

**OPHIOGOMPHUS (OPHIONURUS) AUSTRALIS SPEC. NOV.  
FROM THE GULF COAST OF LOUISIANA, WITH  
LARVAL AND ADULT KEYS TO AMERICAN OPHIOGOMPHUS  
(ANISOPTERA: GOMPHIDAE)**

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*Received February 17, 1992 / Accepted March 3, 1992*

The new sp. is described from adult and larval material (holotype ♂, allotype ♀: Tangipahoa R., 5 km E of Kentwood, Tangipahoa Parish, Louisiana, USA) and its affinities discussed. *Calogomphus* subg.n. (type sp.: *Erpetogomphus eutainia* Calv.) and *Erpetocyclops* subg.n. (type sp.: *Erpetogomphus ophibolus* Calv.) are introduced, and keys to the American onychogomphine genera and subgenera are presented, incl. species keys to adult and larval American *Ophiogomphus*.

INTRODUCTION

The publication of a detailed key (CARLE, 1981) to the species of Eastern North American *Ophiogomphus* has led to a rapid increase in our knowledge of these beautiful and somewhat secretive dragonflies. In addition to *O. acuminatus* CARLE (1981), the following *Ophiogomphus* have been recently described: *O. incurvatus* CARLE (1982), *O. incurvatus alleghaniensis* CARLE (1982), *O. bucharidi* LOUTON (1982a), *O. westfalli* COOK & DAIGLE (1985), and *O. mainensis fastigiatus* DONNELLY (1987). *Ophiogomphus* has also been divided into three subgenera (CARLE, 1986). Additional revisions within *Ophiogomphus* are that *Ophiogomphus i. alleghaniensis* is now considered a separate species (COOK & DAIGLE, 1985; CARLE 1986), and a recent study of *O. bucharidi* has shown it to be conspecific with *O. acuminatus* and not with the new species herein described, a possibility once considered (LOUTON, 1982b). In addition,

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CARLE (1981) has shown *O. edmundo* to be a distinct species, and CARLE (1982) has shown *O. carolinus*, whose type locality is near that of *O. buchardi*, to be conspecific with *O. rupinsulensis* and not with either *O. acuminatus-buchardi* or *O. incurvatus*.

The new *Ophiogomphus* was known from a small collection of Louisiana larvae until a single adult male was found in the Florida State Collection of Arthropods. Additional specimens, including females, were collected by the author in 1986, and by Dr S.W. Dunkle and Mr. J.J. Daigle in 1987, a subsequent visit to known localities in 1988 produced no new material. The new species is among the rarest of Odonata and is only known to occur along pristine sections of two small gravel bottomed rivers along coastal Louisiana east of the Mississippi River. The pristine nature of these and nearby streams has been degraded by the apparent effects of gravel mining to such an extent as to indicate that the species might be in danger of extinction. Unfortunately much negative collecting data exists for regional rivers and streams.

*OPHIOGOMPHUS (OPHIONURUS) AUSTRALIS* SPEC. NOV.

Figure 1

*Ophiogomphus mainensis* Packard, BICK, 1957, *Tulane Stud. Zool.* 5(5): 135.  
*Ophiogomphus* sp. A, CARLE & MAY, 1987, *Odonatologica* 16(1): 67-75.

**Material.** — **Holotype** ♂: UNITED STATES: Louisiana, Tangipahoa Parish, Tangipahoa R., at Rt 38, 5 km E of Kentwood, 18-IV-1986, F.L. Carle leg. — **Allotype** ♀: Mississippi, Pike Co., Tangipahoa R., 0.5 km N of Chatawa Post Office, 21-IV-1986, F.L. Carle leg. — **Paratypes**: same as holotype, 3 ♂, 13 larvae; Tangipahoa R. nr Roseland, 2 larvae, 2-X-1948, G.H. Bick leg.; — same as allotype, 2 ♂, 2 ♀; — Louisiana, Washington Parish, Pushepatapa Creek at Rt 21 nr Varnado, 1 ♂, 8-IV-1966, W.F. Mauffray leg.; — same locality, 1 ♀, 12-IV-1986, F.L. Carle leg.; — same locality, 1 ♂, 1 ♀, 5 larvae, 16-IV-1986, F.L. Carle leg.; — same locality, 4 larvae, 19-I-1952, G.H. Bick leg. — Holotype and allotype deposited in the Florida State Collection of Arthropods (FSCA), Gainesville, Florida, USA.

**E t y m o l o g y.** — *O. australis* [aus-tra'lis], Latin "southern", referring to the southern distribution of the species.

**MALE.** — Total length 43.5-46.0 mm, abdomen including cerci 32.0-34.0 mm, cerci 1.5-1.7 mm, hind femora 5.3-5.8 mm, hind wings 24.0-26.0 mm, pterostigmata 2.8-3.0/3.1-3.3 mm.

**Head.** — Labium, maxillae, and mandibles yellowish white, second palpal segment, apex of maxillae and mandibles brown; labrum and genae yellowish white, anteclypeus and labrum with basomedial area yellow and basal edge lightly tinged with brown; postclypeus yellow; antefrons yellow (lime green in life), basal 1/3 of dorsal surface brown, brown area extended anteriorly near antennae; antennae and vertex (postfrons) brown with posterior surface of postocellar ridge yellow, postocellar ridge bilobed; compound eyes blue above, gray below; occiput

greenish yellow (dorsal portion lime green in life), occipital crest laterally brown with hair fringe dense; posterior surface of head predominantly brown, yellowish white ventrally.

**T h o r a x.** — Prothorax brown, anterodorsal edge yellowish white, dorsomedial lobe with paired medial and lateral greenish yellow areas. Pterothorax greenish yellow (lime green in life) with brown bands; dorsal mesanepisternal pale stripes broadly confluent with pale collar below and narrowly confluent with lateral mesanepisternal pale stripes above, dorsal stripes separated by ca their middle width by middorsal brown band; lateral mesanepisternal pale stripes separated from mesanepimeral pale stripes by brown bands along mesopleural sulci, these bands gradually narrowed ventrally; lateral mesanepisternal pale stripes  $\frac{1}{3}$  -  $\frac{1}{2}$  width of adjacent brown bands at midlength, katapisterna and thoracic sternum light brown; mesanepimeral yellow stripes separated from metanepisternal yellow stripes by brown band along intersegmental interface, brown band occasionally diffuse for short distance above spiracle, metanepisternal and metanepimeral pale areas separated by brown band along metapleural sulci; dorsolateral carinae and antearlars brown.

**L e g s.** — Coxae and trochanters yellowish brown; femora yellow with extreme apex brown, external posterior surface light brown (represented by double brown line on hind femora); tibiae black with external ridges and patellae light yellow; tarsi black; leg spines black; prothoracic tibial keels pale, ca  $\frac{1}{2}$  length of tibiae.

**W i n g s.** — Venation dark brown, costa yellowish green with black spines; pterostigmata tan ventrally, brown dorsally; membrane hyaline. Antenodal crossveins 11-14, 11-14 / 8-10, 8-10; postnodal crossveins 7-10 / 7-9; triangles, subtriangles, and supratrangles without crossveins; basal subcostal crossvein absent; gaff  $\frac{2}{5}$ - $\frac{3}{5}$  length inner side of triangle; bridge crossveins 4-7/4-5; crossveins under pterostigmata 3-5 / 3-5; anal loop 3 or 4-celled. Anal triangle 5 to 7-celled.

**A b d o m e n.** — Brown marked with yellow and white; terga 1 and 2 yellowish white laterally and brown dorsally with median yellow areas, auricles yellowish white with 4-8 black denticles restricted to posterior edge, area posterior to auricle shaded with yellowish brown; terga 3-6 brown, white lateroventrally with posteroventral corner and area along antecostal suture brown, yellow middorsal areas  $\frac{4}{5}$  length of terga, constricted at antecostal suture and near apex, ca. 0.90, 0.70, 0.65, and 0.65 length of terga, respectively; sterna 3-7 brown; intersegmental membrane 2-6 brown, 7-10 yellowish white; tergum 7 brown, yellow laterally with posterolateral corner brown, yellow divided by brown along antecostal suture, dorsal golden yellow area similar to that on tergum 6 but wide basally; expanded lateral rim of terga 7-9 dark brown; tergum 8 brown, golden yellow laterally with small posterolateral brown spot, dorsal yellow spot obovate or lanceolate, ca  $\frac{1}{2}$  length of tergum; tergum 9 golden yellow with middorsal yellow spot oval and surrounded with brown or dorsum golden yellow with two submedian basal brown areas; tergum 10 yellow with diffuse submedian basal brown

areas and apical margin dark brown, sterna 8-10 yellow, basal  $\frac{1}{5}$  of sternum 8 dark brown; terminalia yellow, apices of epiproct and denticles of cerci brown. Cerci slightly shorter than epiproct (Fig. 1), acuminate apically, dorsal and lateral margins slightly convex; cerci strongly narrowed distally and not distinctly incurvate, ventrolaterally with line of 4-5 distinctive denticles along subapical ridge; epiproct with narrow median cleft extended proximally to apices of paraprocts, median cleft not widened basally, each ramus with lateral obtuse spine at ca  $\frac{1}{2}$  length of epiproct; dorsolateral edge basal to lateral spine not strongly convex.

**G e n i t a l i a .** — Anterior hamuli brown each with proximal lobelike portion and distal hooklike portion, apex of distal portion decurved and directed toward proximal shoulder, in lateral view enclosed gap wider than basal width of distal portion, (enclosed notch subcircular  $\frac{3}{5}$  -  $\frac{7}{10}$  as wide as long); posterior hamuli greenish yellow, each with apical portion brown, flattened in cross-section slightly dilated toward apex; shoulder well-developed. Penis brown, penile hood with yellow lateral area, filament and membranes translucent; segment 1 with penile hood erect, in lateral view width at middle ca.  $\frac{3}{5}$  length, apex cleft with two lateral lobes 1.5-2.0 times as long as wide, penile vesicle ca. twice as wide as long, troughlike, thinly expanded laterally with proximal

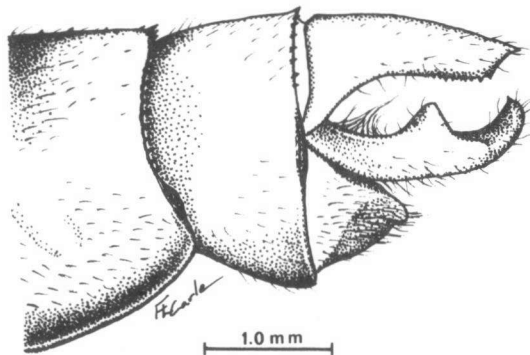


Fig. 1 *Ophiogomphus (Ophionurus) australis* sp. n., lateral view of male terminalia.

edges less than  $\frac{1}{2}$  length of anterior edge; segment 2 "J"-shaped, length ca 1.6 mm, distal portion globose with well-developed retractor spine; segment 3 ca 1.2 mm long excluding prepuce and strongly constricted basally, prepuce elongate and extended between flaplike extensions of segment 4; segment 4 ca 1.0 mm long, filament divided ca 0.6 mm of length, inner surface with lateral translucent expansions, and acute anteriorly-directed spine, outer surface with short medial decurved translucent lobe.

**FEMALE.** — Total length 44.0-46.0 mm, abdomen including cerci 33.0-34.5 mm, cerci 1.1-1.2 mm, hind femora 5.4-5.6 mm, hind wings 27.0-28.0 mm, pterostigmata 3.1-3.5/3.5-3.9 mm.

**H e a d .** — Colored as in male; dorsal portion of occiput with two or more minute horns on anterior surface, horns about half as long as pedicel, directed anterolaterally and separated by distance about equal to  $\frac{1}{2}$  length of postfrontal

suture; postocellar ridge not extended to lateral ridge of vertex (postfrons), small postoccipital horns present. Posterior surface of dorsal portion of occiput level.

**T h o r a x.** — Colored as in male.

**L e g s.** — Colored as in male, inner spines of hind tibiae longer than in male, prothoracic tibiae without keels.

**W i n g s.** — Venation, membrane, and pterostigmata colored as in male. Antenodal crossveins 11-15, 11-13 / 8-10, 8-10; postnodal crossveins 7-10/7-10; triangles, subtriangles, and supradiangles without crossveins; basal subcostal crossvein absent; gaff  $\frac{2}{5}$ - $\frac{3}{5}$  length of inner side of triangle; bridge crossveins 4-6/4-5; crossveins under pterostigmata 4-5/4-5; anal loop 2 or 3-celled.

**A b d o m e n.** — Colored similar to male with middorsal yellow areas and lateral white areas anterior to antecostal suture extended laterally to create lateral brown rectangular areas on segments 3-6, posterolateral brown area extended anteriorly and confluent with brown area along antecostal suture; isolated white lateral areas with hooklike apices, which may be isolated; relative lengths of dorsal yellow spots of segments 3-8, 0.95, 0.85, 0.80, 0.80, 0.70, 0.50, respectively.

**G e n i t a l i a.** — Vulvar lamina yellow ca  $\frac{1}{2}$  length of sternum 9, ca. 1.85 mm long and 1.10 mm wide at base, and cleft for ca  $\frac{1}{4}$  its length, width at base ca  $\frac{9}{10}$  length; apices raised and recurved, lateral subapical margins not expanded.

**LARVA.** — Total length 25.0-27.0 mm, abdomen 15.0-16.5 mm, hind femora 4.0-4.3 mm, prementum 3.6-3.8 mm.

**H e a d.** — Prementum gradually narrowed in basal  $\frac{1}{3}$  to ca  $\frac{7}{10}$  apical width, apical  $\frac{2}{3}$  parallel to slightly convergent anteriorly; ligula convex, ca  $\frac{3}{8}$  apical width of prementum with fringe of moderately long setae and 27-30 dark brown, toothlike denticles; first segment of labial palps rounded distally each with 12-14 teeth in nearly straight row; third antennal segments subelliptical each ca 1.8 times as long as wide, fringed with long, hairlike setae, and each dorsally with papilliform setae more dense laterally and apically; fourth antennal segments each ca  $\frac{2}{3}$  as wide as base of segment 3, base ringed with small papilliform setae; dorsal surface of head with fine granulations, cuticular granules not deeply pigmented.

**A b d o m e n.** — Long-ovoid in shape, widest at segments 5 and 6, lateral taper gradually increasing on segments 7-9, covered with minute nonpigmented granules, and almost devoid of hairs; wing pads divergent, extended to distal half of segment 4 in mature larvae; dorsal tubercles depressed and vestigial, extended beyond posterior cuticular margin of segments 7 or 8-9 only, those of segments 2 and 3 highest, those of 4-7 each slightly more appressed, those of 8 and 9 not appearing elevated in lateral view; segments 7-9 with lateral spines, relative lengths 0.8-1.0:1.0-1.2:1.0, respectively; cerci 1.7-1.8 times middorsal length of segment 10 and ca  $\frac{3}{4}$  length of epiproct, apex of male epiproctal tubercles at ca  $\frac{1}{2}$  length of epiproct, apex of epiproct slightly bent upward, paraprocts slightly longer than epiproct.

**Remarks.** — Adult *O. australis* are characterized by the most extensive dark markings of the subgenus *Ophionurus* and may be easily distinguished from related species by the brown band along the interpleural interface. However, the basal  $\frac{2}{3}$  of the femora, abdominal segment 10, and labrum are yellow; and the tibiae have a yellow streak along the external carinae. These characteristics will separate *O. australis* from the related *O. mainensis*, but not from its near relatives *O. alleghaniensis* and *O. incurvatus*. From these species it may also be distinguished by an only slight basal curvature of the male epiproct and the small postoccipital horns of the female.

The larvae may be readily recognized as belonging to the above mentioned group of species by the short oval third antennal segment which is about twice as long as wide. *O. australis* may be distinguished from *O. incurvatus* and *O. alleghaniensis* by the slightly more elongate third antennal segment, and by the dorsal abdominal processes which are highest and subequal on segments 2 and 3 as opposed to being highest on segments 3 and 4. In addition *O. alleghaniensis* is larger than *O. australis* and *O. incurvatus*, but has the ligula only  $\frac{1}{2}$  the width of the prementum. *O. mainensis* may be separated from *O. australis* by several slight differences listed in the key, the most reliable characteristics for younger larvae seem to be the shape of the third antennal segment which is distinctly asymmetric in *O. mainensis* and the lateral margins of the distal half of the prementum which are slightly divergent in *O. mainensis*.

#### BIOLOGY

The extreme rarity of *O. australis* is most likely related to substrate requirements of the larval stage. Larvae were most often collected from pea-sized gravel in 10-20 cm of water, with areas at the tail of riffles being the most productive. The Tangipahoa River averages less than 10 m wide at the type locality and a few pools reach a depth of 2 m. The substrate is primarily a mixture of sand and pea-gravel eroded from local deposits. Gravel has been extensively mined in the area and this activity has apparently led to a widening and a filling with sand of many regional rivers and streams. A survey of 47 regional sites resulted in the discovery of only two additional occurrences of *O. australis*. It is perhaps significant that the Mississippi site on the Tangipahoa River appears pristine as does the type locality. The Pushepatapa site seems slightly disturbed in that the substrate and banks do not seem as stable as at the type locality. Other Gomphidae which occur along the upper Tangipahoa River and at Pushepatapa Creek include *Gomphurus modestus*, *G. hybridus*, *Progomphus obscurus*, and *Gomphus apomyius*.

Adult males were observed from 10:00-15:00, either flying low over riffle areas or more often perching very near the waters' edge (within 1-5 cm). The relatively dark coloration of *O. australis* allows males to conceal themselves surprisingly well while perching on the dark gravel at the edge of the somewhat tea-colored water. Females were observed ovipositing near midstream while flying low over the tail of pool areas, and then flying up to perch on stream-side vegetation at from 2-3 m above the water surface. On two occasions a more extensive oviposition flight was observed at dusk, female *Gomphus apomyius* were also included in these flights. Mr J.J. Daigle has also observed an extensive dusk flight of males on April 18, 1987 at Pushepatapa Creek. The flight occurred

between 15:00 and 15:30, he writes, "They patrolled only at the ripples rather feverishly. When they tired, they landed on my shoulder and my net and on stream-side twigs and branches. They were very unwary and easy to catch, contrasting with the wariness observed the day before when they perched on the gravel bars. No more were seen after that, although *Hylogomphus apomyius* appeared in a little dusk flight of their own." Although Dr S.W. Dunkle and Mr J.J. Daigle collected 55 males and 4 females during April 9-18, 1987 such abundance appears to be unique to this particular collecting season. It is not known if such variation in apparent population levels is related to natural or man made changes in the environment. However, similar population swings have been noticed by the author in other lotic Anisoptera, notably in species of *Ophiogomphus*, *Gomphurus*, *Stylurus*, and *Gomphus*. Judging from the size of collected larvae the duration of the larval stage is two years.

ADULT AND LARVAL KEYS TO ONYCHOGOMPHINE GENERA AND  
SUBGENERA OF AMERICA, INCLUDING DISTRIBUTIONS OF AND  
KEYS TO AMERICAN *OPHIOGOMPHUS*

DISTRIBUTION

All North American *Ophiogomphus* with the exception of *O. colubrinus* are either eastern or western in distribution. The subgenera *Ophionurus* and *Ophionuroides* occur only in eastern North America; western North American, Asian, and European *Ophiogomphus* all belong to the subgenus *Ophiogomphus*.<sup>+</sup> The known species distributions are as follows: *acuminatus*: U.S.A.: TN; – *alleganiensis*: U.S.A.: AL, TN, VA, WV; – *anomalus*: U.S.A.: ME, NJ\*, NY\*, PA\*, WI; Canada: Ont., Que.; – *arizonicus*: AZ; – *aspersus*: U.S.A.: CT, KY, ME, MI, NH, NJ, NY, NC, VT, VA, WI; Canada: N.B., N.S., Que.; – *australis*: U.S.A.: LA, MS; – *bison*: U.S.A.: CA, NV; – *carolus*: U.S.A.: ME, MA, MI, NH, NJ, NY, PA, VT, VA, WV, WI; Canada: N.B., N.S., Ont., Que.; – *colubrinus*: U.S.A.: ME, MI, NH, WI, WY; Canada: Alta., B.C., Man., Nfld., N.W.T., Ont., Que., Sask.; – *edmundo*: U.S.A.: NC; – *fastigiatus*: U.S.A.: PA, WV; – *howei*: U.S.A.: KY\*, ME, MA\*, NY, NC, PA\*, VA, WI; – *mainensis*: U.S.A.: CT, ME, MA, NH, NJ, NY, NC, PA, SC, VT; Canada: N.B., Que.; – *montanus*: U.S.A.: MT, NV, UT, WA, WY; Canada: Alta., B.C.; – *morrisoni*: U.S.A.: CA, MT, NV, OR, UT; Canada: B.C.; – *nevadensis*: U.S.A.: CA, NV; – *severus*: U.S.A.: CA, CO, ID, MT, NB, NV, OR, UT, WA, WY; Canada: Alta., Sask.; – *rupinsulensis*: U.S.A.: CT, IL, IN, KY, ME, MD, MI, MN, NH, NJ, NY, ND, OH, PA, TN, VT, VA, WV, WI; Canada: Man., N.B., Ont., Que., Sask.; – *westfalli*: U.S.A.: AR, KS?, MO.

<sup>+</sup> However, Chao 1990 has placed a new Chinese *Ophiogomphus* in *Ophionurus*.

\* Apparently extirpated from these states.

## SPECIES KEY TO THE ADULTS

- 1 Anal loop typically 1-celled, solum (posterolateral side of anal loop) less than  $\frac{2}{3}$  length of proximal side of triangle; posterior hamuli without elongate apices; penile ligula with anterolateral ridges, anterior surface flattened; penis short, 3rd segment ca as long as wide; 4th penile segment with lateral lobes; vulvar lamina ca  $\frac{1}{2}$  as long as wide ..... *ERPETOGOMPHUS* 2
- Anal loop 2-4 celled, solum more than  $\frac{2}{3}$  length of proximal side of triangle; posterior hamuli with elongate apices; penile ligula without anterolateral ridges, anterior surface rounded; penis elongate, 3rd segment 2-3 times as long as wide; 4th penile segment without or with minute lateral lobes; vulvar lamina as long as wide or longer ..... *OPHIOMOMPHUS* 4
- 2 Posterior hamuli rodlike; anterior hamuli with small subcircular apical notch, with posterior process ca as long as anterior process, and with processes contiguous apically; prepuce concealed by shieldlike fusion of lateral lobes; vulvar lamina less than  $\frac{1}{2}$  length of dome shaped membranous area of sternum 9, female sternum 9 without medial ridge ..... (*CALOGOMPHUS*) subgen. n.  
 Type species: *Erpetogomphus eutainia* Calvert
- Posterior hamuli without small subcircular apical notch, without posterior process typically as long as anterior process, and without processes contiguous apically; prepuce not concealed by shieldlike fusion of lateral lobes; vulvar lamina more than  $\frac{1}{2}$  length of V-shaped membranous area of sternum 9, female sternum 9 with medial ridge ..... 3
- 3 Metanepimera each with posterior brown band; postocellar ridge and prepuce well developed; 4th penile segment slightly longer than wide; penile flagella lobate; male cerci each typically with laterally compressed dorsal process; female with anterior margin of median ocellus typically posterior to lateral ocelli ..... (*ERPETO CYCLOPS*) subgen. n.  
 Type species: *Erpetogomphus ophibolus* Calvert
- Metanepimera each without posterior brown band; postocellar ridge and prepuce vestigial; 4th penile segment ca twice as long as wide; penile flagella elongate; male cerci without laterally compressed dorsal process; female with anterior margin of median ocellus anterior to lateral ocelli ..... (*ERPETOGOMPHUS*)
- 4 Male epiproct with apical half directed dorsally, with rami widely separated, and without medioapical processes; male cerci triangular in dorsal view, nearly symmetrical; female occipital ridge located 7-8 tenths length of postfrontal suture from suture; female sternum 10 ca 4 times as wide as long ..... (*OPHIONUROIDES*) 6
- Male epiproct with apical half not directed dorsally, with medioapical processes well developed and approximate or contiguous; male cerci not triangular in dorsal view, asymmetrical; female occipital ridge located 4-6 tenths length of postfrontal suture from suture; female sternum 10 ca 3 times as wide as long ..... 5
- 5 Male epiproct with lateral rami developed into prominent dorsolaterally directed processes; posterior hamuli with elongate hooklike apices; female vulvar lamina with lateroapical ridge, distally strongly undulate, and typically with short beaklike apices; female postocellar ridge well developed medially ..... (*OPHIONURUS*) 7
- Male epiproct with lateral rami vestigial, rami typically represented by middorsal angulation; posterior hamuli without elongate hooklike apices; female vulvar lamina without lateroapical ridge, distally slightly undulate, and with robust conical apices; female postocellar ridge typically vestigial medially ..... (*OPHIOMOMPHUS*) 17
- 6 Antefrons and postclypeus transversely striped with black; metanepisterna each with oblique brown band; basal  $\frac{2}{3}$  of hind wings hyaline; abdominal terga 9 and 10 with dorsomedial yellow spots; vulvar lamina ca 1.5 times as long as wide ..... *anomalous* Harvey
- Antefrons and postclypeus not transversely striped with black; metanepisterna each without oblique brown band; basal  $\frac{2}{3}$  of hind wings tinted with yellow; abdominal terga 9 and 10 without dorsomedial spots; vulvar lamina ca as long as wide ..... *howei* Bromley



- 7 Middorsal brown band of mesanepisterna vestigial or absent ..... 8
- Middorsal brown band of mesanepisterna well developed ..... 10
- 8 Tibiae with external surface predominantly black; male cerci acuminate; lateral processes of male epiproct at ca ½ length; vulvar lamina longer than sternum 9 ..... *acuminatus* Carle
- Tibiae with external surface predominantly yellow; male cerci not acuminate; lateral processes of epiproct at not less than ¾ length; vulvar lamina shorter than sternum 9 ..... 9
- 9 Lateral mesanepisternal brown band and brown band along mesopleural sulci well developed; male epiproct ventromedially concave and with lateral and apical processes obtuse; female occipital horns near compound eyes or absent, postoccipital horns ca twice as long as wide ....  
..... *rupinsulensis* Walsh
- Lateral mesanepisternal brown band vestigial or absent and brown band along mesopleural sulci vestigial ventrally; male epiproct ventromedially convex and with lateral and apical processes acute; female occipital horns approximate, postoccipital horns vestigial ... *westfalli* Cook & Daigle
- 10 Male cerci inflated, each wider at midlength than at base, and longer than epiproct; apical process of anterior hamuli nearly twice as long as apical process of posterior hamuli; female with large postoccipital horns ..... *aspersus* Morse
- Male cerci not inflated, each not wider at midlength than at base, and not longer than epiproct; apical process of anterior hamuli ca as long as or shorter than apical process of posterior hamuli; female without large postoccipital horns ..... 11
- 11 Tibiae each with yellow streak along external carinae; basal ⅓ of femora yellow ..... 12
- Tibiae each without yellow streak along external carinae; basal ⅓ of femora not yellow ... 14
- 12 Interpleural interface with well developed brown band; male epiproct nearly level in basal half; female with small postoccipital horns ..... *australis* sp. n.
- Interpleural interface without well developed brown band; male epiproct strongly upcurved in basal half; female without postoccipital horns ..... 13
- 13 Metapleural sulci with brown bands; male cerci not incurvate; male with lateral spine of epiproct at ca ½ length, spine longer than basal width; female occipital horns contiguous, 1.5 to 2.5 times length of pedicel; vulvar lamina more than twice as long as wide at base .....  
..... *alleghaniensis* Carle
- Thorax without brown bands along metapleural sulci; male with cerci incurvate; lateral spine of epiproct at ca ⅓ length, spine shorter than basal width; female occipital horns separated, ca as long as pedicel; vulvar lamina less than twice as long as wide at base ..... *incurvatus* Carle
- 14 Dorsal mesanepisternal pale stripes parallel-sided, separated by ca ⅓ their maximum width; gap of anterior hamuli subcircular; lateral flange of penile hood ca ¼ as wide as long .....  
..... *edmundo* Needham
- Dorsal mesanepisternal pale stripes widened ventrally, separated by ca ⅔ their maximum width; gap of anterior hamuli ovoid; lateral flange of penile hood ca ⅓ as wide as long ..... 15
- 15 Distal margin of labrum not black; male epiproct with apical cleft ca 2 times as long as wide, anterior hamuli each with apical branch more than 3 times as long as basal branch; female occiput level posteriorly, without or with small widely separated horns anteriorly; vulvar lamina parallel-sided, apices directed posterolaterally ..... *carolus* Needham
- Distal margin of labrum black; male epiproct with apical cleft more than 3 times as long as wide, anterior hamuli each with apical branch less than 2 times as long as basal branch, female occiput bilobate posteriorly, with large contiguous horns anteriorly; vulvar lamina constricted near base, apices directed posteriorly ..... 16
- 16 Male epiproct with lateral rami well developed and located at about ⅔ length .....  
..... *m. mainensis* Packard
- Male epiproct with lateral rami weakly developed and located at about ½ length .....  
..... *mainensis fastigiatus* Donnelly
- 17 Tibiae predominantly black externally ..... 18

- Tibiae predominantly yellow externally ..... 19
- 18 Metapleural sulci without brown bands; antefrons, postclypeus, and labrum entirely greenish yellow; postocellar ridge not developed medially; male cerci not incurvate; female with large submedian occipital horns, postoccipital horns absent ..... *bison* Selys
- Metapleural sulci with brown bands; antefrons, postclypeus, and labrum transversely striped with black; postocellar ridge well developed medially; male cerci slightly incurvate; female without occipital horns, postoccipital horns robust ..... *colubrinus* Selys
- 19 Lateral mesanepisternal brown band extended to collar ..... 20
- Lateral mesanepisternal brown band not extended to collar ..... 22
- 20 Lateral mesanepisternal brown bands sinuous; male cerci strongly constricted basally without subapical ventromedial expansion, male epiproct with apical rami directed posterodorsally and without dorsobasal elevation; female with both widely separated occipital horns on anterior face and robust postoccipital horns ..... *occidentis* Hagen
- Lateral mesanepisternal brown bands not sinuous; male cerci not strongly constricted basally but with subapical ventromedial expansion, male epiproct with apical rami directed posteriorly and with dorsobasal elevation; female without both occipital and postoccipital horns, (occipital horns occasionally on crest near compound eyes) ..... 21
- 21 Lateral brown bands of mesanepisterna confluent dorsally, lateral mesanepisternal pale stripes vestigial ..... *m. morrisoni* Selys
- Lateral brown bands of mesanepisterna widely separated by lateral mesanepisternal pale stripes ..... *morrisoni nevadensis* Kennedy
- 22 Postocellar ridge not developed medially; male epiproct ca 1/10 length of cerci, in lateral view widest beyond middle; female occiput typically with two short tubercles near compound eyes, and with crest strongly concave; anterior face of female occiput often damaged by apex of male epiproct ..... *arizonicus* Kennedy
- Postocellar ridge low and U-shaped medially; male epiproct longer than cerci, in lateral view widest before middle; female occiput without two short tubercles near compound eyes, and with crest nearly level; median portion of female ocellar ridge often damaged by apex of male epiproct ..... 23
- 23 Middorsal mesanepisternal brown band vestigial or absent, lateral mesanepisternal brown spots not wider than lateral mesanepisternal pale stripes, occasionally absent ..... *s. severus* Hagen
- Middorsal mesanepisternal brown band well developed, lateral mesanepisternal brown spots wider than mesanepisternal pale stripes ..... *severus montanus* Selys

SPECIES KEY TO THE LARVAE

- 1 Dorsal abdominal processes vestigial or absent, in lateral view that of segments 2, 3 and 4 longer than high; base of antennal segment 3 wider than antennal segment 2 ..... (*OPHIONUROIDES*) 2
- Dorsal abdominal processes well developed, in lateral view that of 2, 3 or 4 higher than long; base of antennal segment 3 narrower than antennal segment 2 ..... 3
- 2 Lateral abdominal spines absent; antennal segment 4 minute, less than 1/4 width of antennal segment 3 ..... *howei* Bromley
- Lateral abdominal spines well developed on segments 7, 8 and 9; antennal segment 4 capping apex of segment 3, about 1/10 width of antennal segment 3 ..... *anomalus* Harvey
- 3 Dorsal abdominal processes appressed-subfalcate, in dorsal view that of abdominal segments 2, 3 and 4 with obtuse apices extended to near granulate posterior border ... (*OPHIONURUS*) 4
- Dorsal abdominal processes raised-falcate, in dorsal view those of abdominal segments 2, 3 and 4 with acute apices extended well beyond granulate posterior border of segments ..... (*OPHIOGOMPHUS*) 12

- 4 Third antennal segment 1.7-2.0 times as long as wide ..... 5
- Third antennal segment 2.3-3.0 times as long as wide ..... 8
- 5 Third antennal segment 1.7-1.8 times as long as wide; dorsal abdominal processes highest and subequal on segments 2 or 3 to 4 or 5 ..... 6
- Third antennal segment 1.8-2.0 times as long as wide; dorsal abdominal processes highest and subequal on segments 2 and 3 ..... 7
- 6 Ligula  $\frac{2}{3}$  width of prementum; lateral margins of prementum level and parallel-sided in distal half; dorsal abdominal processes highest and subequal on segments 2, 3 and 4; apices of epiproctal processes at less than  $\frac{2}{3}$  length of epiproct ..... *incurvatus* Carle
- Ligula  $\frac{1}{2}$  width of prementum; lateral margins of prementum gently curved and slightly convergent in distal half; dorsal abdominal processes highest and subequal on segments 3, 4, 5 and 6; apices of epiproctal processes at more than  $\frac{7}{10}$  length of epiproct ..... *alleghaniensis* Carle
- 7 Lateral margins of prementum slightly divergent in distal half, ligula ca  $\frac{1}{2}$  width of prementum; dorsal abdominal processes extended beyond posterior granulate margin on segments 4-9, third antennal segment strongly asymmetric, widest beyond midlength, and abruptly narrowed near apex ..... *mainensis* Packard
- Lateral margin of prementum slightly convergent in distal half, ligula ca  $\frac{3}{8}$  width of prementum; dorsal abdominal processes extended beyond posterior granulate margin on segments 8 and 9 only; third antennal segment slightly asymmetric, widest just before midlength, and gradually narrowed toward apex ..... *australis* sp. n.
- 8 Third antennal segment 2.7-3.0 times as long as wide ..... 9
- Third antennal segment 2.3-2.6 times as long as wide ..... 10
- 9 Lateral margins of prementum slightly convergent in distal half; lateral abdominal spines about  $\frac{1}{6}$  length of lateral margins; dorsal cercal length 2.5 times basal width; dorsal abdominal processes 3, 4, 5 and 6 erect and subequal ..... *aspersus* Morse
- Lateral margins of prementum parallel to slightly divergent in distal half; lateral abdominal spines about  $\frac{1}{2}$  length of lateral margins; dorsal cercal length 2.0 times basal width; dorsal abdominal processes 3, 4, 5 and 6 appressed and subequal ..... *rupinsulensis* Walsh
- 10 Lateral margins of prementum strongly convergent in distal half; ligula strongly convex about  $\frac{2}{3}$  width of prementum; mesoapical portion of antennal segment 3 produced ventrally; lateral margin of abdominal segment 8 undulate; dorsal abdominal processes 2-7 erect and subequal in height ..... *acuminatus* Carle
- Lateral margins of prementum not strongly convergent in distal half; ligula moderately convex, ca  $\frac{1}{2}$  width of prementum; mesoapical portion of antennal segment 3 not produced ventrally; lateral margins of abdominal segment 8 not undulate; dorsal abdominal processes 2-7 successively appressed ..... 11
- 11 Lateral margins of prementum divergent in distal half, in folded position labium extended behind posterior procoxal articulation; antennal segment 3 gradually narrowed toward apex; dorsal abdominal processes strongly appressed, those on 6-9 nearly flat, in dorsal view 8 and 9 triangular posteriorly ..... *carolus* Needham
- Lateral margins of prementum parallel-sided to slightly convergent, in folded position labium not extended behind posterior procoxal articulation, antennal segment 3 abruptly narrowed near apex, dorsal abdominal processes moderately appressed, those on 6-9 arcuate, in dorsal view 8 and 9 rounded posteriorly ..... *westfalli* Cook & Daigle
- 12 Lateral spines on abdominal segments 6 to 9 ..... 13
- Lateral spines on abdominal segments 7 to 9 ..... 14
- 13 Cerci about  $\frac{9}{10}$  length of paraprocts; lateral abdominal spines 6 and 7 directed posteriorly; ligula  $\frac{1}{2}$  width of prementum ..... *bison* Selys
- Cerci about  $\frac{7}{10}$  length of paraprocts; lateral abdominal spines 6 and 7 directed posterolaterally; ligula  $\frac{1}{2}$  width of prementum ..... *occidentis* Hagen

- 14 Dorsal abdominal processes 5-9 strongly appressed; processes 3, 4 and 5 descending in height; antennal segment 3 gradually narrowed toward apex. .... *severus* Hagen  
 – Dorsal abdominal processes 5-9 not strongly appressed, processes 3, 4 and 5 subequal in height; antennal segment 3 abruptly narrowed near apex ..... 15
- 15 Dorsal abdominal processes narrow and erect, apices of 3, 4 and 5 directed dorsally; cerci abruptly narrowed basally, length ca 7 times width at midlength ..... *morrisoni* Selys  
 – Dorsal abdominal processes robust and slightly appressed, apices of 3, 4 and 5 directed posteriorly; cerci not abruptly narrowed basally, length 4 to 5 times width at midlength ..... 16
- 16 Dorsal abdominal processes 4-7 subequal in height, in lateral view processes of 8 and 9 strongly arched; portion of labial palp beyond base of end hook ca 1.5 times as long as wide; apices of male epiproctal tubercles at about  $\frac{2}{3}$  length of epiproct ..... *colubrinus* Selys  
 – Dorsal abdominal processes 4-7 descending in height, in lateral view processes of 8 and 9 slightly arched; portion of labial palp beyond base of end hook ca as long as wide; apices of male epiproctal tubercles at about  $\frac{1}{2}$  length of epiproct ..... *arizonicus* Kennedy

#### ACKNOWLEDGEMENTS

I am grateful to Dr M.J. WESTFALL, Jr for the loan of larvae and an adult of the new species. I am indebted to Dr R.W. GARRISON for information concerning the form of the female 9th sternite of an undescribed species of *Calogomphus*. I thank Dr S.W. DUNKLE and Mr J.J. DAIGLE for their efforts in gathering additional information on *O. australis* sp. n.

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