *Telebasis* in Florida, *T. byersi*, has a pointed upper process on the palpal lobe (Fig. 14.4), similar to *Argia*; the shape of the process appears to be unique within the genus as a number of other *Telebasis* species from other regions have a more truncate upper lobe. The caudal lamellae are only 2.0–2.6 times longer than their max width and are usually spotted near the margins (Fig. 14.3a), this combination distinguishing them from most other coenagrionid genera.

Habitat, Distribution, Life Cycle:

Telebasis nymphs are primarily lentic; *T. byersi* inhabits shallow swamps but can be found also in slow portions of small streams that have abundant aquatic vegetation, especially duckweed and water lettuce. The nymphs are often found clinging to roots of floating plants.

Telebasis byersi occurs nearly throughout the state except for the extreme southern portion (Map 144).

The flight season of *T. byersi* in Florida appears to be year-round, although in northern Florida adults are not on the wing in the colder months. This species appears to emerge through much of the year in Florida and is probably bivoltine.



15. LESTIDAE

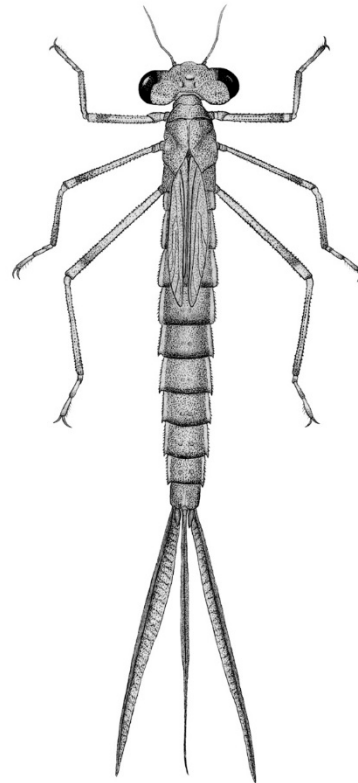
Lestid nymphs are predominantly lentic; they cling to narrow plant stems and small sticks in the water column. They have elongated, agile bodies with long, very slender legs. There is little variability in general body shape within the family.

The family is characterized by: 1) antenna seven-segmented (segment 1 short, segments 3 and 4 longest, usually subequal in length); 2) posterolateral corners of head broadly rounded; 3) prementum scoop-shaped distally, petiolate proximally, the basal portion comparatively long and slender; 4) ligula with a long, closed medial cleft; 5) movable hook with two or three prominent setae (rarely one) and basal portion of palp usually with only one prominent seta; 6) palp bilobed, upper lobe (near movable hook) with three processes; 7) venter of pterothorax without a transverse suture; 8) all caudal lamellae flat, usually transversely banded, apical portion broad, extreme tip sometimes pointed.

One genus, *Lestes* Leach, a large cosmopolitan group, occurs in Florida. Of the eight recorded species, a few can be readily identified, but others are difficult.

Lestes

Elongate, very slender; antennal segment 1 short, others subequal; ligula cleft small, closed; prementum petiolate, long, w/ 5–7 prominent setae per side; movable hook w/ 1–3 prominent setae; caudal lamellae large, flat, typically transversely banded



Notes for using the following key:

- To determine presence/absence of posterolateral spines on the abdominal segments, it is sometimes necessary to view the segments from a ventral or slightly ventrolateral angle. Spines are outgrowths of the cuticle; small, spiniform setae present along the lateral margin and sometimes at the posterolateral corner should not be mistaken for a posterolateral spine (Fig. 15.1).

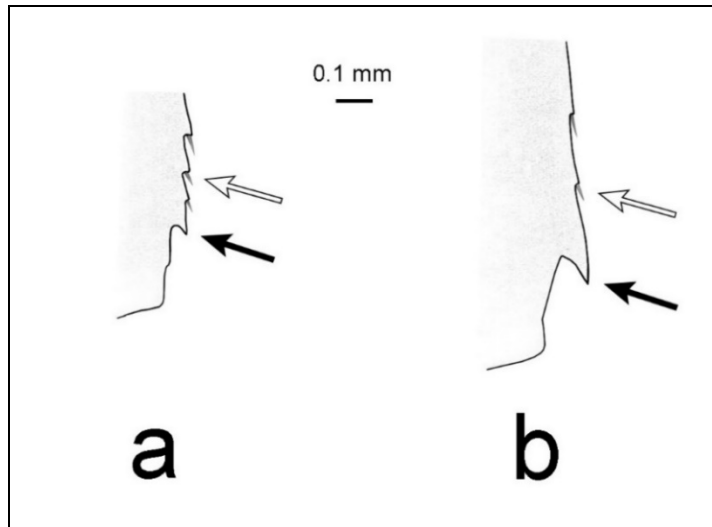


Fig. 15.1. *Lestes*, posterolateral portion of abdominal segments 2 (a) and 3 (b), ventral view, showing difference between a marginal spiniform seta (clear arrow) and a posterolateral spine (black arrow).

- Beginning with couplet 3, the dimensions of the prementum provide important characters for separating *Lestes* species. Total length, length of the widened distal part, and length of the slender proximal part were measured as shown in Fig. 15.2a (length measurements are taken excluding the labial hinge); maximum width of the distal part (W) is shown in Fig. 15.2b.

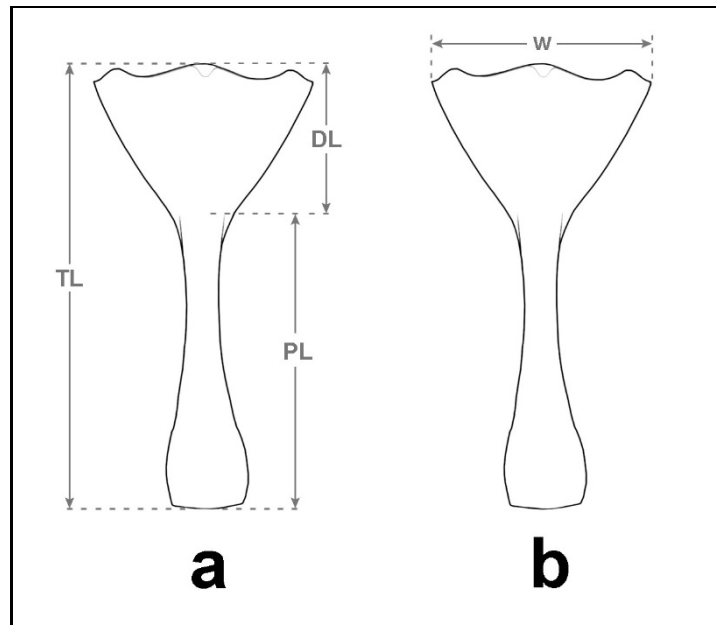


Fig. 15.2. *Lestes*, prementum measurements, ventral view: a) total length (TL), distal length (DL), and proximal length (PL); b) distal max width (W).

- Premental setae decrease in size toward the median, so that the one or two setae nearest the median are usually small, slender, and less obvious than the setae that are more laterally positioned.

Key to *Lestes* Species

1. Abdominal segment 3 with a distinct posterolateral spine on each side (Fig. 15.3a); dorsal and ventral margins of caudal lamellae approximately parallel for 9/10 of their length, dorsal margin straight to slightly convex (Fig. 15.4a)2
- 1'. Abdominal segment 3 without a posterolateral spine on either side (Fig. 15.3b); dorsal and ventral margins of caudal lamellae usually converging from basal third to midlength, dorsal margin usually strongly convex (Fig. 15.4b)3

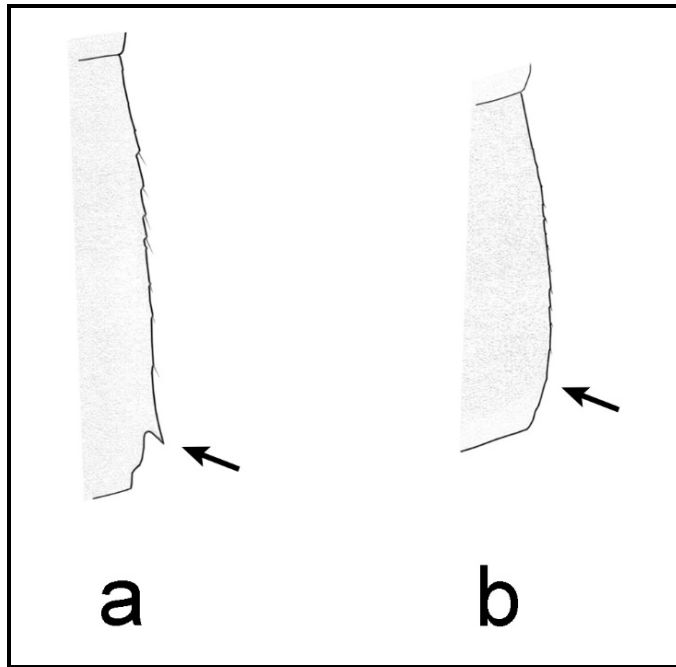


Fig. 15.3. *Lestes*, abdominal segment 3, right side, dorsal view: a) *L. vigilax*; b) *L. vidua*.

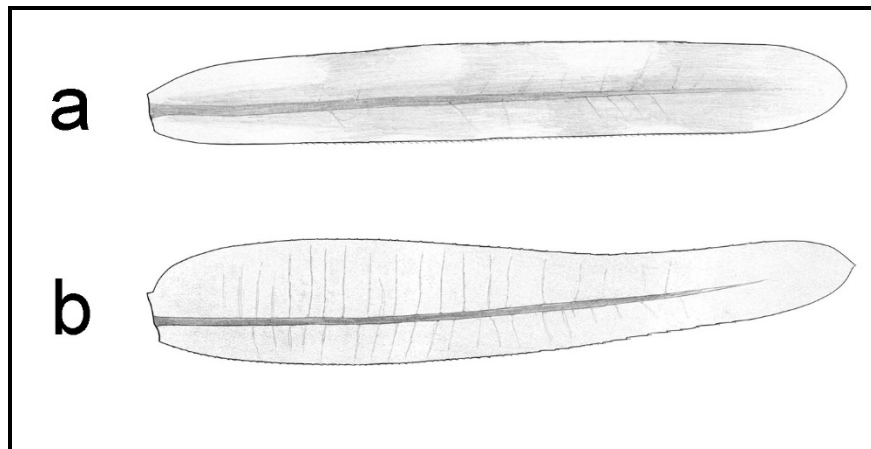


Fig. 15.4. *Lestes*, left lateral caudal lamella: a) *L. vigilax*; b) *L. vidua*.

2. Abdominal segments 1 and 2 with a small posterolateral spine on each side, spine distinctly larger than closest marginal seta (Fig. 15.5a); apex of tibiae and 3rd tarsal segments dark (Fig. 15.6a); antennal segment 6 dark..... *inaequalis*
- 2'. Abdominal segment 1 and usually segment 2 without a small posterolateral spine on either side, if small spine present on segment 2, about same size as closest marginal seta (Fig. 15.5b); apex of tibiae and tarsal segments completely to mostly pale (Fig. 15.6b); antennal segment 6 pale..... *vigilax*

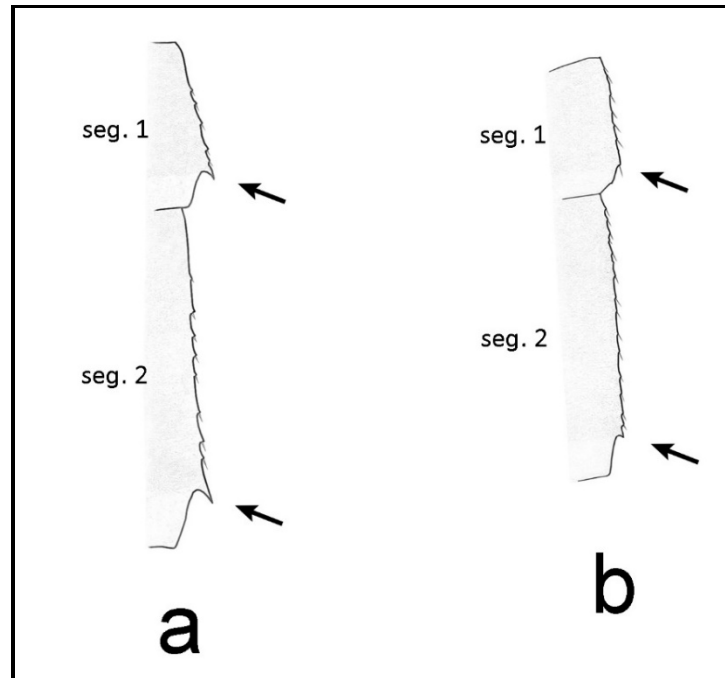


Fig. 15.5. *Lestes*, abdominal segments 1 and 2, dorsal view: a) *L. inaequalis*; b) *L. vigilax*.

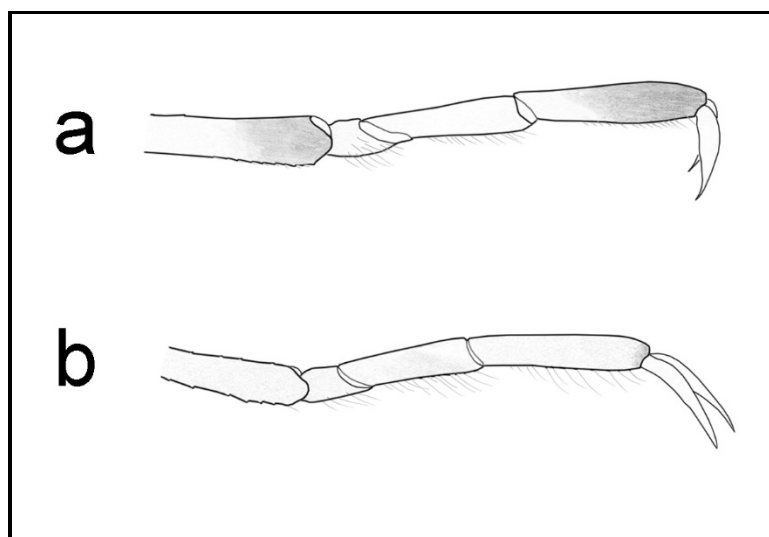


Fig. 15.6. *Lestes*, apex of mesothoracic tibia and tarsus, lateral view: a) *L. inaequalis*; b) *L. vigilax*.

3. Length of slender proximal portion of prementum < 0.7 times total length of prementum (Fig. 15.7a); abdominal segment 5 without a distinct posterolateral spine4
- 3'. Length of slender proximal portion of prementum > 0.7 times total length of prementum (Fig. 15.7b); abdominal segment 5 with a small, distinct posterolateral spine.....5

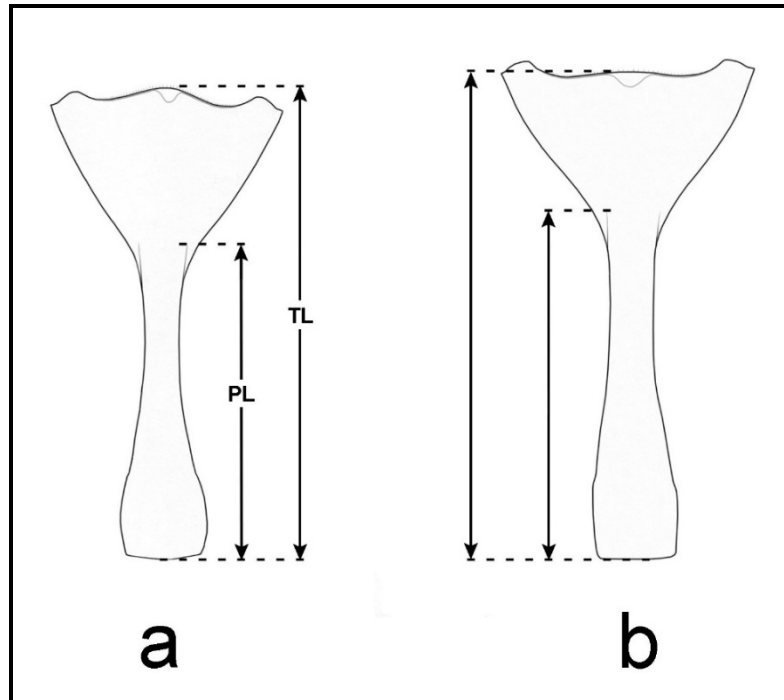


Fig. 15.7. *Lestes*, prementum, ventral view: a) *L. tenuatus*; b) *L. rectangularis*. TL = total length of prementum, PL = length of slender proximal part of prementum.

4. Denticulate process of palpal lobe about as wide as inferior notch (Fig. 15.8a); 7 premental setae per side; tips of caudal lamellae acute *spumarius*
- 4'. Denticulate process of palpal lobe wider than inferior notch (Fig. 15.8b); 5 or 6 premental setae per side; tips of caudal lamellae obtuse *tenuatus*

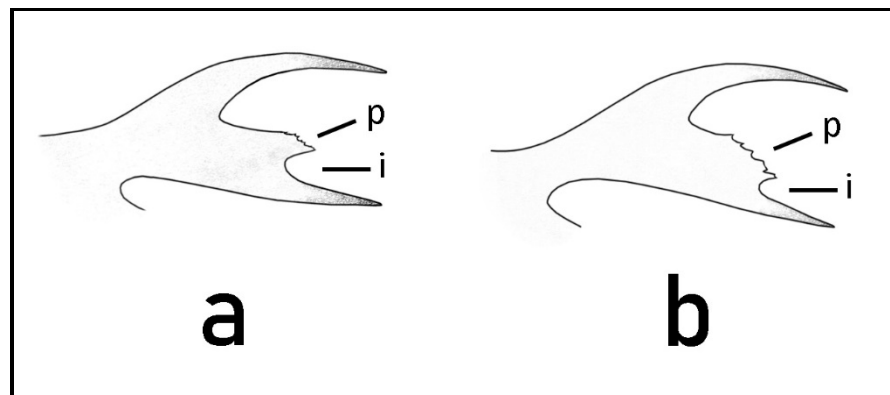


Fig. 15.8. *Lestes*, upper lobe of right palp (movable hook and lower lobe of palp not shown), ectal view: a) *L. spumarius*; b) *L. tenuatus*; p = denticulate process, i = inferior notch.

5. Prementum, at rest, with apex of hinge extending at most to anterior aspect of metathoracic coxae; median caudal lamella slightly narrowed in apical third (Fig. 15.9a), width at midlength < 1.8 mm; F-0 prementum total length 3.0–3.5 mm.....*rectangularis*
- 5'. Prementum, at rest, with apex of hinge extending to middle or posterior aspect of metathoracic coxae; median caudal lamella markedly narrowed in apical third (Fig. 15.9b), width at midlength usually > 1.8 mm; F-0 prementum total length 3.4–4.6 mm6

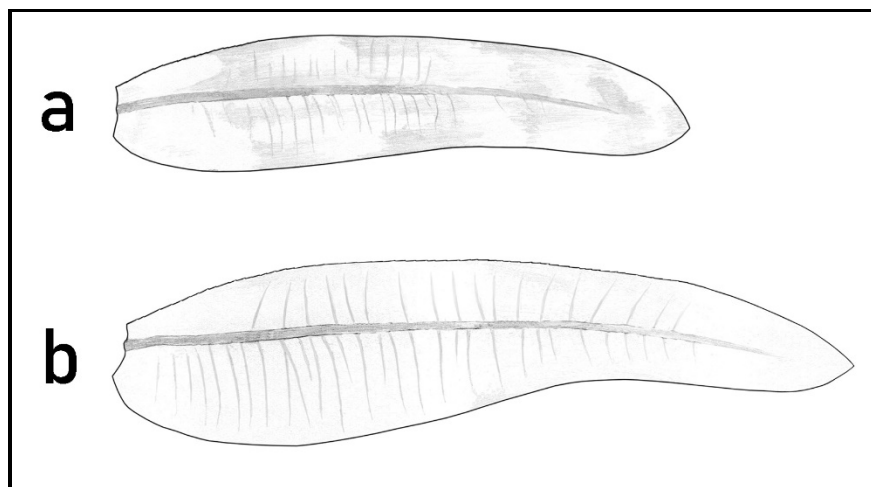


Fig. 15.9. *Lestes*, median caudal lamella: a) *L. rectangularis*; b) *L. vidua*.

6. F-0 prementum max distal width < 1.4 mm and total length 3.2–3.6 mm; F-0 antennal segment 3 length < 0.8 mm and ratio of segment 3 length:segment 4 length 1.1–1.2.....*forficula*
- 6'. F-0 prementum max distal width > 1.6 mm and total length 3.8–4.8 mm; F-0 antennal segment 3 length > 0.9 mm and ratio of segment 3 length:segment 4 length 1.25–1.4.....7
7. Prementum total length ≤ 2.5 times max distal width; antennal segment 4 length < 1.5 times length of segment 2 *australis*
- 7'. Prementum total length > 2.6 times max distal width; antennal segment 4 length > 1.5 times length of segment 2 *vidua*

Diagnostic Remarks:

The new key characters presented here to distinguish the *Lestes* species of Florida involve relative antennal segment lengths and the shape of the caudal lamellae. Several previously used characters are reinterpreted here (e.g., dimensions of the prementum), while a few were deemed variable or unreliable and thus were omitted. Most of the characters apply to F-1 and F-2, but instars younger than F-2 should be identified only to genus.

There is an exception to the caudal lamella character in couplet 1': the lateral lamellae of *L. rectangularis* are only slightly wider at the base than they are distally, and the dorsal and ventral margins converge only slightly from the basal third to the distal part of the lamellae (Fig. 15.10);

as such, their shape is similar to the lateral lamellae of *L. inaequalis* and *L. vigilax*. Although the shape and patterning of caudal lamellae appear to distinguish certain species (Plate 12), intraspecific variation, loss of pattern after preservation, and regeneration and absence of lamellae present problems in trying to utilize them to a great extent as key characters.

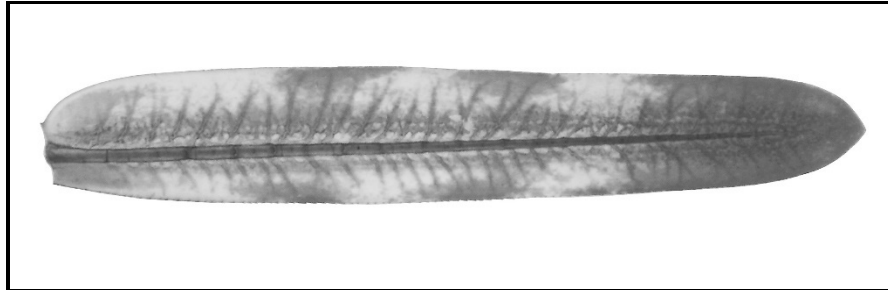


Fig. 15.10. *Lestes rectangularis* lateral caudal lamella.

The species are remarkably uniform in morphology, such that few supplemental characters can be added to the key. In *L. inaequalis*, the denticulate process on the palpal lobe is truncate and wider than the inferior notch versus tapered and narrower than the notch in *L. vigilax*; the difference corresponds to that between *L. spumarius* and *L. tenuatus* (see Fig. 15.8).

Regarding the remaining four species, *L. rectangularis* is distinct in the dimensions of the prementum, in that the length of the proximal, petiolate part is 2.6–3.0 times the length of the widened distal part; the ratio in the other three species combined ranges from 3.2–4.05 (see Fig. 15.2 for measurement of these parts of the prementum).

The remaining three species, *L. forficula*, *L. australis* and *L. vidua*, are difficult to distinguish (couplets 6 and 7). To date, *L. forficula* has rarely been found in Florida whereas the other two species are common in ponds and swamps nearly throughout the state. The characters in couplet 6 that separate *L. forficula* apply only to F-0; younger instars were not available for study. In addition to couplet 7 characters, female F-0 specimens of *L. australis* and *L. vidua* can be distinguished by the length of the developing ovipositor: the tip of the ovipositor reaches the posterior margin of segment 10 in *L. australis* whereas it reaches beyond the posterior margin in *L. vidua*. The relative lengths of the posterolateral spines on abdominal segments 8 and 9 have been used previously to distinguish *L. forficula* from *L. vidua* (segment 8 spines were purported to be longer than those on segment 9 in *L. forficula* compared to being at most equal in *L. vidua*); unfortunately, the distinction is small and not always reliable. The posterolateral spines are essentially identical in *L. australis* and *L. vidua*.

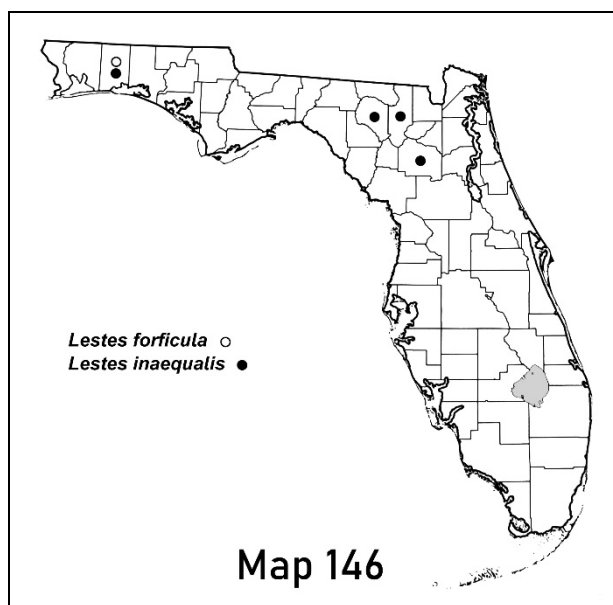
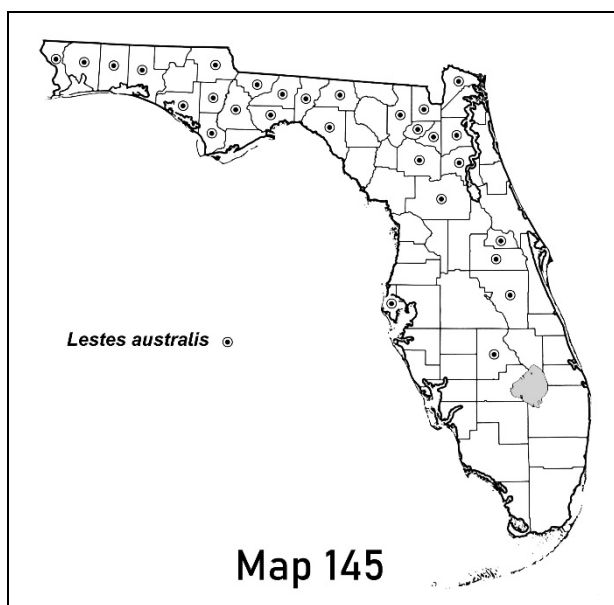
Habitat, Distribution, Life Cycle:

Lestes nymphs are mostly lentic although a few species can be found in slow-flowing parts of streams and canals. *Lestes australis*, *L. forficula*, *L. spumarius*, *L. tenuatus*, *L. vidua* and *L. vigilax* tend to occupy more open marshes and ponds, which can be temporary, whereas *L. inaequalis* and *L. rectangularis* occupy more wooded swamps, lakes, and ponds. Nymphs of *Lestes* are uncommon in most benthic samples.

Lestes australis, *L. vidua* and *L. vigilax* occur nearly throughout Florida (Maps 145, 149, and 150), although none of the three has been found on the Keys and *L. australis* has not been recorded south of Lake Okeechobee. *Lestes forficula*, *L. inaequalis* and *L. rectangularis* are known

from only northern Florida (Maps 146 and 147), whereas *L. tenuatus* has been found only in the southern half of the peninsula (Map 148) and *L. spumarius* only on a few of the Keys (Map 148).

The flight seasons of most *Lestes* species are long. *Lestes australis* flies from March 16 through the rest of the year and into the next January; there are no records of adults being found in February. The season for *L. vidua* is from February 20 to December 8, and that of *L. vigilax* from March 20 to December 16. *Lestes inaequalis* is more restricted in flight season from April 13 to August 8. The only adult record of *Lestes forficula* in Florida is July 11, although dates from Texas are from March 27 to December 14. Flight seasons for some *Lestes* species in Florida may be incomplete: *L. spumarius* has been recorded from July 7 to the following April and *L. tenuatus* from August 27 to the following May; *L. rectangularis* has been recorded from April 16 to November 5 but no records are known for June, July, and August. Most *Lestes* species appear to emerge over an extended period in Florida, indicating they are at least bivoltine.



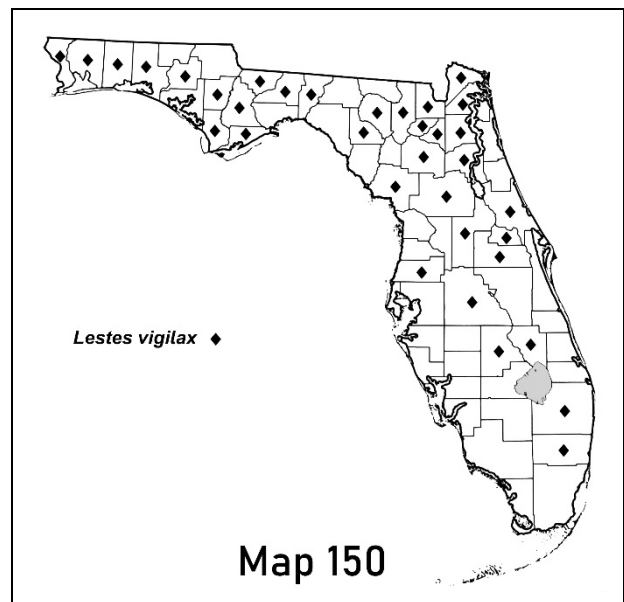
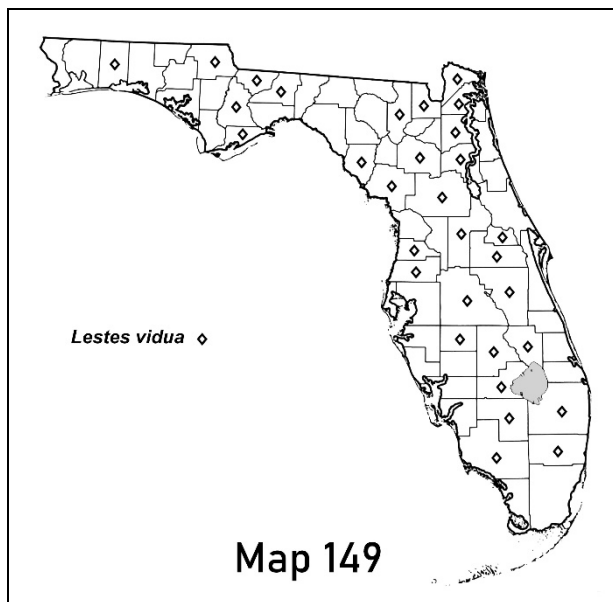
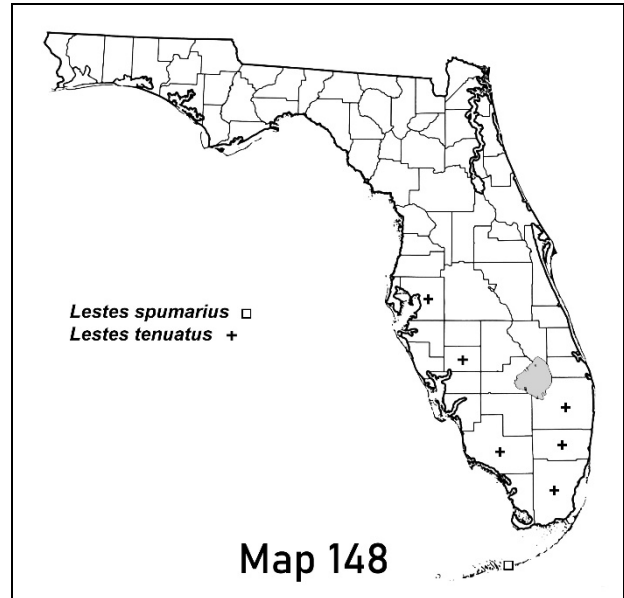
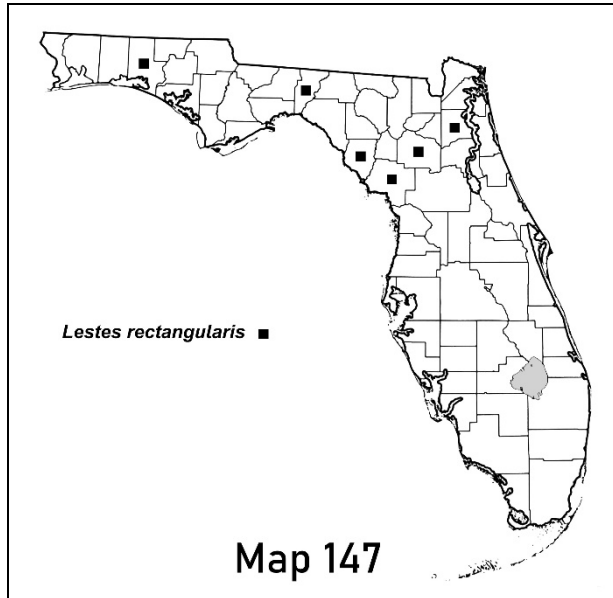
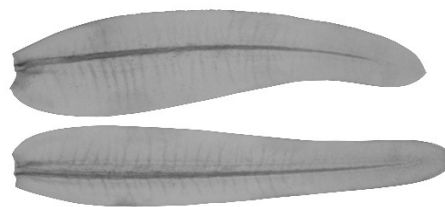


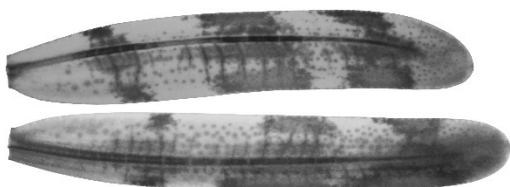
Plate 12. The caudal lamellae of the eight *Lestes* species of Florida, to scale (upper photograph is the median lamella, lower photograph is the left lateral lamella).



australis



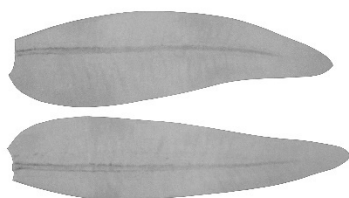
forficula



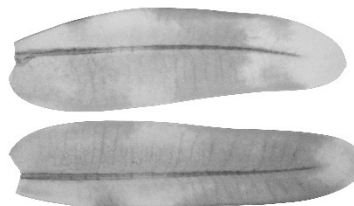
inaequalis



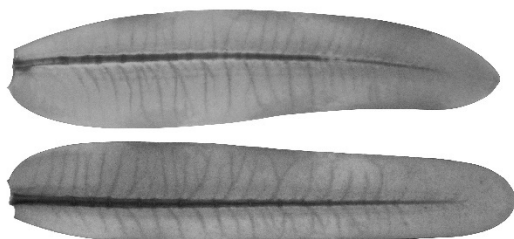
rectangularis



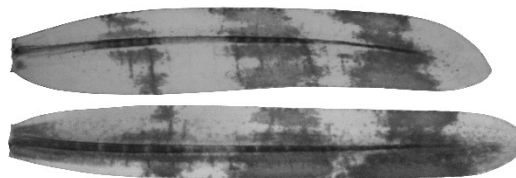
spumarius



tenuatus



vidua



vigilax



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Glossary

The terms in this glossary are supplemental to the morphology discussion in Chapter 2; refer to the treatment there for further explanation and illustration. Main references are Snodgrass (1935), Torre-Bueno (1937), Chapman (1971), and Grimaldi and Engel (2005). Some definitions are amended to apply specifically to Odonata; ant. = antonym, pl. = plural.

anal pyramid— collectively the five anal appendages of Anisoptera nymphs; usage rare.

antennomere— an antennal segment.

antenodal— proximal to the nodus, as applicable to caudal lamellae.

autotomy— separation or self-amputation of an appendage, especially legs and caudal lamellae.

bivoltine— completing two generations in a year.

carina— a cuticular ridge, varying from narrow and sharp to rounded protruding; pl. carinae.

caudal—toward the anal or posterior end of the body; caudad refers to an anal or posterior direction.

cleft— split; partly divided.

clypeus— anterior sclerite of epicranium, between labrum and frons.

crenate— scalloped, usually referring to a margin; with low, rounded lobes.

crenation— a rounded lobe on a crenate margin.

crenulate— referring to a margin, with very small more or less rounded or scallop-shaped projections (smaller than a crenate margin); a single such lobe is a crenulation.

crenulation— a small, more or less rounded or scallop-shaped lobe.

cuticle— outer, noncellular, multi-layered part of the body wall or integument, made up of epicuticle, exocuticle and endocuticle.

discriminal line— a longitudinal medial suture on the metathoracic sternum.

distal— away from the body, referring to part of an appendage or a character on an appendage; ant. proximal.

dorsal rim— the dorsolateral margin of the palpus, as developed in the superfamilies Cordulegastroidea and Libelluloidea.

dorsolateral rim— the lateral margin of the prementum, from base at hinge with postmentum to apex at base of palpus.

ectal— outward; pertaining to the outer aspect of a mouthpart.

emarginate— notched, usually in an obtuse or quadrate shape.

ental— inward; pertaining to the inner aspect of a mouthpart.

entire— evenly margined; not divided, cleft, or notched.

epaulet— lateral projection of prothoracic notum.

epimeron— posterior part of the pleural region; in the Odonata pterothorax, fused with the episternum to make up the lateral wall.

episternum— anterior part of the pleural region; in the Odonata pterothorax, extended dorsally and fused with the epimeron to make up the lateral portions of the pterothorax as well as the mesothoracic dorsum.

extratracheal— outside the tracheae, usually referring to pigmentation of the cuticle surrounding the tracheae.

exuviae— shed cuticle of an arthropod after a molt; considered both singular and plural, although exuvia is sometimes used in the singular sense.

filiform— slender with same width for entire length; thread-like.

frons— anterior portion of head, typically subdivided into an antefrons and postfrons.

furcal pit— outward depression on ventral side of insect thorax where base of an interior forked cuticular process, or apophysis, is positioned; muscles attach to furca.

fusiform— spindle-shaped; rounded and tapering from middle toward each end

gonopore— opening of genital duct on body surface, for release of gametes.

granulate— appearing to have small bumps or grains, similar to pig skin; referring to the outer surface of the integument; also granular, granulose or maculose.

hemimetabolous— incomplete metamorphosis; development from egg to adult without a pupal stage, with wings developing externally.

holometabolous— complete metamorphosis; developmental stages are egg, larva, pupa, adult, with wings developing internally.

homoplasy— a character shared by two or more taxa but not present in their common ancestor; a character convergence. Example: wings of insects and wings of birds are a homoplasy, i.e., they are not homologous.

hypognathous— the head oriented more or less in vertical plane with the mouthparts directed ventrally.

instar— in insects, the actual nymph or larva between molts; because instar is the form of the nymph, terms such as nymphal instar are redundant and are to be avoided.

intersegmental membrane— the flexible integument between two segments.

keel— a raised crest of integument, in cross-section acute or sharp.

labial hinge— the point of articulation between the postmentum and prementum of the labium.

lamella— a flattened structure, mostly used to refer to the leaf-like appendages on the epiproct and paraprocts of Zygoptera (sometimes called gills); pl. lamellae.

lanceolate— spear- or lance-shaped, margins subparallel, tapering at apex.

lateral carina— projecting outermost edge of an abdominal segment, usually ridge-like.

lentic— occupying still, non-flowing water, as in lakes, ponds, swamps, marshes.

ligula— in Odonata nymphs, the anterior margin of the prementum.

lotic— occupying moving, flowing water, as in rivers, streams, seeps.

maculose— spotted, usually attained by dark setal bases that appear as spots against a lighter background.

medial— at or near the middle of the body.

mesal— pertaining to the inner side of a body part.

mesepimeron—the posterior portion of the mesothorax.

mesinfraepimeron—the lateral sternite of the mesothoracic venter.

middorsal hook— a medial protuberance at or near the posterodorsal margin of an abdominal segment, varying in shape from a rounded hump to a sharp point. Referred to as “dorsal hook” in previous works.

monotypic— taxon containing one subordinate taxon, such as a genus containing only one species.

multivoltine— completing three or more generations in a year.

nodus— a discontinuity; referring to caudal lamellae of Zygoptera, usually indicated by a marginal notch or a change in color.

oblanceolate— nearly spear- or lance-shaped, but margins expanded distal to midlength, apex tapered.

occiput— dorsoposterior surface of head from frons to hind margin.

partivoltine— completing one generation in more than two years.

piliform— resembling a hair.

pleural area— the ventrolateral part of a body segment where the limbs are (thorax) or were (abdomen) based.

postnodal— distal to the nodus, applicable to caudal lamellae.

preapical— slightly proximal to the actual apex of a structure; e.g., a preapical seta based slightly proximal to the distal end of a femur.

prognathous— the head oriented more or less in horizontal plane with the mouthparts directed anteriorly.

prosternum— the median ventral sclerite of the prothorax; also called the prothoracic basisternum.

proximal— near the body, referring to part of an appendage or a character on an appendage; ant., distal.

raptorial— adapted for seizing prey.

ridge— a raised longitudinal section of integument, variable in height and angle but less acute than a keel.

rugulose— minutely wrinkled, applied to the outer integument.

sclerite— any hardened part of the body wall defined by sutures.

sclerotization— the chemical process during which the exocuticle of the body wall is hardened.

segmentation— dividing of the body into successive annular subdivisions separated by membranous cuticle.

semivoltine— completing one generation in two years.

sensillum— a sensory, innervated structure of the body wall for receiving stimuli; sense organ; e.g. a seta; pl. sensillae.

serrate— toothed appearance, saw tooth-like.

serrulate— finely serrated, inconspicuous tooth-like appearance.

seta— a one-celled sensillum or receptor, variable in form, from hair-like, bristle-like, spiniform, etc.; articulates with surrounding cuticle, not fused with it; pl. setae.

spine— a cuticular outgrowth of the integument; immovable, clearly fused with surrounding cuticle.

spiniform— spine-like, sharp; usually referring to small setae.

spiracle— an opening in the body wall for respiration.

spur— a multi-celled, spine-like process of the body wall with which it articulates.

sternite— a subdivision of the sclerotized sternum.

sternum— the ventral sclerotized plate of a segment, often subdivided into sternites; pl. sterna.

submedian— near the middle or the midline.

sulcus— a furrow or groove.

suture— a seam, depressed line, or narrow membranous area dividing two parts of the body wall.

tarsomere— a tarsal segment.

teneral— condition of newly-emerged adult, not yet hardened or having attained its mature coloration; soft.

tergite— a subdivision of the sclerotized tergum.

tergum— the dorsal sclerotized plate of a segment, also called the notum; tergal plates are often subdivided in tergites.

trachea— cuticular, air-filled tube inside body wall, functioning in gaseous exchange; pl. tracheae.

triquetral— triangular or with three ridges in cross-section.

tubercle— multi-celled, immovable raised area of the integument; shape round or oval.

univoltine— completing one generation in a year.

voltinism— the number of generations, or broods, per year.

References

- Abbott, J. C. 2006-2020. OdonataCentral: An online resource for the distribution and identification of Odonata. Available at: <https://www.odonatacentral.org/app/#/maps/?filterqs=%7Cexclude%7Cexcludeinat>. (Accessed: 2019–2020).
- Artiss, T., T. R. Schultz, D. A. Polhemus, and C. Simon. 2001. Molecular phylogenetic analysis of the odonate genera *Libellula*, *Ladona*, and *Plathemis* (Odonata: Libellulidae) based on mitochondrial cytochrome oxidase I and 16S rRNA sequence data. *Molecular Phylogenetics and Evolution* 18: 348–361.
- Asahina, S. 1954. A morphological study of a relic dragonfly *Epiophlebia superstes* Selys (Odonata, Anisozygoptera). The Japan Society for the Promotion of Science, Tokyo. 153 pp.
- Baird, I. R. C. 2017. A review of current knowledge of the coastal petaltail dragonfly, *Petalura litorea* (Odonata: Petaluridae). New South Wales Office of Environment and Heritage Save Our Species Program, North East Region. 58 pp.
- Benke, A. C., and S. S. Benke. 1975. Comparative dynamics and the life histories of coexisting dragonfly populations. *Ecology* 56: 302–317.
- Bick, G. H. 1951. Notes on Oklahoma dragonflies. *Journal of the Tennessee Academy of Science* 26: 178–180.
- Boose, A. E. 2014. *Epiaeschna heros* (Swamp Darner) and survivorship during dry periods in vernal pools. *Argia* 26(1): 35–37.
- Byers, C. F. 1930. A contribution to the knowledge of Florida Odonata. University of Florida Press, Gainesville. 327 pp.
- Calvert, P. P. 1928. Report on Odonata, including notes on some internal organs of the larvae. *University of Iowa Studies* 12(2): 1–44.
- Cannings, R. A. 1989. *Enallagma basidens* Calvert, a dragonfly new to Canada, with notes on the expansion of its range in North America (Zygoptera: Coenagrionidae). *Notulae Odonatologicae* 3(4): 53–55.
- Carle, F. L. 1983. A new *Zoraena* (Odonata: Cordulegastridae) from eastern North America, with a key to the adult Cordulegastridae of America. *Annals of the Entomological Society of America* 76: 61–68.
- Carrillo-Lara, D. E., and R. Novelo-Gutiérrez. 2018. Description of the larva of *Orthemis ferruginea* (Fabricius, 1775) (Odonata: Libellulidae). *Zootaxa* 4455(3): 547–554.
- Dunkle S. W. 1977. Larvae of the genus *Gomphaeschna* (Odonata: Aeshnidae). *The Florida Entomologist* 60: 223–225.

Dunkle S. W. 1985. Larval growth in *Nasiaeschna pentacantha* (Rambur) (Anisoptera: Aeshnidae). *Odonatologica* 14(1): 29–35.

Dunkle, S. W. 1992. Distribution of dragonflies and damselflies (Odonata) in Florida. *Bulletin of American Odonatology* 1(2):29–50.

Flenner, I., K. Olne, F. Suhling, G. Sahlen. 2009. Predator-induced spine length and exocuticle thickness in *Leucorrhinia dubia* (Insecta: Odonata): a simple physiological trade-off? *Ecological Entomology* 34: 735–740.

Garrison, R. W., N. von Ellenrieder, J. A. Louton. 2006. *Dragonfly Genera of the New World: An Illustrated and Annotated Key to the Anisoptera*. The Johns Hopkins University Press, Baltimore. 368 pp.

Geijskes, D. C. 1934. Notes on the Odonate-fauna of the Dutch West Indian islands Aruba, Curaçao and Bonaire, with an account on their nymphs. *Internationale Revue der gesamten Hydrobiologie und Hydrographie* 31: 287–311.

Gentilini G., and G. Peters. 1993. The Upper Miocene aeshnids of Monte Castellano, central Italy, and their relationships to extant species (Anisoptera: Aeshnidae). *Odonatologica* 22(2): 147–178.

Glotzhober, R. C. 2006. Life history studies of *Cordulegaster erronea* Hagen (Odonata: Cordulegastridae) in the laboratory and the field. *Bulletin of American Odonatology* 10: 1–18.

Hawking, J. H., and B. A. Ingram. 1994. Rate of larval development of *Pantala flavescens* (Fabricius) at its southern limit of range in Australia (Anisoptera: Libellulidae). *Odonatologica* 23(1): 63–68.

Huggins, D. G. 1978. Redescription of the nymph of *Enallagma basidens* Calvert (Odonata: Coenagrionidae). *Journal of the Kansas Entomological Society* 51(2): 222–227.

Huggins, D. G., and W. Brigham. 1982. Odonata. Chapter 4, pages 1–100 in Brigham, A. R., Brigham, W. U., Gnilka, A. (eds.). *Aquatic insects and oligochaetes of North and South Carolina*. Midwest Aquatic Enterprises, Mahomet.

Johansson, F., and J. Samuelsson. 1994. Fish-induced variation in abdominal spine length of *Leucorrhinia dubia* (Odonata) larvae. *Oecologia* 100:74–79.

Landwer, B. H. P., and R. W. Sites. 2005. Diagnostic efficacy of morphological characters of larval *Tramea lacerata* Hagen and *Tramea onusta* Hagen (Odonata: Libellulidae) in the prairie regions of Missouri. *Great Lakes Entomologist* 38:155–163.

Landwer, B. H. P., and R. W. Sites. 2006. Variability in larval character states used to distinguish between species of *Pantala* Hagen (Odonata: Libellulidae). *Florida Entomologist* 89: 354–360.

Landwer, B. H. P., and R. W. Sites. 2010. The larval Odonata of ponds in the prairie region of Missouri. *Transactions of the American Entomological Society* 136: 1–105.

Lutz, P. E. 1968. Life-history studies on *Lestes eurinus* Say (Odonata). *Ecology* 49: 576–579.

Lutz, P. E., and C. E. Jenner. 1964. Life-history and photoperiodic responses of nymphs of *Tetragoneuria cynosura* (Say). *Biological Bulletin* 127(2): 304–316.

Marczak, L. B., J. S. Richardson, and M. C. Classen. 2006. Life history phenology and sediment size association of the dragonfly *Cordulegaster dorsalis* (Odonata: Cordulegastridae) in an ephemeral habitat in southwestern British Columbia. *Canadian Field Naturalist* 120: 347–350.

May, M. L. 2012. A critical overview of progress in studies of migration of dragonflies (Odonata: Anisoptera), with emphasis on North America. *Journal of Insect Conservation* 17: 1–15.

May, M. L. 2013. A critical review of progress in studies of migration of dragonflies (Odonata: Anisoptera), with emphasis on North America. *Journal of Insect Conservation* 17: 1–15.

May, M. L., J. A. Gregoire, S. M. Gregoire, M. A. Lubertazzi, J. H. Matthews. 2017. Emergence phenology, uncertainty, and the evolution of migratory behavior in *Anax junius* (Odonata: Aeshnidae). *PLOSOne* 12(9):1–27.

McCauley S. J., C. J. Davis, and E. E. Werner. 2008. Predator induction of spine length in larval *Leucorrhinia intacta* (Odonata). *Evolutionary Ecology Research* 10: 435–447.

Meurgey, F., and G. Weber. 2007. The Odonata of Dominica, British West Indies – 2006 collecting trip. *Argia* 18(4): 14–15.

Morin, P. J. 1984. Odonata guild composition: experiments with colonization history and fish predation. *Ecology* 658: 1866–1873.

Needham, J. G. 1904. New dragon-fly nymphs in the United States National Museum. *Proceedings of the United States National Museum* 27: 685–720.

Needham, J. G., M. J. Westfall, Jr., and M. L. May. 2000. *Dragonflies of North America*. Revised Edition. Scientific Publishers, Gainesville. 940 pp.

Needham, J. G., M. J. Westfall, Jr., and M. L. May. 2014. *Dragonflies of North America*. Third Edition. Scientific Publishers, Gainesville. 657 pp.

Paulson, D. R. 1966. *The dragonflies (Odonata: Anisoptera) of Southern Florida*. Ph. D. dissertation, University of Miami. 603 pp.

Paulson, D. R. 1978. An Asiatic dragonfly, *Crocothemis servilia* (Drury), established in Florida (Anisoptera: Libellulidae). *Notulae Odonatologicae* 1(1): 9–10.

- Paulson, D. 2011. *Dragonflies and Damselflies of the East*. Princeton University Press, New Jersey. 538 pp.
- Paulson, D. R., and C. E. Jenner. 1971. Population structure in overwintering larval Odonata in North Carolina in relation to adult flight season. *Ecology* 52(1): 96–107.
- Raebel, E. M., T. Merckx, P. Riordan, D. W. Macdonald, D. J. Thompson. 2010. The dragonfly delusion: why it is essential to sample exuviae to avoid biased surveys. *Journal of Insect Conservation* 14: 523–533.
- Richardson, J. S. 2010. Identification Manual for the Damselfly Nymphs (Zygoptera) of Florida. State of Florida, Department of Environmental Protection, Tallahassee. 57 pp.
- Smock, L. A. 1988. Life histories, abundance and distribution of some macroinvertebrates from a South Carolina, USA coastal plain stream. *Hydrobiologia* 157: 193–208.
- Snodgrass, R. E. 1935. *Principles of Insect Morphology*. McGraw Hill, New York. 665 pp.
- Snodgrass, R. E. 1954. The dragonfly larva. *Smithsonian Miscellaneous Collections* 123(2): 1–38.
- Tennessen, K. 2017. A method for determining stadium number of late stage dragonfly nymphs (Odonata: Anisoptera). *Entomological News* 126(6): 299–306.
- Tennessen, K. J. 2019a. *Dragonfly Nymphs of North America: An Identification Guide*. Springer, Switzerland. 620 pp.
- Tennessen, K. J. 2019b. Odonata. Chapter 14, pages 341–409 in Merritt R., Cummins, K. and Berg, M. B. (eds.). *An Introduction to the Aquatic Insects of North America*. Fifth Edition. Kendall/Hunt, Dubuque, Iowa.
- Theischinger, G., and G. Fleck. 2003. A new character useful for taxonomy and phylogeny of Anisoptera (Odonata). *Bulletin de la Société entomologique de France* 108(4): 409–412.
- Tillyard, R. J. 1917. *The Biology of Dragonflies (Odonata, or Paraneuroptera)*. University Press, Cambridge. 396 pp.
- Walker, E. M. 1953. *The Odonata of Canada and Alaska*. Volume 1. University of Toronto Press. 292pp.
- Walker, E. M. 1966. On the generic status of *Tetragoneuria* and *Epicordulia* (Odonata: Corduliidae). *Canadian Entomologist* 98: 897–902.
- Walker, E. M., and P. S. Corbet. 1975. *The Odonata of Canada and Alaska*. Vol. 3. University of Toronto Press, Toronto. 307 pp.

Ware, J. L., E Pilgrim, M. L. May, T. W. Donnelly, K. Tennessen. 2017. Phylogenetic relationships of North American Gomphidae and their close relatives. *Systematic Entomology* 42: 347–358.

Westfall, M. J., Jr. 1974. A critical study of *Gomphus modestus* Needham, 1942, with notes on related species (Odonata: Gomphidae). *Odonatologica* 3: 63–73.

Westfall, M. J., Jr., and M. L. May. 2006. Damselflies of North America. Revised Edition. Scientific Publishers, Gainesville. 502 pp.

Williams, F. X. 1937. Notes on the biology of *Gynacantha nervosa* Rambur (Aeschninae), a crepuscular dragonfly in Guatemala. *The Pan-Pacific Entomologist* 13(1-2): 1–8.

Wissinger, S. A. 1988. Life history and size structure of larval dragonfly populations. *Journal of the North American Benthological Society* 7(1): 13–28.



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