

NOTES ON THE LIFE HISTORY AND ECOLOGY OF THE DRAGONFLIES (ODONATA) OF CENTRAL CALIFORNIA AND NEVADA.

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INTRODUCTION.

This is the second of three general papers on Pacific Coast Odonata. The first concerned Washington and Oregon Odonata.¹ The third, which is now in preparation, will be based on collecting done in southern California during the summer of 1915.

The object of this series is, first, to give a view of Pacific coast dragonflies and their varied and interesting environments, and, second, to bring the data together on which a list of western Odonata can be written. This list is now in preparation and, covering that area of Canada and the United States west of the one hundredth meridian, already includes nearly 200 species.

In the present paper, as in the first, I have made descriptions and illustrations as complete as possible because much of the literature on western dragonflies is inaccessible to even the average college student.

The trip to Nevada was made possible by a liberal advance of money from Mr. E. B. Williamson, who later received his pay in a series of the specimens collected. At all times in the work I have received his constant encouragement and help. The greater part of the work on the paper was done in the Stanford University laboratories under Prof. Vernon L. Kellogg, whose kindly appreciation and critical help have been among the pleasures of the undertaking. The paper was completed in the Cornell University laboratories, where Dr. J. G. Needham very kindly assisted me on the gomphines.

A series of specimens covering all the forms discussed in the following pages, except such as are specifically stated to be elsewhere, has been deposited in the United States National Museum.

1. A PACIFIC COAST VARIETY OF *AGRION AEQUABILE*.

Since my arrival at Cornell I have received a shipment of interesting California Odonata from Mr. and Mrs. L. R. Reynolds, of San Francisco. These were interesting in that several species were taken at altitudes of 8,000 to 10,200 feet in the Sierras. These are listed in the final section of this paper.

¹ Kennedy, C. H. Notes on The Life History and Ecology of The Dragonflies (Odonata) of Washington and Oregon. Proc. U. S. Nat. Mus., vol. 49, pp. 259-345, July 28, 1915.

Among these were a male and female *Agrion aequabile* (Say), the first recorded from California, which were larger than var. *yakima* and had slightly more color in the wings. These are apparently an undescribed race. This is the third variety of *aequabile* found in the West, var. *yakima* being found in the Columbia River basin, var. *coloradicum*¹ described from Boulder County, Colorado, and this form now found in California.²

Mr. and Mrs. Reynolds have very kindly deposited these specimens in the United States National Museum.

AGRION AEQUABILE CALIFORNICUM, new variety.

Type.—Cat. No. 20814, U.S.N.M. A male from the collection of L. R. and C. D. Reynolds, taken at Blue Lake, Humboldt County, California, May 6, 1911, by F. W. Nunenmacher.

Allotype.—Cat. No. 20814, U.S.N.M. A female from the collection of L. R. and C. D. Reynolds, taken at Blue Lake, Humboldt County, California, May 6, 1911, by F. W. Nunenmacher.

Male, color.—Thorax and abdomen metallic blue, except the second lateral suture, the metepisternal keel and the dorsal edge of the metinfraepisternum, which are creamy. Coxae and legs black. Pterostigmas absent. Wings (fig. 1) flavescens with the apices dark. The specimen is teneral so that the wings are not as dark as in the figure. The front wings are dark on the apical three-fourths of the distance from nodus to apex. The hind wings are dark on the apical four-fifths of the distance along the costa from the nodus to the apex. In the front wings the basal edge of the dark area is vertical to the costa. In the hind wings it slants from the costal edge toward the base of the wing, reaching the anal margin opposite the nodus.

Female, color.—Similar to that of the male but general body color metallic green. Labrum creamy with a black center. Abdominal segments 8–10 with a middorsal pale stripe and their sides largely pale. Wings (fig. 2) with white stigmas. Front wings with the dark area covering the apical three-fifths of the distance from nodus to apex. In the hind wings the dark covers, along the costa, the apical three-fourths of this distance. The basal edge of the color is perpendicular to the costa in the front wings and diagonal in the hind wings.

Male, abdomen (including appendages), 40 mm.; appendages, 15; hind wing, 32. Female, abdomen, 39; hind wing, 35.

2. NOTES ON LESTES STULTUS AND ITS NYMPH.

This black *Lestes* was described in 1861 by Hagen³ from a single mutilated male in the Museum of Comparative Zoology. Since that

¹ Cockerell, T. D. A., *Psyche*, vol. 20, 1913, p. 173.

² Since writing this I have found in the Cornell collection a male *Agrion aequabile yakima* taken at Corvallis, Oregon, June 29, 1896. This is west of the crest of the Cascade Mountains. In the collection of the U. S. Biological Survey in Washington, D. C., are a male and a female of *Agrion aequabile* collected on the Owyhee River, Rome, Malheur County, Oregon, June 20, 1915, which are intermediate between variety *yakima* and variety *californicum*. Other specimens of *californicum* from Seattle, Washington, are in the collection of Dr. Philip P. Calvert.

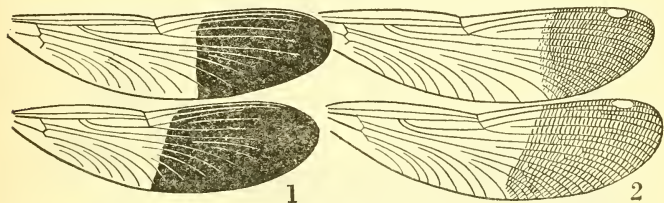
³ *Syn. Neur. N. Amer.*, 1861, p. 67.

time few specimens have been taken. I found it common in the San Francisco Bay region and extending up the Sacramento Valley as far as Marysville. Probably it will be found throughout the Sacramento and San Joaquin valleys. I can see no difference between the habits of this and those of *disjunctus* and *unguiculatus* with which it is usually associated. This is the earlier of the three species but their periods overlap. *L. stultus* at Palo Alto, California, emerges in April and May and is scarce by the middle of July. It is distinctly a slough or pond species. (See figs. 3-10, 14-18.)

During May this species was very abundant about the small ponds on the crest of the Coast Mountains west of Stanford University. By July 15 it had been largely displaced about these ponds by *disjunctus*.

LESTES STULTUS Hagen.

Male, color.—Labrum, vertical surface of clypeus, bases of mandibles and genae pale pure blue. Dorsal surface of clypeus, frons,

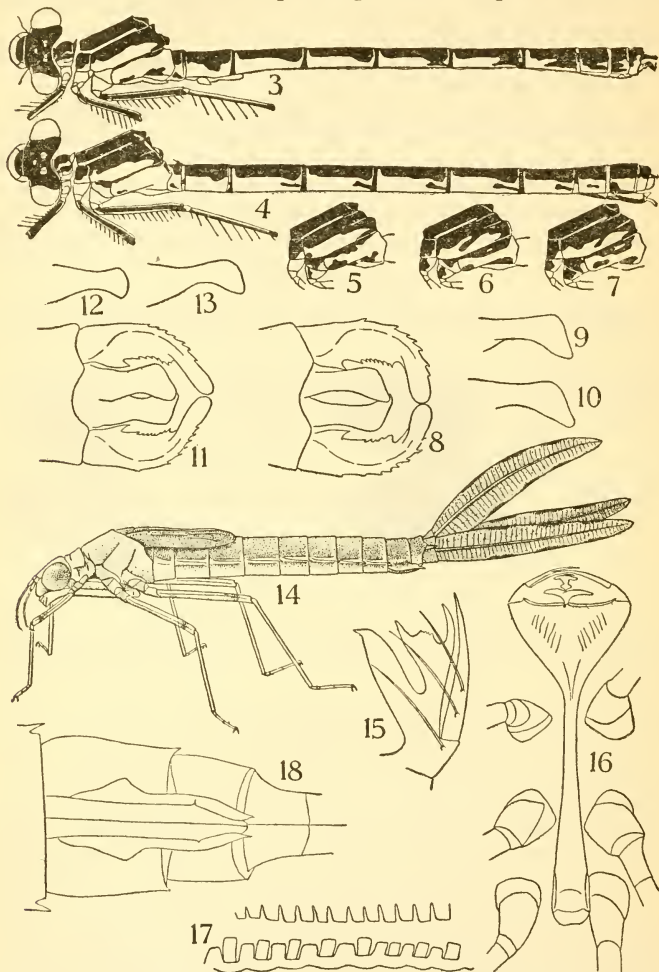


FIGS. 1-2.—*AGRION AEQUABILE CALIFORNICUM*. 1. WINGS OF MALE. 2. WINGS OF FEMALE.

vertex, and postocular areas black, except a minute pale area external to each lateral ocellus. Eyes pale pure blue above, grayish below. (See fig. 3.)

Prothorax black except a pale creamy stripe below the edge of the lateral lobe and another pale stripe just above the coxa. Coxa usually pale, in some individuals with an external black spot. Legs creamy with an external black stripe on trochanter and femur, an internal black stripe on tibia, and tarsus black. Mesothorax and metathorax with anterior surface black except in some individuals middorsal keel narrowly creamy. In all a narrow antehumeral pale bluish green stripe extending not quite to the antealar ridge. Upper half or two-thirds of mesinfraepisternum black. Sides of thorax creamy with bluish areas, except some black anterior to first lateral suture, the demarcation angulated or irregular. Second lateral suture narrowly and irregularly black, in some individuals followed by an irregular black stripe (see figs. 5-7). Metepimeron with a black spot on its lower anterior edge. In some individuals a spot on the posterior third of the metasternum. Metinfraepisternum entirely pale or with its upper third black. Coxae creamy or with a black spot. Legs colored as those on the prothorax. Pterostigmas black.

Abdomen with dorsum broadly black with greenish and purplish reflections, except a narrow pale ring on base of segments 2-8. Pale



FIGS. 3-10, 14-18.—*LESTES STULTUS*. 3-4. USUAL COLORATION. 5-7. VARIATION IN THORACIC PATTERN. 8-10. APPENDAGES OF MALE. 14-18. NYMPH.

FIGS. 11-13.—*LESTES UNCATUS*, APPENDAGES OF MALE.

areas creamy. Segments 2-7 with a narrow, black apical ring. On segments 5-7 and in some individuals also on 8 and 9 there is an irregular black blotch in the lower apical angle which is broadly con-

nected with the black of the dorsum. Segments 3-9 with sternum black; creamy on 1, 2, and 10. Superior appendages black; inferior pale. Segments 9 and 10 heavily pruinose.

Female, color.—Colored like the male but with a dumbbell-shaped black spot in the lower apical angle of segments 3-8, which is not connected with the dorsal black. Segment 9 with a large black blotch on its lower anterior angle. Genital valves broadly black on their lower edge. (See fig. 4.)

The teneral colors of *stultus* are similar to those of the teneral *uncatus*; a general color of salmon pink with pale bronzy markings.

The color pattern is quite variable but differs from that of *uncatus*, its nearest relative, in being always black, where in *uncatus* it is always metallic green; in the well developed blue antehumeral stripe, where in *uncatus* there is seldom even the slightest indication of one, and in the less amount of black on the legs; in *uncatus* the legs are black except an internal stripe on the femur and a mere hair line of pale on its exterior surface, and a very short, narrow, exterior pale line on the proximal end of the tibia.

Structurally *stultus* differs from *uncatus* in its greater size, as is shown in the following comparative measurements:

	abd., male.	h. w., male.	abd., female.	h. w., female.
<i>stultus</i>	30-34	21-23	32	26
<i>uncatus</i>	26-28	20-21	27	24

The individual *stultus* the abdomen of which measures 30 mm. in the table is unusually small. The average is around 33 or 34. The male appendages are very similar, as is shown in figures 11-13 (*uncatus*) and 8-10 (*stultus*). In *stultus* the inferior appendages have a slightly more acuminate point than in *uncatus*.

The description of the nymph of this species which follows is based on exuviae collected on "Mud Lakes" west of Stanford University during May, 1915. As these were collected when *stultus* was abundant and no *disjunctus* were caught I did not doubt their authenticity until I returned in July and found but few *stultus* flying and *disjunctus* abundant. Probably they are *stultus*.

Nymph.—A long slender nymph (figs. 14-18) much larger than its nearest relative, *uncatus*.

Labium (figs. 15-17) long and slender, reaching back to middle of hind coxae or even to their hind margin. The proximal part of the mentum is about two-thirds of its length, and its breadth is less than one-eighth of the width of the mentum at the bases of the lateral lobes. It expands proximad to three times its middle breadth. Mental setae 7. Lateral setae 3, two on the movable hook and one on base of lateral lobe. Lateral lobe of same general shape as that

of *uncatus*.¹ Teeth along distal edge of mentum and on internal edge of the lateral lobe similar to those figured by Walker for *unguiculatus*.² Antenna seven jointed.

Wings short, reaching beyond middle of third segment. Lateral spines on segments 5-9. Hind femur reaching to beyond apex of third segment; 8-11 spicules on lateral carina of segment 9. Ovipositor reaching just beyond apex of segment 10 and styli of valves slightly beyond ovipositor. Ventral edge of valves with a row of five or six minute spinules, no hairs. Gills sickle-shaped, the median curved down and the two laterals curved up, each broadest at the proximal third, tapering thence to the obtusely pointed apex. Edges of gills with conspicuous spinules (none on *uncatus*). Each gill with three spots on its dorsal edge and three on its ventral edge. Apices of femora with a dusky ring, otherwise no color pattern. Length without caudal gills, 21-23 mm.; gills, 12 mm.; hind femur, 5.5 mm.

The nymph of *stultus*, if that is what these specimens are, is close to that of *disjunctus*. Since writing the preceding description I reared a *disjunctus* nymph from these same Mud Lakes. This reared nymph agrees in detail in size, numbers of spines, etc., with Walker's description of *disjunctus* nymph. On comparing it with the *stultus* exuviae I find these larger, the caudal gills hardly as acuminate, the spicules on the lateral keel of segment 9, 12-13 in number. I should have supposed that the *stultus* nymph would be closer to *uncatus*.

3. A NEW GENUS BASED ON AGRION EXCLAMATIONIS.

ZONIAGRION, new genus.

Arculus placed at or near the second antenodal; M_2 arising basad of the sixth postnodal in the front wing and basad of the fifth postnodal in the hind wing; anal bridge separating from the hind margin of the wing as far before the anal crossing as the latter is long; three post-quadrangular cells; antenodal costal spaces with the second space slightly more than half the length of the first and slightly less than half the length of the third; quadrilateral of fore wing with basal side contained in the distal side 2-2.75 times and in the posterior side 3.5 times; anterior side varying greatly, from 1-2 times length of basal side. Stigmas alike in front and hind wings; costal and posterior margins equal; either slightly longer than the proximal or distal margins, which are equal.

Female with a large apical spine on the ventral side of segment 8. Male with segment 10 terminating dorsally in a fork which is slightly higher than the anterior end of the dorsum. Shaft of penis with spines, the tip spatulate; distinguished from that of 110 other agrionine genera examined, including all the North American genera, by a

¹ See Can. Ent., vol. 46, p. 199, pl. 14, fig. 9, *uncatus*, mental lobe.

² Idem, p. 349, pl. 23, fig. 1, *unguiculatus*, mental teeth.

transverse row of short spines at the base of the distal or spatulate lobe (see figs. 24 and 32, and compare with figs. 35 and 38-42).

Color blue and black, with blue postocular spots and a striped thorax.

This genus differs from *Coenagrion* in the male having nine external tibial spines and the female having a vulvar spine, also in the penis, which in typical *Coenagrion* (*puella* Linnaeus) has a divided tip (see fig. 42). It differs from *Enallagma* in the high forked apex of segment 10 in the male, in the coloration, and in the penis which in *Enallagma* is of the type shown for *Enallagma civile* Hagen (see fig. 41).

From *Ischnura* it differs in having stigmas similar in front and hind wings and in the origin of M_2 as well as in the penis (see figs. 70-81). From *Acanthagrion gracile* (fig. 37) it differs in that A arises basad of the anal crossing. (See also figs. 33, 34, and 36.)

Type of the genus.—*Agrion exclamationis* Selys.¹

The name proposed is suggested by the heavily banded caudal gills of the nymph. Ζώνιον = a little girdle; ἄγριον = living in the fields, wild, savage—the name of a genus of dragonflies.

4. NOTES ON ZONIAGRION EXCLAMATIONIS AND ITS NYMPH.

It was my good fortune to rediscover Selys's *Agrion exclamationis*. This species had been described by Selys in 1876 from a single male in the collection of McLachlan, since which time no other specimens had been collected. (See figs. 19-32, 43-52.)

On May 17, 1914, while collecting west of the Stanford campus, I found this species very abundant about the permanent pools in San Francisquito Creek. It was most abundant in the half mile below the Searsville dam. Two hundred feet below the dam was a pool fifteen feet across and four feet deep the sides of which were bordered by mud banks fringed with a rank growth of *Sparganium*. A few males and numerous females were flying in and out among the rank stalks of this plant, while several females were ovipositing in the tips of the leaves which hung over and touched the surface of the water.

The eggs are inserted in the tissue of the leaf blade in a zigzag row (see figs. 50-52). The female, unassisted by the male, backs down until the abdomen is submerged, when she inserts the first or lowest egg of the series. The second is inserted after moving *up* a short distance. (In most agrionines the female moves down as she oviposits.) With each move up she moves slightly to one side or the other, leaving a zigzag row of incisions below her.

These *Sparganium* clumps had many exuviae of this species clinging to them. A careful examination of their roots, which hung in masses in the edges of the pool, brought to light several live nymphs. These were carried to the laboratory, where they emerged a few days later.

¹ Bull. Acad. Belg. (2), vol. 41, 1876, p. 1251.

A quarter of a mile below Searsville dam many pairs were caught about a pool shaded by large alders and in the open glades in the underbrush males were abundant.

During May I found a few individuals about a deep pool in Coyote Creek at San Jose, California. On June 11, 1914, I caught this species on the Sacramento River at Colusa, California, and on June 14, on the Chico River at Chico, California. On July 9 it was common in the willows along the San Lorenzo River near Santa Cruz, California. This was the last date on which it was seen. Thus the season extends from April to July.

Measurements: Length of abdomen: Male, 26-27 mm.; female, 20-22. Length of hindwing: Male, 20 mm.; female, 20-22.

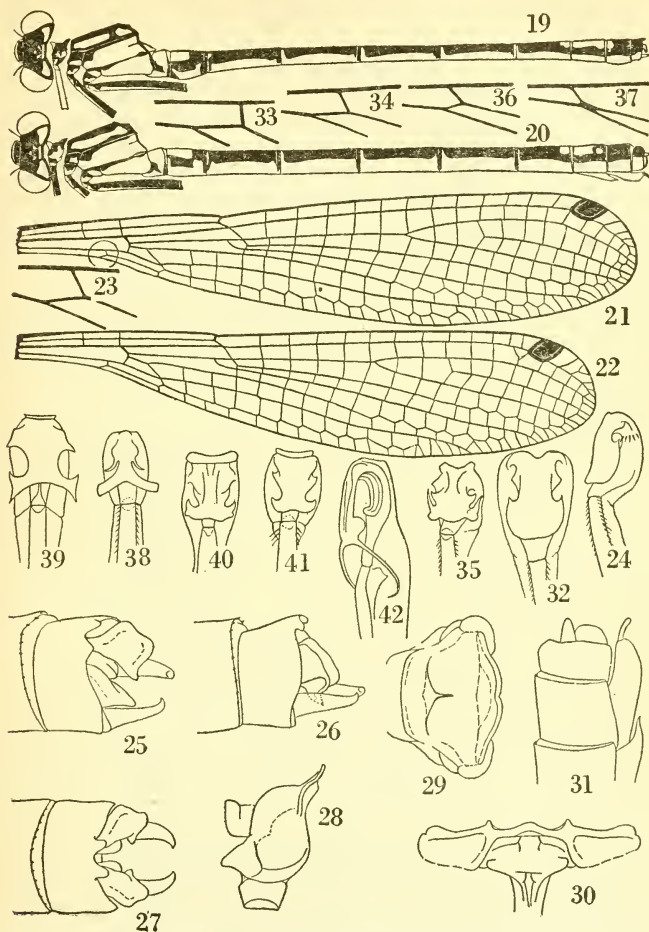
Male, structural notes.—Head wide, its extreme width twice its length. Antennal and fronto-vertical fossae well developed. Occipital ridge low. Prothorax with middle lobe divided along mid-dorsal line from front to center into two low, smoothly rounded halves (figs. 28-29). Posterior lobe thin, as much higher than the middle lobe as that is than the anterior lobe, erect (almost vertical), slightly emarginate on the posterior edge. Just ventrad of the lateral terminations of the posterior lobe the side of the prothorax is bulged into a conspicuous swelling.

Front femur with 4 internal and 6 external spines, middle with 9 internal and 8-10 external spines, hind with 8-9 internal and 8-9 external spines. Front tibia with 3 internal spines and 9 external, middle with 13 internal and 7-8 external, hind with 18 internal and 10 external spines. Hind femur reaching to middle of segment 2. Wings reaching to apical fourth of segment 6.

Pterostigmas equilateral, rhomboidal (almost square). A large hemispherical tubercle on ventrum of metathorax with a pair of conspicuous black spots on its anterior surface.

Posterior hamules low, rounded, not reaching the ventral edge of the genital fossa. A minute spine on inferior, anterior angle of side of segment 3. Abdomen slender. Segment 10 with a middorsal, apical, forked projection, which projects little above the middorsal contour. Inferior appendages with two branches, a flat branch extending dorsad and mesad and closely applied to the posterior end of 10 and a slender ventro-external branch as long as 10, this tapering regularly to its incurved slightly hooked tip. The dorsal appendages are thin and laminalike and curve abruptly mesad and ventrad, each terminating ventrally in a small point lying on the inner side of the base of the external branch of the respective inferior appendage. (See figs. 25-27.)

Female, structural notes.—Structure as in male except in the genitalia. Segment 10 one-half length of 9. Appendages three-fifths length of 10, broad with rounded tip. Segment 8 with a large flat



FIGS. 19-32.—*ZONIAGRION EXCLAMATIONIS*. 19-20. COLORATION. 21-23. VENATION. 24 AND 32. PENIS. 25-27. MALE, APPENDAGES. 28-29. PROTHORAX. 30. FEMALE, MESOSTIGMAL LAMINAE. 31. SEGMENTS 9 AND 10 OF FEMALE.

FIG. 33.—*ENALLAGMA CARUNCULATUM*, BASAL POSTCOSTAL VEIN.

FIGS. 34-35.—*ACANTHAGRION INTERRUPTUM*. 34. BASAL POSTCOSTAL VEIN. 35. PENIS.

FIG. 36.—*ENALLAGMA HAGENI*, BASAL POSTCOSTAL VEIN.

FIGS. 37-38.—*ACANTHAGRION GRACILE*. 37. BASAL POSTCOSTAL VEIN. 38. PENIS.

FIG. 39.—*AMPHIAGRION SAUCIUM*, PENIS.

FIG. 40.—*ENALLAGMA POLLUTUM*, PENIS.

FIG. 41.—*ENALLAGMA CIVILE*, PENIS.

FIG. 42.—*COENAGRION PUELLA*, PENIS.

spine. Genital valves long, extending beyond apex of 10, denticulate along their ventral edge, stylus equaling appendages in length. (See figs. 30-31.)

Male, live color.—Labrum greenish blue, edged above with black. Base of mandible greenish blue edged basally with black. Nasus, vertical surface of frons, genae and base of mandibles greenish blue. Post-clypeus, dorsal surface of frons and vertex black, except the large, triangular, pure blue postocular spots. Rear of head black but edged along the ocular border with a wavy line of blue. Labium pale brown. Eye, upper half black with an anterior blue horizontal stripe, lower half greenish gray, the line of demarcation abrupt, but not a sharp line. (See fig. 19.)

Prothorax black, with a wide triangular spot on the anterior lobe, a minute spot on the middorsal line of the anterior edge of the middle lobe and a small spot on each lateral end of the posterior lobe, pure blue. A dumb-bell-shaped pale brown spot on the lower side of the prothorax.

Mesothorax and metathorax with the anterior surface black, excepting a broad interrupted antehumeral stripe resembling an inverted exclamation point, pure blue. Sides pure blue except the lower end of the metepisternum shading into pale brown and the following black markings: All alar ridges broadly black, the black of the mesepisternum overlapping the humeral suture and forming a narrow posthumeral stripe which abruptly widens below into a square spot on the lower end of the mesepimeron. A narrow wedge of black running down on the upper sixth of the first lateral suture. Second lateral suture broadly black, the dorsal third of this stripe dilated into an oval spot, the ventral end of the stripe continuous with an irregular black area on the anterior end of the metepimeron. Lateral metasternal keel broadly black. Mesinfraepisternum black except ventral third brown. Metinfraepisternum brown but broadly edged with black above. Ventral surface of thorax pale brown. All coxae black on their external and posterior surfaces (with usually a narrow brown spot on the ridge between these surfaces), their mesal surfaces brown. Trochanters and femora black externally, pale brown internally; tibiae and tarsi black. Wings hyaline; stigmas black. Abdomen black with blue and pale-brown markings. Segment 1 pure blue, except a baso-lateral, rectangular, black spot and a narrow apical, vertical stripe on each side.

Segment 2 black, except a pure blue rectangular spot occupying the anterior two-thirds of the dorsum and a broad greenish blue stripe along the ventral edge of the side.

Segments 3-6 black, except a narrow pale brown, basal ring, interrupted middorsally (but sometimes obsolete on segment 3) and a narrow pale-brown stripe along the ventral edge of the side.

Segments 7-10 black, with the narrow brown stripe along the ventral edge of the side, as in segments 3-6. Intersegmental membranes brown. A large subrectangular pure blue spot covering all the dorsum of 8 and extending caudad over the anterior third of 9 and cephalad over the posterior sixth of 7. Ventrums of segments 1, 9, and 10 brown, of segments 2-8 black. Appendages black with the bases of the inferiors brown.

Female, color of dried material.—Labrum brownish, edged above with black. Nasus gray. Genae and vertical surface of frons bluish gray. Postclypeus, horizontal surface of frons and vertex black. Postocular spots large, triangular, connected. Postoccipital areas black on internal and dorsal edges, pale cream on inferior, exterior edge. (See fig. 20.)

Prothorax black on dorsal surface with anterior lobe pale and posterior lobe edged with pale cream, sides creamy olive.

Mesothorax and metathorax colored as in the male, but the antehumeral pale stripe continuous, showing only a constriction where in the male is the break. The pale colors are less bright in the female, the antehumeral stripe being olive brown, with a narrow stripe of the same, posterior to the black humeral stripe, this shading into a pale bluish gray on the metepisternum. The pale areas of the posterior and inferior surfaces are creamy as are the pale areas of the legs. Wings hyaline with brown stigmas.

Abdomen colored as in the male, except that the dorsum of segment 9 is entirely black.

Nymph.—Length, exclusive of gills, 14 mm.; gills, 7.5; hind femur, 4; head, 3.5 wide. (See figs. 43-49.)

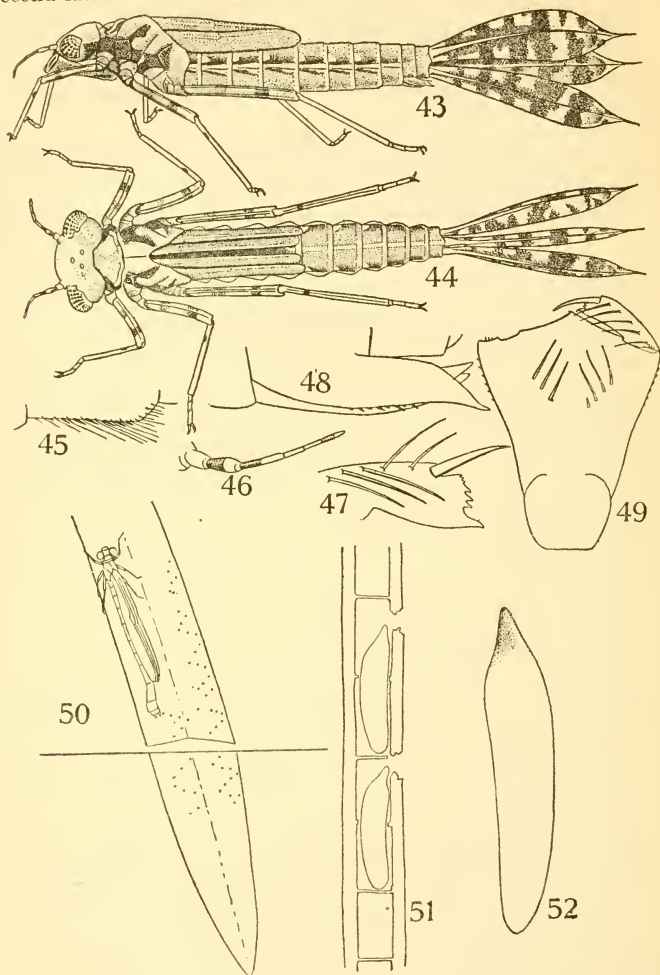
Color usually muddy brown with black markings.

Head wide, its length being five-ninths of its width. Occiput deeply concave. Postocular areas covered with numerous minute spicules. Dorsal surface very flat. Antennae seven jointed, the sixth and seventh closely united and appearing as one; segments 1 and 6 black, and the proximal half of segments 2 and 3 black. Eyes with a checker pattern.

Labium with three large mental setae on each side and occasionally a smaller one at the base of one or both rows. Five lateral or raptorial setae. Each lateral lobe with a large movable hook and several end teeth as follows: A large internal tooth set off from three smaller teeth, which are followed by three or four minute teeth on the outer side of the end (see fig. 47). Labium when closed reaching to the second coxae.

Prothorax with posterior lobe wide, each side of which is curved cephalad on the side of the prothorax, where it ends in a low prominence laterad of the middle lobe. Sides below the forward curve of the posterior lobe black.

Mesothorax and metathorax with a humeral stripe and a stripe on second lateral suture black. Infraepisterna black. Femora with a



FIGS. 43-52.—*ZONIAGRION EXCLAMATIONIS*. 43-49. NYMPH. 45. LATERAL CARINA. 46. ANTENNA. 47 AND 49. MENTUM. 48. SEGMENT 9 OF FEMALE NYMPH. 50. FEMALE OVIPOSITING. 51. EGGS IN LEAF. 52. EGG.

dark basal and also subapical band and a paler median band. Tibiae with a black spot one-fourth the distance from the proximal end. (In a sketch of a live nymph I find on the femora a dark apical band,

preceded by an equal pale band, which is preceded by a very dark band. A narrow band occurs on the extreme base of the femora.) Femur of hind legs reaching apex of segment 4, and wings, which lie parallel, reaching to first third of segment 5.

Abdominal segments 1 to 8 with wide lateral keels; these edged with a single row of spicules and numerous long hairs (see fig. 45). Color brown, with median dorsal stripe and lateral keels white. A dark lateral stripe above lateral keel, a less conspicuous dark line below. Segments 2-7 each with a white spot above anterior end of lateral keel.

The male organ on segment 9 is as usual in Zygoptera. The vulva of the female has the outer valves edged with a row of 4-6 prominent spines. Between these are smaller spines and long hairs (see fig. 48).

The caudal gills narrowly oblanceolate, increasing in width to the apical third, where the lateral gills are one-sixth as wide as long and the median slightly more than one-sixth. From this point they taper suddenly to the apical sixth, the last sixth being the attenuate apex of the gill. The gills have two patterns of color—(1) a dark brown stripe of pigment bordering the rib from the base to the middle of the fin with a crescent of the same at the apex, and (2) a series of 5 or 6 intense black cross-bars produced by the pigmentation of the tracheal branches in these areas. Edges of gills fringed with hairs.

This nymph differs from *Enallagma* nymphs in having long hairs on lateral keel as well as spicules.

It differs from *Ischnura* in the female lateral vulvar valves having four or more spines (in *Ischnura* only one or two very small spines, in *Enallagma* four or more spines).

5. A NEW GENUS BASED ON ISCHNURA DENTICOLLIS.

CELAENURA, new genus.

Venation and stigmas as in *Ischnura*. Arculus at the second antenodal: M_2 arising basad of the fourth postnodal in the front wing and basad of the third postnodal in the hind wing; anal bridge separating from the hind margin of the wing as far before the anal crossing as the latter is long; three post-quadrangular cells in each wing except in the front wings of the types where there are four; antenodal costal spaces with the basal twice the length of the middle, and about three-fifths the length of the distal; quadrilateral of the front wing with the basal and anterior sides equal or the anterior slightly longer and either contained 2-2½ times in the posterior side (the preceding proportions vary considerably owing to the variability of the anterior side, which in one specimen is almost 1½ times as long as the basal side). Stigmas rhomboidal, in the male those of the front wings black, of the hind wings brown; the costal and distal edges slightly longer than the basal and posterior edges. Female with a minute, acute, ventral spine on the

apex of segment 8. Male with segment 10 terminating dorsally in a high narrow fork. Shaft of penis without a longitudinal row of spines; penultimate joint of penis without the pair of heavy spines found in *Ceratura*, *Anomalagrion*, and *Ischnura* (see figs. 85 and 92); ultimate lobe terminating in a fleshy fork, the branches of which curve dorsad and caudad, tapering regularly to acute points.

Color blue and black with blue postocular spots, the dorsum of the thorax solid black, the dorsum of the abdomen black except a blue dorsal spot on segments 7-9.

This genus is erected to contain *Ischnura denticollis* (Burmeister) and a new species almost identical in structure and color. The venation (figs. 86-87) is apparently like that of *Ischnura* but these species differ from the American species of *Ischnura* in having the anterior surface of the thorax solid black. In the structure of the penis they lack the pair of erect spines on the penultimate segment, which is characteristic of the penis of *Ceratura capriola* (Hagen) (fig. 82), *Anomalagrion hastatum* (Say) and *Ischnura pumilio* (Charp.) which are the type-species of their respective genera. In *Ischnura* (see figs. 70-81), I have examined over 20 species, including all the American species and find the penis to possess always the pair of erect spines on the penultimate segment, excepting one exotic species (*elongata* Martin), very evidently not an *Ischnura*.

The species of *Nehalennia* have been confused with *Ischnura denticollis* having been placed in that genus by Kirby,¹ but, as seen by the figures 83-84, the *Nehalennia* penis is very different in structure. Also the female is without a spine on segment 8.

I feel some trepidation in using the penis as a generic character of so much importance, as little is known concerning its value.

Type of the genus.—*Ischnura denticollis* (Burmeister).²

The name proposed is suggested by the black dorsum of the abdomen; *κελαινός* = black; *οὐρά* = tail.

6. A NEW SPECIES OF CELAENURA, WITH NOTES ON *C. DENTICOLLIS* AND ITS NYMPH.

In May, 1914, I found among some specimens of *Celaenura denticollis*, which were collected on Sharon Pond a mile west of Stanford University campus, a single male of coloration similar to *denticollis* but with very different appendages. Though I collected some hundreds of *denticollis* in various parts of California and Nevada during 1915 and 1916, only three more specimens of this new species were taken. These were caught on Coyote Creek, in the city of San Jose,

¹ Kirby, W. F. A Synonymic Catalogue of Neuroptera Odonata, or Dragonflies, 1890, p. 147.

² It is possible that the type, a female in the museum of Halle, may be the female of the species we now know as *damula*. The female of *damula* has been discovered recently and has a prothorax very similar to that figured by Calvert for the type-specimen of *denticollis*, in Halle (Trans. Amer. Ent. Soc., vol. 25, 1898, p. 38).

Santa Clara County, California, on May 15, 1915. Sharon Pond is an artificial pool 200 feet long and 3 feet deep on the estate of the same name west of Stanford. The single male was collected by sweeping in the sedges growing about its borders. The three specimens from San Jose were collected in the sedges along the edge of Coyote Creek, which at this season is a sluggish and almost stagnant stream. I have no data that would indicate that the habitat and habits of this species differ from those of *denticollis*, except that this has been found in only the two places mentioned, while *denticollis* is found throughout the southwestern States and northwestern Mexico. A fuller discussion of Coyote Creek and its odonate fauna is given on page 596 of this paper. The following is a description of this species:

CELAENURA GEMINA, new species.

This is a small species with coloration almost identical with that of *denticollis*. (See figs. 53-55 and compare with figs. 56-58.)

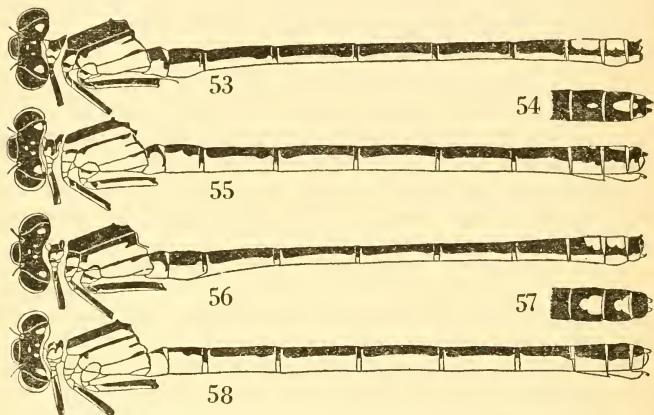
Type.—Cat. No. 20816, U.S.N.M. A male, from Coyote Creek, San Jose, Santa Clara County, California, May 15, 1915.

Allotype.—Cat. No. 20816, U.S.N.M. A female, from Coyote Creek, San Jose, Santa Clara County, California, May 15, 1915, taken in copulation with the type.

Length of abdomen: Male, type, 19 mm.; of the remaining two, one measures 19, the other 22 mm.; female, allotype, 21. Length of hind wings: Male, type, 14 mm.; of the remaining males, one measures 15, the other 16; female, allotype, 17.

Male structure.—As compared with other species of this group (*Ceratura*, *Anomalagrion* and *Ischnura*) this, for its size, is fairly robust. Head with shallow antennal fossae and a prominent occipital ridge. Prothorax with the posterior lobe half the length of the middle lobe and slanting caudad and dorsad at an angle of 45°. This lobe is thin antero-posteriorly and viewed from in front slightly concave on each lateral edge, but evenly convex on the posterior edge. A tuft of long hairs on each outer end of the middle lobe. Femur of front leg with a single internal basal spine, a single internal apical spine and 5-6 external spines; femur of the middle leg with 8 internal and 8 external spines; of the hind leg with 12 internal and 10 external spines. Tibia of fore leg with 2 spines above the comb and 2 below and 8 internal spines; of middle leg with 13 internal and 8 external spines; of hind leg with 18 internal and 11 external spines. Hind femur reaching to second third of segment 2. A large, hairy, hemispherical tubercle on the ventral side of the metathorax. Wings extending to apex of segment 6, with rhomboidal stigmas, those of the fore wing black, of hind wing brown. Penis of the two-horned ischnuran type but without the pair of large internal spines (fig. 92). The terminal processes ("horns") one-half longer than in *denticollis*; two minute

spines on each side of the apex of the shaft. Posterior hamules twice as long as wide, tips rounded and barely reaching the edge of the sexual fossa. A short but distinct spine on antero-ventral edge of segment 3 next the seminal vesicle. Segment 10 with a narrow, high, forked, dorso-apical projection (see figs. 94-96). Superior appendage, viewed from the side, with a conical base from the ventral side of which a long, basal, pointed branch extends ventrad and behind the upturned dorsal branch of the inferior appendage. Viewed from the side the inferior appendage very short, the inferior branch merely a rounded tubercle, the superior branch short, turned up and covering



FIGS. 53-55.—*CELAENURA GEMINA*. 53. MALE COLOR PATTERN. 54-55. FEMALE COLOR PATTERN.
FIGS. 56-58.—*CELAENURA DENTICOLLIS*. 56. MALE COLOR PATTERN. 57-58. FEMALE COLOR PATTERN.

the inferior branch of the superior appendage. Viewed from above the superior appendages are sigmoid-conical and diverge widely from the median line.

Female, structure.—Differing from male as follows: Prothorax with posterior lobe divided by two notches in its posterior edge into a median and two lesser lateral portions. Viewed from side the posterior edge of hind lobe presents two concavities, one from base to lateral notch and one between notch and apex (see figs. 62, A-B). (Mesostigmal lamina, fig. 93.) A minute spine on apex of ventrum of segment 8. Segment 10 three-fifths as long as 9. Superior appendages two-thirds as long as segment 10, ends obtuse. Genital valve reaching almost to apex of segment 10, its ventral edge smooth but covered with short hairs. Palp two-thirds length of 10.

Male, color.—Labrum, bases of mandibles and genae bluish green. Base of labrum edged with black. Nasus blue, postclypeus black. Frons blue on vertical surface, its dorsal surface black, which is con-

tinuous with the black of the vertex. Postocular spots blue, minute, not connected. Eyes with the ventral three-fourths blue, which is sharply separated by a horizontal line from the black dorsal fourth. Rear of head blue. (See fig. 53.)

Prothorax black, except anterior lobe, which is pale, and the side of the middle lobe, which is blue.

Mesothorax and metathorax black dorsally, the black extending caudad halfway to the first lateral suture. Upper half of mesinfraepisternum black. Second lateral suture narrowly black except on its upper third where the black stripe dilates into an elliptical mark. Sides otherwise blue. Coxae greenish blue with a black stripe across the external face. Trochanters and femora black with the inferior side yellowish green. Tibia yellow with an external, black stripe. Tarsi yellow. Stigmas of the front wings black, of the hind wings brown.

Abdomen with the lower sides of segments 1 and 2, the basal half of the side of segment 3 and the lower sides of segments 8-10 blue. The dorsum of segments 1-7 and 10 broadly black, except a narrow, pale basal ring, interrupted on the middorsal line, excepting also the apex of segment 1, which is blue, and the blue dorsum of segments 8 and 9. Sides of segments 4-7 creamy.

Female, color.—Similar to that of the male but with a broad, pale, antehumeral stripe. (See figs. 54-55.)

Labrum yellow, edged above with black. Nasus, genae, bases of mandibles and anterior surface of frons yellow. Postclypeus, dorsal surface of frons and vertex black. Occiput edged with yellow. Postocular spots larger than in the male, not connected with each other but confluent posteriorly with the pale brownish of the rear of the head. Eyes greenish, darker above.

Prothorax black on the dorsal surface, except the anterior lobe pale and the pale olive of the sides extending up farther than in the male.

Mesothorax and metathorax olive on the sides, shading into creamy on the coxae and into brown on the antehumeral stripe. The black confined to the mesepisterna, a spot on the dorsal edge of the mesinfraepisternum and a small spot on the upper end of the second lateral suture. A brown antehumeral stripe one-third as wide as mesepisternum. Trochanters and legs creamy, with a broad black stripe on the dorsal surface of the femur and a narrow external stripe on the tibia. Feet pale. Wings with brown stigmas.

Abdomen broadly black above except the apex of segment 1, a minute middorsal spot on segment 8, a large apical middorsal spot on 9 and a minute, basal, middorsal spot on 10, blue. Segments 3-7 with a narrow basal pale ring interrupted on the middorsal line. Intersegmental membranes of segments 2-7 black; of segments 1-2 and 7-10 blue. Lower sides of segments 1-10 pale creamy yellow.

This pair, the type and allotype, are dried alcoholics. My memory is that in life the female had the pale colors on the thorax and abdomen pale green.

CELAENURA DENTICOLLIS (Burmeister).

This smallest of western dragonflies occurs throughout the warmer valleys of California, Nevada, Arizona, and northwestern Mexico. My data for Mexico are from Calvert.¹ This species is found commonly on the high central plateau of Mexico, where the farthest south record is on the slope of Mount Orizaba at an elevation of over 6,000 feet. It does not occur on the lower land of the east coast but it is found down the west coast, although not as far south as it occurs on the cooler plateau. In California and Nevada it is found from sea level up to 4,400 feet. It is, in the latter States, distinctly a spring stream species, though in southern California it is found about almost any permanent, sluggish water. Many of my northern records are spring-stream records. In the hot Sacramento Valley I found it at Colusa, which was as far north as I went. At Calistoga, California, it was very abundant in the cooler of the warm outlets of the Hot Springs. It occurred in a spring stream at Auburn, California (3,400 feet elevation), on the east side of the Sacramento Valley. At Golconda, Nevada (elevation, 4,400 feet), perhaps the coolest climate in which I found it, *denticollis* flourished in a warm spring where freezing weather could have little influence on the nymphs. In none of the localities mentioned in the preceding, with the exception of Golconda, Nevada, where the nymphs are protected from the freezing weather by the warm water, are there heavy frosts with any severe winter weather.

Its distribution then indicates that it is distinctly a subtropical insect, but just as distinctly that it is not tropical. It is with equal distinctness confined to the semiarid and arid regions. This interesting distribution from sea level on the northern boundary of its habitat to the great elevation on its southern boundary is found in many other western Odonata, many species having very definite temperature limits.

The habits of this species are in general ischnuran but indicate greater feebleness. Early in the morning it is found in the sedges and grasses bordering the water but during the heat of the day it spends the greater part of its time over the surface of the water, usually seated on trash or aquatic vegetation. At Calistoga I had an excellent opportunity of observing its habits because of its great abundance.

Here several nymphs ready to transform were taken from the trash around the edge of a warm spring and the exuviae were common on the grass stalks fringing the water. I caught none in the act of transforming, as it was cold rainy weather, but I feel reasonably certain of the identity of these nymphs.

¹ Biol. Amer., Neur., pp. 126, 387.

The females resorted to the little drain ditches to oviposit; there the males in great numbers awaited their coming. After a considerable time in copulation, seated on some grass stem the female, still accompanied by the male, would fly to the surface of the stream, preferably a quiet lateral pool, and commence ovipositing.

In ovipositing the male held the female by the head.

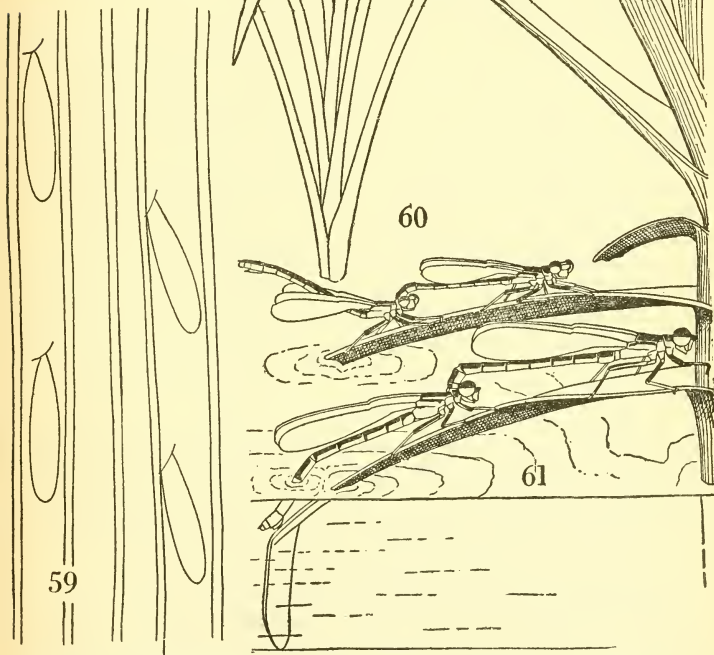


FIG. 59.—*CELAENURA DENTICOLLIS*, PAIRS OF EGGS IN TISSUE OF GRASS LEAF.

FIGS. 60-61.—*CELAENURA DENTICOLLIS*. 60. PAIR RESTING BETWEEN OVIPOSITIONS, FEMALE WITH ABDOMEN RAISED. 61. FEMALE OVIPOSITING.

The pair would alight on floating vegetation, in a horizontal position, and the female would bend her abdomen slightly and make usually one or two incisions, after which she would raise the end of her abdomen con-

siderably above the horizontal and wait in this position several seconds, when the pair would fly to another straw and repeat the one or two thrusts followed by the wait with the tip of the female's abdomen in the air. (See figs. 60-61.) This was kept up, by a pair under observation, for 20 minutes. In no place did they make more than one or two thrusts. Further, I was not positive at the time that the ovipositor was actually thrust into the plant tissue, as the females observed put forth none of that painstaking effort usually shown by ovipositing dragonflies. Later, when these grass blades were examined in the laboratory, eggs were found in pairs (see fig. 59). This species is undoubtedly the feeblest of all the western Odonata, not excepting *Telebasis salva*, which is no larger but much more active.

Length of abdomen: Male, 19 mm.; female, 20. Length of hind wings: Male, 12 mm.; female, 14.

Male, structure.—Only 2 internal spines on anterior femur, one at base, the other at apex. Hind tibia with 6 external spines. Hind femur reaching to middle of segment 2. Wings reaching to middle of segment 6. A low hairy prominence on ventral side of metathorax. Segment 3 with a low spine at anterior ventral angle of side. Penis (fig. 85) two-horned as in *Ischnura* but without the pair of erect spines on the ventral side of the penultimate segment. The fleshy tips but two-thirds as long as in *gemina*. Segment 10 with a raised forked process on the middorsal apex. Appendages of segment 10 (figs. 89-91) similar to those of *gemina* with the following differences: The external branch of the superiors wanting; the inferior-external branch of the inferiors developed into a short upturned hook; the dorso-lateral branch of the inferiors very short. In *denticollis* the inferiors project beyond the superiors. In *gemina* (fig. 95) the inferior branch of the superior falls anterior to the superior process of the inferior.

Female, structure.—Similar to that of male except as follows: Prothorax with the dorsum of the middle lobe with a pair of low conical protuberances or horns. The posterior lobe rounded and moderately developed. (The only female with which *denticollis* might be confused is that of *damula*, which has the same two horns but the posterior lobe is reduced to a large tubercle projecting caudad.) (See figs. 63, A-B.) (Mesotigmal laminae, fig. 88.)

Anterior femora with but two internal spines, one at base and one at apex. Posterior femora reaching to middle of segment 2. Wings reaching to base of segment 7. Segment 10 half as long as 9; appendages two-thirds length of 10. Segment 8 with minute spine.¹ Genital valve reaching to apex of 10, and minutely serrate along its ventral margin. Palp two-thirds length of 10.

¹ Calvert has shown that as many as 80 per cent of the females from a locality may not possess this spine. Biol. Cent. Amer., Neur., pp. 126, 387.

Male, color.—Labrum pale, nasus pale, edged above with black, postclypeus black. Genae, bases of mandibles and anterior surface of frons greenish blue. Vertex black. Postocular spots small, pure blue, not connected, and not confluent with the blue of the rear of the head. Eyes greenish below, abruptly black above. Rear of head blue, with a large, central, black spot. (See fig. 56.)

Prothorax shining greenish black, except anterior lobe, pale, and lower half of side, pale blue. Coxa blue.

Mesothorax and metathorax greenish blue, with the anterior surface black, this extending caudad along the sides to halfway between the humeral and first lateral sutures. Mesinfraepisternum blue, its upper third black. Second lateral suture narrowly black, this widening above into a narrow elliptical spot. Coxae blue with a black spot. Legs: Trochanters and femora black with a broad blue stripe on the interior side; tibiae greenish with an external black stripe; feet pale. Stigmas of front wings black with white apices; hind wings brown with white apices.

Abdomen shining black, except as follows: Side of segments 1, 2, the anterior two-thirds of side of 3, sides of 8–10, blue. Also apex of 2 blue; a trifoliate pure blue spot on apex of dorsum of 8, as well as the dorsum of 9 blue. Sides of segments 4–7 yellow. Segments 3–7 with a narrow, pale, basal ring, interrupted middorsally. Intersegmental membranes of segments 8–10 pale.

Female, usual adult color.—Labrum greenish, edged above with black; nasus, base of mandibles, genae and anterior surface of frons bluish green; postclypeus and vertex black. Postocular spots moderate, blue, and confluent with the greenish blue of the rear of the head. Eyes greenish below, with a black cap, sharply demarked by a horizontal line. (See figs. 57–58.)

Prothorax bluish green on the sides, its dorsum black, except the anterior lobe and the two horns, usually pale.

Mesothorax and metathorax blue, except for the following black markings: A broad middorsal stripe occupying half of the mesepisternum on either side, a narrow humeral stripe and narrow stripes on the upper fourth of the first and second lateral sutures. Legs greenish with the femur broadly black above and the tibia with an external black stripe; feet pale. Pterostigmas brown.

Abdomen with entire dorsum black, except a narrow basal pale ring, interrupted middorsally on segments 3–7, and the intersegmental membranes of segments 1–2 and 7–10, which are blue. Sides of segments 1, 2, and 8–10 blue, of 3–7 yellow.

The female of this species from the teneral to the senile color passes through several remarkable color stages, and is dimorphic and possibly trimorphic in color. The large series of females collected at Calistoga, California, June, 1914, were studied as to their color patterns

with the following results, which are transcribed from notes taken at the time.

Color No. I, *teneral on emerging*.

Face pale luteous, the vertex and dorsal surface of frons dark gray; postocular spots large, broadly connected and of the same luteous tint as the rear of the head. Eyes pale green, with no dark cap.

Thorax pale luteous (straw color), with broad middorsal and narrow humeral stripes, which are dark gray. Legs straw color, with a faint external dark stripe on the tibia; feet greenish.

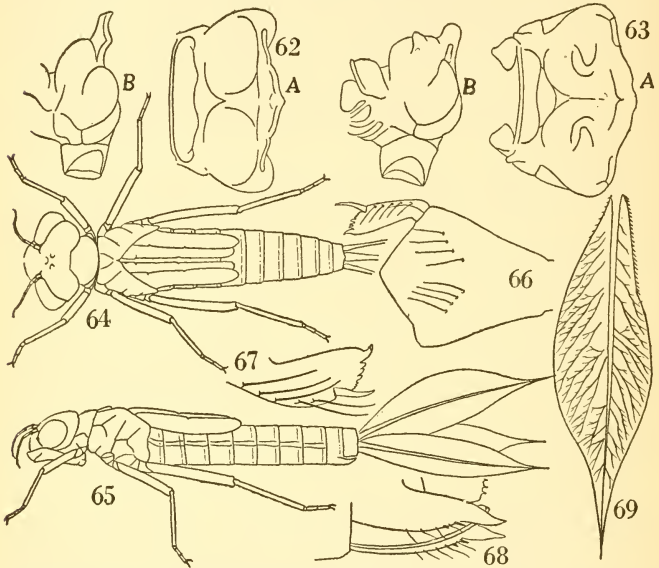


FIG. 62, A AND B.—*CELAENURA GEMINA*, FEMALE PROTHORAX.

FIGS. 63-69.—*CELAENURA DENTICOLLIS*. 63, A AND B. FEMALE PROTHORAX. 64-69. NYMPH. 66. MENTUM. 67. MENTAL LOBE. 68. SEGMENT 9 OF FEMALE. 69. CAUDAL GILL.

Abdomen with sides straw colored and dorsum gray, except a broad straw dorsal spot on segments 8 and 9, this spot interrupted on base of 9 in some females.

This extreme teneral phase rapidly changes into the following:

Color No. II. Black pattern as in No. I, but face, postocular spots, sides of thorax, legs, sides of 1 and 2 and dorsum of 8 and 9 pink. This changes into:

Color No. III. Black pattern as in Nos. I and II; pale colors as in No. II, but postocular spots reddish, sides of 3-7 yellow; dorsum of 8 and 9 blue. This changes to:

Color No. IV. Postocular spots blue, legs still pink; thorax, sides of 1 and 2 and dorsum of 8 and 9 blue. Sides of 3-7 yellow. In this stage the postocular spots have become disconnected and much reduced in size. The eyes previous to this stage have been pale green, lighter below, but now the black cap is sharply indicated. The black humeral line has become broader; the external line on the tibia is heavier and an external line is appearing on the femur. This changes into:

Color No. V. This is close to the "adult" stage described first. In this final stage the postocular spots are becoming obscured by smoky, the humeral line has widened until it has obliterated the pale ante-humeral line, the blue spots on dorsum of 8 and 9 have been replaced by black and the femora have become broadly black above.

This final stage seems to be dimorphic, as some old females have the pale areas green and some pure blue. Among the 75 *Calistoga* females I saw but two green females.

Dr. Calvert¹ described a yellow form of the female of this species. As he had dried material only, it is possible that his yellow form is the same as this green form with the blue factor of the green faded. Some agrionines, greenish blue in life, fade to yellow in dried material.

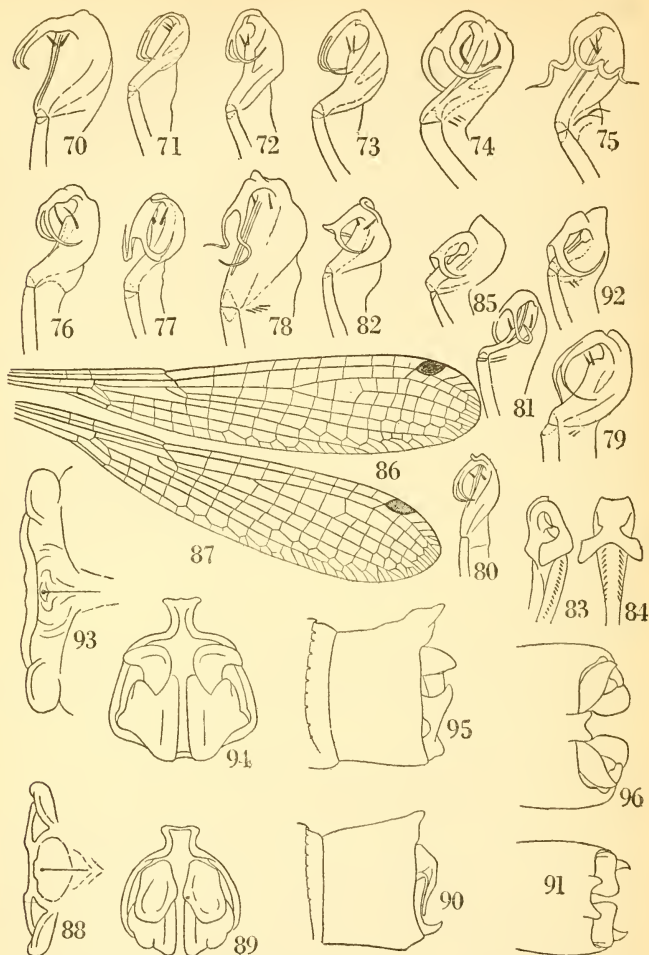
Nymph.—Described from a male nymph (alcoholic) collected at *Calistoga*, California, June, 1914. Deposited in the United States National Museum.

Abdomen (exclusive of gills), 6 mm.; gills, 5.5; hind femur, 3; head, 3 mm. wide.

Nymph (see figs. 64-69) of the usual *ischnuran* form with wide flat head, short abdomen, long legs and acuminate gills. Antenna seven jointed. Labium with four mental setae on each side and a row of five setae on the lateral lobe. Wings reaching to the middle of segment 4. Hind femora reaching to middle of segment 4. The abdomen tapering regularly to apex, with a well-defined lateral keel on segments 1-8. Genital valves of female reaching to beyond apex of 10; the ventral edge with two small spines and several long hairs. Gills widening to the apical two-fifths, whence they taper to an acuminate point. The inferior edge of the gill is straight from the base with but slight taper for the first third, when the widening of the gill increases rapidly to the apical two-fifths, as stated previously. This first straight third of the interior edge is heavily spiculed while the remaining portions of the superior and inferior edges are smooth, except 8 widely spaced spicules on the base of the dorsal edge (see fig. 69).

The colors in this nymph were inconspicuous. This peculiar restriction of the spicules to the base of the gills distinguishes this nymph from those of *Ischnura cervula* and *I. perparva*, in both of which both edges of the gills are spiculate to beyond the middle. In both

¹ Biol. Cent. Amer., Neur., p. 127.



FIGS. 70-81.—ISCHNURA PENES. 70. *I. PERPARVA*. 71. *I. DEMORSA*. 72. *I. VERTICALIS*. 73. *I. DAMULA*. 74. *I. ERRATICA*. 75. *I. RAMBURII CREDULA*. 76. *I. KELICOTTI*. 77. *I. BARBERI*. 78. *I. ELEGANS*. 79. *I. CERVULA*. 80. *I. POSITA*. 81. *I. PUMILIO* (GENOTYPE).

FIG. 82.—*CERATURA CAPRIOLA*, PENIS.

FIGS. 83-84.—*NEHALENNIA IRENE*, PENIS.

FIGS. 85-91.—*CELAENURA DENTICOLLIS*. 85. PENIS. 86-87. WINGS. 88. FEMALE, MESOSTIGMAL LAMINAE. 89-91. MALE, SEGMENT 10.

FIGS. 92-96.—*CELAENURA GEMINA*. 92. PENIS. 93. FEMALE, MESOSTIGMAL LAMINAE. 94-96. MALE, SEGMENT 10.

of these the spiculation weakens gradually caudad, while in this *denticollis* nymph it is strong and ends abruptly at the apical end of the straight basal section of the inferior edge.

7. A NEW GENUS BASED ON TACHOPTERYX HAGENI.

While labeling the dragonflies in the collection of the California Academy of Science it was my good fortune to find a pair of the very rare *Tachopteryx hageni* Selys. With the permission of the director, Dr. Barton W. Evermann, I had the privilege of bringing these specimens to Stanford, where I was able to make a careful study of them.

Tachopteryx Selys is, perhaps, the most primitive genus of living anisopterous dragonflies in North America. Only three species are known: *Tachopteryx pryeri* Selys from Japan, *Tachopteryx thoreyi* (Hagen) from the Alleghanies of eastern North America, and *Tachopteryx hageni* Selys, which was described in 1879 from a single male specimen collected in "Nevada" and now in the Selys collection in Brussels.

In September I had the privilege of working in Mr. Williamson's collection at Bluffton, where studies of *thoreyi* were made. Through the kindness of Mr. Williamson and Doctor Ris I was enabled to get into touch with MM. Severin and Meuninger, who have forwarded photos and drawings of *pryeri*. At about the time of the arrival of these figures my attention was called by Doctor Calvert to three very fine specimens of *pryeri* in his collection in the Philadelphia Academy of Science. These I had the privilege of studying while working in this collection recently. Further, Mr. Williamson has loaned me the original of his published drawing of the nymph of *thoreyi*.

From my study and comparison of this data I believe that the two species *hageni* and *pryeri* should be placed in a genus distinct from *Tachopteryx thoreyi*, as the latter shows structural characters and a higher development of the venation which separate it from *hageni* and *pryeri*.

TANYPTERYX, new genus.

Of the Petalurinae. Eyes widely separated, labium with median lobe cleft. Whip of antenna jointed. The internal triangle of the front wings three celled, its sides subequal. Superior appendages of the male only moderately dilated. A large hairy tubercle on the ventral side of the metathorax. Color largely black.

Wings with normally a more reduced venation than in *Tachopteryx thoreyi*. The third, fourth, or rarely fifth antenodal developed as a brace vein. The anal loop with two to four cells. (This varies in some wings, for the female *hageni* in Philadelphia has five in one

wing and the female *pryeri* in the same collection has six in the left and seven in the right hind wing.) Anal vein of hind wings with four to six branches. (See figs. 126-129.)

Type of the genus.—*Tachopteryx hageni* Selys. This genus contains also *Tachopteryx pryeri* Selys of Japan.

The name proposed is from the Greek: $\tau\acute{\alpha}\nu\pi\tau\acute{\epsilon}\rho\upsilon\chi\acute{\iota}$ = swift-winged.

The erection of this genus leaves in *Tachopteryx* Selys only the species *thoreyi*, which occurs in the Appalachian Mountains of the eastern United States. The genus *Tachopteryx* may then be described in its restricted sense as follows:

TACHOPTERYX Selys, restricted.

Of the Petalurinae. Eyes widely separated. Labium with median lobe cleft. Whip of antenna jointed. The internal triangle of the front wings three celled, its sides subequal. Superior appendages of the male only moderately dilated. No large tubercle on ventral side of metathorax. Color largely yellowish olive.

Wings with a richer venation than in *Tanypteryx*. The sixth or seventh antenodal developed as a brace vein. The anal loop with five to seven cells. The anal vein of hind wings with six to eight branches. (See figs. 130-132.)

Type of the genus.—*Tachopteryx thoreyi* Selys.

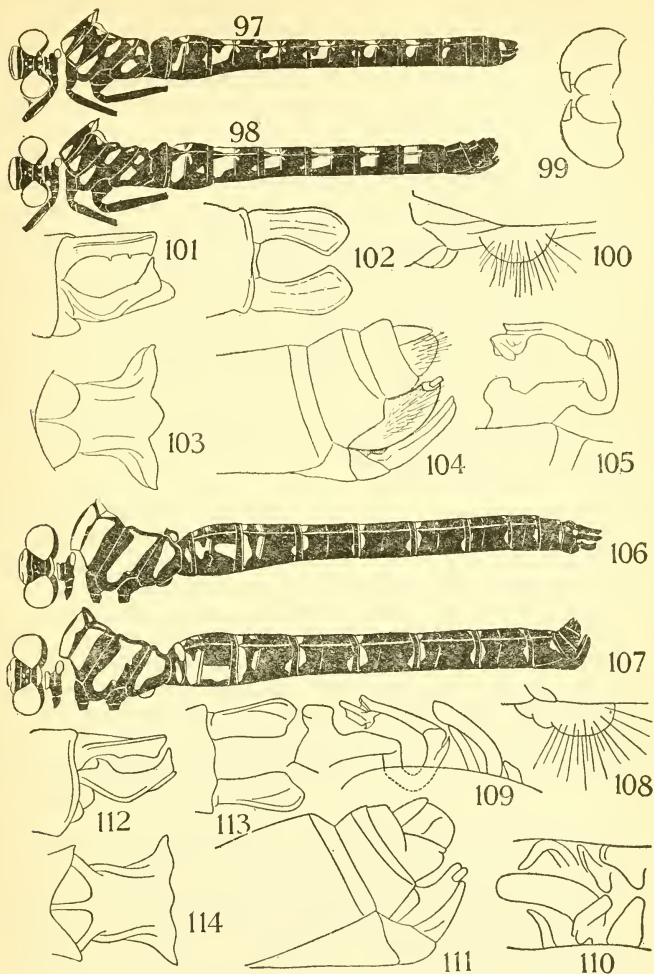
TANYPTERYX HAGENI (Selys).

Tanypteryx hageni has not been recorded since the original specimen was described by Selys. The two specimens in the California Academy of Science collection were taken by Prof. E. C. Van Dyke, at Monroe, Washington, in July, 1915. The eastern *Tachopteryx thoreyi* inhabits mountain swamps and bogs. As Monroe, Washington, is on the west side of the Cascades where there is a very long rainy season, probably *Tanypteryx* inhabits similar situations there, and with a step further one can infer that the type-specimen collected in "Nevada" came from some high mountain swamp.

A teneral female of *Tanypteryx hageni* is preserved in the Philadelphia Academy of Science. This was collected in California, probably by Behrens, in Shasta County. One other specimen is in the Museum of Comparative Zoölogy. This is from Reno, Nevada, collected by Morrison in 1878.

The following is a description of the two specimens in the Museum of the California Academy of Science:

Color of male.—Face dark brown except a yellow spot at base of each mandible (the "dark brown" of this species approaches black, only a close examination showing that it is not true black). Frons yellow, excepting a small brown area on each side below and a narrow brown band across its posterior edge. Vertex dark brown.



FIGS. 97-105.—*TANYPTERYX HAGENI*. 97-98. COLOR PATTERN. 99. LABIUM. 100. METATHORACIC TUBERCLE. 101-103. MALE, APPENDAGES. 104. FEMALE, SEGMENTS 9 AND 10. 105. PENIS.
 FIGS. 106-114.—*TANYPTERYX PRYERI*. 106-107. COLOR PATTERN. 108. METATHORACIC TUBERCLE. 109. PENIS. 110. HAMULES. 111. SEGMENTS 9 AND 10 OF FEMALE. 112-114. MALE, APPENDAGES.

Occiput brown with twin yellow spots on its posterior surface. The posterior surface of the head black. Labium pale brown. (See fig. 97.)

Prothorax dark brown with a pale yellow spot on each side of the posterior lobe and a pair of minute yellow spots just posterior to the anterior lobe, also a yellow spot on each coxa and a smaller spot just above each coxa. Front legs black with a yellow stripe occupying the middle two-fourths of the ventral (internal) face of the femur.

Mesothorax and metathorax dark brown with the following yellow spots: A triangular spot on the lower half of each mesepisternum, a minute spot above this just below the antealar sinus, a second minute spot in the antealar sinus. The sides of the thorax with four large spots arranged in pairs obliquely; the anterior pair on the mesepimeron, one in the lower anterior angle and its mate in the upper posterior angle with a third and minute spot in the upper anterior angle. The posterior pair of lateral spots are on the metepimeron, the lower spot in the center of the lower end and the upper in the center of the upper end. Also a minute spot in the upper end of the metepisternum. Coxae and middle and hind legs black. Wings with a brownish tinge.

Abdomen black with orange markings. Segment 1 with a brown transverse dorsal band on its apex. Segment 2 with an anterior S-shaped spot on each side and a minute spot on each side of the apical end. Segment 3 with a wide V-shaped anterior spot on each side followed by a minute spot just posterior to the vertical carina. Segments 4 and 5 with the V spot broken into a minute anterior arm and a large posterior arm which lies just anterior to the vertical carina. A small dorsal spot just posterior to the vertical carina and a small latero-apical spot. Segments 6 and 7 marked as are 5 and 6, except that the latero-apical spot is wanting on both segments and the minute anterior spot is wanting on 7. Segment 8 with only a large antero-lateral spot representing the posterior arm of the V in the anterior segments. Segments 9 and 10 black, but the intersegmental membrane of 8-9-10 pale brown. Appendages black.

Color of female.—Female colored as in the male, except that the V spots of the male abdomen are represented on segments 2 to 7 by a rectangle of orange occupying almost the entire space from the anterior end of the segment to the vertical carina and from the middorsal line to the middle of the side. Segments 2-4 each with a pair of minute dorsal spots just posterior to the vertical carinas, and a latero-apical spot on each side. Segments 8-10 black, except the intersegmental membranes of 7-10, which are pale brown. (See fig. 98.)

Male abdomen, 44 mm.; hind wing, 34. Female abdomen, 42 mm.; hind wing, 36.

Structurally this species is characterized by its small size, the hairy tubercle on the ventral side of the metathorax, the superior appen-

dages of the male with three minute teeth along their lower edge, the inferior appendage with a large midapical lobe and lacking the pair of superior basal hooks found in *thoreyi* and *pryeri*. The stylus in the female is placed at the apex of the genital valve. (See figs. 99–105.)

TANYPTERYX PRYERI (Selys).

This interesting species is found in Japan, and like a number of other species finds its nearest relative on the Pacific slope of North America. The wings reproduced in the accompanying illustrations (figs. 124–125) are traced from photographs made in Brussels, while the remainder of the illustrations of *pryeri* are from the specimens in the Philadelphia Academy of Science.

The following is a description of these specimens.

Color of male.—Black and yellow with the general appearance of *hageni*.

Labium black. Face black, except a small yellow spot on base of mandible. Frons yellow, except on its posterior edge. The yellow of the frons extends down in front over the dorsal fourth of the middle two-fourths of the nasus. Vertex black. Occiput black on the anterior surface, yellow on the posterior surface. Posterior surface of head black. (See fig. 106.)

Prothorax large, black, except its anterior lobe yellow, and a large yellow oval on each side of the posterior lobe.

Mesothorax and metathorax black, with the dorsal or inner half of each mesepisternum yellow as are also the anterior alar fossae. A large yellow area lying between the humeral and second lateral sutures; this extending dorsoventrad from just below the lateral alar ridge to below the spiracle; its upper edge paralleling the alar ridge, its ventral end rounded, its width approximately one-half the distance between the humeral and second sutures. A large triangular yellow area on the metepimeron. Infraepisterna, coxae and legs black. Pterostigmas brown.

Abdomen black with yellow as follows:

Segment 1 with a small dorso-lateral spot on each side of apex.

Segment 2 with an hourglass-shaped spot on each side above the auricle and anterior to the lateral vertical carina. A large wedge-shaped spot posterior to the vertical carina.

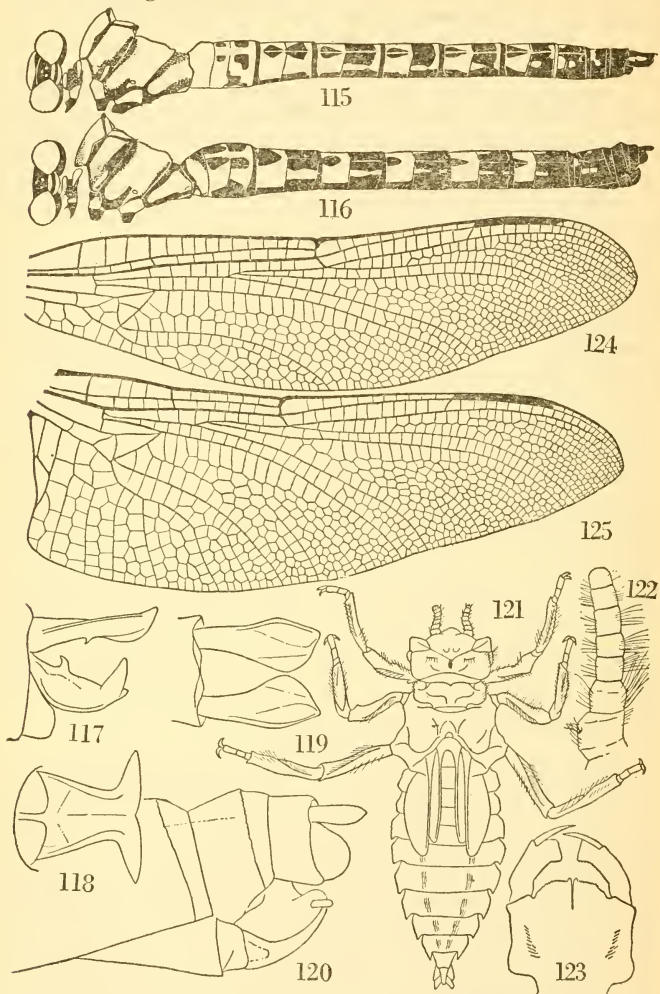
Segment 3 on each side with a narrow, vertical, basal spot extending from middorsal carina almost to lower edge of side, a narrow vertical spot on the anterior side of the vertical carina and a minute latero-apical spot.

Segments 4–7 similar to segment 3, but the spot anterior to the vertical carina lacking.

Segments 8 and 9 with the apical spots only.

Segment 10 with a minute spot in the center of the dorsal surface. Appendages black.

Color of female.—Similar to that of male, but—
Segment 1 with a dorso-apical spot as well as the two lateral apical spots. (See fig. 107.)



FIGS. 115-123.—TACHOPTERYX THOREYI. 115-116. COLOR PATTERN. 117-119. MALE, APPENDAGES. 120. SEGMENTS 9 AND 10 OF FEMALE. 121-123. NYMPH. 122. ANTENNA. 123. MENTUM.
FIGS. 124-125.—TANYPTERYX PRYERI, WINGS.

Segment 2 with what was an hourglass-shaped spot above the auricle in the male, in the female a large yellow area extending ventrad

almost to the lower edge of the side. The lateral apical wedge in the male represented by a broad lateral stripe extending from the vertical carina to the apex of the segment.

Segments 3-8 as in the male.

Segments 9 and 10 black, as are the appendages.

The measurements of the three Philadelphia specimens are as follows:

No. 1, male, abdomen (incl. app.), 49 mm.; hind wing, 42.

No. 2, male, abdomen (incl. app.), 53 mm.; hind wing, 43.

No. 3, female, abdomen (incl. app.), 51 mm.; hind wing, 47.

Structurally this species is characterized by the following: A large hairy tubercle (fig. 108) on the ventral side of the metathorax, the male superior appendages with a low tubercle about midway of the edge, the inferior appendage with its lobes acute, widely spreading, but with merely a suggestion of a median terminal lobe (figs. 112-114.) (See also figs. 109-110, penis and hamules.) Female with the stylus of the genital valve arising below the apex (see fig. 111).

TACHOPTERYX THOREYI Selys.

The following summary of the habits of this species is from Mr. Williamson's published paper on the subject.

On June 4, 1900, Mr. D. A. Atkinson collected the only known nymph of this species in a boggy spot near Pittsburgh, Pennsylvania.

In the boggy spot, where the nymph was collected, at that time the only surface water was retained in small depressions, such as the tracks of cattle, among the roots of sedges and grasses. On July 15, 1900, Mr. J. L. Graf observed a female ovipositing in this same swale. She alighted among the dense grasses and placed the eggs among the roots or in wet decaying vegetable matter above the surface of the water. She would raise or lower her abdomen 8 or 10 times in one place, then fly to another spot. On June 23, 1900, Mr. Graf discovered another female ovipositing. A mere thread of water flowed from several small springs. The bed of this small stream was composed of cinders and sand. The dragon fly alighted in the grass near this stream and placed her eggs in a small depression in the cinders. This depression contained not more than a tablespoonful of water. Into this small basin she thrust her abdomen a number of times at the rate of 15 or 20 times a minute.¹

This same paper gives a very detailed description of the nymph mentioned previously. Mr. Williamson very kindly loaned me his drawing, which I have reproduced as figure 121.

In its heavy awkward shape the nymph is perhaps adapted to slow but powerful movements in bogs and mud. It is peculiar in its labium with the cleft median lobe and in the primitive, unspecialized form of the antenna (see figs. 122-123).

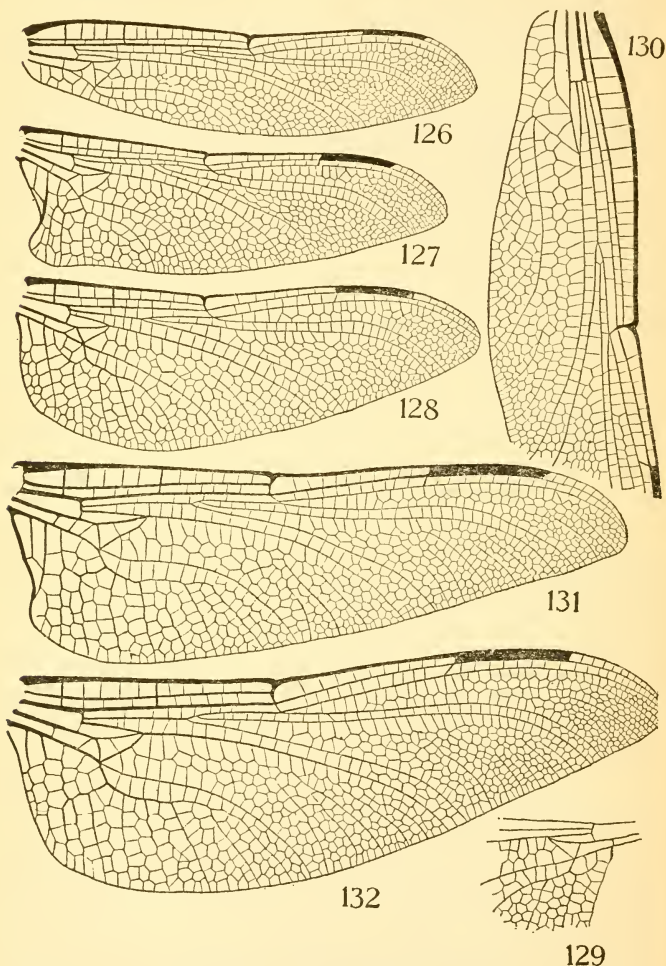
Prof. J. G. Needham² writes that this species has been taken from Massachusetts to Florida and Texas.

¹ Ent. News, vol. 12, 1901, pp. 1-3.

² Bull. 47, N. Y. State Mus., 1901, p. 472.

The following is a description of the color of *thoreyi*:

Male.—Labrum luteous, edged above and below with black, that above connecting with a circular median spot on the center of the



FIGS. 126-129.—TANYPTERYX HAGENI, WINGS.

FIGS. 130-132.—TACHOPTERYX THOREYI, WINGS.

labrum. Nasus black. Frons yellow, except the posterior edge of its horizontal surface which is edged with black. Vertex black.

Occiput yellow with a black band along its posterior edge. Posterior surface of head black. (See fig. 115.)

Prothorax black, its anterior and posterior lobes yellow. Proinfraepisternum pale.

Mesothorax and metathorax olive brown with dark brown, obscurely edged markings. Middorsal carina black. All alar ridges black. A broad band on humeral suture, a similar broad band on second lateral suture, and a third on the metasternal keel brown. Infraepisterna yellow. All coxae and legs black.

Abdomen with segment 1 pale.

Segment 2 yellow, with four dorsal black spots and a spot on each side posterior to the auricle.

Segment 3 yellow, with the lower edge of the side black and two tandem, lozenge-shaped, black spots on the middorsal line.

Segments 4 and 5 similar to 3 but with the posterior of the two dorsal spots expanded into a quadrilateral spot covering the entire dorsum posterior to the vertical carinae except a narrow band across the apex of the segment.

Segments 6 and 7 similar to 4 and 5 except in the greater extent of the post-dorsal spot which connects at its apex on each side with the black of the lower edge of the segment.

Segment 8 black except for a row of three small yellow spots on the upper part of each side.

Segment 9 with an irregular anterodorsal spot.

Segment 10 and appendages black.

Female.—Colored as the male but the black slightly more extensive (see fig. 116).

The upper end of the mesinfraepisternum black. The anterior edge and dorsum of segment 1 dark. The four dorsal spots on segment 2 and the lateral spot of the same segment larger. The postdorsal spot in segments 3 to 7 covering the entire dorsum posterior to the vertical carinae. Segment 9 as well as 10 entirely black.

Measurements: Male abdomen (incl. appendages), 55 mm.; hind wing, 50. Female abdomen, 57 mm.; hind wing, 50.

Structurally this species is peculiar in lacking the metathoracic tubercle found in *Tanypteryx*. In the male the superior appendage has a minute tooth on the middle of its inferior edge. The inferior appendage is without a median terminal lobe and has a pair of superior basal hooks. In the female the stylus is placed subapically on the genital valve. (See figs. 117-120.)

8. NOTES ON *CORDULEGASTER DORSALIS* AND *C. DIADEMA*.

The nine species of *Cordulegaster* known from North America are recorded from mountainous regions, though two are found also in the hillier areas of the northern Mississippi Valley. Six of these species occur in the Appalachians. Two are found in the mountains

of the Pacific slope while one other is recorded so far only from Mexico and Central America. The western species are *C. dorsalis* Hagen and *C. diadema* Selys. *Dorsalis* occurs in the coast mountains from Sitka, Alaska, south to the San Gabriel Mountains at Los Angeles, California. It is found up to an elevation of 4,000 feet on the west slope of the Sierras in California but has never been recorded from the eastern side of these mountains. *Diadema* is recorded from the mountains of Arizona and northern Mexico.

My records for *Cordulegaster dorsalis* are as follows: Stevens Creek, Santa Clara County, California, May 31, a single fresh exuvia and several grown nymphs were collected but no imagoes were seen; July 7, eight males were observed; August 16, three males and one female were caught, the latter while ovipositing. Zyante Creek, Santa Cruz County, California, July 9, numerous exuviae were found but no adults were seen. Napa Asylum Grounds, Napa County, California, June 8-9, six males were taken on a small mountain stream flowing from the Hospital reservoir; no females were seen. In Mr. Fordyce Grinnell, jr.'s, collection is a male taken on the Arroyo Seco at Pasadena, California, June 29, 1910.

The following records are from the west slope of the main Sierra Chain: On the American River at Auburn, Placer County, California, July 20, a single male was seen repeatedly at close range which had probably strayed from one of the small spring-fed side streams. In Bear Valley at Emigrant Gap, Placer County, California, a single male was taken July 21; two others were seen. This was at an elevation of 4,000 feet, the highest elevation at which this species is recorded, and is also the most eastern record, though it is still on the west slope of the Sierras.

Much that I shall write concerning *Cordulegaster dorsalis* will be almost a repetition of that concerning *Octogomphus*, as the habits and distribution of these in California are in many ways similar.

As far as I have observed, *C. dorsalis* is found usually on those swift mountain torrents which do not freeze in the winter time. There may be exceptions to this, as I took this species at an elevation of 4,000 feet in Bear Valley (Emigrant Gap, California), where there is a heavy winter snowfall and probably the streams freeze, though many of them are fed by numerous springs which may moderate their temperature. In the Coast Mountains of California, where it appears to reach its greatest numbers, it is found in the swift upper reaches of all the perennial streams. Here it is associated with *Octogomphus specularis*, *Aeshna walkeri*,¹ and *Argia vivida*, the last breeding in the springs of the mountain gorges. I have never seen or taken *Cordulegaster*, except in the steep canyons of the mountains. It does not occur on the lower reaches of these same streams after they have emerged onto the level valley floors and have lost their

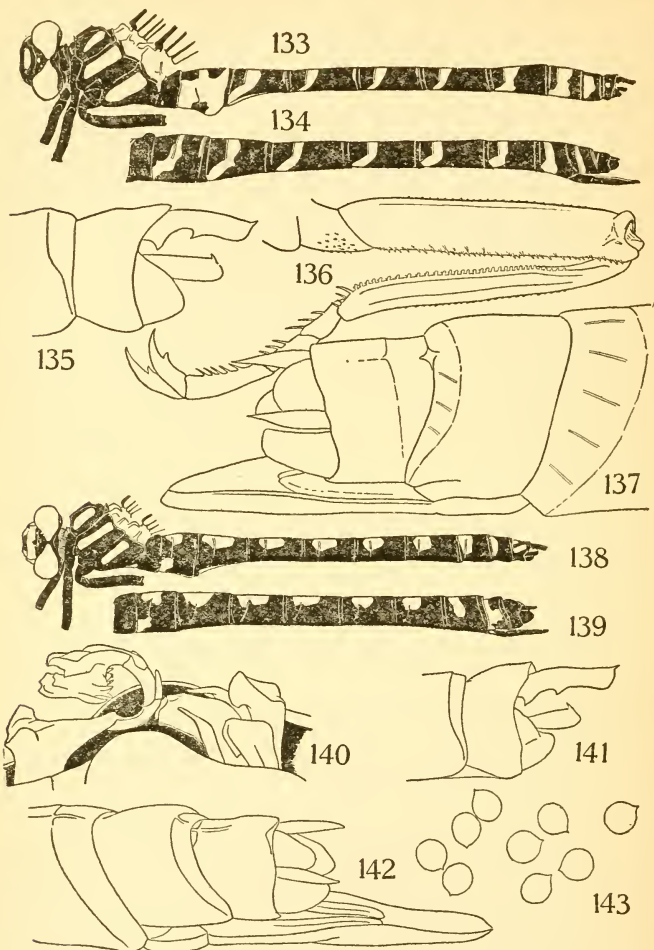
¹ See pages 588-592.

swiftness to become warm and muddy. In the steep and narrow mountain gorges where the rushing torrents pour down through the shade of the redwoods and alders, this dragonfly adds a note of mystery to the scene, for the individuals with their strange ophidian coloration glide noiselessly up stream or down, never showing that curiosity toward strangers or unusual surroundings which is exhibited by the libellulines of the sunny valleys, but always moving straight ahead as though drawn irresistibly onward. Only males are common on the streams, the females seldom resorting to the water except to oviposit. The males, as indicated above, fly on the longest beats I have observed for any dragonfly, for they fly continuously up stream or down until they come to the head of the stream or to the slow water below, or until some unusual obstruction turns them aside, when they face about and fly as steadily in the opposite direction. The course is usually a foot or two above the surface of the stream and goes through dense shade and any loose brush or foliage which may hang over the water. *Octogomphus*, with the possible exception of *Aeshna walkeri*, is the only other western dragonfly which will fly in such close dark places. Because of this habit of flying in long beats this dragonfly is not easily taken, as the collector has but a single chance at each individual.

I have seen but one female over the water. This one was ovipositing. I have seen two others which I thought were females on the mountain side several hundred feet above the stream. As I have seen many males on the streams and only the single female, I conclude that these seldom resort to the water except to oviposit.

In the streams of the Coast Mountains of California, where I have had opportunity to observe the habits of *Cordulegaster* most, it shows a marked upstream migration of the imagoes. The eggs are laid in the shallow water along the edges of the stream and the nymphs wander aimlessly over the bed. Because the nymphs are free on the stream bottom each freshet during the three or four years of nymphal life serves to wash them farther down stream so that when they come to emerge they may be far downstream from the place where the eggs were deposited. On Stevens Creek (Santa Clara County, California) exuviae were abundant almost down to the Trout Farm, while few imagoes were seen below Soda Spring, which is 2 miles farther up the creek, and imagoes were common on the divide at the head of the creek, where few exuviae were found. Exuviae were abundant on the lower part of Zyante Creek (Santa Cruz County, California), where no adults were seen, though it was at the height of the *Cordulegaster* season. From the above and similar observations on *Octogomphus*, I have concluded that the imagoes show such a preference for the swifter water of the upper reaches of these streams that when they reach the upper part of the stream in their first flights they remain

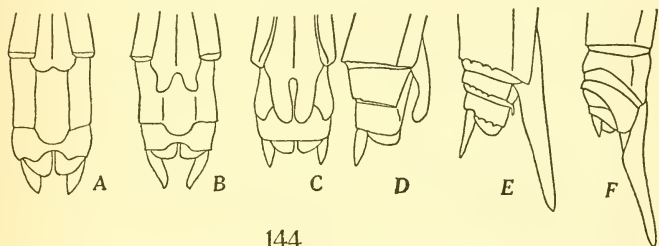
there. This, then, would appear as a general migration of the imagoes upstream.



FIGS. 133-137.—*CORDULEGASTER DIADEMA*. 133-134. COLOR PATTERN. 135. SEGMENT 10 OF MALE. 136. FORE LEG OF MALE. 137. SEGMENTS 9 AND 10 OF FEMALE.
 FIGS. 138-143.—*CORDULEGASTER DORSALIS*. 138-139. COLOR PATTERN. 140. PENIS AND HAMULES. 141. SEGMENT 10 OF MALE. 142. SEGMENTS 9 AND 10 OF FEMALE. 143. EGGS.

I have never observed copulation in this species, but in the matter of oviposition I was more fortunate. August 16, on Stevens Creek,

I saw a female oviposit and a chance acquaintance described to me the manner of oviposition of another female that agreed with my own observations, which are as follows: The female flew hurriedly up the creek and every few yards stopped and with a sudden backing or downward stroke, while hovering with the body in a perpendicular position, stabbed her large ovipositor into the coarse sand along the stream edge where the water was about 1 inch deep. She thus thrust her abdomen down through the inch of water driving her ovipositor into the sand beneath. Four to ten such perpendicular thrusts were made at each stop. Some stops were along the open beaches, but more were in quiet nooks between large rocks where she would have barely room enough for her wing expanse. She usually faced the center of the stream while ovipositing, though once she faced upstream and once toward the bank. The peculiar perpendicular position with the up and down motion reminded me strongly of the manner of



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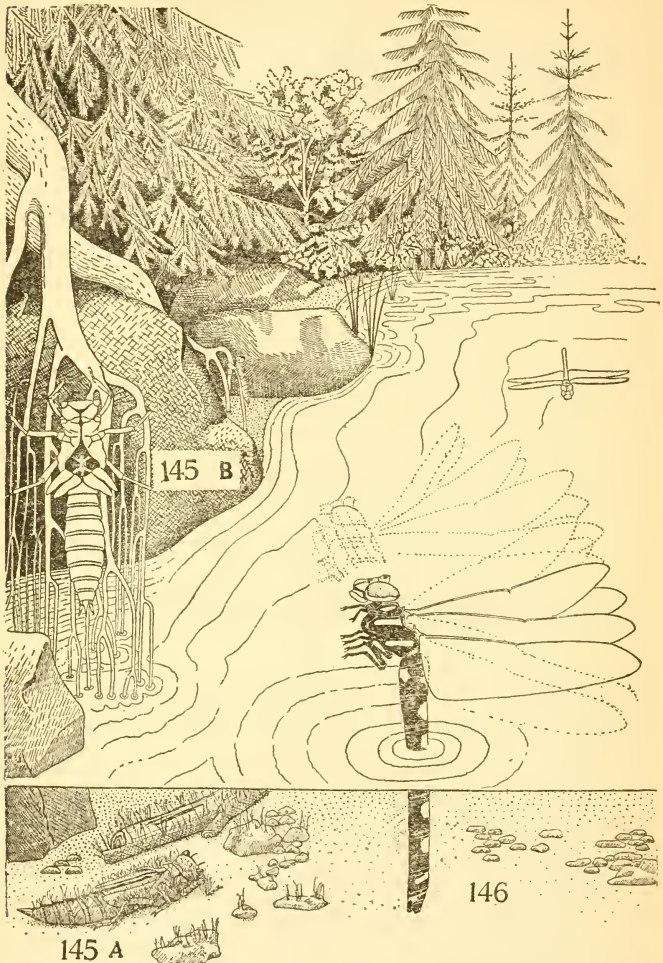
FIG. 144.—VULVAR LAMINA AND OVIPOSITORS (FROM RIS) IN: A. *SYMPETRUM FREQUENS*. B. *SYMPETRUM MATUTINUM*. C. *SYMPETRUM EROTICUM*, VENTRAL VIEW. D. SAME, LATERAL VIEW. E. *SYMPETRUM CORDULEGASTER*. F. *URACIS OVIPOSITRIX*.

oviposition of some crane flies, except that the latter oviposit in damp soil and support themselves on their slender legs while making the vertical thrusts. Figure 146 shows the position of the female while ovipositing.

This large shovel-shaped ovipositor is found in few species of Odonata. It is characteristic of the subfamily Cordulegasterinae and is found in a few species of the Libellulinae. This is the third of those species which have this style of ovipositor, in which oviposition has been observed. After the matter had puzzled naturalists for many years, oviposition was first observed for the European *Cordulegaster annulatus* Latreille by Ris, who described it as follows:¹

Cordulegaster (annulatus), when ovipositing, flew vertically. It thrust the hindmost pointed part of the abdomen vertically in the crumbled limestone deposit on the bottom of the very shallow water.

¹ Ent. News, vol. 16, 1905, p. 113.



FIGS. 145-146.—*Cordulegaster dorsalis*. 145, A. NYMPH WITH PROTECTIVE COAT OF ALGAE. 145, B. EXUVIA. 146. FEMALE OVIPOSITING IN STREAM BED.

Later Williamson observed *Cordulegaster maculatus* Selys of the eastern United States while in the act of ovipositing, which he described as follows: ¹

Cordulegaster maculatus was observed to fly down from trees, alighting on algae-covered rocks in the stream bed. On portions of these rocks not covered with water they crawled about in an awkward, almost crippled manner, thrusting their abdomen with much commotion into the algae beneath the water.

An interesting summary of our knowledge of oviposition in *Cordulegaster* is given by Dr. C. Wesenberg-Lund in *Odonaten-Studien*.²

It is interesting to note that this very special form of ovipositor may not be of any great systematic significance. It occurs in all of the few cordulegasterine Odonata known. It is found in the libelluline genus *Uracis* (see fig. 144, F, *Uracis ovipositorix* Calvert), the several species of which occur in South America and have habits of oviposition similar to those of *Cordulegaster* except that they oviposit in the mud about the water. More strange yet is the fact that a single species of the large genus *Sympetrum* of the North Temperate Zone has this same highly specialized ovipositor. This species, *Sympetrum cordulegaster* (Selys) (see fig. 144, E), occurs in northeast Asia and nothing is known of its habits. While the majority of the *Sympetrum*s have no ovipositor and oviposit by washing the eggs from the tip of the abdomen, one or two Asiatic species have extraordinarily long vulvar laminae and form a sort of connecting series between the numerous species of *Sympetrum* with no laminae or very small ones and this freak species, *Sympetrum cordulegaster* (Selys), with the vulvar laminae longest and united into a monster ovipositor (see fig. 144, E), *Sympetrum frequens* (Selys), with small vulvar laminae (fig. 144, A) and *Sympetrum eroticum* (Selys), from Japan, with very large vulvar laminae but these not united into an ovipositor (fig. 144, C and D). Figure 144, B, is *Sympetrum matutinum* Ris, an intermediate form. These widely scattered cases of this special form of ovipositor are an excellent example of convergent evolution.

As neither of the western species of *Cordulegaster* has been well figured, I have shown in the figures some of the peculiarities of structure and have represented the color patterns diagrammatically. *Diadema* is slightly larger than *dorsalis*. A male and female of *diadema* measure as follows: Male, abdomen, 64 mm., hind wing, 48; female, abdomen, 65 mm., hind wing, 55. Male and female of *dorsalis* measure as follows: Male, abdomen, 55 mm., hind wing, 44; female, abdomen, 57 mm., hind wing, 45. As is shown in the figures 135, *diadema*, and 141, *dorsalis*, the appendages on segment 10 of the male do not differ noticeably. Figure 136 shows the peculiar armature of the tibia in *diadema* which does not differ from that in *dorsalis*. Figure 140 shows the organs of segment 2 of the male *dorsalis*, which are very simi-

¹ Ohio Nat., vol. 7, 1907, p. 144.

² Mitthl. biol. Süßwasserlab. Halleröd (Denmark), No. 16, p. 187.

lar to those of *diadema*. These are characterized by the very large swollen head of the penis and by the thin shell-like anterior hamules. Figure 143 shows the eggs of *dorsalis* drawn to the same scale as the abdominal segments 9 and 10, figure 142. Figures 137, *diadema*, and 142, *dorsalis*, show the ovipositors of the females. The ovipositor consists of a large ventral ovipositor proper which arises from the eighth segment and in the nymph is divided longitudinally. This may be homologous to the ovipositor in the Aeshninae. In the concave dorsal surface of this lie a pair of slender organs which in the nymph arise from the ventral surface of segment 9. These in *diadema* do not extend caudad beyond the apices of the appendages of segment 10, but in *dorsalis* are much longer. These, because they arise from segment 9, may be homologous to the genital valves of the aeshnine dragonflies, though their position in the imagoes is just the reverse of these parts in the Aeshninae.

In color the two species are similar. The general color in teneralis is chocolate brown which, in age, may become almost black. The markings are pure yellow. The frons in *diadema* is black with a yellow oval on its dorsal surface while in *dorsalis* it is yellow with a dark band across its anterior face. The markings of the abdomen in *diadema* are characterized by the yellow oblique rings on segments 3 to 8, and in *dorsalis* by the subcircular dorsal spots on segments 2 to 7. The eyes in *dorsalis* are gray. (See figs. 133-134 and 138-139.)

The nymphs of *Cordulegaster* are short-legged, slow-moving creatures and are usually abundant in the streams of the Coast Mountains. They occur with *Octogomphus* nymphs in the leafy trash of the eddies, but are also found crawling slowly about over the bed of the stream. Their very slow and apparently cautious movements do not betray them, and they carry with them further protection in the coat of long hairs which collects dirt and on which flourishes a thick growth of filamentous algae (see fig. 145, A). Because of this covering of dirt and algae the nymph, though on an otherwise barren bottom, will usually escape the closest scrutiny of the collector, for it does not appear any different from a stick or stone covered with dirt and aquatic growths.¹

At emergence, which takes place in June (I found a single exuvia May 31), the nymphs crawl from 1 to 5 feet up the trunk of the nearest alder tree (see fig. 145, B). A male was reared in the laboratory, but the hour of emergence was not ascertained. This species spends four years in the egg and nymphal stages.

The following table shows the four sizes of nymphs I collected on Stevens Creek (Santa Clara County, California) during the past summer. The measurement used is the width of the head (eye to eye);

¹ On Mission Creek, Santa Barbara, California, I found nymphs of *dorsalis* buried in flocculent silt, as is described by Dr. J. G. Needham (N. Y. State Mus. Bull. 47, 1901, p. 473) for the various eastern species of this genus.

length is unreliable, for some have swollen and some have shrunken in alcohol.

Collected.	1918 brood.	1917 brood.	1916 brood.	1915 brood.	1914 brood.
		mm.	mm.	mm.	mm.
May 31, 1914.....		4			
Do.....		4			
Do.....		3.75			
Do.....			5.5		
Do.....			5.5		
Do.....			5		
Do.....			5		
Do.....			5		
Do.....			5		
Do.....				7	
Do.....				6.75	
Do.....					8.5
Do.....					8
Aug. 16, 1914.....		4			
Do.....				6.5	
Do.....				6.5	
Do.....				6.5	
Do.....					Numerous exuviae.
Do.....					
Do.....	Eggs from 1914 females.				

With these differences in size go much more marked differences in structure. In the 1917 brood or smallest size, the wing pads are minute triangular projections, which are erect and do not overlap. In the 1916 brood they are 2 mm. long, and are no longer erect but overlap three-fourths of their length. In the 1915 brood they are 5 mm. long and assume the adult shape and position. In the mature nymph or 1914 brood they are 9 mm. long. The sex appears in all sizes. In the smallest or 1917 brood the females are distinguished by a pair of minute tubercles at the posterior edge of the ventrum of segment 8. In the next size, 1916, these are distinct triangular projections, though very minute, while in the next size, 1915, they assume the adult shape but are only half the length of segment 9, while in the adult nymph they are slightly longer than segment 9. The male organ on segment 2 is less apparent, being distinct in the adult stage only.

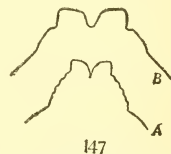


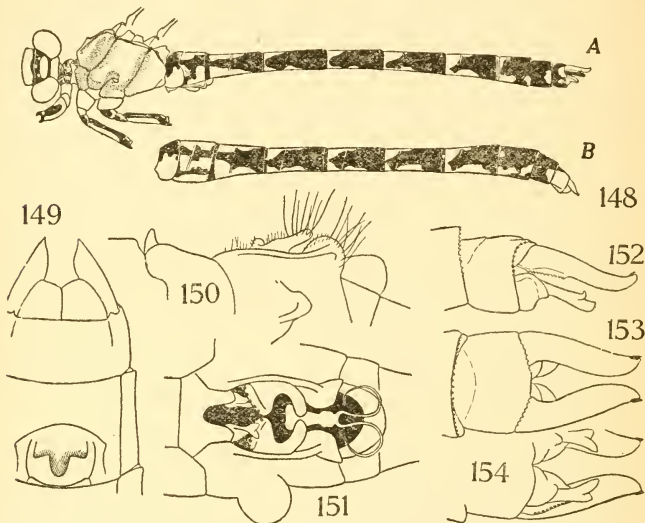
FIG. 147.—DIVIDED MEDIAN TOOTH OF MIDDLE LOBE OF NYMPHAL LABIUM (FROM NEEDHAM). A. CORDULEGASTER DORSALIS. B. CORDULEGASTER DIADEMA.

The nymphs of both *dorsalis* and *diadema* have been described by Needham¹ (fig. 147 is copied from Needham's description and shows the divided median tooth of the middle lobe of the labium in the two species).

¹ Proc. U. S. Nat. Mus., vol. 27, 1904, pp. 696, 697.

9. NOTES ON *PROGOMPHUS BOREALIS*, WITH A DESCRIPTION OF ITS NYMPH.

This western *Progomphus* is apparently widely distributed throughout California,¹ but during the summer's collecting I have seen not more than ten or twelve specimens on the wing. Perhaps the expression "widely distributed" should be used with some qualification as under it I have included the evidence from the wide distribution of the nymphs, which I have ascribed to this species. These nymphs



FIGS. 148-154.—*PROGOMPHUS BOREALIS*. 148. COLOR PATTERN. 149. SEGMENTS 9 AND 10 OF FEMALE. 150-151. SEGMENT 2 OF MALE. 152-154. SEGMENT 10 OF MALE.

seem to occur in the drifting beds of all the sand-bottomed streams of central and southern California where there is a permanent flow of water.

I have the following records of adults: Chico River, five miles east of Chico, California, several males caught on June 17, 1914; Coyote Creek, San Jose, California, two seen on July 4, 1914. Mr. Fordyce Grinnell, jr., has collected specimens at Los Angeles, May 27, 1900, and on Mount Wilson, August 3, 1904. He has also a record from the Santa Rosa Mountains (Riverside County, California) and a specimen from the San Jacinto Mountains, California, at an elevation of 2,500 feet, this taken June 17, 1908.² The nymphs associated with this

¹ Calvert (Biol. Cent. Amer., p. 151) records *borealis* from both Oregon and Arizona as well as from western Mexico, where it extends down the west edge of the plateau as far as Uruapan.

² In August, 1915, I found *borealis* abundant in the Mojave River at Victorville. None were found in the Owens River Valley nor in the Lehontin Basin. Apparently it does not occur immediately east of the Sierras.

species were common in the American River at Sacramento, Kings River at Readley, the San Joaquin at Friant, and Kern River at Bakersfield, which are all wide, shallow streams with beds of drifting sand.

Apparently this species has a long season on the wing as Grinnell's records are from May to August. On the Chico River the few individuals I saw were flying about a quiet pool at the head of a long rapids and when not in motion were seated on snags in the water or on the gravelly shore. Their habits seemed much like those of *Ophiogomphus bison* with which they were associated, except that they were much more wary and difficult to capture. Their large size, slender abdomen and peculiar brown thorax readily distinguish them in the field from any other western gomphine.

Both the imago and nymph of this slender, graceful species differ widely in structure from any other western gomphine. The anterior hamules in the male are covered by wide laminae on the posterior hamules and the seminal vesicle is invaginated on its anterior face, which makes a deep hollow in which the two long filaments of the penis are coiled when in repose. The inferior appendage of the tenth segment is divided to its base, making a pair of inferior appendages. (See figs. 150-154.)

In life *Progomphus borealis* is noticeable for the reddish brown of the front of the thorax and the yellow abdomen with the large black triangles on segments 3-8. In detail the color is as follows:

Male.—Entire face gray but horizontal surface of frons pale brownish; vertex dark brown, lighter posterior to the ocelli; occiput gray with brownish tinges; eyes gray. (I find that I have omitted the live eye color in my field notes.) Upper third of postoccipital region dark brown, lower two-thirds creamy with a horizontal brown stripe. (See fig. 148, A.)

Thorax with anterior surface pale brown and sides pearly gray. The following markings occur: An obscure reddish brown stripe on each side of the middorsal carina, these stripes wedge shaped, with the wide end below; a wide reddish brown humeral stripe, and anterior to this, separated by a pale line, a second wide stripe, the upper end of which usually connects with the upper end of the wedge stripe next the middorsal carina; a brown spot on the metathoracic spiracle and the second lateral suture brown; legs with coxae pale, femora pale with black apices and a black stripe on the upper and posterior surface of each; tibiae and tarsi black; wings hyaline except a reddish brown fleck at base which, in the costal and subcostal spaces, does not reach beyond the basal subcostal crossvein. There is no color in the origin of the sectors of the arculus, as occurs in the eastern species, *Progomphus obscurus*; costa yellow, pterostigma jet black.

The abdomen is creamy yellow with the following intense black markings: The upper half of segment 1, an irregular triangular spot on side of segment 2, an approximately triangular spot on the side of each of segments 3-7; the apex of each of these is at the anterior end of the segment, and the two spots on the opposite sides of any segment meet dorsally across the apical end; sides of segments 8-10 heavily mottled with black; superior appendages yellow; inferior black.

Female.—Colored as is the male, but the side of segment 2 with two horizontal black stripes and segment 10 largely yellow. (See fig. 148, B; 149.)

Five Chico males measure as follows:

Abdomen, 42-44 mm.; hind wing, 30. Two females from Los Angeles measure, abdomen, 43 mm., hind wing, 33-34.

The nymph of this species is more highly specialized for burrowing than any other odonate nymph with which I am familiar. It is the most frequently occurring form of large insect life found in the sand beds of the rivers of central and southern California.

All the rivers of California originate in the mountains as swift, clear streams, but nearly all before reaching the sea have almost level lower courses where they lose their swiftness, become warm and meander over beds of shifting white sands. These sand beds are so unstable that they actually flow with the water though at a much slower rate. Perhaps this needs further explanation. A good example is that of the Kern River at Bakersfield. Above the intake of the irrigating canal in the latter part of summer this river was on an average a foot deep and one hundred feet wide. Its bed was of pure, loose sand. This was formed by the current into sand ripples which faced with their steep slope down stream. The sand was in constant movement as the current carried sand from the upper gradual slope, up over the crest of each ripple to let it drop down the steeper downstream slope. Where there were eddies and turns these sand ripples became waves in size, being frequently six inches to a foot high though they were usually less than 6 inches in height. In such a stream the bottom inch of water is turbid with moving sand.

It is in such an unstable environment that *Progomphus* flourishes. Only once or twice have I actually found nymphs in the flowing streams but in any side channel where the water has ceased to flow the sand bed is marked in all directions by the curving burrows of these wandering nymphs. They burrow in the loose upper stratum of sand and just deep enough to cover the back. Usually the tenth segment protrudes. I have traced burrow tracks that were from ten to fifty feet long. If one arrived at the fresh end of the burrow before some water fowl had found it the nymph would be found spasmodically burrowing forward. These nymphs could burrow as rapidly as the average nymph can walk. Only such vigor and speed

could save an insect of this size from being buried in the moving sand.

The nymph of *Progomphus* has been described by Dr. J. G. Needham as follows: ¹

Head depressed, sloping anteriorly, cordate, broadly notched behind; hind angles rounded. Antennae inserted into cylindroid elevations on the front, depressed and incurved so as to almost surround the pilot-shaped labrum: two basal joints very short; third, twice as long as the two basal combined, slightly flattened and upcurved at the tip; fourth joint small, one-third to one-fifth [*obscurus*] as long as the third, slender and strongly recurved.

Labium rather small, reaching, when folded, to the bases of the middle legs; submentum shortened; mentum narrowed at its proximal end, its median lobe prominent, rounded, fringed with a row of flabellate scales whose bases are overlaid by another row of shorter semicylindrical scales; beneath this fringe, the margin cut into a series of obscure rectangular teeth; lateral lobes short, nearly straight, unarmed, rounded at apex; movable hook stout, moderately incurved, and tapering.

Thorax sloping to the head and to the bases of the legs; prothorax of unusual dimensions on the dorsal side, its hind margin on line with the bases of the hind legs, being extended back upon the other thoracic segments, shield shaped, with a short collar close behind the head. Wing-cases strongly divergent. Legs conspicuously fossorial, fore legs approximate to the sides of the head, bearing shields of stiff hairs behind which the middle legs may be brought forward. Middle legs approximated on the venter, rotated downward and extended horizontally close under the fore legs. Hind legs longer, more nearly normal, directed posteriorly. Fore tarsi with soles facing laterally; middle tarsi rotated on tibiae so as to point backward; hind tarsi elongate, the third segment about as long as both basal segments, its claws sharp and long; claws of fore and middle tarsi short and blunt. Each femur with a distal anterior process which rests against and supports the tibia when moved backward.

Abdomen spindle-shaped [*obscurus*], segments about equal, the ninth a little longer than the others; dorsal hooks variable, rudimentary, more or less well represented on segments 2 to 9 [*obscurus*]. Lateral spines on 5 to 9 [*obscurus*], on 5 rather minute. Appendages slender, tapering, superior and inferiors equal, about one third longer than segment 10, laterals about half as long as the others.

The preceding description was written for the eastern species, *Progomphus obscurus* (Rambur). I believe the Pacific coast form to be a distinct species, so it would have to be called *Progomphus borealis* McLachlan. It differs in the imago in being larger than *obscurus* and in having a single row of denticles on the inferior side of the male superior appendages (fig. 154). In *obscurus*, as pointed out by Calvert,² the posterior end of this row is double or treble.

I have quoted the description of *obscurus* from Needham and have figured the *borealis* nymph to show that the differences between the two species are more conspicuous in the nymph than in the adult. (See figs. 155-163.)

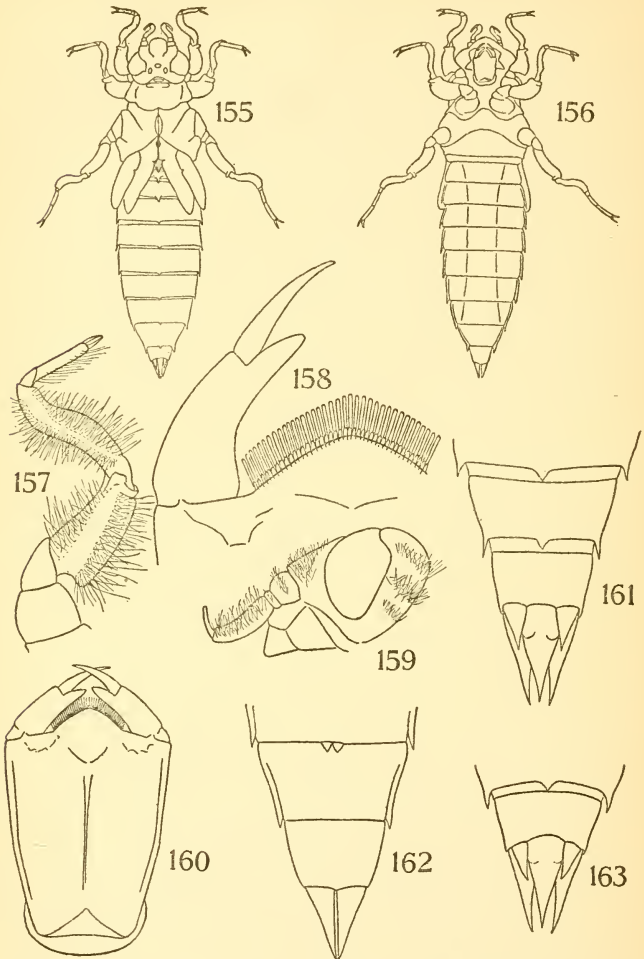
The specific characters of the *borealis* nymph may be given as follows:

Length shorter than that of *obscurus* nymph and width greater so that the *borealis* nymph has none of the appearance of extreme slenderness as

¹ Needham and Hart., Bull. Ill. State Lab. Nat. Hist., vol. 6, art. 1, 1901, pp. 55-56.

² Biol. Cent. Amer., Neur., p. 149.

in *obscurus*.¹ Fourth segment of antenna nearly one-half as long as third (in *obscurus* one-third to one-fifth.) Abdomen with lateral



FIGS. 155-163.—*PROGOMPHUS BOREALIS*, NYMPH. 157. FIRST LEG. 158. MENTUM, DETAIL. 159. HEAD. 160. MENTUM. 161. SEGMENTS 9 AND 10 OF MALE. 162-163. SEGMENTS 9 AND 10 OF FEMALE.

spines on segments 3-9 (in *obscurus* on 5-9); dorsal spines on segments 1-9, those on segments 1-3 large and recurved, the remainder

¹ Needham and Hart., Bull. Ill. State Lab. Nat. Hist., vol. 6, art. 1, 1901, p. 94, pl. 1, fig. 3.

minute (in *obscurus* on segments 2-9, and only that on segment 2 developed).

Length of abdomen, 18 to 20 mm.; width of abdomen, 7; length of hind femur, 4.

10. THE WESTERN SPECIES OF OPHIOGOMPHUS, INCLUDING A NEW SPECIES AND TWO NEW VARIETIES.

Ophiogomphus is a genus in which nearly all of the species live on streams or lakes which have gravelly beds or beaches. Because of this preference of *Ophiogomphus* in the matter of environment nearly all of the species are restricted to either the Appalachian region or to the mountainous portions of the western half of the United States. In Muttkowski's catalogue six species¹ are listed from this western region. In my collecting during the past two summers I have taken all these six species except *montanus*, and *phaleratus*, which Prof. J. G. Needham described from a single male captured on the Willamette River of Western Oregon.² The individuals of *Ophiogomphus*, while apparently emerging in considerable numbers, are scarce and seldom found except on gravel bars or gravelly rapids, which are places usually avoided by collectors. Occasionally the odonatist stumbles onto a place where a single species is very abundant. *Severus* was abundant on Satus Creek, in Yakima County, Washington. *Occidentis* was abundant in the two acres of sagebrush at the mouth of the Umatilla River in Oregon, and *morrisoni* was common on the north beach of Donner Lake, California. But during the more than three months of actual field work, the most of which was spent on streams, a half dozen specimens of *Ophiogomphus* after having walked 6 or 7 miles of stream was considered a good days catch.

The imagoes of the various species spend the greater part of their time seated on gravel bars from which they fly up at intervals to catch insects or to intercept individuals of their own kind. They are rarely found far from running water.

Copulation is a lengthy affair. The male usually captures the female as she flies along the water's edge on her business of oviposition, when he grasps her head with his feet and then, bending his abdomen forward, grasps her occiput with his claspers while freeing his feet. She in the meantime bends her abdomen forward and copulates. After a short nuptial flight the pair settles on some bush and remains in copulation many minutes. In ovipositing the female deposits the eggs in swift water, usually on rapids, where she flies back and forth dipping the tip of her abdomen in the stream. Though the eggs are laid on the shallow rapids, the nymphs during the latter part of their life live in the muddier bottom of the quieter water, for

¹ *Sequoiarum* was described by Miss Butler in Can. Ent., vol. 46, 1914, p. 346, but is a synonym of *bison*.

² Since arriving at Cornell University I have examined the type of *phaleratus* and find it to be a form of *occidentis*.

the exuviae are usually found along the edges of the deeper pools. Nymphs of *severus* from Satus Creek, Washington, indicate a three-year period for their life cycle. See pp. 544-549 for nymphs.

Mites rarely infest the species of this genus, and as imagoes they have few enemies except the birds which attack them while teneral. *Ophiogomphus morrisoni* on Donner Lake was seriously attacked by robins while emerging. As with many western species the most serious cause of premature death among imagoes seemed to be the occasional cold rains which come even in desert regions. On Satus Creek I have seen *severus* practically wiped out for the first day or two after a rain and regaining its numbers only after more had emerged. Very old imagoes show a condition which might be called the "staggers." They appear weak or drunk and on alighting will commonly fall over on their sides and regain their feet with difficulty.

The following notes cover the species of *Ophiogomphus* I have taken in California and Nevada. With them I have included *Ophiogomphus severus montanus* and a new species from Arizona, though neither has been recorded from this territory. Hagen's reference of *severus* in Nevada is probably *nevadensis*. It is probable that *severus* will be found in the northern part of this area and that the new species, *arizonicus*, will be found in the southern part.

The forms listed fall into the following four groups:

Females without occipital spines.

Group I. *a*¹. Size small (abd., male, 34-36 mm.); humeral suture with a narrow stripe preceded by an oval spot; posterior hamules broadly truncate.

*b*¹. Pale, markings brown.....*severus*.

*b*². Markings black.....*montanus*.

*a*². A double humeral stripe (the anterior stripe sometimes reduced to an oval spot in *nevadensis*); posterior hamules pointed.

*b*¹. Size small (abd., male, 35-36 mm.); superior appendages of male usually shorter than inferior; markings intense black; humeral stripe double, broad and black.....*morrisoni*.

*b*². Size larger (abd., male, 37-39 mm.); pale colors ashy; markings restricted; lateral stripe widely interrupted on segments 3 and 4; humeral stripe double, but each stripe narrow or the anterior reduced to an oval spot.....*nevadensis*.

Females with two occipital spines.

Group II. *a*¹. Occipital spines short and widely spaced; male with inferior appendage one-half length of superiors; humeral stripe reduced to a line and an anterior oval spot.....*arizonicus*.

Group III. *a*². Occipital spines slender and close together; male superior appendages long and cylindrical, the inferior three-fourths length of superiors; humeral stripe broad, heavy, and usually double.....*bison*.

Females with four occipital spines.

Group IV. *a*¹. A black, broad, double humeral stripe; entire pattern heavy; male inferior appendage with inferior profile almost semicircular.

occidentis.

*a*². Same as for *a*¹ but paler, the entire pattern brownish instead of black.....*californicus*.

OPHIOGOMPHUS SEVERUS Hagen.

Live colors, male.—Thorax green, abdomen yellow, markings dark brown.

Face yellow; eyes gray; vertex black; rear of head yellowish; occiput yellow. (See fig. 192.)

Thorax in teneral and young specimens clear pale green which turns yellowish olive in old specimens. It is marked as follows: Middorsal carina narrowly brown, which color extends along the antealar sinus to the humeral suture. This is narrowly brown and in some specimens the brown extends ventrad on the suture posterior to the mesinfraepisternum. A small oval spot on the upper end of the mesepisternum. (This spot distinguishes the species except from *arizonicus* and some individuals of *nevadensis*.) Legs creamy with an external black stripe on the femur of the first pair (in some specimens on the outer half only), and on the distal half of the femur of the second and third pairs; tibiae black with an external yellow stripe; tarsi black. Costa yellow; pterostigmas gray, even in old specimens.

Abdomen lemon yellow above the lateral markings, except on sides of segments 1 and 2, which are greenish; below the lateral markings the sides pure white. A sawtoothed brownish black lateral stripe on segments 2-9. In most males this stripe is broken into a series of detached triangular spots, one on the side of each segment. Segment 10 with obscure traces of this band. In old specimens the green of the thorax becomes yellowish olive, and the abdominal yellow deepens to a chrome especially on the sides of segments 7-10. In such old specimens the dark antehumeral spots fade and frequently disappear altogether.

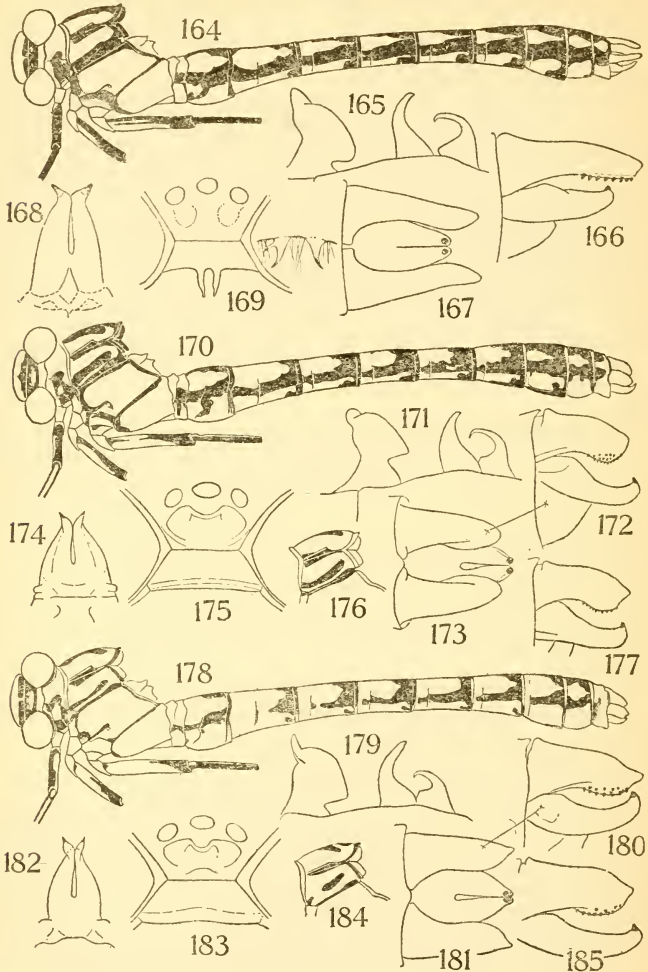
Female.—Colored similarly to the male but the dark on the legs more restricted and the triangular spots on the abdomen lengthened and widened on the proximal end of each segment so as to give the effect of a continuous sawtoothed lateral band.

The female is readily distinguished from the females of other species, except *arizonicus*, by the narrow humeral stripe and the small oval antehumeral spot. (Some females of *nevadensis* may be colored thus, though the specimens I have possess the double humeral stripe.) Both sexes are distinguished from *nevadensis* by the lack of black on the second lateral suture of the thorax. The males are distinguished by the spatulate tips of the posterior hamules. (See figs. 193-197.)

Abdomen, male, 34-36 mm.; female, 35-36; hind wing, male, 28-29 mm.; female, 31-32.

The only place I have found this species, with the exception of Umattilla, Oregon, where I collected two specimens, is on Satus Creek, Yakima County, Washington, where it is abundant from June 15 to August

15. The eggs are laid on the riffles. In ovipositing the females operate from stones in the rapids. A female will fly out from a seat on a



FIGS. 164-169.—*OPHIOGOMPHUS BISON*. 164. COLOR PATTERN. 165. HAMULES. 166-167. MALE, APPENDAGES. 168. VULVA. 169. OCCIPUT OF FEMALE.

FIGS. 170-177.—*OPHIOGOMPHUS MORRISONI*.

FIGS. 178-185.—*OPHIOGOMPHUS MORRISONI NEVADENSIS*.

stone, make one tap on the water with her abdomen, and then return to rest for a moment, when she repeats the single tap. The imagoes emerge during the middle of the day from the deeper pools.

OPHIOGOMPHUS SEVERUS MONTANUS (Selys).

Male.—Entire face yellow, except the posterior third of the horizontal surface of the frons. Vertex black. Occiput yellow. Rear of head yellow, edged with black along dorsal border. (See fig. 186.)

Prothorax black with an oval yellow spot on each side of posterior lobe.

Mesothorax and metathorax yellowish (green in life?), with the following black markings: A broad middorsal stripe, twice as wide below as above. Alar ridges black, the sinus pale. A narrow sharply edged humeral stripe widening to an oval in its upper half, anterior to which is an oval spot which in some specimens is two-thirds the length of the humeral suture. Mesinfraepisternum with a black line across its upper half. A black stripe curving caudad from the lower end of the humeral stripe around the ventral end of the mesepimeron and rising dorsad to terminate just anterior to the metathoracic spiracle. Second lateral suture narrowly black, this continued ventrad around the upper side of the metinfraepisternum. Coxae and femora pale (cream in life?); the dorsal surface of the fore femora black; the apical half of the dorsal surface of the hind femora black; the black on the middle femora intermediate in extent. Tibiae black with an external pale stripe. Tarsi black. Pterostigmas brown.

Abdomen colored as follows:

Segment 1 yellow with a pair of dorsal black spots.

Segments 2—10 with the dorsum black, each containing a mid-dorsal roughly triangular yellow spot extending from the base to the apical fourth; this spot on each segment and slightly constricted at the vertical carinae with its broad end cephalad. Appendages yellow. Probably in life the side of segment 2 is yellow, of 3-6 white and 7-10 rich yellow. (See figs. 186-189.)

Female.—Coloration identical with that of the male. (See figs. 190-191.)

Measurements.—Male, abdomen, 35-37 mm.; hind wing, 30-31; female, abdomen, 34-38 mm.; hind wing, 32.

In the Cornell collection are four males and four females of an *Ophiogomphus* which has appendages similar to those of *severus* but has a very dark coloration. The preceding description is based on these, which bear the label "Y P.,¹ Aug." They also bear the label *montanus*, having been identified by Prof. J. G. Needham. The superior appendages of the male, while resembling those of *severus* closely, are slightly more bulbous at the apex, the inferior is slightly longer than in *severus* and the apex of the posterior hamule hardly as truncate. Nevertheless, all these differences are so slight as to be negligible.

¹ Yellowstone Park.

The coloration, however, is remarkable in the extent of the black markings, which give the species the appearance of *morrisoni*, except that the antehumeral black stripe is reduced to an oval spot. This form is of interest because the Columbia River form is pale (the true *severus* form) and the State of Colorado form is also pale (probably the true *severus*), while this form (*montanus*) is intermediate geographically, but very dark. This darker form may be due to the great altitude of Yellowstone Park.

It is possible that a more extensive survey of the Northwest will show that *severus*, *montanus*, *morrisoni* and *nevadensis* are forms of the same species. Some males of both *morrisoni* and *nevadensis* have appendages very similar to those of *severus* and *montanus* (see figs. 177, 180, 188, 194). The resemblance occurs also in the nymphs, as these have three pairs of lateral abdominal hooks in *severus*, *morrisoni*, and *nevadensis*. The nymphs of *montanus* are unknown.

OPHIOGOMPHUS MORRISONI Selys.

Live colors, male.—Olive green thorax and chrome-yellow abdomen; markings intense black. (See fig. 170.)

Face greenish-yellow with a narrow black line above the labrum and usually another above the nasus. Dorsal surface of frons black on its posterior half; vertex black except an oval spot posterior to the postocellar ridge; occiput yellow. Eyes gray, darker above.

Thorax olive green with the following intense black markings: Middorsal stripe 2 mm. wide at the bottom and narrower above; antearlar ridge and sinus covered by a line 1 mm. broad, which connects with a double humeral stripe 2 mm. broad. This humeral stripe has a narrow green stripe running the entire length of its central line; this green stripe 0.5 mm. wide below. A stripe 1 mm. broad borders the mesinfraepisternum above and posteriorly, and connects with a similar stripe on the dorsal half of the metinfraepisternum. Lower third of first lateral suture black. A stripe 0.5 mm. wide runs from the antearlar sinus below the fore wing to the second lateral suture; a stripe on the second lateral suture 0.5 mm. broad. Legs pale greenish gray; the femora with a heavy external (dorsal) stripe the full length, which is less heavy or interrupted on the hind femur; tibiae black with an external pale stripe; tarsi black. Costa yellow; pterostigmas brown.

Abdomen intense chrome yellow above, greenish yellow on sides of segment 1, yellow on sides of segments 2, and 7-10, and white on the sides of segments 3-6. Markings intense black as follows: A band 1.5 mm. wide on the upper side of segment 1 running caudad and meeting its fellow on the middorsal apex of segment 2; a spot on the anterior end of segment 1 and a spot posterior to the auricle; a lateral stripe extending from segments 3-10 which is broken into a

series of triangular spots, one each on segments 3, 4, and 5 and which widens caudad to 1.5 mm. on segment 8. On each segment a broad band across the apical end, occupying the apical fourth on segments 3, 4, and 5, apical third on 6 and 7, and apical half on 8 and 9. In some specimens the lateral bands are most widely connected dorsally on segment 6, being less widely connected on segments 7-9. No connecting apical band on segment 10. Appendages yellow. Apical ventral angles of segments 3-8 with a black spot. (See also figs. 171-173.)

Female.—Colored similarly to the male but some of the females have black on the mesinfraepisternum greatly reduced or in one specimen even lacking. Usually the spots in the apical ventral angles of segments 3-8 are detached. (Vulva, fig. 174, occiput, fig. 175.)

In some specimens of both sexes the two parts of the humeral stripe are separated for their entire length. Such, while resembling *nevadensis*, never have the black stripes as narrow (see figs. 176 and 184). This species differs from the other western species in its intense varnished appearance due to the scanty pile.

Abdomen, male, 35-36 mm.; female, 36-37.5; hind wing, male, 28-30 mm.; female, 32-33.

This is the only species of *Ophiogomphus* I have found in the Transition and Canadian Zones. It occurred in Oregon on the Big Meadows of the Deschutes, 18 miles south of Bend, which lie at an elevation of about 4,000 feet. Here it was associated with northern species such as occur at sea level in northern Washington or southern Canada. On Lake Tahoe, which has an elevation of 6,000 feet, on August 1, I collected a single male of this species at the mouth of Emerald Bay. In a week's collecting along the shores of the lake this was the only specimen of *Ophiogomphus* I saw. Collecting on Tahoe may have been better at one time, for the Reclamation Service has recently raised the lake level several feet by a dam across its outlet, which has very evidently disturbed the littoral fauna.

The place where *morrisoni* occurred in its greatest abundance was on Donner Lake, which has an elevation of 5,000 feet, or 1,000 feet lower than Lake Tahoe. Here it was associated with almost the same series of northern forms as were found with it on the Big Meadows in Oregon. Three distinct kinds of beaches occur around this lake. At its western end is pure sand where *Gomphus donneri* occurs. Along the northwest shore is a series of gravel beaches which are gradually displaced, as one passes toward the east end of the lake, by cobble beaches. At the eastern end near the outlet, gravel occurs again. *Ophiogomphus morrisoni* is found on these gravel beaches.

The males rest on the cobblestones scattered over the gravel or pursue each other in zigzag flights along the lake shore. The females are not as numerous and are usually found seated on stones very close to the edge of the water. Here the males find them and take

them back among the bushes in copulation. In ovipositing the female poises just over the water and as the wave passes beneath her drops the tip of the abdomen into the water, raising it again as soon as the wave has passed. Emergence occurred between 10 in the morning and 4 in the afternoon. Usually the nymph crawled just above the wash of the waves. Robins caught many of the teneral among the rocks.

OPHIOGOMPHUS MORRISONI NEVADENSIS, new variety.

Type.—Cat. No. 21143, U.S.N.M. A male, Pyramid Lake, Nevada, August 4, 1914.

Allotype.—Cat. No. 21143, U.S.N.M. A female, Humboldt River, Carlin, Nevada, August 7, 1914.

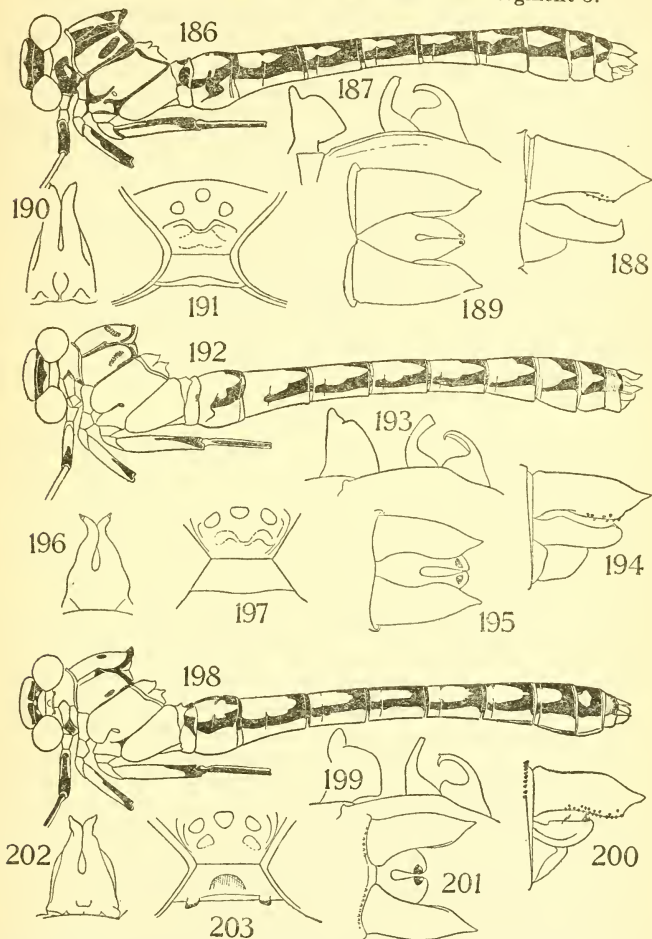
Live colors, male.—Thorax greenish gray, abdomen pale yellow and white, markings dark brown.

Face pale greenish gray with an obscure dark line above labrum; posterior edge of the horizontal surface of the frons black; vertex black except oval postocellar pale spot; occiput yellow; eyes gray, darker above (See fig. 178.)

Thorax grayish olive green with the following dark markings: Middorsal stripe 1.5 mm. wide at lower end, narrower above. Antalar ridge brown. Humeral stripe usually double, each member being 0.5 mm. wide at the upper or wider end. The stripes are widely separated for their entire length. In two of the six males the anterior humeral stripe is represented above by an oval spot only, and a small dot below. (This form has been confused by Hagen with *severus*, from which it differs in the pointed posterior hamules.) A black line crosses the dorsal end of the mesinfraepisternum and connects along the posterior edge of the same plate with a black line on the lower third of the first lateral suture. Second lateral suture narrowly black. Metinfraepisternum entirely yellow. Lateral alar ridge narrowly brown. Femora creamy with dorsal surface of front femora black, the distal half of the dorsal surface of the middle pair black and the distal third of the hind pair black; tibiae black with an external pale stripe; tarsi black. Wings lightly flavescent (not brownish as in *morrisoni*). Costa pale yellow; veins brown; pterostigmas grayish brown.

Abdomen creamy yellow above, tinged with green on sides of segments 1 and 2, white on lower sides of segments 3-6, and chrome yellow on sides and dorsum of segments 7-10. Sides with a saw-toothed stripe, lacking on the anterior half of segment 3 and broken on the anterior ends of segments 4-7. The dorsal angles of the "sawteeth" of the lateral stripes meet broadly on the middorsal line of the posterior end of segments 3-6. Segment 10 wholly yellow, except a small spot on either side and a smaller one between bases of dorsal appendages. Appendages yellow. Apical ventral angle of segments 3-7 with a small black spot. (Hamulos, fig. 179.)

Female.—Colored similarly to male except that the markings are heavier and approach the markings of *morrisoni*. The lateral abdominal stripe is present on the anterior end of segment 3.



FIGS. 186-191.—*OPHIOGOMPHUS SEVERUS MONTANUS*. 186. COLOR PATTERN. 187. HAMULES. 188-189. MALE, APPENDAGES. 190. VULVA. 191. FEMALE, OCCIPUT.
 FIGS. 192-197.—*OPHIOGOMPHUS SEVERUS*.
 FIGS. 198-203.—*OPHIOGOMPHUS ARIZONICUS*.

Abdomen, male, 37-39 mm.; female, 40-41; hind wing, male, 30-37 mm.; female, 35-38.

I have five males and one female of this species from the lower end of Truckee River where it flows through the desert just before entering Pyramid Lake. One male and three females were taken on the Humboldt River at Carlin, Nevada. All the specimens were taken on gravel bars near rapids. The habits were similar to those of *bison* and *severus*. These desert specimens agree in their large size and ashy coloration, but structurally no character seems to separate them from *morrisoni*. The usual types of appendages found in *morrisoni* are shown in figures 172-173, but an occasional *morrisoni* regular in color and size has appendages as shown in figure 177, where the superiors are more pointed and the inferior is shorter than the superiors. The usual forms of appendages of *nevadensis* are shown in figures 180-181, but one *nevadensis* male, regular in size and coloration, has appendages as in figure 185, with the inferiors distinctly longer than the superiors. Neither are the forms of hamules and seminal vesicle constant. This variety then differs from *morrisoni* in the larger size and paler coloration, and from *severus* in having pointed posterior hamules.¹ (Fig. 182, vulva; 183, female occiput.)

OPHIOGOMPHUS ARIZONICUS, new species.

Type.—Cat. No. 21142, U.S.N.M. A male, Huachuca Mountains, Arizona, F. H. Snow.

Allotype.—Cat. No. 21142, U.S.N.M. A female, Huachuca Mountains, Arizona, F. H. Snow.

Color in dried specimens, Male.—Thorax and abdominal segments 1 and 2 olive, abdomen yellow, markings black. (See fig. 198.)

Face greenish yellow; eyes brown (probably gray in life); a black line, interrupted medially, on the posterior edge of the horizontal surface of the frons; vertex black, inclosing an oval pale area posterior to the ocelli; occiput pale; rear of head yellow, with a large T-shaped black marking. Prothorax largely black. Mesothorax and metathorax olive green (probably bright green in young live specimens), with dark brown markings as follows: A spot on upper end of middorsal keel, antealear ridges and upper third of humeral suture narrowly brown (in one male entire humeral suture brown). A small oval spot, or in one male a comma-shaped spot, on the upper end of the mesepisternum. Lower edge of mesepimeron black, pruinose. A small fleck anterior and one posterior to the lateral spiracle. Legs creamy; distal fourth of femur black, which extends mesad along the dorsal surface of the femur to the trochanter, this stripe broadest on the fore legs; tibiae black with an external pale stripe; tarsi black.

¹ I thought at first that this was a distinct species, as I found a single exuvia on the Truckee River undoubtedly of this species and differing markedly from those of *morrisoni*. However, I found *nevadensis* common on Owens River in eastern California during August, 1915, and seined up several nymphs which are almost identical with those of *morrisoni*. See p. 549, footnote.

Abdomen with segments 1 and 2 olivaceous; segments 3-10 yellow on dorsal surface, and segments 7-10 yellow on the sides also. Probably the sides of segments 3-6 are white in life. The markings on the abdomen are as follows: Segment 1 with a large brown spot above on either side; segments 2-10 with the usual ophiogomphine saw-toothed band on either side, but the teeth of the two bands are broadly connected across the posterior end of segments 3-7 and connected, but more narrowly, across the ends of segments 2 and 7-9. In two of the males there is a small pale brown spot on the upper side of segment 10; in the third the lateral band is continuous to the bases of the dorsal appendages, but on segment 10 is a paler brown. Appendages yellow.

Female.—Color similar to that of the male but the posterior half of vertex pale; tips of occipital horns black. Abdominal black pattern similar to that of the male, but the teeth of the lateral bands broadly connected across the apical end of segments 8 and 9 as well as on segments 3-7. Appendages yellow.

Abdomen, male, 40 mm.; female, 42; hind wing, male, 34 mm.; female, 37.

This species was called to my attention by Mr. E. B. Williamson, who had obtained two males and two females in trade from the Snow collection at the Kansas State University of Lawrence, Kansas. Later I obtained through Mr. Hunter three males and a female from the same collection. All of these specimens were wrongly labeled *Ophiogomphus severus*. The three males in my collection are labelled "S. Arizona, F. H. Snow, Aug., 1902." The female is labelled "Oak Creek Canon, Ariz., 6,000 ft., Aug., F. H. Snow." I have associated the female with the two males because it was so associated in the Snow collection, and because of identity of size and color pattern and the occiput, which seems adapted to the male's inferior appendage.

Structurally this species is distinguished as follows: Size large, male superior appendages 2 mm. in length, subcylindrical, slightly curved ventrad and mesad so that they are convex on the external profile and concave on the inner; the apical end suddenly contracted to a well developed point. The inferior profile from the base of the appendages to the base of the terminal point is an almost straight line, though slightly sinuous in one specimen. The distal two-thirds of the lower surface bears between thirty and forty short conical, black spines. Except in the greater number of spines the superior appendages do not differ from those of *severus*. The inferior appendage is one of the distinguishing characters of the species. It is peculiar in being only half the length of the superiors. Viewed from above it is bifurcate to the basal third, the two branches meeting apically around an oval opening. Viewed laterally the ventral profile is a semicircle, while the dorsal profile is a nearly straight line slightly

indented near the base of the appendage. Each branch terminates in a short, heavy, black spine directed dorsad. (See figs. 200, 201.)

Anterior hamules spatulate, spoon shaped with a long ventral hook (see fig. 199). One male shows a small spine on the tip of this hook. This apical spine is an individual character, some individuals of other species showing it. Posterior hamules terminating in a straight thin limb with subparallel sides and a square tip. The hamules are similar to those of *bison* and *severus*, from either of which the male can be distinguished by the terminal appendages.

The female is distinguished by having two very short, heavy, widely spaced spines on posterior edge of occiput (fig. 203) and a deep semi-circular depression on its superior surface. Probably this depression, which is peculiar to the female of this species, is to adjust the occiput to the extremely short inferior appendage of the male. (Vulva, fig. 202.)

OPHIOMOPHUS BISON Selys.

Live colors, male.—Thorax rich green; abdomen yellow with black markings. (See fig. 164.)

Face pale greenish yellow; eyes gray; vertex entirely black, this color extending onto the posterior edge of the frons; occiput yellow.

Thorax a rich bright green with the following dark brown markings: A middorsal stripe 1 mm. wide connecting along the antealar ridge with a broad (1.5 mm.) usually solid humeral stripe. (In some specimens the humeral stripe has a very narrow internal green line.) The latero-alar ridge brown caudad to the second lateral suture, which is narrowly brown. The mesinfraepisternum and metinfraepisternum as well as the prothorax heavily mottled with black and usually pruinose. Femora with a heavy external (dorsal) black stripe; tibiae and feet black. Costa edged with yellow. Wings heavily veined and with a slight flavescence. Pterostigmas black.

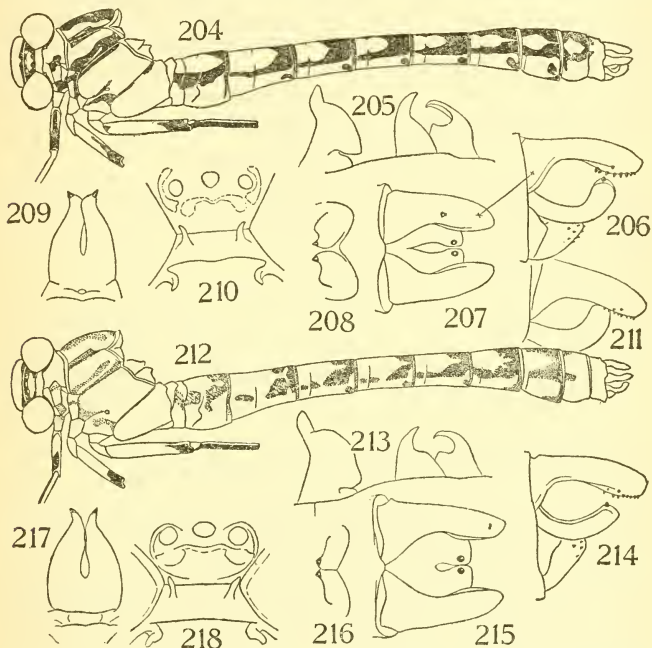
Abdomen bright yellow above the black lateral markings and white below. The black markings are as follows: A broad stripe extending along the upper side of segments 1 and 2, and converging to the dorsal apex of segment 2; a narrower lateral stripe (1 mm. wide) extending along sides of segments 2-10 (pale brown on 9 and 10). This stripe has a rectangular enlargement at the apical end of each segment. These enlargements do not coalesce with their fellows of the opposite side on the middorsal line except at the extreme apex of each segment, and on segments 9 and 10 they are widely open on the middorsal line at the apex. Segments 3-8 with a spot in the postero-ventral angle. (For structural details, see figs. 165-167.)

Female.—Colored like the male but the postocellar region of the vertex yellow. Femora usually with only the outer half in the first pair and the outer fourth in the others black; tibiae with an external pale stripe. Segment 9 of the abdomen less heavily marked than in the male, and segment 10 yellow. (Structural details, figs. 168-169.)

The thorax in this species is covered with pile which softens the intense colors.

Abdomen, male, 36–37 mm.; female, 35–38; hind wing, male, 29–30 mm.; female, 31–31.5.

This species occurs on the smaller perennial streams emptying into San Francisco Bay and Monterey Bay, also on the smaller tributaries



FIGS. 204-211.—*OPHIOGOMPHUS OCCIDENTIS*. 204. COLOR PATTERN. 205. HAMULES. 206-208. MALE, APPENDAGES. 209. VULVA. 210. FEMALE, OCCIPUT. 211. APPENDAGES OF A MALE FROM CORVALLIS, OREGON.

FIGS. 212-218.—*OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS*.

of the Sacramento River. On the Sacramento itself and its larger tributaries it appears to be displaced by *Ophiogomphus occidentis*. I have not found it on streams which carry much snow water. It is found on the same streams that are occupied by *Octogomphus*, but the latter stays on the torrential headwaters while *bison* occupies the lowland sluggish portion of the stream, where it is associated with *Gomphus sobrinus* and *Progomphus borealis*.

Its habits are very similar to those of *severus* and *nevadensis*. It is usually found on gravel bars bordering a riffle and seldom more than five or six are found at one place. The females oviposit where the water is the swiftest.

My own records and those in the Stanford collection and in Mr. Grinnell's collection are all for May and June. The records are for Chico, Butte County; Napa River, Napa County; Oroville in an irrigation ditch; Walnut Creek, Contra Costa County; Los Gatos and Stevens Creek, Santa Clara County; San Lorenzo River, Santa Cruz County. This last is Selys's type locality.

Miss Butler has described this species as *sequoiarum*.¹ Her types are three specimens collected by Dr. J. C. Bradley at Three Rivers, Tulare County, California, July 16, 1907. This place has an elevation of 500 feet. Prof. J. G. Needham² records nymphs from Lake Tahoe, elevation 6,000 feet; I doubt that they are correctly labeled. I did not see this species on Lake Tahoe myself.

OPHIOGOMPHUS OCCIDENTIS Hagen.

Live colors, male.—Thorax green, abdomen yellow, markings dark brown. (See fig. 204.)

Face greenish yellow; vertex black with the postocellar ridge yellow; occiput yellow; eyes gray.

Thorax green on the sides, whitish below, with a middorsal brown stripe which is 1.5 mm. wide below and narrower above, or even terminating in a point at the antealar sinus. Only the extreme edge of the antealar ridge brown. A broad humeral stripe three-fourths the width of which lies anterior to the suture; this stripe, 1.5 mm. wide above and below, is slightly narrower in its middle third and usually includes a fine line of pale green running lengthwise through its two middle fourths. In most specimens a narrow (0.25 mm.) pale brown line between the front wing and the mesepimeron, also one on the second lateral suture which extends down around the metinfraepisternum. Legs grayish white with an external (dorsal) black stripe the entire length of the femur of the first pair and only on the distal half of the second and third femora; tibiae black with an external white stripe; tarsi black. Costa yellow; pterostigmas dark gray to brown.

Abdomen rich yellow dorsally and on sides of segments 7-10, but white on the sides of segments 1-6 below the black markings. These markings are as follows: A band 1.5 mm. wide on the upper half of side of segment 1 running caudad and meeting its mate of the other side at the dorsal apex of segment 2. A small spot posterior to auricle. A lateral black stripe about 1 mm. wide extending from segments 3-9; on the apical third of each segment it widens dorsad, extending to the middorsal line at the apex of the segment. A black spot on the ventro-apical angle of the side of each of segments 3-8. Segment 10 and appendages largely yellow.

Female colored much like the male, but the lateral stripe on the abdomen narrower and more broken, and the apical dorsal extensions narrower. (Structural details: Male, figs. 205-208; female, 209-210.)

¹ Can. Ent., vol. 46, 1914, p. 346.

² Proc. U. S. Nat. Mus., vol. 27, 1904, p. 690.

This species resembles *bison* in appearance but is less intensely colored and does not have the black pruinose infraepisterna, which distinguishes *bison* from the other western species.

Abdomen, male, 35–38 mm.; female, 35–36; hind wing, male, 30–31 mm.; female, 33.

I found this species emerging in abundance from the Columbia River at Umatilla, Oregon, on July 10, 1913. I have one specimen from the Columbia at Sherman, Oregon, and two from Satus Creek, Yakima County, Washington. The specimens collected in the Sacramento basin show a lighter coloration than those from the Columbia Valley, and I have described them separately. One specimen of this dark form from Seattle, Washington, is in Calvert's collection in the museum of the Academy of Natural Sciences of Philadelphia.

The type of *phaleratus* Needham which I have examined appears to be this true *occidentis*. *Phaleratus* was taken on the Willamette River (a tributary of the Columbia) at Corvallis, Oregon. Figure 211 is of the appendages of a male from Corvallis.

OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS, new variety.

Type.—Cat. No. 21144, U.S.N.M. A male, American River, Sacramento, California, July 15, 1914.

Allotype.—Cat. No. 21144, U.S.N. M. A female, American River, Auburn, California, July, 19, 1914.

Colors, male.—Yellow with brown markings. (See fig. 212.)

Face pale yellow, the frons narrowly edged behind with black; vertex black but with a large postocellar area yellow; occiput yellow; eyes gray, darker above.

Thorax yellow with a greenish cast. Markings as in *occidentis*, but pale brown and much reduced in extent. A narrow brown mid-dorsal stripe but antealar ridges yellow. Humeral stripe double, but both lines narrow and separated by a distance equal to one of them. Second lateral suture with a mere suggestion of brown. Faint markings along the lower side of the thorax. Legs creamy white; femora tipped with black; tibiae black with an external pale stripe; tarsi black. Costa yellow, pterostigmas dark brown; venation brownish but the wings otherwise hyaline.

Abdomen yellow with brown markings except below the markings on segments 3–6, which area is white. The sawtoothed lateral stripe is reduced to a series of spots and is not broadly connected with its fellow across the posterior ends of the segments 3–6, as in *occidentis*. Segment 10 wholly yellow and only a trace of brown on segment 9.

Female.—Color as in male but segments 1 and 2 almost wholly yellow, and on segments 3–8 the lateral stripe more nearly continuous than in the male. Segment 9 yellow except a black speck on apical end of the middorsal line. Segment 10 and appendages yellow.

Abdomen, male, 35.5 mm.; female, 37.5-38; hind wing, male, 28 mm.; female, 30.5-32. (Structural details, figs. 213-218.)

I have a male taken on the Sacramento River at Colusa, a male from the American River at Sacramento City, and three females from the American River at Auburn. In structure these are undoubtedly *occidentis*, but in color they are very much lighter than the *occidentis* of Umatilla and Satus Creeks in the Columbia Valley.

The Colusa male was taken June 11, while the other male was caught July 15, 1914, in the willow thicket across the American River from the city of Sacramento and was the only *Ophiogomphus* seen at this point. The three females were caught July 19, 1914, among the rocks below the dam in the American River Canyon at Auburn, California, where only one other specimen was seen.

11. THE NYMPHS OF OPHIOGOMPHUS.

The following generic characterization of the *Ophiogomphus* nymph is given by Needham in *The Dragon Flies of Illinois*:¹

Nymph stout, little flattened. Head abruptly sloping forward from the ocelli. Labrum pilot-shaped. Antennae with the two basal segments globular, third segment twice as long as both basal, much flattened and laid close beside the labrum. Fourth joint a minute rudiment. Median lobe of mentum rounded, with border of short blunt teeth and a double series of fringing scales. Lateral lobes nearly straight, not terminating in an end hook and minutely denticulated within; movable hook short, arcuate.

Legs rather short. Fore and middle tibiae with external hooks, wing-cases divaricate, strongly sloping downward toward the sides. Dorsal hooks on abdominal segments on 2 or 3-9. Tenth segment not inclosed by the 9th but triquetral, exceeding the lateral spines, its own lateral margin forming a part of the margin of the abdomen.²

The nymphs of the western species of this genus are separated from one another with considerable difficulty. Figures 224, 227, 230, 233 and 236 show labia of the five species, which, as with any other single character of the nymphs, vary too little to be of any use in separating the species. The dorsal spines are also practically the same in all species. The characters used in the following notes are the only ones I have found to be of value.

KEY TO NYMPHS.

a¹. Segments 6-9 with lateral spines.

b¹. Superior appendages three-fourths length of median appendage; dorsal hooks strong.....*bison*.

b². Superior appendages two-thirds length of median appendage; dorsal hooks heavy but low, only those on segments 2-4 erect.....*occidentis* and *o. californicus*.

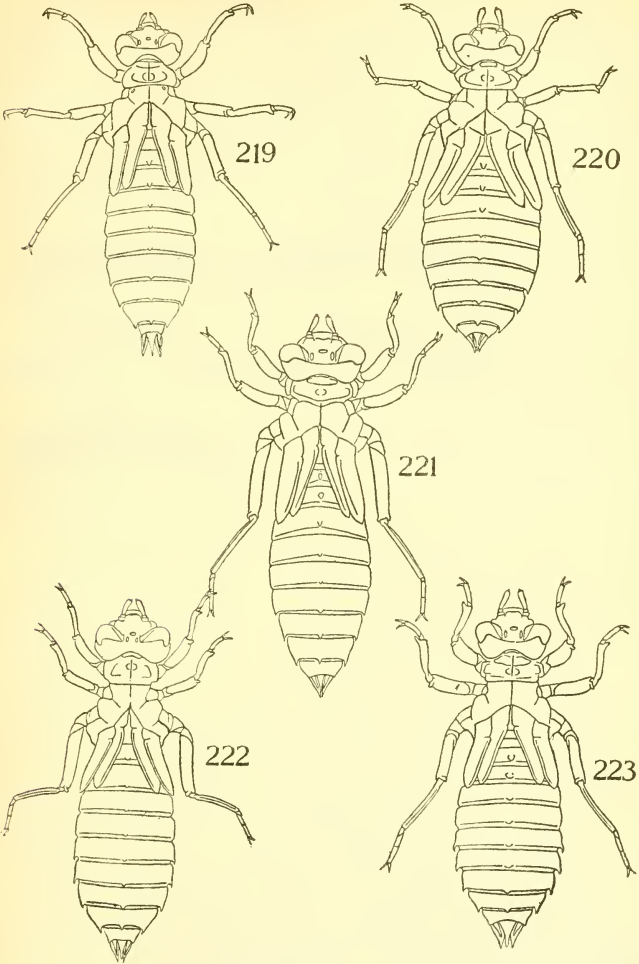
a². Segments 7-9 with lateral spines.

c¹. Dorsal spines weak and low, only the first two or three erect.....*severus*.

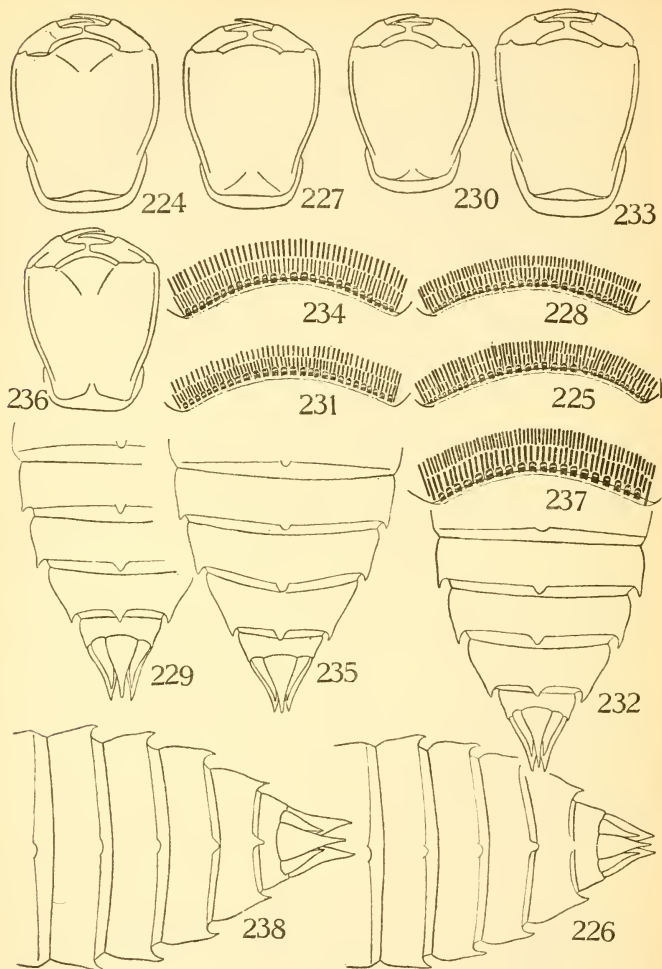
c². Dorsal spines slender, erect, well developed.....*morrisoni* and *m. nevadensis*.

¹ Bull. Ill. State Lab. Nat. Hist., vol. 6, art. 1, 1901, p. 57.

² The nymphs of *Erpetogomphus* are distinguished by dorsal spines on segments 2-4 only. I have examined nymphs of *compositus*, *designatus*, and an undescribed species.



FIGS. 219-223.—OPHIOGOMPHUS NYMPHS. 219. *O. MORRISONI*. 220. *O. SEVERUS*. 221. *O. MORRISONI NEVADENSIS*. 222. *O. BISON*. 223. *O. OCCIDENTIS*.



FIGS. 224-226.—*OPHIOGOMPHUS BISON*, NYMPH. 224. MENTUM. 225. TEETH AND SETAE ON MIDDLE LOBE OF MENTUM. 226. SEGMENTS 6-10.

FIGS. 227-229.—*OPHIOGOMPHUS MORRISONI*.

FIGS. 230-232.—*OPHIOGOMPHUS SEVERUS*.

FIGS. 233-235.—*OPHIOGOMPHUS MORRISONI NEVADENSIS*.

FIGS. 236-238.—*OPHIOGOMPHUS OCCIDENTIS*.

OPHIOGOMPHUS BISON Selys, nymph.

A dark, heavily mottled nymph, very hairy, in which character it resembles *morrisoni*; 27-33 labial teeth, those at either end of the row being only half as long as the median teeth. Abdomen with the dorsal hooks on segments 2-9 longer than in the other species¹ and heavier; lateral hooks on segments 6-9. The paired superior appendages three-fourths the length of the median appendage. (See figs. 222, 224-226, and 239.)

Length, 28-29 mm.; abdomen, 17.5; hind femur, 4.5; width of abdomen, 8.5-9.

The above description is from exuviae collected on the San Lorenzo River near Santa Cruz, which is the type locality for the imago of the species. I have not taken this emerging, but no other species was collected on this stream and these exuviae agree with exuviae I have collected at Chico, where *bison* was on the wing. Needham's description of nymphs and exuviae collected by Schwarz on Lake Tahoe fits my exuviae of *bison*, but I found *morrisoni* on Lake Tahoe and only *morrisoni* in the Tahoe region. I believe the locality given is a mistake. *Morrisoni* is a species of the cool upper limit of gomphine life occurring at from 4,000 to 10,000 feet elevation, while all my records for *bison* are from the low hot valleys of central California.

OPHIOGOMPHUS OCCIDENTIS Hagen, nymph.

A medium colored nymph; a lengthwise row of small light spots along either side of the dorsum of the abdomen. Only moderately hirsute, more hairy than the *nevadensis* exuvia from Winnemucca Slough, but less so than *severus*; 21-25 labial teeth which are equal in length throughout the row. Abdomen with dorsal hooks on segments 2-9, these noticeably variable in height and strength, but usually with the first hook slender, erect, the remainder short and heavy. Lateral hooks on segments 6-9. The paired superior appendages two-thirds the length of the median appendage. (See figs. 223, 236-238, and 240.)

Length, 28 mm.; abdomen, 18; hind femur, 4.5; width of abdomen, 8-8.5.

The above description is from exuviae collected on the Columbia River at Umatilla, Oregon. I am sure of the identity of this, though I took none actually emerging.

OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS Kennedy, nymph.

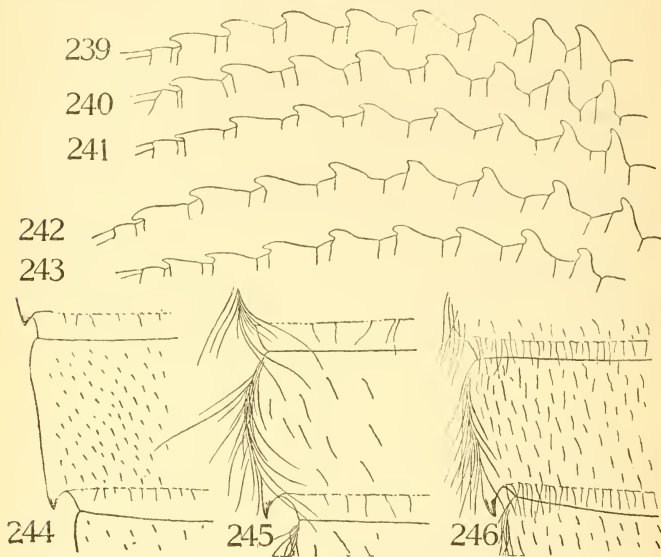
I have eight *occidentis* exuviae from the American River at Sacramento, California. These are probably of the yellow variety, *californicus*, but I can see no characters separating them from the *occidentis* nymphs of the Columbia River. In these the lateral ab-

¹ Not longer than in *morrisoni* and *montanus*, but in these they are slender.

dominal spines are very variable in length, some being short and blunt, others unusually long. Such variations occur even on the individual. In one the spines on segment 6 are blunt, on segments 7-9 long and pointed.

OPHIOGOMPHUS SEVERUS Hagen, nymph.

A medium colored nymph, only moderately hairy; 26-29 labial teeth. Abdomen with dorsal hooks on segments 2-9, low and weak.



FIGS. 239-243.—*OPHIOGOMPHUS*, DORSAL SPINES OF NYMPHS. 239. *O. BISON*. 240. *O. OCCIDENTIS*. 241. *O. MORRISONI*. 242. *O. MORRISONI NEVADENSIS*. 243. *O. SEVERUS*.

FIGS. 244-246.—*OPHIOGOMPHUS*, LATERAL FRINGE ON SEGMENT 7 OF NYMPH. 244. *O. MORRISONI NEVADENSIS*. 245. *O. SEVERUS*. 246. *O. MORRISONI*.

Lateral hooks on segments 7-9. The paired superior appendages four-fifths as long as the median appendage. (See figs. 220, 230-232, 243 and 245.)

Length, 28 mm.; abdomen, 19; hind femur, 4.75; width of abdomen, 8.

Described from exuviae collected on Satus Creek, Yakima County, Washington. I have specimens of this taken emerging.

OPHIOGOMPHUS MORRISONI Selys, nymph.

A medium to dark nymph, very hairy; each abdominal segment on its dorsal aspect fringed posteriorly with numerous long hairs; 25-29 labial teeth. Abdomen with dorsal hooks on segments 2-9, these longer and more erect and more slender than in other species,

except *nevadensis*, which they resemble, but not differing enough to make a positive specific character. Lateral hooks on segments 7-9. The paired superior appendages four-fifths as long as the median appendage. (See figs. 219, 227-229, 241 and 246.)

Length, 28 mm.; abdomen, 18; hind femur, 5; width of abdomen, 8.

Described from numerous emerging nymphs and exuviae collected on Donner Lake, July 23, 1914.

OPHIOGOMPHUS MORRISONI NEVADENSIS Kennedy, nymph.

A large light colored nymph, naked except for a few short hairs on the tibiae and about the head; 26 labial teeth. Abdomen with dorsal hooks on segments 2-9, longer, more slender, and more erect than in other species except *morrisoni*. Lateral hooks on segments 7-9. The paired superior appendages four-fifths as long as the median appendage. (See figs. 221, 233-235, 242 and 244.)

Length, 31 mm.; abdomen, 20; hind femur, 5.5; width of abdomen, 8.5.

Described from a single male exuvia collected on Winnemucca Slough at Pyramid Lake, August, 1914. The only other gomphine found at this place, which is a branch outlet of the Truckee River, was *Erpetogomphus compositus*. This is not the nymph of that.¹

OPHIOGOMPHUS, species.

In the Cornell collection are five dried nymphs from "N. Mex." These are very close to *severus*, but differ in having the dorsal spines noticeably weaker, and only the spine on segment 2 erect, those on segments 3-9 pointing caudad.

Severus is recorded by Selys² from the Merino Valley (elevation, 9,600 feet), New Mexico. I have seen no specimens of imagoes from New Mexico. Selys records the Merino Valley as on the Colorado. If so, this may be the nymph of *arizonicus*.

12. THE WESTERN SPECIES OF GOMPHUS, INCLUDING A NEW SPECIES AND A NEW VARIETY.

I feel fairly certain that future collecting and study of intermountain and Pacific coast species of the genus *Gomphus* will show that there are only three good species.³ These are *intricatus*, *olivaceus*, and *confraternus*. *Intricatus* apparently does not break into varieties. It is recorded from the upper Rio Grande Basin northwest to the Humboldt River in Nevada and west to the Owens River in southeastern

¹ In August, 1915, I collected several *Ophiogomphus* nymphs while seining for fish in Owens River, Inyo County, California. As only *Ophiogomphus morrisoni nevadensis* was taken in Owens River these were probably that species. These were much more hairy than the exuvia described above but hardly as hairy as *morrisoni* exuviae from Donner Lake. Finding these Owens River nymphs made me decide that *morrisoni* and *nevadensis* are forms of the same species.

² Bull. Acad. Belg. (2), vol. 46, 1878, p. 26.

³ Since the above was written a single male of *Gomphus grasilinellus* Walsh was found in the Carnegie Museum of Pittsburgh, which had been caught on Lake Neumon, Washington. Dr. J. G. Needham states that among his notes is a second record of *grasilinellus* from Washington, which he had considered an error.

California. *Olivaceus* is recorded from the San Joaquin River east to the Humboldt and Owens Rivers and north to the British Columbia portion of the Columbia River. I have not examined the British Columbia specimens, but the Humboldt River form is paler in color than the Owens River and Central California form. The species thus breaks into at least two varieties. The situation with *confraternus* is even more complicated. I have not seen the California form called *confraternus* by Selys. From my study of Coast *Gomphus* I believe that *sobrinus*, *donneri* (see pp. 562-570), and the form from Seattle, Washington, called *confraternus* by Osborn¹ will be found to intergrade with this California *confraternus* of Selys, which has not yet been rediscovered. The name which will have to be used for this group of varieties will have to be *confraternus* because of priority.

In the following pages I have considered *donneri* and *sobrinus* as distinct species because I do not have material that absolutely connects them.

Olivaceus and *intricatus* are species of warm, muddy and sluggish rivers. The "confraternus group" have more diversified environments. *Sobrinus* of this group is found in the small sluggish streams of Central California. *Donneri* is from the cool clear mountain lake whose name it bears, while the form from Seattle, Washington, called *confraternus* by Osborn (see p. 565) was taken on Lake Washington, a lake of clear water that never freezes.

The forms of the *confraternus* group do not fall into any of the subgenera established by Dr. J. G. Needham on nymphal characters. See pages 570-571 for descriptions of nymphs.

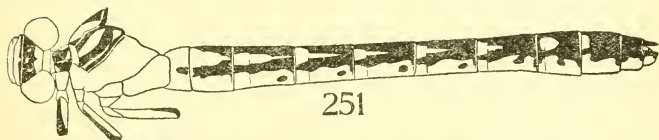
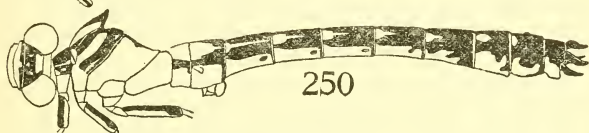
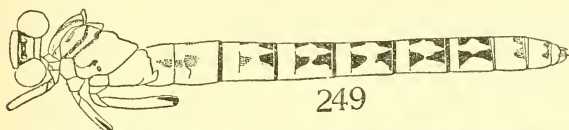
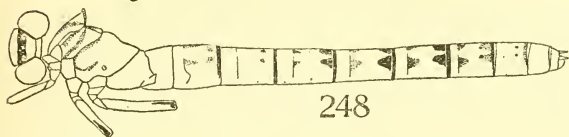
GOMPHUS INTRICATUS Hagen.

I first found this small yellow *Gomphus* on the Humboldt River at Golconda, Nevada, on August 7. Late in the afternoon after a day of ordinary collecting around the hot springs and through the willow thickets of the river bottoms, I caught a male and four female *Gomphus* on the bank of the river. Seeing that they were strange to me but not noticing them closely I took them for a single species. In the evening I went by train to Winnemucca and that night, when papering my day's catch, I decided that the male and two of the females were one species, while the other two females were of another species, of which I had no males. The following day I collected along the Humboldt at Winnemucca and caught a good series of the larger species of which I had a male from Golconda, but did not see a single specimen of the smaller species of which I had but two females.

Not knowing where I might again take the small species, except at Golconda, I boarded the afternoon train and went back, spending the next day collecting again around Golconda. I made a painstaking search among the willows for *Gomphus* and took several of the

¹ Ent. News, vol. 16, 1905, p. 189.

larger species, but until late in the afternoon saw only two of the small species and these females, both of which were wild and unap-



FIGS. 247-249.—*GOMPHUS INTRICATUS.*

FIGS. 250-251.—*GOMPHUS OLIVACEUS.*

FIGS. 252-253.—*GOMPHUS OLIVACEUS NEVADENSIS.*

proachable. But about four o'clock in the afternoon I flushed a male of the small species from a clump of rose bushes and with that suspense, which comes to a collector perhaps once a season as he sees a

prize of prizes flying away, waited several very long moments, while he decided whether to alight or to fly across the river out of my reach. Indifferent to danger, he lit on my side of the river but in the safest place possible as he chose a bare patch of ground in the midst of a broad area of salt grass. As salt grass at its best is only six inches high there was no cover whatever to aid in stalking him. Resorting to the only tactics available I very slowly approached him on my hands and knees and was greatly relieved when I got close enough to see that he, still unmindful of his danger, was busily engaged in scratching his head with his foot. I was more relieved when a moment later I had the net over him, but the suspense was not entirely relieved until I had him in a cyanide bottle and the cork in tight.

That night I took the train down the river to Lovelocks, the last town before the river spread out into the Humboldt Lakes. Here the following day along the river two miles east of town I found both species of *Gomphus* abundant and took a series of the small species as well as several of its exuviae.

As with most species of *Gomphus* this species spends much of its time seated on some bush or piece of driftwood, rarely alighting on the ground. However, when it is on the wing it is very energetic, and the males fly rapidly back and forth in short beats, about 6 inches above the surface of the water. The females oviposit while flying in the same quick, nervous manner. After many attempts I gave up trying to catch these over the water because they flew so close to the surface it was difficult to hit them without striking the water. In copulation the male picks the female up either from over the water or from some bush, and after a very short nuptial flight settles for a very long period in copulation. While I did not time any individuals, I believe such periods lasted an hour or more. Couples thus in copulation were so numerous and so preoccupied that I took more in copulation than single.

This species had been taken before only on the Pecos River,¹ in New Mexico. The only difference apparent between the Humboldt specimens and the description of *intricatus* is that in *intricatus* from the Pecos, the vertex is yellow,² while in all the Humboldt specimens, both male and female, the area about each antenna is dark brown and a dark band connects the three ocelli. Also in structure the Humboldt specimens are larger, being 50 mm. in length as against 45 mm. for the Pecos specimens. See figures 254-262 for structural details.

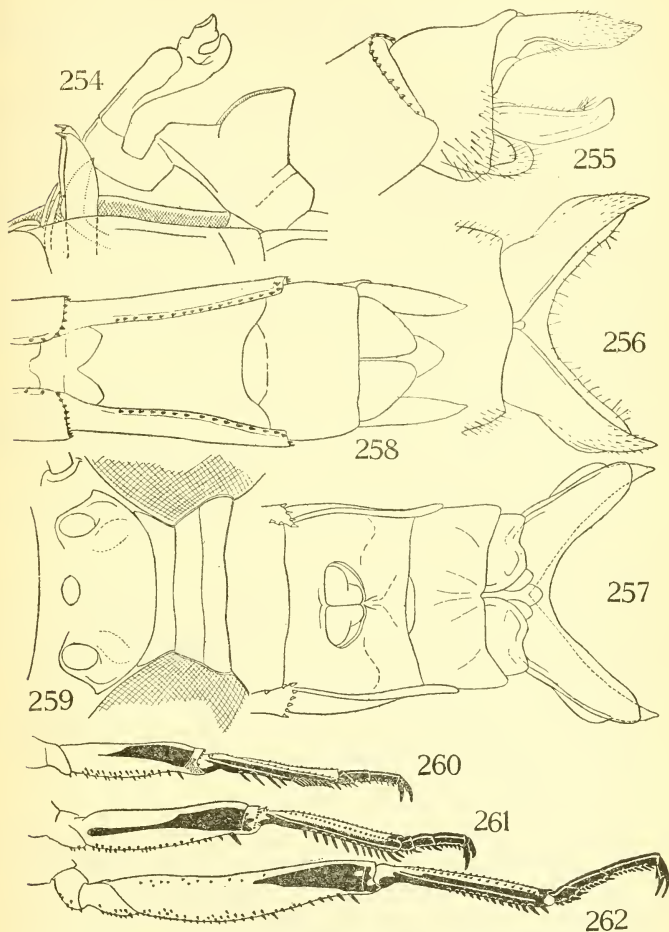
The following is the live color of the Humboldt specimens:

Male.—Face yellow, eyes pale gray, vertex olive yellow with dark brown about each antenna and a brown stripe connecting the three ocelli; occiput yellow. (See fig. 247.)

¹ Since writing this paper I have collected this species on the Owens River, in Inyo County, California, and have found a single male in the Cornell collection from Calexico, California, collected by Dr. Bradley, Aug. 11, 1914. Calexico is in the Imperial Valley.

² Selys, Mon. Gomph., 1858, p. 678.

Prothorax yellowish olive with an H-mark above. Mesothorax and metathorax greenish yellow with brownish markings as follows: Antealar ridges, middorsal stripe (the yellow carina dividing it through



FIGS. 254-262.—*GOMPHUS INTRICATUS*. 254. MALE, SEGMENT 2. 255-257. MALE, SEGMENT 10. 258. SEGMENTS 9-10 OF FEMALE. 259. FEMALE, OCCIPUT. 260-262. MALE, LEFT LEGS.

its center), on either side a narrow incurved antehumeral stripe, which touches the antealar stripe above, but in seven of the nine specimens this fades out below. This dark antehumeral is separated by a yellow

low stripe slightly more than its width from a very narrow paler humeral stripe. A narrow pale spot on the lower end of the first lateral suture. Second lateral suture entirely brown. Wings with costa yellow; pterostigma yellowish, edged with dark brown. Legs yellow, a short antero-dorsal stripe on apical end of femur extending usually less than half its length; tibiae black, yellow externally; tarsi dark.

Abdomen with segments 1-6 greenish yellow and 7-10 deeper, pure yellow, markings black. Segment 1 with pale spot above on either side connected posteriorly with a pale stripe on segment 2, which stripe is darker in its posterior half. Apex of segments 2-6 with a narrow black ring. Each of 3-6 with a small spot posterior to the lateral carina and a large spot, covering two-fifths of the side, on the distal end of the segment. Segments 7-10 deep yellow, segment 7 marked similarly to segment 6, but the spots reduced in area and paler. Segment 8 with broad dorsal apical pale brown area. Superior appendages yellow with ventral apical face black. Inferior appendages yellow with tips black.

Female.—Similar to the male but segments 7-9 with distinct apical spots. Five of the nine females have the antehumeral stripes reaching the mesostigmal lamina. In three the narrow humeral stripe is so faint as to appear wanting. In four females segment 9 is entirely yellow. (See figs. 248-249.)

The following are the measurements of the 18 Humboldt specimens: Male, abdomen, 35-43 mm.; hind wing, 27-29; female, abdomen, 37-38 mm.; hind wing, 31-32.

I had the privilege of examining the following specimens of *Gomphus intricatus* which belong to the United States National Museum: Rio Grande River, Brewster County, Texas, Mitchell and Cushman, collectors, 1 male, 2 females; Albuquerque, New Mexico, Cockerell, 1 male; Chaves, New Mexico (P. P. Calvert), 1 female.

Except that the color pattern is slightly darker in the Rio Grande specimens, approaching almost to black, I can see no difference between the Rio Grande and Nevada series.

GOMPHUS OLIVACEUS Selys.

This is a large species found on warm muddy rivers. I have taken it in two places. On July 15 and 16 I took about 80 males and 6 females on the American River just below the Southern Pacific Railroad bridges at Sacramento. September 2 I took a single female on the dikes of the San Joaquin River at Stockton.¹

¹ Ferris took this on Bean Creek near Modesto, California (see p. 630), which is its present farthest south record in the San Joaquin Valley. In August, 1915, I found this dark form on Owens River, Inyo County, California. Kirby (Catalogue of Odonata, p. 65, 1890) records this from Nebraska. I do not know his authority. Walker (41st Rept. Ent. Soc. Ont., 1909, p. 120) records it from Peachland, British Columbia, which is in the Columbia River watershed. The exuviae recorded by Needham from Seattle, Washington, as *sobrinus* (Proc. U. S. Nat. Mus., vol. 28, p. 692) are of this species.

The specimens I took in Nevada I consider a distinct variety and will discuss them separately.¹

At Sacramento several miles of the American and Sacramento Rivers were explored, but this species was found only on the American River and was confined to that stretch just below the Southern Pacific bridge.

The river at this point was about 200 feet wide with sand bottom and sand shores except along the north shore at the deepest point, where it was 6 feet in depth and the steeper bank showed some clay. Later, in August, the water had fallen until it was only about 3 feet deep at this point. The shore here was bordered with cottonwoods, whose dark green tops rose above a line of paler willow bushes, which hung in the muddy water, while the river bottoms adjoining were an almost continuous thicket of box elder trees, about 30 feet high. In one or two places these box elder thickets thinned out and such glades were rank with grass and clumps of willows.

The males of *olivaceus* were abundant over the yellow river, where they flew leisurely in a broadly zigzag course at a distance of not more than 10 inches above its surface. At intervals they rested, usually in a hanging position, on the willows. The females were not much in evidence. Two were observed over the water and were swifter and more direct in their flight than the males. Several females were taken in the open willow glades back from the river. Here they rested on the bushes and weeds, sunning themselves. Here an occasional male wandered about apparently seeking a mate. When found the pair would fly away in a short nuptial flight, soon coming to rest on bushes where they remained in copulation indefinitely. Individuals were difficult to catch in these glades, because on being disturbed they would fly up out of reach. The large series was taken by wading breast deep in the river's edge and scooping them off of the willows. Much time was spent searching for exuviae, but none were found.

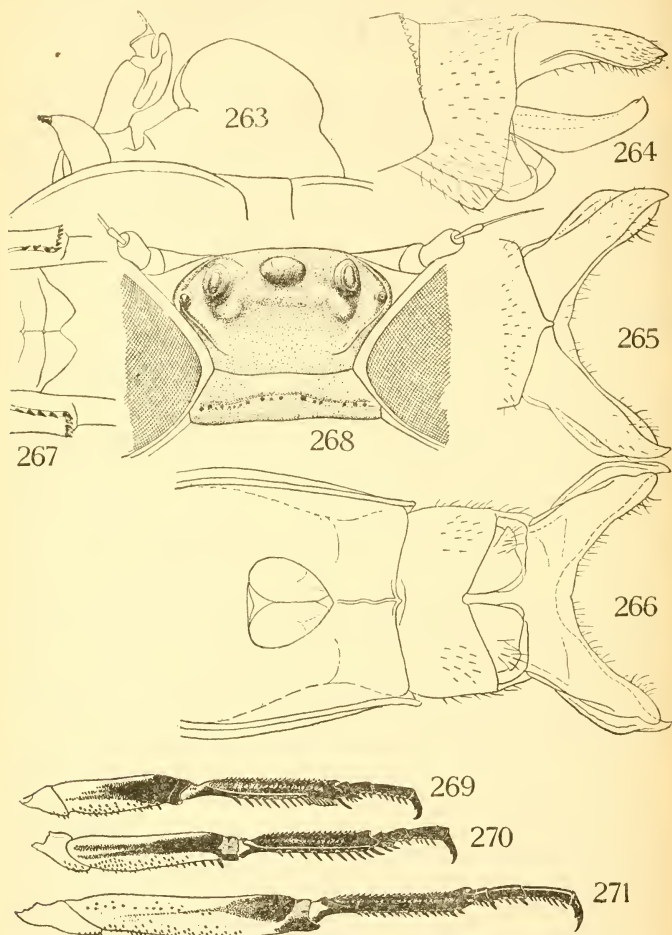
The illustrations (figs. 263-271) show the structural peculiarities of this species. The following is a description of the live colors:

Male.—Labrum pale grayish with greenish brown tints. Frons slightly browner than labrum, but paler except for a black band across its posterior edge. Vertex black except posterior to the ocelli, which with the occiput is pale grayish brown. Eyes blue, paler below. Postocular area pale brownish gray, shading into a bluish gray above. (See fig. 250.)

Prothorax dark brown except the anterior lobe which is yellow. Mesothorax with a black middorsal stripe twice as wide below as at the antealar sinus. Antealar sinus brown, connecting the middorsal stripe with the very wide humeral suture. Usually included in this stripe is a gray hair line lying posterior to the suture and a slightly

¹ See p. 557 of this paper.

wider, more irregular and usually discontinuous gray line lying slightly in advance of the suture. The pale areas of the thorax are pale gray with a slight greenish tint except the infraepisterna,



FIGS. 263-271.—*GOMPHUS OLIVACEUS*. 263. MALE, SEGMENT 2. 264-266. MALE, SEGMENT 10. 267. VULVA. 268. FEMALE, OCCIPUT. 269-271. MALE, LEFT LEGS.

which are yellow. Legs with coxa and trochanter gray, femur gray with a broad dorsal black stripe, tibia and tarsus black. Wings with the costa edged with yellow, pterostigma brown.

Abdomen with segments 1-6 gray, and segments 7-10 creamy yellow, marked as follows: Segment 1 with a narrow black stripe above on either side which connects with a similar stripe on segment 2, on the latter segment the stripe widening caudad. Segments 2-7 each with a lateral stripe as in segment 2, and in the lower posterior angle of the side a spot, on segments 6 and 7 this spot usually connected with the stripe above. Intersegmental membranes of segments 7-10 yellow. Segment 7 with the lateral stripes meeting along the dorsal carina for the posterior two-thirds of its length. Segments 8 and 9 with the lateral stripes broadly united across the posterior end of each segment, leaving on segment 8 a round antero-dorsal spot one-half the segment's length in diameter and on segment 9 a more rectangular antero-dorsal pale spot one-third the length of the segment. Segments 8 and 9 edged below with black. Segment 10 black above, yellow on the sides. Appendages brown with black tips. This species is characterized by the continuous lateral stripes on the abdomen, the lateral spots on segments 3-7 and the general grayish color of the body.

The coloration of the female (fig. 251) is similar to that of the male.

The following are the measurements of 8 males and the 6 females of *olivaceus* taken at Sacramento:

Male, abdomen, 37-40 mm.; hind wing, 31-33; female, abdomen, 38-43 mm.; hind wing, 32-35.

GOMPHUS OLIVACEUS Selys, var. NEVADENSIS Kennedy.

This variety was first taken by Henshaw, whose specimens are probably in the Museum of Comparative Zoology. Hagen¹ lists these specimens as *olivaceus*.

I found this variety only in the Humboldt River, where I took it at Golconda, Nevada, August 7 and 9; Winnemucca, August 8; and Lovelocks, August 10. I did not find it in the swifter parts of the upper reaches of the river at Carlin.

From Golconda to Humboldt Sink, the Humboldt River is a muddy alkali stream, which meanders with many involved loops through this treeless valley. Its banks and bed are of alkali silt and it is bordered at every turn by dense thickets of gray willow, which are called pinwillows by the cowpunchers, because they seldom get larger than an inch in diameter. At this size they die and remain erect among the younger sprouts, making a thicket scarcely penetrable except by animal trails. The surrounding mountains are brown and bare and treeless, not even cottonwoods growing along this strange stream.

Both males and females were found most commonly in these willow thickets. They sunned themselves here, but every now and then one

¹ Rept. Surv. Terr. Colo., 1873, p. 397, 1874.

or more would apparently remember the river and would spend several minutes in a zigzag flight over its surface, returning shortly to rest again on the willows. Several pairs in copulation were seen flying about these thickets.

This variety, except for its slightly greater size, is identical with *olivaceus* of California in structure, but is readily distinguished, especially in fresh material, by the color, which is in general much lighter than in the California specimens. In the field I did not doubt that the two were distinct species, but was surprised when on my return I studied them under a binocular and could find no constant structural differences. The following are the live color notes:

Male.—Eyes blue, gray below. General body color much more yellow than the California specimens, thus giving the Humboldt variety a lemon or gray yellow appearance, rather than the dark gray appearance of the former. Also all markings are more restricted and paler. Thoracic markings medium to light brown. Humeral stripe divided lengthwise into three distinct stripes by two inclosed pale stripes. In perhaps one-third of the material the humeral stripe fades out below. The black dorsal stripe on the femur reduced to a spot on the distal half or third. Pterostigmas in male and female pale gray yellow. In the abdominal markings segments 3-7 have a broad yellow basal ring. The lateral spots are absent except on segment 7, where they are much reduced in size. Segment 10 in male is mottled with brown above, and in the female is yellow, except for its brown dorso-caudal edge. (See figs. 252-253.)

Several exuviae, probably of this species, were found on the large salt grass sods lying in the edge of the water where the banks had been undermined. These will be described later. (See p. 570.)

The following are the measurements of 8 males and 7 females from Lovelocks: Male, abdomen, 40-42 mm.; hind wing, 33-34; female, abdomen, 40-43 mm.; hind wing, 34-36.

GOMPHUS SOBRINUS Selys.

Gomphus sobrinus has been known heretofore only from the type, a single male specimen "collected by Edwards in California" and later deposited in McLachlan's collection. This was described by Selys in the year 1873 in his Third Addition to the Synopsis of the Gomphines.

Except for the above specimen the species has remained unknown until this year. In April of this year I took a single specimen, a female, on Felt Pond on the Stanford campus, and in May I found it very abundant on Coyote Creek within the city limits of San Jose, where in a single day's collecting I succeeded in taking over 50 specimens, though much of the time was spent in endeavoring to catch *Macromia*. During the fore part of June I took several specimens

on one of the ponds on the Napa Insane Asylum grounds, and about June 15 caught several on Chico River east of the city of Chico.

Both Coyote Creek and Chico River are warm sluggish streams with mud banks and much mud bottom. On Coyote Creek on May 10 the species was at the height of its season. On May 27 it was much less abundant, and on July 4 it had entirely disappeared. On Chico River, June 14 and 15, only an occasional *sobrinus* was seen but the exuviae were very abundant, which would indicate that at that time their season was practically over. From the preceding data it is evident that *sobrinus* is an early spring species, appearing in April and gone by July, and that it inhabits the warmer constant streams of medium size and to a lesser extent ponds. Perhaps it is also limited to the more mud-bottomed streams, as I did not find it in the Feather, Yula, or American Rivers, which are sandy bottomed. Neither does it occur on clear spring-fed mountain streams, for one such flowed through the asylum grounds, and another (Stephen's Creek) flows not far from San Jose, in neither of which did *sobrinus* occur.

On Coyote Creek where I observed its habits more fully, it does not appear about the water in numbers until about 11 in the forenoon. Earlier than this it can be found on the sunny patches of bare ground back a few yards from the creek bank. It is active about the water during the heat of the day but leaves about 4 in the afternoon. The males are four or five times as abundant as the females, and usually stay low over the water, seldom rising higher than four or five feet above its surface. They usually rest on the bare sandy spots but light also on logs, brush and willows. The females oviposit by tapping the surface of the water with the abdomen at irregular intervals as they fly close over its surface. It is at such times that the males swoop on them and take them away in copulatory flights, which end in a long resting period in copulation on some tree or bush.

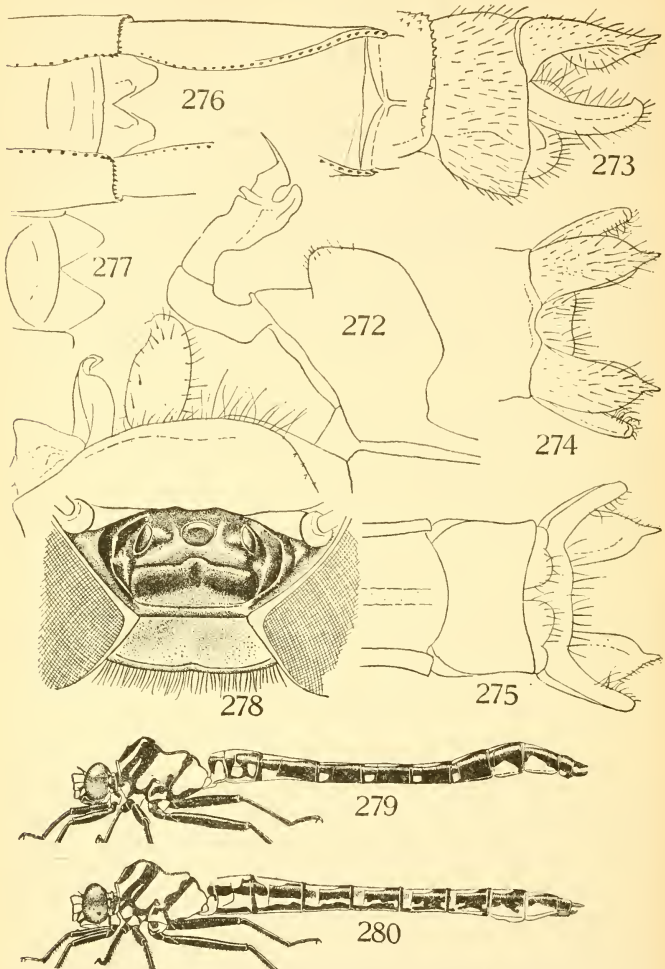
Many of the specimens which I have fit Selys's description closely, but the species varies in a remarkable way, and I believe on further study and wider collection will be found to include Selys's species *confraternus*. If such is found true, the name *confraternus* will supersede that of *sobrinus*, as the former precedes the latter in Selys's writings. The variations of the species will be dealt with more fully in the discussion of the next and closely related mountain species from Lake Donner.¹

The following are color descriptions of *sobrinus*:

Male.—Labium black in the middle; entire face and frons pale greenish yellow, except posterior edge of horizontal surface of frons, which is black as is the entire vertex; occiput yellow; eyes gray, with the posterior surface with three yellow spots. (See fig. 279.)

¹ See p. 550 of this paper concerning *sobrinus* from Seattle, Washington, collected by R. Osburn and called *confraternus*.

Prothorax black with a median and an upper and lower lateral spot yellow.



FIGS. 272-280.—*GOMPHUS SOBRINUS*. 272. MALE, SEGMENT 2. 273-275. MALE, APPENDAGES. 276-277. VULVA. 278. FEMALE, OCCIPUT. 279-280. COLOR PATTERN.

Mesothorax and metathorax dull olive green marked with dark brown as follows: Middorsal stripe 1.5 mm. wide, extending from antealar sinus to the pale posterior edge of the black mesostigmal

lamina; humeral and antehumeral stripes, 2 mm. wide, fused except for a narrow green line through the center of their middle third; upper half of mesinfraepisternum (lower half pale); a broad band connecting inferior end of humeral stripe with the broad irregular stripe on the second lateral suture (see fig. 279). Upper third of mesinfraepisternum dark but conspicuously edged above by pale. Anterior end of metepimeron black. Coxae pale, each with a black spot; legs black. Wings with large dark brown stigmas.

Abdomen black except segment 1, with dorsal and lateral greenish spots. Segments 2-9 each with a narrow triangular yellow middorsal spot, the apex caudad, and reaching posterior end of 2-6 and successively shorter on 7-9, on the last reaching but halfway. Basal articulatory membranes of segments 8-9 yellow. Segment 2 with two large pale spots on sides. Lower edge yellow. Segment 3 with a large antero-lateral spot and lower edge yellow. Segments 4-7 each with a small antero-lateral spot yellow. Segment 8 with a large yellow lateral spot reaching three-fourths distance from anterior and toward posterior end. Segment 9 with a yet larger spot greater than half the depth of the segment and tapering to a point at the lower posterior angle. Segment 10 usually entirely black but in some paler below. (Appendages, figs. 290-293.)

Among twenty selected at random, all from San Jose, five had a very small and obscure spot on 9, while in another it was reduced to a line. In one male lateral spots on 1 fuse with dorsal spot. (See figs. 299-300.)

Female.—Head and thorax colored as in male. Abdomen with more yellow.

Segment 1 greenish with a black spot above on either side. Segment 2 with a broad middorsal yellow stripe variouly pointed posteriorly, a broad lateral stripe and the lateral keel edged with yellow. Segments 3-7 similar to segment 2 but the middorsal spot more triangular. A large antero-lateral spot on each, caudad to which extends a more or less definite yellow stripe, which is interrupted or absent on 6 and 7. The lateral keel edged with yellow. Segment 8 with middorsal triangular spot one-half length of segment. Lateral spot extending four-fifths along lateral keel. Segment 9 similar to 8 but lateral spot larger, extending along keel full length of segment. Segment 10 usually black with the three caudal lobes yellow. Appendages black. Basal articulatory membranes of segments 8-10 yellow.

The female illustrated (fig. 280) is an alcoholic in perfect preservation and happened to be the most yellow of my ten specimens. The abdominal coloration in the female is exceedingly variable, no two of the ten being alike. The majority have a pattern more like the male (fig. 279) than like this female. Figures 302-305 show the

color pattern in four other females. Figures 272-278 show the structural details of this species.

Measurements are as follows: Male, abdomen, 37-40 mm.; hind wing, 31-32; female, abdomen, 36-39 mm.; hind wing, 30-32.5

Because of previous studies of the postanal cells in *Gomphus* relative to their use in grouping the species into subgenera, I give here the forms they take in this species. The fifty males were examined and 24=A (fig. 313), 7=B; 2=C; 9=D; 2=H. Each of the other figures represented one specimen each, and one deformed wing was not figured. The females were not examined.

GOMPHUS DONNERI, new species.

One of the interesting surprises among the Odonata of beautiful Donner Lake was a species of *Gomphus*. This genus, which is associated in one's mind with the warm sluggish streams of the lowlands, was represented here at an elevation of almost 5,000 feet by numerous specimens of an almost black species, a close relative of its near lowland neighbor *Gomphus sobrinus*.

I first saw a specimen of this species on July 23, while I was collecting *Ophiogomphus morrisoni* near the outlet of the lake, but after several attempts failed to catch him. A fuller exploration of the lake revealed the sand beaches around the west end, a different shore from the cobble and pebble beaches of the east end, and on these sandy beaches of the west end, this new *Gomphus*. During two days' collecting about 80 males and 2 females were taken, and after extended search several broken exuviae were found around driftwood and boulders along the shore. Because of the very evident scarcity of females the species was probably past its prime, though still abundant. I was not fortunate enough to observe it emerging, copulating, or ovipositing. It passed most of its time resting on the bare beach or some low stone, though it occasionally lit on a low bush or weed. Along the west shore, where the sandy beach was continuous, it was the only species found, but along the west end of the north shore, where sandy stretches alternated with gravel and rock, it was associated with *Ophiogomphus morrisoni*, *Enallagma cyathigerum*, and *Argia vivida*.

Length of abdomen: Male, 37 mm. (35-38); female, 36 and 37.5. Length of hind wings: Male, 30 mm. (28-32.5); female, 31 and 32. Length of pterostigma of front wing: Male, 2.8 mm. (2.5-3.2); female, 3.

Type.—Cat. No. 20815, U.S.N.M. A male from Donner Lake, Nevada County, California, July 23, 1914.

Allotype.—Cat. No. 20815, U.S.N.M. A female from Donner Lake, Nevada County, California, July 23, 1914.

Apex of hind femur reaching to or beyond auricle, in the male, with only short spines, but in the female with about 15 long spines in the outer two-thirds of each row and 8–10 short spines in the inner third of each row. Long hairs in basal third of femur in both sexes. Anterior hamuli half as long as posterior, slightly dilated upward, then abruptly contracted to a hook which terminates the anterior edge, the tip of the hook pointing caudad. Posterior hamules leaf shaped, the posterior edge thickened, the anterior edge with a subapical point directed cephalad. (Fig. 281.) Seminal vesicle large, black, its anterior surface terminating in two broadly conical projections. Abdominal segments 8 and 9 moderately dilated, inferior edge of 9 two and a half times as long as 10. Superior appendages, when viewed from above, conical, in some specimens terminating in a poorly defined needle point. Viewed from the side, the appendages are slightly convex on the dorsal surface for the anterior two-thirds of their length and slightly concave for the posterior third. A thin ridge or lamina extends along the apical three-fourths to three-fifths on the inner, lower side of each appendage. This appears in the lateral view, but is largely hidden in the view from above. This ridge is as wide as one-third the length of the appendage, being widest in its anterior third, and tapering regularly to the apex of the appendage. Prongs of inferior appendage separated by length of inner edge of either prong; prongs diverging, frequently half the inner edge of either prong visible from above outside the superior appendages. Viewed laterally, upper and lower lines of prong subparallel and the prong terminating in a short tooth pointing dorsad. Viewed from above, the outer line convex in basal two-thirds and straight or slightly concave in distal third; tip rounded. (Figs. 282–285, 294–298.)

Vulvar lamina of female broadly V-cleft, the lobes as long as wide, with blunt points. Female appendages as long as 10. (See fig. 286.)

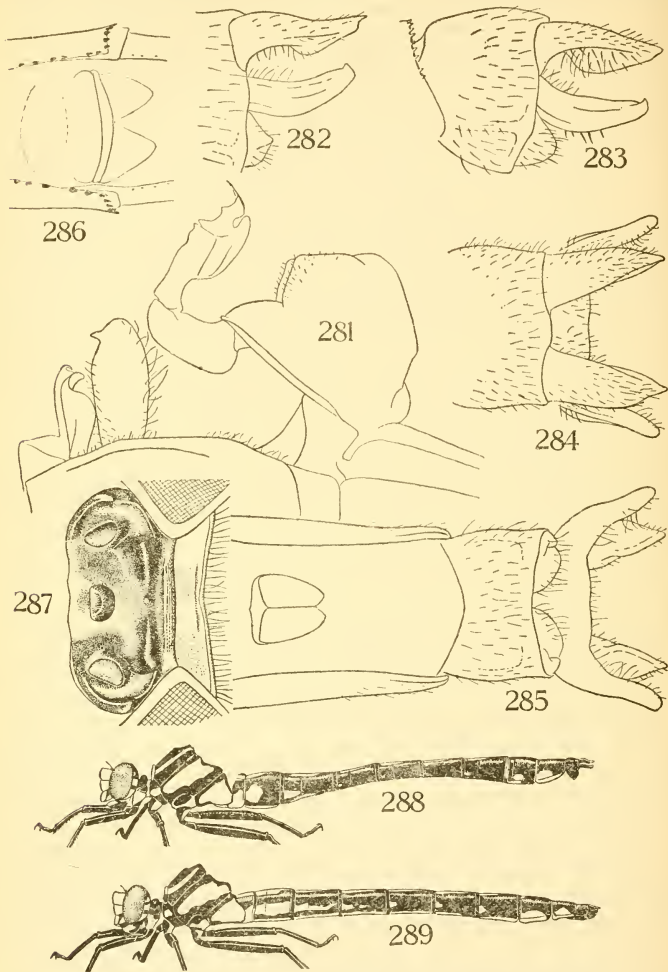
In both male and female the under surface of the occiput is not visible from above; that is, the posterior edge does not turn up as in *Stylurus*. This edge in the two females is straight; in the majority of the males a slightly convex curve, lightly indented in the center. (Fig. 287.)

Coloration, male.—Labium black with yellow lateral edges; entire face and frons greenish yellow except posterior edge of horizontal surface of frons, which is black, as is the entire vertex; occiput yellow. Eyes gray with three yellow spots behind each. (See fig. 288.)

Prothorax entirely black, except obscure median dorsal spot, and in some specimens minute upper and lower lateral spots.

Mesothorax and metathorax dull grayish olive green, marked with black as follows: Middorsal stripe 1.75 mm. wide, extending from the black antealar sinus to the pale posterior edge of the black mesostigmal lamina; humeral and antehumeral stripes entirely fused into a stripe 2.5 mm. wide; a broad band connecting inferior end of

humeral stripe with lower end of the broad stripe on the second lateral suture; anterior and ventral edge of metepimeron broadly



FIGS. 281-289.—*GOMPHUS DONNERI*. 281. MALE, SEGMENT 2. 282-285. MALE, APPENDAGES. 286. VULVA. 287. FEMALE, OCCIPUT. 288-289. COLOR PATTERN.

black. Mesinfraepisternum and metinfraepisternum black above, yellow below. All coxae yellow, each with a black anterior spot. Legs black. Pterostigmas very dark, almost black.

Abdomen black, except a broad middorsal band on segments 1 and 2; lower side of 1 green, which is confluent with a large green spot on side of 2 (in some specimens a second and minute spot posterior to auricle). Lateral keel of segments 1-3 yellow. Segments 3-7 each with a narrow middorsal triangular yellow spot extending full length of segments 3 and 4, and successively shorter to the eighth on which it occupies only the anterior fourth. Large anterolateral spot on segment 3, the anterolateral spots on 4-7 being reduced to mere points. Basal articulatory membranes of segments 8-10 yellow, all others black. A large yellow spot, three-fifths the length of the segment, occupying the lower anterior angle of segment 8. A similar but larger spot occupying the anterior two-thirds of segment 9 and extending caudad along the keel but not reaching the posterior end of the segment as in *sobrinus*. Segment 10 and appendages black.

Female.—Color similar to that of male except on abdomen, which is colored as follows (fig. 289): Black with more extensive yellow pattern than in the male. Segment 1 black, with large dorsal spot and sides yellow. Segment 2 black, with large oval dorsal spot full length of segment and broad lateral stripe with a second narrow stripe along lower edge yellow. Segments 3-7 each with a narrow triangular middorsal spot extending full length of segment; each with lateral keel narrowly yellow. Segment 3 with an irregular lateral stripe. Segment 4 with an anterior lateral spot followed by a second and smaller spot. Segments 5-7 each with an anterior lateral spot larger than those in the male. Segment 8 with short triangular middorsal spot on anterior end of segment, and a large lateral spot extending along three-fourths of the length of lateral keel and dorsad half the height of the segment. Segments 9 and 10 black, except a large lateral yellow spot on 9 extending along the entire length of the lateral keel and at its anterior end dorsad half the height of the segment. The three round terminal lobes of segment 10 yellow. Articulatory membranes of segments 8-10 yellow.

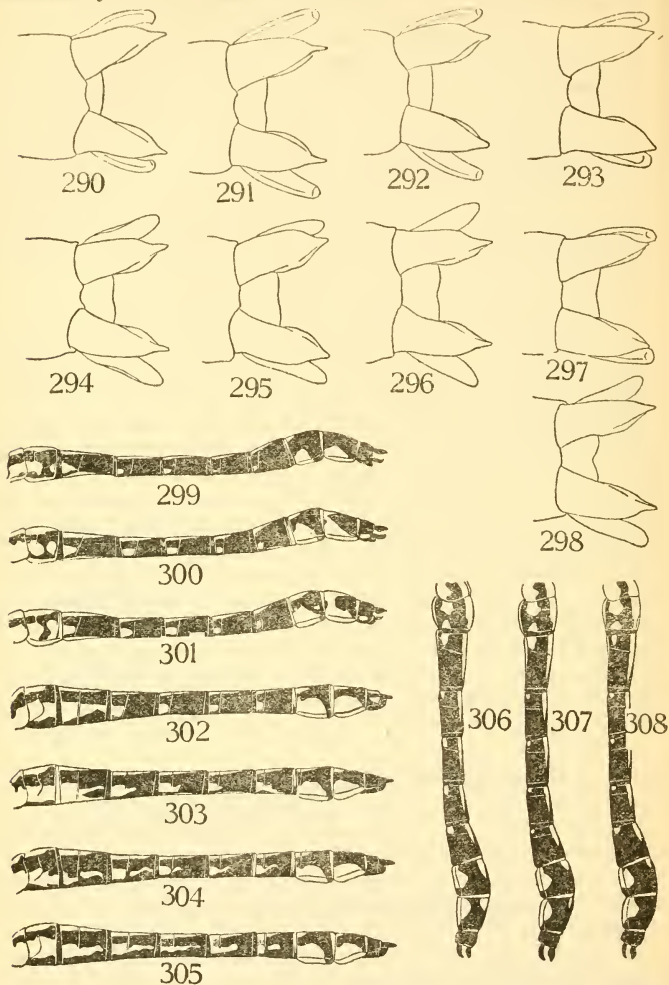
The variations of the cells between A and A₂, on being checked against figure 313, show 8 = A, 10 = B, 11 = C, 15 = D, 10 = F.

Donneri is very close to *confraternus*, appearing to differ only in coloration. *Confraternus*, which I have not seen, has blunt superiors but has a double humeral stripe. *Donneri* and *confraternus* both are smaller than *sobrinus* and both have little or no color on the dorsum of segment 9.

In the collection of Cornell University are three males and one female from Seattle, Washington, collected by R. Osburn,¹ which are labeled *confraternus*. These agree with my *sobrinus* specimens from California in detail, having the larger size of *sobrinus*, the double humeral stripe, the large spot on the dorsum of segment 9, the lateral spot on 9 reaching to the lateral inferior angle of the seg-

¹ Osburn, R., Ent. News, vol. 16, 1905, p. 189.

ment and the pointed superior appendages. The exuviae from Seattle, described by Dr. J. G. Needham¹ as *sobrinus*, are a form near *olivaceus*,



FIGS. 290-293, 299-305.—*GOMPHUS SOBRINUS*. 290-293. MALE, APPENDAGES. 299-305. COLOR VARIATION.
 FIGS. 294-298, 306-308.—*GOMPHUS DONNERI*. 294-298. MALE, APPENDAGES. 306-308. COLOR VARIATION.

which has been reported from Peachland, British Columbia.² The nymphs from Crooked River (Baker County), Oregon, described by

¹ Proc. U. S. Nat. Mus., vol. 27, 1904, p. 692.

² 41st Report Ent. Soc. Ont., 1909, p. 120. (E. M. Walker.)

Doctor Needham¹ as *confraternus*, are close to the nymphs of *donneri* but are slightly broader.

In color this species is characterized and set off from *sobrinus* by the narrow antehumeral stripes (1 mm.), the solid black humeral stripe, the minute lateral spots on segments 4-7, the usual absence of a dorsal spot on segment 9, and the fact that the lateral spot of segment 9 never quite reaches the lower posterior angle of the segment. (See figs. 306-308.)

Structurally the species is characterized by its shorter pterostigma (2.5-3.2 mm.), by its more slender abdomen and by its more blunt superior appendages and slightly lyrate inferior appendage.

This species is very close to *sobrinus*, differing from it in the above characters and in its season. The season of *sobrinus* is entirely past before this reaches its prime. The difference in altitude would account for part of this, but hardly for so great a difference. And as to the characters above, none of them are constant except that of the extent of the yellow lateral spot of segment 9. In *sobrinus* it always attains the posterior angle and in *donneri* it never does. Occasional specimens show intergradations in any of the other characters, but no single specimen from the valley (*sobrinus*) or from the lake (*donneri*) shows a major part of its characters varying toward the other species.

To test this I tabulated each specimen of the males of the two species (54 *donneri* and 50 *sobrinus*) in regard to the following seven characters: 1, width of pale antehumeral stripe; 2, length of pale mid-humeral stripe; 3, length of stigma of left forewing; 4, extent of lateral spot of segment 9 along the inferior edge of the segment; 5, length of dorsal spot on segment 9; 6, character of superior appendages (whether needle pointed *sobrinus* form or the blunt *donneri* form or one of three intermediate forms); 7, character of inferior appendage. The table (see p. 568, table A) following shows the variations and the number of specimens showing any given variation. The arrangement of the table brings out the overlapping or intergrading of the various characters.

To show the distinctness of the two groups of dragonflies in spite of the intergrading of the various characters, I reduced the measure of each character to its equivalent in a scale of ten, allowing 0 for the extreme *donneri* form of each character and 10 for the extreme *sobrinus* form of each character. The equivalents for each character are inserted in the table of variations.

Following this (see p. 568, table B) are for example the measurements of the first three *donneri* specimens and following each in the table are inserted the equivalents for that specimen with their sur- in the end column.

¹ Proc. U. S. Nat. Mus., vol. 27, 1904, p. 691.

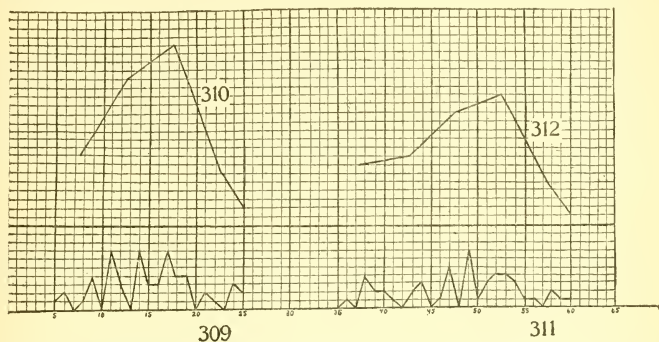
A. TABLE SHOWING NUMBER OF EACH SPECIES POSSESSING EACH CHARACTER STUDIED.

Antehumeral stripe, width.	Equivalents.	Donneri.	Sobrinus.	Midhumeral stripe, length in mm.	Equivalents.	Donneri.	Sobrinus.	Pterostigma, length in mm.	Equivalents.	Donneri.	Sobrinus.	Lateral spot seg. 8, length in 10ths of seg.	Equivalents.	Donneri.	Sobrinus.	Dorsal spot on seg. 9, length in mm.	Equivalents.	Donneri.	Sobrinus.	Superior appendages, male, rating.	Equivalents.	Donneri.	Sobrinus.	Inferior appendages, male, rating.	Equivalents.	Donneri.	Sobrinus.					
0.8	0	2	1	0.0	0	2	1	2.5	0	2	1	1	0	45	5	1	0	0	11	1	0	0	0	0	32	2	1	0				
1.0	1	45	5	1.5	1.5	2	5	2.8	2.3	29	5	5	2.5	5	2	5	2.5	2.5	15	5	2.5	2.5	5	5	15	5	11	5				
1.1	3	6	18	1.5	0	5	1	3.0	3	5	1	1	2.5	2	5	5	5	18	11	5	5	5	5	8	18	11	5	7				
1.2	1	6	15	2	0	13	23	3.4	4	13	3	3	3.7	1	3	3	4	5	10	22	7.5	7.5	7.5	7.5	10	22	10	22				
1.3	5	4	4	2.5	5.3	3	12	3.5	6	3	6	5	5	0	12	12	5	6	0	0	10	10	10	10	3	0	11	10	3			
1.4	7	4	6	3.2	7.6	2	6	3.5	3	2	2	8	7.5	1	4	4	7	8.7	7	6	6	6	6	6	6	6	6	6	6			
1.5	7	4	6	3.5	10	1	1	3.8	5	10	1	8	10	4	4	4	8	10	4	4	4	4	4	4	4	4	4	4	4	4		
1.6	8	7	6	4	10	1	1	10	10	10	1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
1.7	10	10	10	5	13	1	1	50	50	50	1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	
1.8	10	10	10	13	13	1	1	50	50	50	1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

B. FIRST THREE DONNERI MALES TABULATED FOR THE SEVEN CHARACTERS STUDIED AND UNDER EACH THE EQUIVALENTS. THE SUM OF THE EQUIVALENTS IS THE VARIATIONAL STANDING OF THE INDIVIDUAL.

Number of specimen.	Width of antehumeral stripe, mm.	Length of mid-humeral pale stripe.	Length of lateral spot on 9, in 10ths of seg.	Length of dorsal spot on 9, mm.	Superior appendages, rating.	Inferior appendages, rating.	Sum of equivalents.
1	1	0	0	1	2.5	0	2.5
(1)	2	0	2	1	2.5	0	12.8
(2)	2	0	0	0	2.5	0	9.3
3	2	0	2	0	2.5	8	21.5
(3)	1	0	3	0	2.5	8	

The sum of the equivalents, then, gives the variational standing of the individual. That is, a *sobrinus* with each character of extreme *sobrinus* form would total 70 and a *donneri* with each character 0,



FIGS. 309-310.—GOMPHUS DONNERI. 309. CURVE REPRESENTING ABOUT 50 SPECIMENS. 310. SAME CURVE AS 309 REDUCED TO PERIODS OF 10.

FIGS. 311-312.—GOMPHUS SOBRINUS. 311. CURVE REPRESENTING ABOUT 50 SPECIMENS. 312. SAME CURVE AS 311 REDUCED TO PERIODS OF 10.

or the extreme *donneri* form, would total 0 and a perfect intermediate would total 35. Figures 309 and 311 are curves representing the two species and figures 310 and 312 are these same curves redrawn

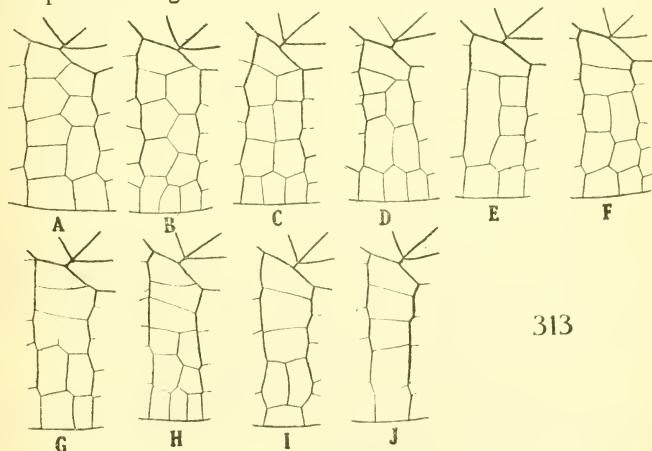


FIG. 313.—GOMPHUS SOBRINUS, VARIATIONS IN THE ANAL AREA IN THE MALE HIND WINGS.

to groups of 10 to smooth them up. These curves show better than words the distinctness of the two species.

I am not familiar enough with the genus *Gomphus* to attempt to place these species in a subgenus.

13. THE NYMPHS OF WESTERN GOMPHUS.

The following characterization of the nymphs of *Gomphus* is from Doctor Needham's Aquatic Insects in the Adirondacks (pp. 435-436 and 443):¹

Middle legs not more approximate than fore legs at base, the fourth segment of the antenna a mere rudiment, much shorter than the third segment is wide; tenth abdominal segment much shorter than ninth. Wing cases laid closely parallel along the back; lateral lobe of labium ending in a sharp, incurved hook. Abdomen only slightly depressed, ovate to lanceolate in outline, at least twice as long as wide. Third joint of antenna elongate, linear, little flattened. Dorsum of ninth abdominal segment rounded, or with a low, obtuse median longitudinal ridge.

GOMPHUS INTRICATUS, nymph.

A thin skinned, whitish exuvia with sooty tints on the abdomen; moderately slender. Surface very sparsely coated with exceedingly minute bristle-like hairs. This is a typical *Stylurus* nymph and is distinguished by the following characters:

Mentum of labium transparent, tapering proximad with sinuate sides, width of posterior margin one and three-fourths times in that of anterior margin. Middle lobe convex, with a fringe of about 60 bristlelike scales. Each lateral lobe broad at base, with a crescentic tip that is suddenly contracted to a large terminal point standing at right angles to the lobe; three large and two smaller rounded teeth on the concave edge posterior to the terminal point. Burrowing hooks rudimentary on both first and second tibiae. Wing pads reaching to segment 4. Abdomen lanceolate, very slightly contracted at base of segment 9, subcircular in cross section. A dorsal groove on segments 3-7. No middorsal hooks or spines. Segments 6-9 with lateral hooks, those on 9 one-half the length of segment 10. Segments 2-9 subequal in length; segment 10 one-third the length of segment 9, and twice as wide as long. Appendages twice length of 10. (See figs. 315 and 321-323.)

Length, 27 mm.; abdomen (including appendages), 19; hind femur, 4. Width of head, 5 mm.; abdomen, 6.

Described from 4 female nymphs collected on the Humboldt River at Lovelocks, Nevada, August 10, 1914. These were taken from dead weed stems 2 feet above the lowest level of the river. At this point was a deep hole (3 feet) with a muddy bottom, the greatest part of the river bed being composed of a coarse grit.

GOMPHUS OLIVACEUS NEVADENSIS,² nymph.

A large, slender, whitish exuvia, sparsely covered with minute bristlelike hairs. This is a typical *Stylurus* nymph and is distinguished by the following characters:

¹ Bull. 47, N. Y. State Mus., 1901.

² A form of *olivaceus* nymph has been described by Needham from Seattle, Washington, as *sobrinus* in Proc. U. S. Nat. Mus., vol. 27, 1904, p. 692.

During August, 1915, I found the same form of *olivaceus* on the Owens River, Inyo County, California, as that found at Sacramento, which is the typical *olivaceus*. The nymphs of the Owens River *olivaceus* were identical with those of *Gomphus olivaceus nevadensis*.

Mentum translucent, its width one and two-fifths in its length; sides of anterior portion subparallel and quickly contracted by a short sinu-

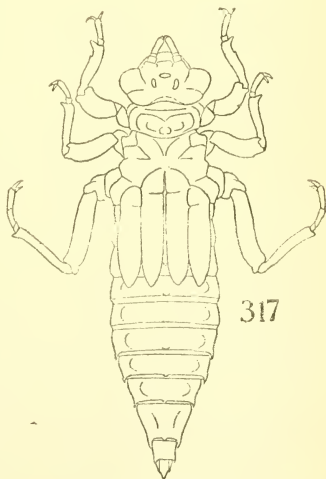
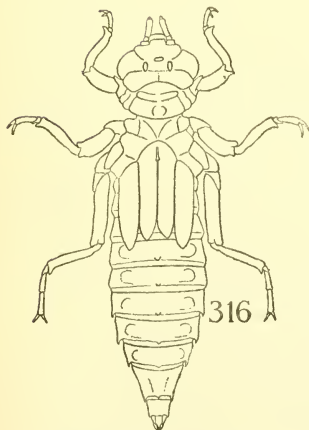
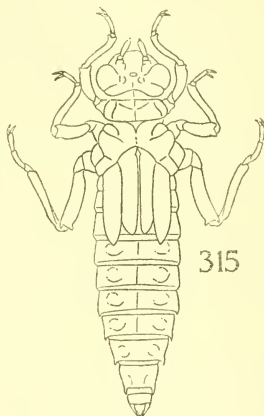
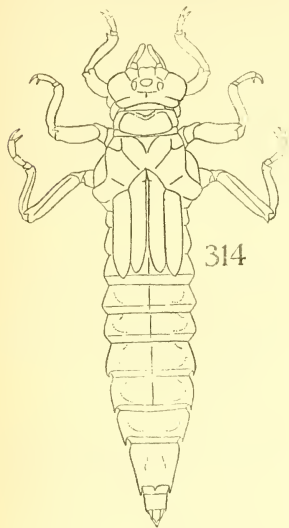


FIG. 314.—*GOMPHUS OLIVACEUS NEVADENSIS*, NYMPH.
FIG. 315.—*GOMPHUS INTRICATUS*, NYMPH.

FIG. 316.—*GOMPHUS DONNERI*, NYMPH.
FIG. 317.—*GOMPHUS SOBRINUS*, NYMPH.

ate curve to the narrower posterior portion, which tapers slightly; width of posterior end one and a half to one and three-fourths times

in that of anterior end; middle lobe convex, with 30-35 bristlelike scales; each lateral lobe with a crescentic tip turned inward at right angles; on the concave edge 3-4 large rounded teeth. Burrowing hooks rudimentary on both first and second tibiae. Wing pads reaching segment 4. Abdomen lanceolate, tapering regularly, subcircular in cross section. A dorsal groove on segments 3-7. A minute mid-dorsal spine on apex of segment 9. Lateral hooks on segments 6-9, those on 9 reaching to base of 10. Segments 3-8 subequal; segment 9 one and a half times the length of 8; segment 10 three-fifths length of 8. Appendages equal to 10. (See figures 314 and 318-320.)

Length, 38 mm.; abdomen, 26; hind femur, 5.5. Width of head, 6 mm.; abdomen, 7.

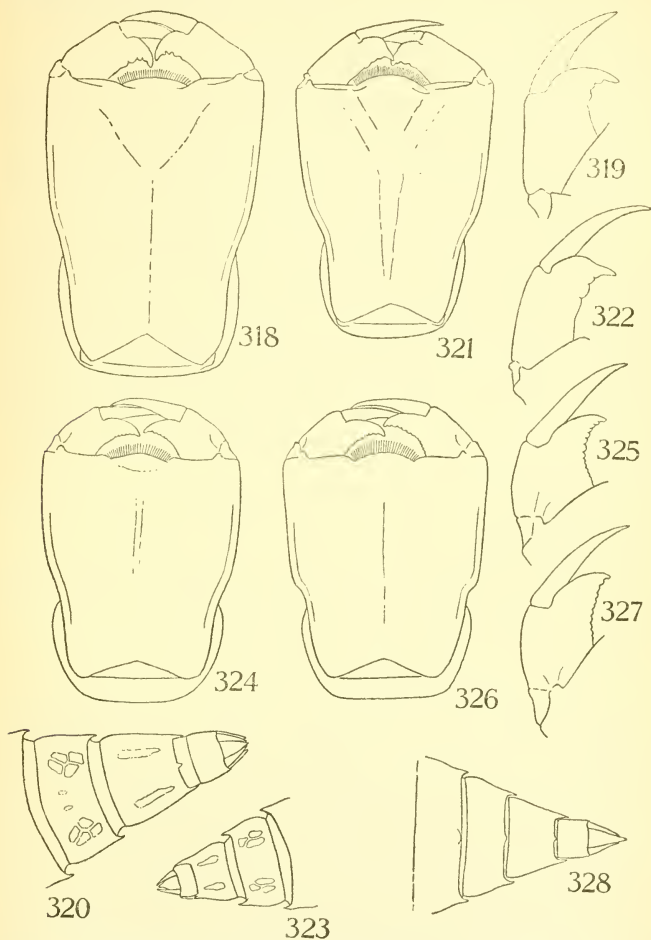
Described from 6 exuviae collected on the Humbolt River at Golconda, Nevada, August 9, 1914. The river at this point flows through an alkaline, salt-grass flat. As it meanders it undermines the salt grass sod which caves into the edge of the stream in large squares. It was on these sods that the exuviae were found.

GOMPHUS SOBRINUS, nymph.

A heavy thick-skinned exuvia usually thickly coated with mud because of a dense coat of very short spiny hairs, differing noticeably in this regard from *donneri* exuviae, which have few hairs and these usually very clean. General shape intermediate, neither short nor slender. Abdomen much less arched than in *donneri*. It is distinguished by the following characters: Mentum of labium slightly longer than wide, its posterior edge three-fifths to two-thirds width of anterior edge, its sides instead of being sinuate suddenly contracted proximad, making a sharp angle or "step" on either side. (A small percentage of the specimens is intermediate in this mental character, the "step" of the side being more sinuous.) Middle lobe of mentum convex and fringed with about thirty bristle-like scales. Lateral lobes broad at base, tapering regularly to a crescentic tip, the inner margin of which bears 7-9 low rounded teeth, followed by smaller ones toward the base of the lobe. Well developed burrowing hooks on both first and second tibiae. Wing pads reaching middle of segment 4. Abdomen lanceolate, slightly contracted at base of segment 9, only moderately arched, its ventral surface much flatter than in *donneri*. No dorsal groove, but apex of segments 2-7 with a low rounded middorsal tubercle. A minute middorsal tooth, hardly discernible, as it is concealed in a tuft of hairs on apex of segments 2-7, larger on segments 8 and 9. Lateral hooks on segments 6-9, those on segment 9 one-third the length of 10. Segments 2-8 subequal in length. Segment 9 one and a half times the length of 8; segment 10 two-thirds the length of 8. Appendages equal to 10. (See figs. 317 and 326-328.)

Length, 38 mm.; abdomen, 26; hind femur, 5.5. Width of head, 6 mm.; abdomen, 7.

This species differs from *donneri* in the sides of the mentum being angulated, in the heavier skinned character of the exuvia and in the dense coat of minute, spiny hairs.



FIGS. 318-320.—*GOMPHUS OLIVACEUS NEVADENSIS*, NYMPH. 318. MENTUM. 319. MENTAL LOBE. 320. SEGMENTS 8-10.

FIGS. 321-323.—*GOMPHUS INTRICATUS*.

FIGS. 324-325.—*GOMPHUS DONNERI*.

FIGS. 326-328.—*GOMPHUS SOBRINUS*.

Described from exuviae collected May 31, 1914, on Coyote Creek, San Jose, California, where the exuviae were numerous along the mud banks of the stream.

GOMPHUS DONNERI, nymph.

A light colored, very delicate and thin skinned exuvia, its surface thinly covered with very short, spiny hairs. General shape intermediate, neither broad nor slender. It is distinguished from other *Gomphus* nymphs by the following characters:

Mentum of labium slightly longer than wide, its posterior edge two-thirds width of anterior edge, its sides slightly sinuate. Its middle lobe convex, with a fringe of about 30 bristlelike scales. Lateral lobes broad at base, tapering regularly to a crescentic tip, the inner margin of which bears about 7 low rounded teeth between which and the base of the lobe are other smaller teeth. Well developed burrowing hooks on both the first and second tibiae. Wing pads reaching to or beyond apex of third segment. Abdomen lanceolate, slightly contracted at base of ninth segment, well arched, no sign of a dorsal groove, but apex of segments 2-7 with a low rounded middorsal tubercle terminating caudad in a minute middorsal tooth on apex of segments 2-7, larger on segments 8 and 9. Lateral hooks on segments 6-9, those on 9 one-fourth to one-third the length of segment 10. Segments 2-8 subequal in length; segment 9 one and a half times as long as 8; segment 10 as long as broad and two-thirds length of 8. Appendages as long as segment 10. (See figs. 316 and 324-325.)

Length, 29 mm.; abdomen, 20; hind femur, 6. Width of head, 5 mm.; abdomen, 6.5.

Described from 2 male and 1 female exuvia and 6 fragmentary exuviae collected on the west end of Donner Lake, California, July 24, 1914. These were found in the trash of the wave line on the sandy beaches along the northwest point of the lake.

14. NOTES ON OCTOGOMPHUS SPECULARIS AND ITS NYMPH.

This graceful dragonfly appears most commonly and in greatest abundance on the perennial torrents of the coast mountains of California. These are streams which never freeze, not even carrying snow water, and which vary in size from trickling spring streams to roaring torrents. The coast mountains are heavily timbered with redwoods and fir on their ocean slopes, but on their eastern side are covered with dense growths of brush except in the deep V-shaped gulches where are found mixtures of redwoods, oaks, alders, and bays. It is in the rushing streams which hurry down through the dense shade of these steep and narrow gorges that *Octogomphus* is found. Here it is accompanied by only three other dragonflies. *Cordulegaster dorsalis* and *Aeshna walkeri* breed with it in the stream and *Argia vivida* occupies the springs along the lower courses of the torrents. Both *Octogomphus* and *Cordulegaster* are confined to the torrential headwaters of the stream but *Aeshna walkeri* and *Argia*

vivida may occur along the stream for some distance after it emerges onto the more level valley floor. Besides occurring on all the streams of the Coast Mountains, *Octogomphus* is found on the smaller streams of the west slope of the Sierras which are perennial but do not rise high enough in the mountains to carry snow water.

From April to August it is abundant on the mountain streams west of Stanford University. On June 8 I found it common on the small streams in the gorge east of the Napa Asylum. This record for Napa County, California, is at present the northernmost record for the Coast Mountains, though it will probably be found as far north as southwestern Oregon, when that region is explored. On June 15 I found numerous exuviae along the banks of the Chico River, where it emerges from the gorge east of the city of Chico. This point, in Butte County, California, is on the west slope of the Sierras and is at present the northernmost record for the species. My southernmost records are from Mr. Fordyce Grinnell's collection in the Southwest Museum of Los Angeles, one being a specimen from the San Gabriel Mountains and the other from the Mount Wilson trail, both in Los Angeles County.¹ Calvert² records this species from Baja or Lower California.

For a gomphine this species has a very long season, probably the longest season of any of the western gomphines. A teneral male was taken on San Francisquito Creek (Santa Clara County, California) April 20, 1914. Many were seen on Stevens Creek (Santa Clara County, California) May 31, while oviposition was observed on the same stream on July 17 and two old males were captured there on August 16, which is the latest seasonal record for the species.

The nymphs of this species occur abundantly in the leafy trash which collects in the pools and eddies of the stream. I do not believe that they burrow in the sandy bottom, as I have observed no tracks even where the exuviae showed the species to be very abundant. In June, after the annual emergence, I found two sizes of nymphs, the larger of which was immature and would have emerged the following season (1915). (See figs. 342-344.) The nymphs included in the smaller size showed considerable variation in size, but as there was a complete series between the largest and the smallest, I concluded that they were probably from early and late ovipositings of the same year and all would emerge in the second season (1916) (see figs. 342 and 343). This would indicate that the nymphs spend three years in the water. Nymphs taken August 16 had assumed the final stage, in which they wintered to emerge the following season. The emergence takes place previous to May 31, probably occurring (on Stevens Creek, Santa Clara County) during the latter half of

¹ In August, 1915, I found *Octogomphus* nymphs in the headwaters of the Mojave River. Since writing the foregoing I have found in Dr. P. P. Calvert's collection an *Octogomphus* female collected by Prof. Trevor Kincaid, July 25, 1895, at Olympia, Washington.

² Proc. Cal. Acad. Sci., ser. 2, vol. 4, 1895, p. 502.

April and the first two weeks of May, for on May 31 I found the exuviae very abundant and no mature nymphs were found. The exuviae were found about the roots of the alder trees, especially where these overhung pools, and usually occurred from one to two feet above the water. On Zyante Creek, a tributary of the San Lorenzo near Santa Cruz, California, frequently a dozen exuviae were found on one tree root.

After emergence the imagoes appear to migrate upstream, not a migration in numbers but each individual probably gradually working up to the swifter waters. This same upstream migration is observable in the associated species, *Cordulegaster dorsalis*. My observations are as follows: On Stevens Creek, where, because of its nearness, I have been able to observe *Octogomphus* at various seasons, exuviae were very abundant in the 2 miles from the trout farm up to the soda spring but occurred less commonly above this point. Imagoes were not found below the soda spring in this region of greatest emergence, though they were common above the spring, even to the head of the creek on the divide 8 miles distant. On the lower stretch of Zyante Creek on July 9, the exuviae were very abundant but not a single imago was observed. The same was true for the Chico River where it emerged from the canyon east of the city of Chico (Butte County, California).

As the nymphs apparently do not burrow in the bed of the stream but live in the loose organic trash that collects in the pools and eddies, this upstream migration is probably to offset the washing down of the nymphs during the winter rainy season when the streams are foaming mill races. Theoretically, some such compensation should occur or this species would gradually spread to the lower portions of these streams, where it is certainly not now found.

As with most gomphines, the males of this species stay near the water while the females are seldom seen there. The males are usually found in the sunlit openings of the streams where they perch on stones, driftwood, or on the foliage of the surrounding alders. But while preferring the sunny spots they do not hesitate to hunt up and down stream through the shade. The four females I have taken were found along a road on the side of the gorge several hundred feet above the stream. They appear to resort to the stream only to oviposit.

After having spent various days wading down mountain streams observing *Octogomphus* more often than catching them, I was rewarded on July 7 by seeing a female oviposit. She came volplaning down through an opening in the canopy of alders and, while going through evolutions involving several figures, 8's and S's, she touched the surface of the pool lightly with the tip of her abdomen at intervals of 2 to 6 feet. After 20 seconds of this she airily spiraled up and out into the sunshine, where she alighted on a bush on the hillside above the creek.

The following are live color notes of *Octogomphus*:

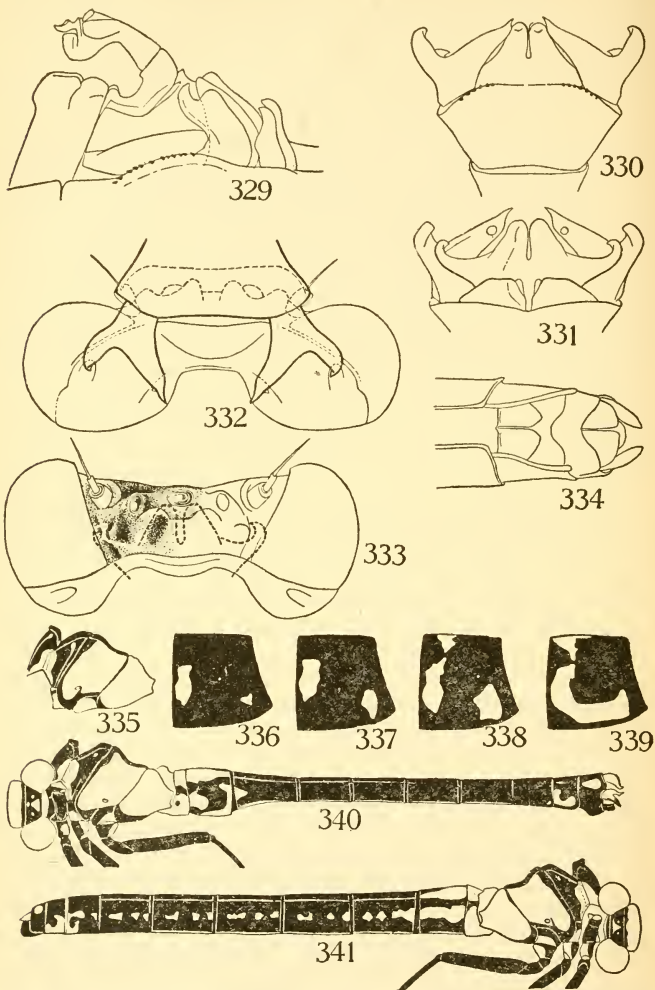
Male.—Labrum black, its lateral edges yellow. Face greenish yellow, with the labrum edged with black above and below, and a triangular spot on its median line; nasus black, in some specimens pale but surrounded by black. Vertex and occiput black, except triangle of greenish yellow posterior to the ocelli. Rear of head black. Eyes gray. (See figs. 336–340.)

Prothorax with anterior lobe yellow and a broad middorsal stripe yellow, otherwise black. Mesothorax and metathorax greenish yellow with a very broad black antehumeral stripe which, in some specimens, extends caudad slightly beyond the humeral suture. In some individuals the humeral stripe is divided by a vertical yellow line, a remnant of which always remains as a small, round, yellow spot in the upper end of the black stripe (see figs. 335 and 340–341). Anterior and lateral alar ridges black. Second lateral suture narrowly black, and side of thorax edged with black below. Both infraepisterna greenish, bordered with black above. Coxae greenish, heavily marked with black. Legs black. Pterostigmas black.

Abdomen black, with a broad greenish-yellow middorsal stripe on segments 1 and 2, which is attenuated caudad in a fine hair line on segments 3 to 6. Side of segment 1 greenish, in the center of which is a small black spot. Auricle on segment 2 greenish yellow, which color also forms a wide stripe along the posterior and ventral edges of its side. Segment 3 with an anterolateral spot and its lower edge yellow. The intersegmental membrane of segments 7–10 yellow. Segment 9, black, except a minute middorsal spot and yellow mottling on its side, which is usually confined to an anterior and a posterior spot, but in some specimens a bar joining these. The figures 336–339 show the variation in this mottling. Perhaps extensive series might show local races with regard to these mottlings, as the Stevens Creek specimens have the least yellow on segment 9 and the Napa series shows several with the spots large and confluent. Segment 10 black, with a large oval middorsal spot, which in most specimens is followed by a minute spot. Appendages black, except the dorsal surface of the superiors, which is yellow.

Female.—Color similar to that of the male. Each of the two at hand has a small yellow spot in the dorsal end of the humeral stripe. Dorsal abdominal stripe as in the male. The side of the abdomen with two yellow stripes, one of which is a hair line along the lower edge of the pleura, while the other is a midlateral stripe on segments 1 and 2, but on segments 3–7 breaks up into a series of small yellow dots, of which there are two to four on each segment. Segments 8 and 9 with yellow mottling on the side. Segment 10 black, except a round middorsal spot. The superior appendages and the cerci yellow. (See figs. 335 and 341.)

In the male, and probably in the female, the teneral colors are bright yellow and black. This teneral yellow changes to greenish



FIGS. 329-341.—*OCTOGOMPHUS SPECULARIS*. 329. SEGMENT 2 OF MALE. 330-331. MALE, APPENDAGES. 332-333. MALE, APPENDAGES AS APPLIED TO HEAD OF FEMALE. 334. FEMALE, SEGMENTS 9-10. 335. THORACIC COLOR IN A PASADENA, CAL., FEMALE. 336-339. VARIATION IN COLOR OF SEGMENT 9 IN MALE. 340-341. COLOR PATTERN.

yellow in breeding individuals, and in very old ones fades to a pale gray with scarcely a trace of the green remaining.

This species is peculiar to Lower California and the coast of California. In spite of its peculiarities in color and structure its venation shows it to be a near relative of the cosmopolitan genus *Gomphus*.

The figures show the structural oddities of this species. In the male the superior appendages are bifurcate, the two outer hooks fitting into narrow recesses on the dorsal edge of the postocular surfaces of the female, while the spines on the inner rami fit into special depressions lower down on the postocular surfaces. The four prongs of the inferior appendage hook over the four tubercles on the vertex of the female. (See figs. 330-333.) The coloration is unusual in gomphines in that the middorsal thoracic stripe is yellow instead of being dark. Figure 329 shows the male genitalia on segment 2, and figure 324, the female genitalia.

Measurements of 10 males and 2 females are as follows: Length of abdomen: Male, 36-39 mm.; average, 37.3; female, 35 and 38 mm. Length of hind wing: Male, 29-31 mm.; average, 30.1; female, 30-32 mm.

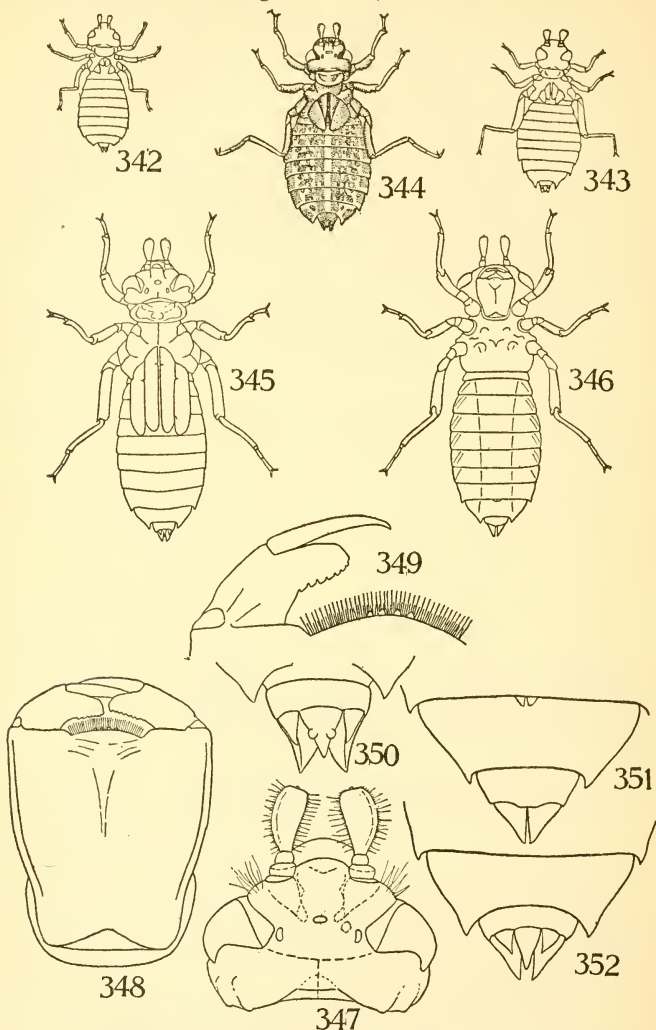
The nymph is as interesting as the imago, as it does not show the short crooked legs and other features characteristic of most gomphines, which are correlated with their burrowing habits. In habits and appearance it is more corduline than gomphine.

Nymph.—Length of exuvia, 24 mm.; abdomen, 15; width of abdomen, 7 mm.; length of hind femur, 5 mm.

Body flat, deeper and more cylindrical in the exuvia than in the live nymph. (See figs. 342-352.)

Head broad cordate, flat above, conspicuously granulated over entire surface. Occiput slightly concave, postocular angles rounded and postocular areas each entirely covered by a large scar which is characterized by from two to four vertical ridges. Antennae: Two basal joints globular, second smaller than the first, third joint three times as long as combined length of first two and one and a half times as wide, depressed, elongate-obovate when viewed from above, its inner edge less convex than its outer; fourth segment a mere tubercle set in the end of segment 3. Head naked except for long hairs on genae and a series of mixed long and short hairs on the edges of the third antennal segment, and numerous short hairs on the labrum. Labium reaching to the posterior side of the fore coxae. Anterior segment of mentum only slightly less broad than long, its posterior end two-thirds as wide as the anterior end. Median lobe regularly convex; its edge with from 30 to 40 long bristles among the bases of which are numerous shorter bristles; four large conical teeth on its middle third, these placed just below or outside the double row of bristles. Lateral lobe short and broad, its end squarely truncate but no inner apical hook, the outer three-fifths of its inner edge with

six to eight broad blunt teeth, these directed proximad and the series graduated distad. (See figs. 348-349.)



FIGS. 342-352.—*OCTOGOMPHUS SPECULARIS*, NYMPH. 342-346. NYMPHS. 347. HEAD. 348. MENTUM. 349. MENTAL DETAIL. 350. MALE, APPENDAGES. 351-352. FEMALE, APPENDAGES.

Dorsal surface of prothorax with an elevated semicircular flat area in the center of which are twin tubercles. No supracoxal processes,

but long hair just above the coxa. Wing pads parallel and reaching almost to the fifth abdominal segment. Legs short but not especially distorted for burrowing; burrowing hooks on fore and middle tibiae.

Abdomen flat ventrally, convex dorsally and thin at the edges, ovate when viewed from above. This may be broadly ovate in the live nymph, which can make itself very flat (thin dorso-ventrally) or narrowly ovate in the exuvia, which is convex on both dorsal and ventral surfaces. Short lateral spines on segments 7, 8, and 9. Segment 10 one-half as long as segment 9 and slightly more than one-third as wide, but one-third longer than the lateral spines of segment 9 between which it lies. Appendages of segment 10 short, conical, the inferiors twice as long as segment 10, the middle only slightly less long, the dorsal paired appendages slightly longer than 10. The entire thorax and abdomen granulated except the intersegmental membranes. Postero-dorsal and lateral edges of segments 2-8 with a crowded row of short heavy bristles scattered among which are very long hairs. Segment 1 is one-third as long as segment 2. An impressed line on each side of the median line of the ventral surface, each line running out posteriorly at the base of the lateral spine on segment 9.

The male larvae can be told by the scar on segment 2, the females by the genitalia at the base of segment 9.

Octogomphus imagoes are close to *Gomphus* in the venation of the wings and the nymphs are very similar to those of *Lanthus*. They differ from nymphs of *Lanthus albistylus*¹ in greater size, in the narrower third joint of the antennae, in the narrower head, in having two to four vertical ridges on the postocular areas instead of one large one, in the smaller teeth on the lateral lobe of the labium and that these are larger at the proximal end of the series. (Both have four teeth on the middle lobe.) Legs and thorax and abdomen are similar except that there are lateral hooks on segments 7-9 in *Octogomphus*, while in *Lanthus* they occur only on segments 8 and 9.

15. NOTES ON AESHNA INTERRUPTA NEVADENSIS AND ITS NYMPH.

This dragonfly, originally named *nevadensis* by Dr. E. M. Walker, is classed in his recent monograph as a variety of *Aeshna interrupta*. Only eight specimens, all males, are recorded. These were collected at Reno, Nevada, by H. K. Morrison, and were deposited in the Museum of Comparative Zoology.

This *Aeshna* is an alpine form. I first met it on July 21, when I was climbing down the thousand-foot hill from Emigrant Gap (California) into Bear Valley. Here, on the fir-covered hillside along the power company's canal, two specimens were catching insects with that peculiarly airy flight and dextrous turning characteristic of this variety. I was unable to catch either, and decided they were *Aeshna interrupta interna*, which they resembled in appearance and habits.

¹ Collected by E. B. Williamson on Pine Creek, Ashland County, Ohio, June 7, 1915.

During the day, I took *Aeshna multicolor* about the lake in the floor of the valley, and *Aeshna palmata* among the willow thickets. On returning at 4 o'clock in the afternoon, I found a single *Aeshna* catching Diptera in an open glade of the hillside, where, with numerous short turns up and down and sidewise, and an occasional figure eight, and various volplanings, it was exhibiting the same ease on the wing as shown by a *Brechmorhoga*. On catching it I saw it was a *nevadensis* teneral. Bear Valley lies at an altitude of 4,500 feet, the lowest altitude at which I took this species.

I next met this species at Donner Lake, California, at an elevation of 5,200 feet, where it was associated with *Aeshna palmata* and an occasional *Anax junius*. Here on cool windy days it hunted among the willow thickets, but on bright, warm days it spent most of its time hunting high and wide, much after the habit of *multicolor*, seldom coming lower than 10 or 15 feet above the ground. But even on the cool days, when flying frequently in the protection of the willow clumps, it never persisted in confining itself to a low, thoroughly protected beat as does *umbrosa* or *palmata*, both of which will work many minutes at a time on a short beat only 4 to 6 feet above the ground. On July 25, in Donner Creek, 200 feet from the outlet of the lake, I took several exuviae clinging to a log, and one nymph, which was ready to emerge.

Along Truckee River, California, for the 9 miles from Squaw Creek to Lake Tahoe, and along the west shore of Lake Tahoe, *nevadensis* was common, frequently three or four being in sight at the same time. Observations here indicated that their flight was free and wide, the individual making from one to a half dozen wide turns in an open space, and then wandering on into the next glade, with an occasional few minutes hanging from some limb usually high in the air.

I next met this species at an elevation of 6,500 feet in a small meadow-like opening of the fir forest, where the Rubicon Springs road crosses McKinney Creek (California). Here at 9 o'clock in the morning it was cool and in an hour I had caught five or six on the wing. They were flying low and many stopped flight to hang on weeds only a foot or two high. Such a one would hunt for a suitable weed, and after trying one or two, would hang from the underside of one of the leaves, when it was easily taken by approaching from the opposite side, and slapping the net over both weed and dragonfly. Also I saw several flying close over the surface of the creek on short beats, apparently after small insects which hovered over the surface of the water. No other species of *Aeshna* was seen or taken here or elsewhere around Lake Tahoe, with the possible exception of a single exuvia from the McKinney Lakes which Doctor Walker referred to *palmata*.

I finally found this species in its greatest numbers about four lakes on the divide between McKinney Creek and the Rubicon River

(California), where, at an elevation of 7,000 feet, this species dominated all other dragonfly life. Here, in a mountain pass fairly level for about two miles, lie four small, shallow lakes, two of which flow east into McKinney Creek and Lake Tahoe, and two flow west into the Rubicon River and the Pacific drainage. On both sides rise granite crags for a thousand feet above the level of the lakes, with their lower slopes and the borders of the lakes covered by green firs, and their higher naked slopes spotted white with small patches of snow. Three of the lakes are covered with yellow pond lilies and fringed with sedges, while numerous clumps of gray willows dot their shores. These lakes swarm with insect life and are apparently without fish, while the fourth lake is free of aquatic plants and is said to contain fish. This lake has few dragonflies. The three lakes supporting dragonflies were surprisingly warm. Expecting cold lakes at this altitude, I found the water too warm to drink with relish. This unusual warmth appeared to be due to the shallowness, the depth not exceeding three feet, and to the black peaty mud covering the bottom, which combination with the constant clear weather in this region during the summer months caused the lake water to heat rapidly from the sun's rays. At this elevation the air was so cool that *Aeshna* was easily taken on the wing and in two days' collecting I succeeded in catching 60 males and 28 females.

This species emerges from these lakes in immense numbers. I have never seen *Aeshna* exuviae so numerous. At the lake about which I did most of my collecting there was a zone of sedges 5 to 25 feet wide along the shore. The majority of the sedge stems were riddled with eggs, and exuviae hung frequently two or three deep on the prominent ones. I picked nearly a quart from an area about 15 feet square. While adults swarm over these ponds, they are not one-tenth as abundant as the exuviae, a fact explained by the wandering proclivities of both males and females.

As far as is known, those species of *Aeshna* which have been observed have emerged in the nighttime. I have reared both *multicolor* and *californica*, which emerge about midnight, but this species on these lakes, where the night temperature usually approaches freezing, emerges in the daytime. I found many teneral and took ten individuals in the act of emerging, which occurred at any time from 10 in the morning to 4 in the afternoon. This change in the time of emergence, perhaps, permits this species to live at this altitude, a thousand feet higher than I took any other species of *Aeshna*; and a true alpine habitat with nightly freezing temperatures.

At my earliest arrival on the lakes (10 in the morning) females were ovipositing and males were circling the borders of the lakes catching insects and watching for females, which were usually captured while ovipositing. The males, while around the lakes, usually flew at a height of from 1 to 4 feet above the sedge border, gradually

making their way around the lake in a series of short beats, which if plotted would show a series of loops overlapping, but each in advance of the preceding with occasional side flights after passing females and insect prey. Because of this habit of circling the edge of the lake, which was more pronounced in the morning while the sexual impulse was strong, I caught the majority of my specimens by standing in one place and catching the individuals on the wing as they passed.

In catching the females, the males would pounce down on them as they moved among the sedges from one oviposition to the next, or would themselves quietly drop, from their swifter coursing, down among the sedge stems and slowly work through the narrow channels until they found some female ovipositing. She would be seized, and the pair would dash away in a nuptial flight, which soon ended in a long rest in copulation while hanging to a tree. Many pairs flew about the lakes with the male holding the females' head, but not in copulation. This was more common than usual in *Aeshna*, reminding one of *Celithemis* or *Anax junius*. The females oviposited below water, as is usual among *Aeshnas*, most of the ovipositing being done in *Carex* stems. The egg is illustrated in figure 382.

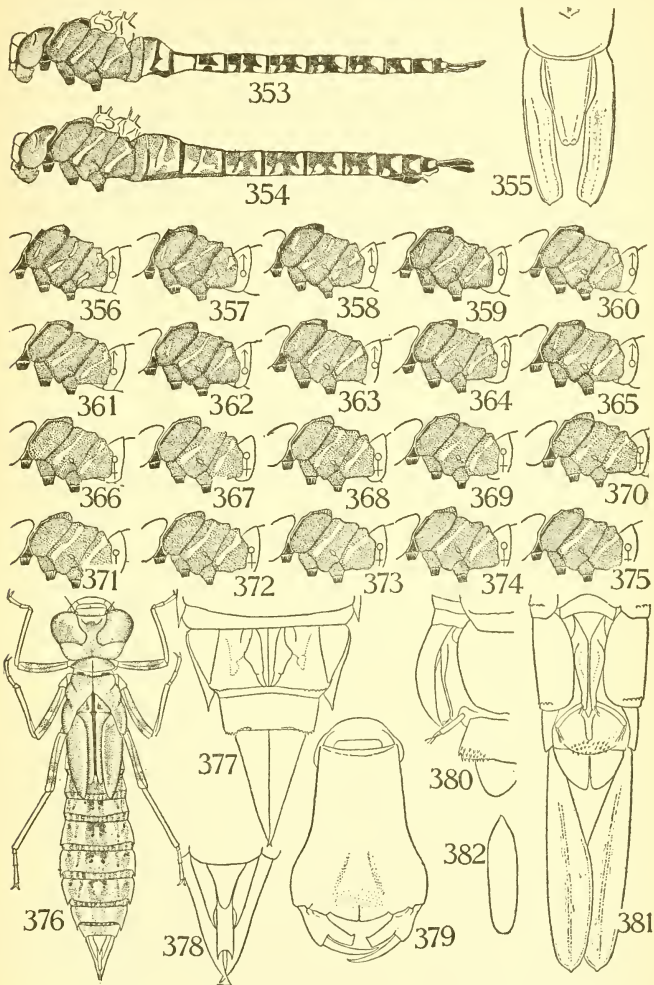
Females were common through the open places in the timber far from the lakes, where they were ranging for food, but while around the water their whole attention seemed to be concerned with ovipositing, except when males took them away in copulation.

Male.—The male of this species is easily distinguished from *interrupta interna* by the shape of the superior appendages (see fig. 355).

My field notes indicate that the pale colors are blue with the lower ends of the thoracic stripes paler but not distinctly yellow, while the dried material shows a majority of the specimens with lower end of thoracic stripes distinctly yellowish. (Fig. 353.) My impression is that the thoracic stripes were always blue in the male. The thoracic stripes varied remarkably from completely interrupted lateral stripes, which occurred in four of the sixty males, though various narrowly connected stripes of which there were about 12 resembling *lineata*, to the common form shown by the majority with the anterior stripe broad at the base and tapering to a point above, while the posterior stripe was moderately wide throughout its length. The figures 356-365 show these variations. In life the eyes were blue above and brownish or grayish below, with a narrow blue and black dash across the upper surface. The thorax was grayish brown, the abdomen black. The wings of the males were always hyaline.

Female.—I can not distinguish the female of *nevadensis* from several undoubted females I have of *interna*. Both blue and yellow females were taken on McKinney lakes. My field notes of July 28 give colors of 17 females taken that day as follows: One, all markings yellow, except the blue stripes in the brown eyes, wings strongly

flavescent to the stigmas; one with all markings yellow, except the blue eye stripes and the markings on segments 5-10 greenish, wings



FIGS. 353-382.—*AESHNA INTERRUPTA NEVADENSIS*. 353-354. COLOR PATTERN. 355. MALE, APPENDAGES. 356-375. THORACIC COLOR VARIATIONS. 376-379. NYMPH. 377. VULVA. 378. MALE, APPENDAGES. 379. MENTUM. 380-381. SEGMENTS 9 AND 10 OF FEMALE. 382. EGG.

flavescent to stigmas; five with all markings pure blue; the other 10 with various intermediate colorations, the common form being

with greenish blue abdominal spots and the stripes on the thorax blue above and creamy yellowish below. The abdomen of the latter is brown shading darker caudad, the thorax brown, and the eyes grayish, never as blue as in the male. The females, whether yellow or blue, invariably had the blue dash in the eye. (See figs. 354, 366-375, and 380-381.)

Abdomen (without appendages), 45-47 mm.; appendages, 6; hind wing, 45-46.

Nymph.—I have not been able to distinguish the nymph from that figured by Walker¹ for *interrupta interrupta*. Some show the same color pattern as figured in his monograph, while others show each middorsal dark spot inclosing a pale spot as in my figure of *nevadensis* nymph. (See figs. 376-379.)

Length of body, 34 mm.; mentum, 6.5 long, 5.5 broad; hind wing, 9-10; hind femur, 6.5; inferior appendages, 4-4.5; genital valves, 2; width of head, 8; abdomen, 8.

16. A NEW SPECIES OF AESHNA—ITS NYMPH AND ITS HABITS.

This near relative of *palmata* was recorded first from Baja California by Calvert as *constricta*.² Walker in his monograph³ corrected this determination, placing part of Calvert's material under *palmata*, but noting the differences in coloration and structure between these Baja specimens and true *palmata*. As Walker had only males he deferred final judgment on the status of this form.

In the collection of Stanford University I found seven males of this species, which had been collected on the streams in Santa Clara County, California, during September and October of previous years. During these months in 1914 I was unable to collect, though on two different occasions I saw individuals, which were probably this species, on San Francisquito Creek west of the university buildings. On January 6, 1915, I found 14 exuviae on Los Trancos Creek, which is a stream of the Coast Mountains west of Stanford University. Other exuviae were collected on Arroyo Seco at Pasadena, California. During the summer of 1915 I collected nymphs in Mission Creek, back of Santa Barbara, California, and 16 males and 8 females on the streams of Santa Cruz Island, which lies 23 miles south of Santa Barbara. Numerous nymphs and exuviae were collected here also.

My few observations and the data on the Stanford specimens indicated that this species around Palo Alto emerges during August, and is on the wing until November. It is a stream species with habits similar to those of *palmata*. It inhabits the warmer frost-free streams

¹ The North American Dragonflies of the genus Aeshna. University of Toronto Studies, Biol. Series No. 11, 1912, pl. 6, fig. 2.

² Odonata of Baja California, Mexico. Proc. Cal. Acad. Sci., ser. 2, vol. 4, 1895, p. 509. Specimens from La Chuparosa, October, 1893.

³ North American Dragonflies of the Genus Aeshna, 1912, p. 164.

of the Coast Mountains, while *palmata* lives mostly on the colder streams of the Sierras. The ranges of the two species touch around San Francisco Bay. I have two female *palmata* from Stockton. A single female, which is probably *palmata*, was collected on Stevens Creek, Santa Clara County, California, which is only a few miles from Stanford. On this same creek I collected several exuviae of *walkeri*. These records from the neighborhood of Stanford are the northernmost records for *walkeri* and the farthest southwest records for *palmata*.

Since writing my first description of this species (not published) I found it very abundant on Santa Cruz Island, August, 1915. This mountainous island, 23 miles off the coast of California, contained no water except that found in the small, clear spring streams flowing down the narrow mountain gorges which opened to the sea at various points in the line of cliffs which surround it.

Aeshna walkeri was most abundant on the stream flowing down at Fry's Harbor. This stream was about 2 miles long and in that length fell over a thousand feet. It flowed down from Mount Diablo, a rocky crag rising to a height of about 3,000 feet. The canyon containing the stream was a V-shaped gorge a thousand feet deep with its sides covered with a thin growth of grass and scattering clumps of live oaks, where they were not too precipitous for vegetation.

Except in one or two places, either one or both banks of the stream were nearly vertical walls of rock and the course was broken every few hundred feet by a waterfall of from 10 to 40 feet. In places the stream was shaded by live oaks and alders, and here and there great clumps of green sword ferns, 7 feet high, gave a pleasing relief to the gray and brown of the naked rock. In several quarter-mile stretches the course of the stream was so deep that its bed was a fairly smooth trough of rock, being too steep to retain the rocks and sand washed down from above. Such stretches frequently contained pools, mere rock bowls, 6 to 10 feet in diameter, filled with water, in which green clouds of filamentous algae floated over the black leaves and vegetable trash in the bottom. Such pools were alive with tadpoles, *Aeshna walkeri* nymphs, and *Archilestes* nymphs. The upper half-mile of the stream was very stagnant, and here *Argia vivida* flourished. At no place in the stream did aquatic vegetation occur and in only a few places did roots hang in the water. Because of this lack of vegetation in which *Aeshna* usually oviposits, the habits of this species were unusual.

During the sunny part of the day the males are found coursing up and down the creek. As there is usually a morning fog on the island, which does not clear away until 9 o'clock, it is frequently 11 o'clock before the *Aeshna* males are on the creek. They then persist in flying up and down until the middle of the afternoon, when they leave the

water one by one to hunt insects in the sunshine above on the hill-tops. In the patrolling of the creek they combine feeding and hunting for females. A male will fly slowly along the rocky wall overhanging the water, inspecting every nook and cranny, and only give a hurried inspection to the open side of each pool. After being satisfied that he has not overlooked a female he will rise over the waterfall at the head of the pool and proceed to inspect, in the same manner, the stream above.

In a single afternoon's collecting I caught 14 males, which was probably a half of all living on the stream at the time, for in the next two days males were so scarce that I took only two more.

The females do not spend as much time on the creek as the males. Few were found on the creek before 3 o'clock, but when it had become almost twilight in the depths of the gorge they were nervously hurrying up and down the creek ovipositing. The method of this was so unusual that I did not recognize at first what they were doing. A female would alight on one of the rock walls overhanging a pool and would try to insert her ovipositor in the rock. After an attempt or two she would fly a few inches or feet and make another attempt. As the rocks over the pools in the shadier spots were seamed with lines of green moss, she would soon locate such a seam and drive her ovipositor into the vein of moss. The eggs thus were laid in the thin seam of moist earth which supported the moss. Usually less than a half dozen stabs would be made in one seam when she would fly to another and repeat the laying. In two places where tree roots hung into the water, females were flushed that were probably ovipositing in these. Oviposition was going on as late as 5 o'clock when it was almost twilight in the shadier portions of the gorge.

In copulation a male usually found a female while she was seated on a vertical wall of rock, and picking her off the two would fly away in copulation. This usually lasted some time while the pair hung to some live oak bush on the hillside. Pairs did not fly in couple as does *Anax*.

The nymphs were abundant in the shallow algae-filled pools, where they crawled slowly under and over the masses of green algae. One was observed eating a small tadpole of which there were many of at least two species in the stream.

This remarkable *Aeshna*, which is probably one of the last to be described from north of Mexico, I take pleasure in naming for Dr. E. M. Walker, who in his beautiful monograph of the North American species of this group has opened the way for future students.

AESHNA WALKERI, new species.

Length of abdomen, including appendages: Male (Palo Alto, California), 51-57 mm.; female (Santa Cruz Island, California), 56. Female appendages, 6 mm. Hind wing: Male, 43-47 mm.; female, 48.

Type.—Cat. No. 20817, U.S.N.M. A male from San Francisquito Creek, Santa Clara County, California.

No allotype has been named as I have no females from the same region as the male.

Structurally the males of this variety differ from *palmata* in the broader superior appendages with shorter preapical spines, and in the shorter anterior lamina and shorter anterior hamuli. (See figs. 385–386 and 395–396; also fig. 404, *constricta*.) As to the number of cells between A_2 and A_3 at their origin, four of the Stanford males have one cell in each hind wing and three have one cell in one hind wing and two cells in the other. This venational character is not reliable because it also varies in *palmata*, of which I have two males from the Sierras in each of which there are two cells between A_2 and A_3 at their origin.

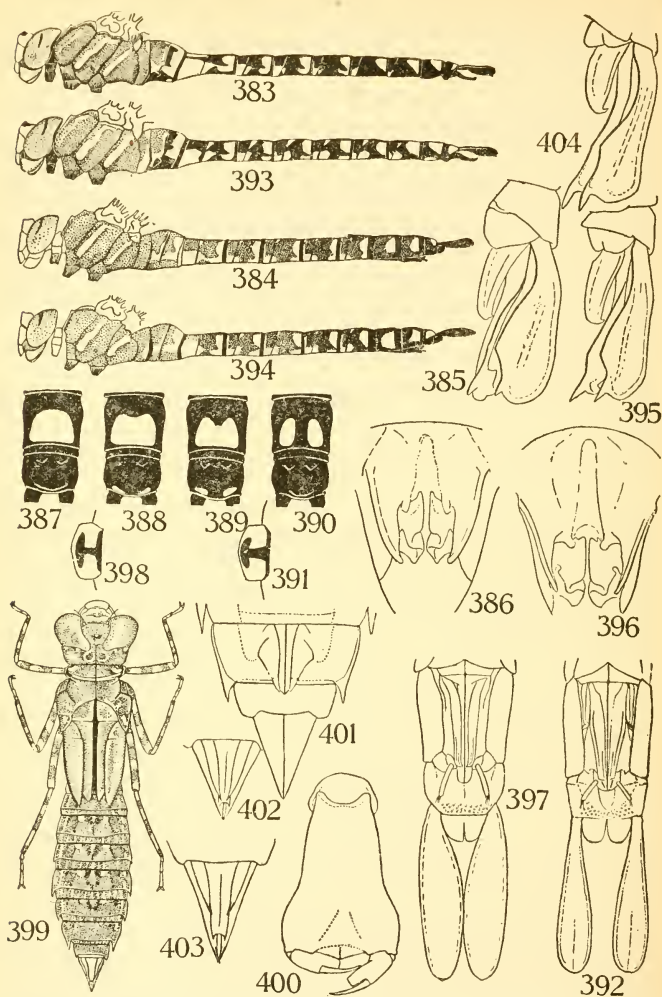
The live colors of the Santa Cruz Island males are as follows:

Labrum grayish white, face bluish gray, horizontal surface of frons creamy. Stem of "T" mark wide at base. Frontal vesicle and occiput creamy. Eyes gray above, pale gray below with a narrow blue dash backed by a narrow black line. Postocular areas black. (See figs. 383 and 391.)

Prothorax brown, with the anterior and posterior lobes paler. Mesothorax and metathorax dark brown. Anterior stripes pale blue and at antealar sinus two-thirds as wide as the lateral stripes, tapering regularly to the mesostigmal ridge. Lateral stripes whitish, blue-gray, very slightly bluer above. Both lateral stripes with nearly straight parallel edges, 1–1.2 mm. wide. This character varies, as four of the sixteen Santa Cruz males have the upper end of the antero-lateral stripe slightly sinuous. Legs very dark brown except tibiae and tarsi which are black. Wings hyaline; pterostigmas black.

Abdomen black, except segments 1 and 2, which are dark brown. All markings pure blue. The color pattern is similar to that on male *palmata* (figs. 393 and 398) except that ML is present only to 6 and is very minute. AL decreases rapidly in size from 3–8, being very small on 7 and 8. PL is present only to 5 or 6 and when present is broadly joined to PD. On all the Santa Cruz Island males the right and left PD on segment 9 are broadly joined. In the seven Stanford males all conditions of fusion were present (see figs. 387–390).

The female differs but slightly from that of *palmata*. In my southwestern *palmata* females (from Auburn, Stockton, and Stevens Creek, Santa Clara County) the anterior edge of the posthumeral pale stripe is distinctly sinuate as also in a female from Sunnyside, Washington. In *walkeri* females, of which I have eight from Santa Cruz Island, this anterior edge is either straight or slightly convex. The pterostigmas are black while in the western *palmata* females these are brown. The appendages are more spatulate than in *palmata* and the occiput is only half as large. (See figs. 392 and 397.)



FIGS. 383-392.—*AESHNA WALKERI*. 383-384. COLOR PATTERN. 385. MALE, APPENDAGES. 386. HAMULES. 387-390. COLOR, SEGMENTS 9 AND 10 OF MALE. 391. FRONS. 392. FEMALE, SEGMENTS 9 AND 10.

FIGS. 393-398.—*AESHNA PALMATATA*.

FIGS. 399-402.—*AESHNA WALKERI*, NYMPH. 400. MENTUM. 401. VULVA. 402. FEMALE, APPENDAGES.

FIG. 403.—*AESHNA PALMATATA*, NYMPH, FEMALE APPENDAGES.

FIG. 404.—*AESHNA CONSTRICTA*, MALE APPENDAGES.

The live colors of the Santa Cruz Island females are as follows:

Labrum grayish white, face pale brown, dorsal surface of frons creamy, stem of the "T" mark wide at the base. Frontal vesicle and occiput creamy. Eyes dark brown, paler and more grayish below, with a blue and black dash. Postocular area entirely black. (See fig. 384.)

Prothorax dark brown, the anterior and posterior lobes paler. Mesothorax and metathorax dark brown (not as dark as in the male). The anterior stripes mere blue lines. Lateral stripes as in the male, but the anterior not sinuous on its anterior edge, color a pale blue-gray, very slightly bluer above; both stripes bordered on each side by very dark brown. Both stripes run up onto the wing sclerites. The posterior edge of the dorsal end of the anterior lateral stripe is extended caudad more or less distinctly for the width of the stripe along the alar ridge. But little variation in thoracic color occurs among the eight females caught. Wings with stigma very dark brown, black except on a very close inspection; costal half of wing membrane flavescent as far as stigma, posterior to which it is more intense than elsewhere. Legs with coxae, trochanters, and femora dark brown, tibiae and tarsi black.

Abdomen dark brown, becoming darker caudad so that segments 8-10 are nearly black; appendages black. One female was taken in which the abdominal markings were blue; in the others they were yellowish olive green. None with pure yellow markings were seen.

The abdominal markings are similar to those of the male. From those of the female *palmata* (fig. 394) they differ in having a minute AD present on segments 3-7, in having PL present on segment 7, and in having PL and PD connate on all segments on which both occur. There are no blue markings on the ventral surface of the abdomen.

Nymphs.—Two females. Length of body, 34-37.5 mm., labium, 6.5-7, hind femur, 6.5-7; hind wing, 7.5-8; head, 8-9. Width of abdomen, 7-8 mm. (See figs. 399-402.)

The nymphs show a combination of *umbrosa* and *palmata* nymphal characters. The shape of the labrum is intermediate between that of *umbrosa* and *palmata*, its apical breadth between two-thirds and three-fourths of its length; but the lateral lobes have no internal distal tooth, thus resembling *palmata*. The dorsal paired appendages are almost as long as or, in one specimen, slightly longer than the middle appendage. In the specimen having the shortest dorsal appendages these were four-fifths as long as the middle appendage. In this character it differs from both *umbrosa* and *palmata* (fig. 403), as in both of these the dorsal appendages are only two-thirds as long as the middle appendage. In the female nymphs the genitalia extend under the anterior fourth or third of segment 10. The coloration in all the exuviae is very dark, the legs especially being very vividly banded, both on the femur and tibia.

These nymphal skins were collected January 6, 1915, on the roots and trunks of alder trees overhanging Los Trancos Creek where they had been probably since the preceding August.

17. SOME LISTS OF ODONATA COLLECTED IN NEVADA AND CENTRAL CALIFORNIA DURING 1913 AND 1914.

The following pages are devoted to lists by localities of Odonata collected in California and Nevada by the writer during the summer of 1914.

My collecting in California comprised three trips. One during June up the Napa River and up the Sacramento Valley to Tehama, one during July up the American River and about Lakes Donner and Tahoe, and a third during September up the San Joaquin Valley to Bakersfield, thence to the vicinity of Los Angeles.

Because of its great length north and south, because one border is on the coast and one on the desert, and because its great Sierra holds many northern forms, California has the richest odonate fauna of any of the Western States.

Faunistically the State can be roughly divided into three sections, though these are nowhere sharply defined. The entire western border of the State for a width of from 50 to 100 miles is occupied by the Coast Ranges. These are mainly north and south ridges of about the size and appearance of the Alleghanies of the eastern United States. In the north these are heavily timbered. In the central parts of the coast the timber is light, and on the east slopes replaced by brush (chaparral), while in the south, Los Angeles and vicinity, the timber is found only in the narrow canyons. Throughout the entire length of these Coast Ranges are numerous perennial streams, but in the southern half of these mountains many of these streams are dry beds of white sand in their lower courses during the dry season. This coast region is characterized by several local coast species.

The second great region is that of the valleys of the Sacramento and San Joaquin. As these rivers empty into the Bay, their valleys are connected by the Bay region and become a continuous plain 300 miles long and in places 50 miles broad. This is more level than a Kansas prairie and is a dry region with summer temperatures of 90° to 120° F. It is farmed largely to grains and its cities are walled about by great dykes, as it is subject to floods when the snows melt in the mountains each spring. It is characterized by several Mexican species which here reach their northernmost limits.

The third region is that of the great Sierra Range, which runs for the greater length of the eastern side of the State. The passes over this are from 7,000 to 8,000 feet above sea level and its snow peaks tower from 11,000 to 14,000 feet. The west slope is 50 miles wide, but yet so steep that the numerous rivers come down through can-

yons from 1,000 to 3,000 feet deep. This west slope is a dry region, except in the bottoms of the canyons, and has a fauna similar to that of the Coast Ranges, but at an elevation of about 4,000 feet this begins to give place to the purely Canadian fauna of the crest of the range. Here, at elevations of 6,000 to 10,000 feet, are found many species which flourish at sea level in British Columbia. It is in this Sierra region that several of these species reach their southernmost ranges.

The entire northern third of the State is unexplored as far as its dragonflies are concerned. The southeastern part of the State has a fauna which resembles that of the interior valleys, but is more strongly Mexican.

PALO ALTO, SANTA CLARA COUNTY, CALIFORNIA.

Palo Alto and Stanford University are situated on the flat at the southern end of San Francisco Bay. This is a plain dotted by the rich green of numerous low, round-topped live oaks and, except for artificial reservoirs, is dry from April to December of each year. Five miles west of the University the rolling dark green slopes of the Coast Range rise to an altitude of 2,000 feet. These are covered by conifers on their west slopes and in the deep moist canyons, but on their drier eastern side the redwoods and firs give place to scrub oaks, laurels, and dense brush. Numerous perennial torrents rush down through the heavy shade of the alders in the narrow winding gorges of these mountains to sink into the sand of their dry beds in the lower foothills, or to be dammed up and led away in irrigation pipes. Hidden away on the high slopes of the mountains are various spring-fed dams made to water stock, which have a more abundant dragonfly fauna than the ponds of the flat below. Such are the "Mud Lakes" of Stanford students, which lie at an elevation of 1,400 feet on the ridge between Corte de Madero and Los Trancos Creeks.

1. ARCHILESTES CALIFORNICA *Mc Lachlan*.

Many specimens in the Stanford collection. Probably on all large ponds in the fall. I have not collected about Stanford at this season.

2. LESTES CONGENER *Hagen*.

Occasional on all ponds.

3. LESTES DISJUNCTUS *Selys*.

On the mountain ponds. Specimens from the Coast Range have the pterostigmas black, the humeral stripe blue and little or no black on or posterior to the second lateral suture. The appendages are identical with eastern *disjunctus*.¹

¹ Specimens from the Lake Tahoe region have a broad stripe on the second lateral suture. Specimens from Washington and Oregon are as black on the sides as those from the Eastern States. One Oregon male has the thorax entirely black.

4. *LESTES STULTUS* Hagen.

Very abundant on the "Mud Lakes"; emerging during June (see page 484).

5. *LESTES UNGUICULATUS* Hagen.

Occasional on the mountain ponds.

6. *ARGIA VIVIDA* Hagen.

Common about all perennial springs.

7. *ENALLAGMA CALVERTI* Morse.

Occasional on Felt Pond during May and June, also on "Mud Lakes."

8. *ENALLAGMA CARUNCULATUM* Morse.

Common on all ponds and streams except the mountain torrents.

9. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common on all streams and ponds except the mountain torrents.

10. *ENALLAGMA PRAEVARUM* (Hagen).

Occasional on all lowland streams and ponds. Common at "Mud Lakes."

11. *TELEBASIS SALVA* (Hagen).

Occasional about ponds.

12. *ZONIAGRION EXCLAMATIONIS* (Selys).

Common in the outlet to Searsville Lake. Occasional on ponds.

13. *ISCHNURA CERVULA* Selys.

Common on all ponds. The females colored like the males are common in this locality. The females are very definitely dichromatic.

14. *ISCHNURA ERRATICA* Calvert.

Occasional about ponds. Most often taken on the westernmost of the "Mud Lakes."

15. *ISCHNURA PERPARVA* Selys.

Common about all ponds and stagnant streams. The local males have less yellow on the abdomen than Oregon and Washington males.

16. *CELAENURA DENTICOLLIS* (Burmeister).

Occasional on ponds.

17. *CELAENURA GEMINA* Kennedy.

One male, Sharon Pond.

18. *CORDULEGASTER DORSALIS* Hagen.

On all perennial mountain torrents (see p. 515).

19. *GOMPHUS SOBRINUS* Selys.

A stray female was taken on Felt Pond in April, 1914 (see p. 558).

20. *OCTOGOMPHUS SPECULARIS* (Hagen).

On all perennial mountain torrents (see p. 574).

21. *ANAX JUNIUS* (Drury).

Occasional on the larger ponds.

22. *AESHNA CALIFORNICA* Calvert.

Common about ponds from April till July.

23. *AESHNA MULTICOLOR* Hagen.

Common from May to September.

24. AESHNA WALKERI Kennedy.

Common on San Francisquito and other creeks from August to November.

25. LIBELLULA FORENSIS Hagen.

Common on ponds and stagnant streams.

26. LIBELLULA PULCHELLA Drury.

Occasional on ponds.

27. LIBELLULA SATURATA Uhler.

Common on all ponds.

28. PLATHEMIS LYDIA (Drury).

Common on all ponds.

29. ERYTHEMIS SIMPLICICOLLIS (Say).

Common on all ponds.

30. SYMPETRUM CORRUPTUM (Hagen).

Common on ponds. This is on the wing from the latter part of February till December.

31. SYMPETRUM ILLOTUM (Hagen).

The most common *Sympetrum*. This has also a long season, March till November.

32. SYMPETRUM MADIDUM (Hagen).

Common on the mountain ponds, emerging in June.

33. PACHYDIPLAX LONGIPENNIS (Burmeister).

On Felt Pond.

34. TRAMEA LACERATA Hagen.

On Sharon Pond.

STEVENS CREEK, SANTA CLARA COUNTY, CALIFORNIA.

The upper 10 miles of this creek is a clear, swift mountain stream. During the rainy season it empties into San Francisco Bay, but from June to December there is no water in its lower more level course. It comes down through a narrow gorge, and is heavily shaded by alders and bay trees.

1. ARGIA VIVIDA Hagen.

Occasional about springs along the lower course of the creek.

2. CORDULEGASTER DORSALIS Hagen.

Common on the swift upper end of the creek (see p. 515).

3. OPHIOGOMPHUS BISON Selys.

One specimen was seen near the Trout Farm.

4. OCTOGOMPHUS SPECULARIS (Hagen).

Common on the swift upper end of the creek.

5. AESHNA PALMATA Hagen.

One female was taken in August near Soda Spring. This is the farthest southwest record for the species.

6. AESHNA WALKERI Kennedy.

Common along the creek (see p. 586).

7. SYMPETRUM ILLOTUM (Hagen).

Two seen below the Trout Farm.

SAN JOSE, SANTA CLARA COUNTY, CALIFORNIA.

San Jose is on the flat land at the extreme southern end of San Francisco Bay. The collecting was done along Coyote Creek, a sluggish mud-banked stream flowing through the city.

1. *HETAERINA AMERICANA* (Fabricius).

Four specimens taken May 16, 1914.

2. *ARCHILESTES CALIFORNICA* Mc Lachlan.

Nymphs common. Have not collected at this place later than July 4.

3. *HYPONEURA LUGENS* Hagen.

One specimen taken. Not common.

4. *ARGIA AGRIOIDES* Calvert.

Abundant during July when stream is most stagnant.

5. *ARGIA VIVIDA* Hagen.

Not common.

6. *ENALLAGMA CARUNCULATUM* Morse.

Common.

7. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common.

8. *ENALLAGMA PRAEVARUM* (Hagen).

Not common.

9. *TELEBASIS SALVA* (Hagen).

Common.

10. *ZONIAGRION EXCLAMATIONIS* (Selys).

Occasional during May and June.

11. *ISCHNURA CERVULA* Selys.

Abundant.

12. *ISCHNURA PERPARVA* Selys.

Common.

13. *CELAENURA DENTICOLLIS* (Burmeister).

Occasional.

14. *CELAENURA GEMINA* Kennedy.

Pair in copulation.

15. *PROGOMPHUS BOREALIS* Mc Lachlan.

Two seen.

16. *GOMPHUS SOBRINUS* Selys.

Very abundant during May, 1914; none seen during May, 1915; this probably due to late rains (see p. 530).

17. *ANAX JUNIUS* (Drury).

Occasional.

18. *AESHNA CALIFORNICA* Calvert.

Abundant during May.

19. *AESHNA MULTICOLOR* Hagen.

Abundant during summer.

20. *MACROMIA MAGNIFICA* Mc Lachlan.

Abundant during May, 1914. These emerged in numbers, the exuviae being common in the grass roots two feet above the stream. In 1914 the emergence took place before May 10. Few were seen in 1915.

21. *LIBELLULA SATURATA* Uhler.

Common.

22. *PLATHEMIS LYDIA* (Drury).

Common.

23. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common.

24. *SYMPETRUM CORRUPTUM* (Hagen).

Occasional.

25. *SYMPETRUM ILLOTUM* (Hagen).

Common.

SAN LORENZO RIVER, SANTA CRUZ, CALIFORNIA.

This is a stream less than 20 miles long, which flows down the heavily timbered west slope of the Coast Range and empties into Monterey Bay at the town of Santa Cruz. I collected on Zyante Creek, where I saw no imagoes but found every stream-side tree and log covered with the exuviae of *Octogomphus* and *Cordulegaster*. The adults of these had evidently migrated farther up stream. The other species were taken on the San Lorenzo in the rocky gorge between Big Trees and Rincon, the best collecting being in the vicinity of Rincon. Probably the best collecting in the San Lorenzo is in the open valley towards Felton, above Big Trees, which part of the stream I did not visit.

1. *HETAERINA AMERICANA* (Fabricius).

Common below Big Trees.

2. *ARGIA EMMA* Kennedy.

Common from Big Trees to Rincon.

3. *ARGIA VIVIDA* Hagen.

Occasional below Big Trees.

4. *ENALLAGMA CARUNCULATUM* Morse.

Occasional below Big Trees.

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common below Big Trees.

6. *ENALLAGMA PRAEVARUM* (Hagen).

Occasional below Big Trees.

7. *ZONIAGRION EXCLAMATIONIS* (Selys).

Common below Big Trees.

8. *CORDULEGASTER DORSALIS* Hagen.

Exuviae very abundant on middle reaches of Zyante Creek. No imagoes seen at all and no exuviae found below the swift water in the Zyante. The imagoes had emerged and evidently migrated farther up the creek.

9. *OPHIOGOMPHUS BISON* Selys.

Two specimens were taken on a small gravel bar in the San Lorenzo at Big Trees, where two exuviae were found on the base of an alder overhanging the stream. Two other imagoes were taken on a riffle at the Rincon powder works. These catches are interesting in that this species had been known only from a female, the type, which, deposited in the McLachlan collection, was labeled "from Santa Cruz, California." Probably the type had been taken on the San Lorenzo River.

10. *OCTOGOMPHUS SPECULARIS* (Hagen).

The exuviae of this species were abundant with the *Cordulegaster* exuviae on the middle reaches of Zyante Creek, but none were seen below this and no imagoes were seen.

11. *AESHNA CALIFORNICA* Calvert.

Several were seen above Rincon.

12. *AESHNA MULTICOLOR* Hagen.

Several seen along the railroad above Rincon.

LOS GATOS RIVER, SANTA CLARA COUNTY, CALIFORNIA.

Excepting for *Argia vivida* Hagen and a few *Cordulegaster* and *Octogomphus* on its headwaters, this stream is practically without Odonata. This is because of the very dense shade on the upper part of the stream, and the fact that so much water is removed by irrigation and for the town of Los Gatos that in any ordinary season the river is entirely dry in its open portion below Los Gatos.

From June 6 to 9 I collected at points on the Napa River. This small river, lying entirely in Napa County, drains a shallow valley on the north side of San Francisco Bay. This valley, lying just east of the main range of the Coast Mountains, is rather dry so that it resembles the Sacramento Valley. At Napa, where the first collections were made, the river is a tide stream and gave no Odonata. At Calistoga, the only other place examined, the river was also without Odonata.

NAPA, NAPA COUNTY, CALIFORNIA.

The collecting at Napa was done on the extensive estate of the Insane Hospital. A small, clear mountain stream, which comes down through a deep ravine east of the asylum, is led into a series of ponds and reservoirs. These swarm with Odonata.

1. *ARCHILESTES CALIFORNICA* Mc Lachlan.

The shallows about the main pond swarmed with the nymphs of this. One teneral was taken.

2. *LESTES*, species.

This species was common on the pond.

3. *ARGIA VIVIDA* Hagen.

Common along the lower half of the stream.

4. *ENALLAGMA CARUNCULATUM* Morse.

On the "Fire Pond."

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Common on streams and all ponds.

6. *ISCHNURA CERVULA* Selys.

On "Fire Pond."

7. *ISCHNURA PERPARVA* Selys.

On all ponds.

8. *CELAENURA DENTICOLLIS* (Burmeister).

On "Fire Pond."

9. *CORDULEGASTER DORSALIS* Hagen.

On the mountain stream, where both imagoes and exuviae were collected.

10. *GOMPHUS SOBRINUS* Selys.

Several were caught on the largest pond.

11. *OCTOGOMPHUS SPECULARIS* (Hagen).

Common on the stream where several were taken while seated on rocks or foliage in the sunny openings.

12. *ANAX JUNIUS* (Drury).

A single female caught on one of the ponds.

13. *AESHNA CALIFORNICA* Calvert.

Abundant about the ponds.

14. *AESHNA MULTICOLOR* Hagen.

Common.

15. *MACROMIA MAGNIFICA* Mc Lachlan.

One male caught on the largest pond. This was the only individual of this species seen.

16. *TETRAGONEURIA CANIS* Mc Lachlan

These were very abundant on the largest ponds. This is the only place in the west at which I have taken this species though it has been recorded from the State of Washington.¹

The individuals flew slowly and dodged awkwardly and always stayed in loosely organized flocks, the individuals in which flew in short (40 feet) frequently changed beats. During windy weather they flew in a protected ravine opening onto the pond and at such times flew close to the ground so that they were easily caught. Early in the morning (9 o'clock) many spent much of their time perched on low bushes. When the wind was down they flew above the tree tops. These flocks were composed of males and females in about equal numbers and all were intent on catching the various minute insects filling the air. While many flew over the surface of the water their presence there appeared to be for food rather than a flight of the males hunting ovipositing females. During the two days collecting I saw no females ovipositing and no pairs in copulation. However the gelatinous strings of eggs were abundant in the

¹ Maitkowsky, Catalogue of the Odonata of North America, p. 125.

Potamogeton in the edge of the pond. I collected about eighty individuals which seemed to reduce the abundance a third or a half. Several exuviae were found clinging to stones about 4 feet above the water. These I have misplaced or lost.

In life the eyes of the male were bright green above and gray below; those of the female less green above and gray below.

17. *LIBELLULA FORENSIS* Hagen.

On the "Fire Pond."

18. *LIBELLULA SATURATA* Uhler.

On all ponds.

19. *PLATHEMIS LYDIA* (Drury).

On the small "Fire Pond."

20. *ERYTHEMIS SIMPLICICOLLIS* (Say).

On the "Fire Pond."

21. *SYMPETRUM CORRUPTUM* (Hagen).

On all ponds.

22. *SYMPETRUM ILLOTUM* (Hagen).

On the largest pond.

23. *SYMPETRUM PALLIPES* (Hagen).

Occasional.

CALISTOGA, NAPA COUNTY, CALIFORNIA.

The Napa River at this point is a small, sluggish stream and seemed to contain no Odonata. The collecting was done in the streams from a group of warm springs in the fields east of the town. Several acres of flat land at the foot of the low hills on the east side of the narrow valley fairly oozed warm water. The larger springs were so hot that they contained no life. Ditches had been dug in different directions through this boggy area for drainage. In these the water varied from tepid to cool and supported various species of Odonata. Several days of rain had very evidently reduced the collecting at this point.

1. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional.

2. *ENALLAGMA CARUNCULATUM* Morse.

3. *ISCHNURA CERVULA* Selys.

Occasional about the cooler water.

4. *ISCHNURA PERPARVA* Selys.

Common.

5. *CELAENURA DENTICOLLIS* (Burmeister).

The most abundant species. For habits see page 500.

6. *AESHNA CALIFORNICA* Calvert.

Seen.

7. *AESHNA MULTICOLOR* Hagen.

Several seen. One taken.

8. *LIBELLULA FORENSIS* Hagen.

Occasional.

9. *LIBELLULA SATURATA* Uhler.

Common. Many females of this species were found dead in the hot stream flowing from the largest spring. Perhaps they had tried to oviposit here, as the other streams were badly overgrown with vegetation.

10. *PLATHEMIS LYDIA* (Drury).

Common.

11. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Abundant.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Occasional.

13. *SYMPETRUM ILLOTUM* (Hagen).

Common.

COLUSA, COLUSA COUNTY, CALIFORNIA.

From the Napa Valley I traveled up the Sacramento to Colusa, where I collected on June 11. This town is on the banks of the Sacramento, which is a navigable stream at this point. The bottoms here are many miles wide and being lower than the flood stage of the river, are traversed in various directions by dykes. These break up the natural drainage so that waste irrigating water has produced numerous more or less permanent sloughs.

1. *HETAERINA AMERICANA* (Fabricius).

Common among the willows fringing the river.

2. *LESTES CONGENER* Hagen.

Very abundant on the slough west of town.

3. *ARGIA EMMA* Kennedy.

Abundant on the banks of the river. The majority of the individuals were tenerals.

4. *ENALLAGMA CARUNCULATUM* Morse.

Common on the sloughs.

5. *ZONIAGRION EXCLAMATIONIS* (Selys).

Two males and one female on the river bank. Not abundant.

6. *ISCHNURA CERVULA* Selys.

Common on the sloughs.

7. *ISCHNURA PERPARVA* Selys.

Common on the sloughs.

8. *CELAENURA DENTICOLLIS* (Burmeister).

The most abundant species on the sloughs.

9. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

Two males of this pale variety of *occidentis* were taken on the sandy bank of the river opposite the town. Exuviae were very abundant among the willows along the river (see p. 547).

10. *AESHNA MULTICOLOR* Hagen.

Common about the sloughs.

11. *LIBELLULA FORENSIS* Hagen.

Common on the sloughs.

12. *LIBELLULA SATURATA* Uhler.
Occasional.
13. *PLATHEMIS LYDIA* (Drury).
Common about the sloughs.
14. *ERYTHEMIS SIMPLICICOLLIS* (Say).
Abundant on the sloughs.
15. *SYMPETRUM CORRUPTUM* (Hagen).
Common on the sloughs.
16. *SYMPETRUM ILLOTUM* (Hagen).
Occasional on the sloughs.
17. *PACHYDIPLAX LONGIPENNIS* (Burmeister).
One male was taken in the willows across the river from Colusa.

MARYSVILLE, YUBA COUNTY, CALIFORNIA.

Marysville is in the great Sacramento Bottoms on the Yuba River near its juncture with the Feather River. Marysville exists only through the protection of its great dykes. Hydraulic mining on the Yuba has filled the stream so full of tailings that it is but a shifting bed of white sand. Where at one time navigable, its bed is now above the level of the town of Marysville and the stream is wide and very shallow. This has killed any Odonata fauna it may have had at one time. The few species collected were taken in the sloughs back of the dykes across the bridge from the city.

1. *LESTES STULTUS* Hagen.
Several taken (see p. 484).
2. *ENALLAGMA CARUNCULATUM* Morse.
Not common.
3. *TELEBASIS SALVA* (Hagen).
One seen.
4. *ISCHNURA CERVULA* Selys.
Common; the most abundant species.
5. *ISCHNURA PERPARVA* Selys.
Common. Orange teneral females abundant.
6. *CELAENURA DENTICOLLIS* (Burmeister).
The second most abundant species.
7. *AESHNA MULTICOLOR* Hagen.
Several seen.
8. *LIBELLULA FORENSIS* Hagen.
Several seen flying with the next.
9. *PLATHEMIS LYDIA* (Drury).
Abundant.
10. *ERYTHEMIS SIMPLICICOLLIS* (Say).
Common.
11. *SYMPETRUM CORRUPTUM* (Hagen).
Very common. The most abundant large dragonfly. Emerging from the sloughs in large numbers.

OROVILLE, BUTTE COUNTY, CALIFORNIA.

Oroville is on the Feather River where it emerges from its canyon in the Sierras. This is a barren, dry, hilly region where farming is carried on by irrigation. It was on the irrigating and waste-water ditches across the river from Oroville that the following species were taken:

1. HETAERINA AMERICANA (Fabricius).

On irrigating ditch. Exuviae common.

2. ARGIA AGRIOIDES Calvert.

Several taken on irrigating stream.

3. ARGIA EMMA Kennedy.

One male taken on beach of Feather River.

4. ARGIA VIVIDA Hagen.

Abundant on a spring streamlet on side of Table Mountain.

5. ENALLAGMA CARUNCULATUM Morse.

Common.

6. ENALLAGMA CYATHIGERUM (Charpentier).

Occasional on the waste stream west of the Odd Fellows' Home.

7. ISCHNURA PERPARVA Selys.

Common.

8. CELAENURA DENTICOLLIS (Burmeister).

Several observed which were probably this.

9. OPHIOGOMPHUS BISON Selys.

Two males taken.

10. OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS Kennedy.

One male taken.

11. ERPETOGOMPHUS COMPOSITUS Hagen.

One female, a teneral, was taken on the irrigating ditch across the river from Oroville. All the gomphines were taken on or near this ditch. As this water came from a tributary of the Feather River, probably the nymphs came down in the water. The Feather River was high and no Odonata except the *Argia* were seen on its banks.

12. GOMPHUS SOBRINUS Selys.

One male taken.

13. ANAX JUNIUS (Drury).

A pair were taken on the waste stream back of the Odd Fellows' Home.

14. AESHNA MULTICOLOR Hagen.

Common.

15. MACROMIA MAGNIFICA Mc Lachlan.

Two males and several exuviae seen.

16. LIBELLULA COMANCHE Calvert.

A single male, the only specimen I have ever seen alive, was caught while seated on the top of a weed near the waste stream. The fol-

lowing are live color notes: Eyes bluish gray, paler below; front of thorax dark pruinose blue-slate; sides of thorax and sides of segments 2 and 3 whitish.

17. *LIBELLULA FORENSIS* Hagen.

Several seen.

18. *LIBELLULA NODISTICTA* Hagen.

This was the most abundant species of this genus. Individuals were common on the side of Table Mountain, a half mile from water, where they spent most of their time seated on the dead branches of bushes scattered through the stunted Blue Oaks and Digger Pines. These were indolent and easily captured, but individuals flying about the waste-water stream were more wary.

19. *LIBELLULA PULCHELLA* Drury.

Several seen. Two captured.

20. *LIBELLULA SATURATA* Uhler.

Several were seen. Here I had an excellent opportunity to compare the habits of these species of *Libellula*. *L. saturata* was the most active and restless, *nodisticta* was most indolent, while *pulchella* and *forensis* had habits very similar.

21. *PLATHEMIS LYDIA* (Drury).

Several were observed.

22. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common.

23. *SYMPETRUM CORRUPTUM* (Hagen).

Common.

24. *SYMPETRUM ILLOTUM* (Hagen).

Common. With the last three species this is found close over the water as is also the next species.

25. *PACHYDIPLAX LONGIPENNIS* (Burmeister).

Several were taken at one spot on the waste stream back of the Odd Fellows' Home.

26. *TRAMEA LACERATA* Hagen.

A single male, the only individual seen, was captured on the side of Table Mountain.

CHICO RIVER, CHICO, BUTTE COUNTY, CALIFORNIA.

On June 14 and 15 I collected on the Chico River between the city of Chico and the mouth of the canyon 5 miles east of the city. The river was shallow because of much irrigating water withdrawn. It was very warm for the season, evidently carrying no snow water. The bottom was gravelly and the banks heavily shaded by brush and trees.

1. *HETAERINA AMERICANA* (Fabricius).

Very abundant.

2. *LESTES CONGENER* Hagen.

Common at the mouth of the canyon.

3. *HYPONEURA LUGENS* Hagen.

Very abundant in the mouth of the canyon. In ovipositing the male does not stand erect while attached to the female as does the male *Argia*. Oviposition is in any green branch lying in the running water.

4. *ENALLAGMA CARUNCULATUM* Morse.

Occasional.

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional.

6. *ZONIAGRION EXCLAMATIONIS* (Selys).

One pair taken at the canyon.

7. *ISCHNURA CERVULA* Selys.

Scarce.

8. *ISCHNURA PERPARVA* Selys.

Several observed. Not as common as usual.

9. *PROGOMPHUS BOREALIS* Mc Lachlan.

Several males were taken. Difficult to approach.

10. *OPHIOGOMPHUS BISON* Selys.

Found on the same pools as the preceding but much less wary.

11. *GOMPHUS SOBRINUS* Selys.

A number were seen where the river ran through the city park. Evidently its season was almost over.

12. *OCTOGOMPHUS SPECULARIS* (Hagen).

Imagoes of this were not seen but the exuviae were very abundant in the mouth of the canyon.

13. *AESHNA MULTICOLOR* Hagen.

Not as common as usual.

14. *MACROMIA MAGNIFICA* Mc Lachlan.

Common. I took 12 of these in less than an hour where they were beating up and down a narrow lane. In the late afternoon this species loves to hunt away from the water.

15. *LIBELLULA SATURATA* Uhler.

Several seen.

16. *SYMPETRUM PALLIPES* (Hagen).

Not common.

17. *BRECHMORHOGA MENDAX* (Hagen).

Several individuals of this graceful species were seen. Two males and a female were taken. The males were taken while flying on short beats over the stream. The female was captured while cutting S's and figure 8's through a swarm of small Diptera. She was indifferent to several passes I made at her before I succeeded in netting her. This species is the most graceful on the wing of any odonate with which I am familiar. Frequently they fly with a swinging mayfly-like motion. In the heat of the day they floated around among the tree tops.

TEHAMA, TEHAMA COUNTY, CALIFORNIA.

On June 16 I tried collecting at Tehama, but the temperature was 112°, and both the Sacramento and Mill Creek (Los Molinas) were too high for collecting.

On July 15 I started on a collecting trip from Sacramento up the American River to Auburn across the Sierras to Lakes Donner and and Tahoe, thence to Reno, Pyramid Lake, and the Humboldt River in Nevada.

AMERICAN RIVER, SACRAMENTO, CALIFORNIA.

Sacramento lies at the juncture of the Sacramento and American Rivers. Here as far as the eye can see the valley is perfectly flat and is flooded annually by the Sacramento River. To one approaching Sacramento only the second stories of the houses and the tops of the numerous shade trees are visible for it is entirely surrounded by a great 20-foot dyke, through which the railroads enter by flood gates that can be closed in times of high water. The American River at the time of my visit was about 300 feet wide, with half the bottom exposed as sand bars; the 15-foot banks, as well as the entire bed, were composed of loose sand. Opposite the city, where I collected, the bottoms were a jungle of box elder trees about 30 feet high, except for a few cottonwoods along the bank and an occasional more open glade occupied by willows. The river itself, even among the cottonwood trees, was fringed with willows. The sloughs mentioned in the following list were in the bottoms back some distance from the river. No collecting was attempted on the Sacramento River at this place.

1. *HETAERINA AMERICANA* (Fabricius).

Not common. On river.

2. *LESTES CONGENER* Hagen.

Some about sloughs.

3. *ENALLAGMA CARUNCULATUM* Morse.

Common about sloughs.

4. *ISCHNURA CERVULA* Selys.

About sloughs.

5. *ISCHNURA PERPARVA* Selys.

About sloughs.

6. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

One male taken in a willow glade opposite the city.

7. *GOMPHUS OLIVACEUS* Selys.

This species was very abundant on the American River opposite the city. None were found except in the half mile between the two railroad bridges. The males were abundant over the swift muddy water or resting on the overhanging willows. The females were caught in the willow glades back from the bank. (See page 554.)

8. ANAX JUNIUS (Drury).

About the sloughs.

9. AESHNA MULTICOLOR Hagen.

About the sloughs. This species was observed catching insects on the market street of the city at twilight. They flew among the wagons and buggies entirely indifferent to the numerous passers-by. This habit of familiarity with man's haunts is very noticeable in *multicolor*. It is the most domestic of all the western Odonata

10. LIBELLULA FORENSIS Hagen.

About the sloughs.

11. LIBELLULA SATURATA Uhler.

Common.

12. PLATHEMIS LYDIA (Drury).

On the sloughs.

13. ERYTHEMIS SIMPLICICOLLIS (Say).

Occasional on the sloughs.

14. SYMPETRUM CORRUPTUM (Hagen).

Common. This species throughout the Sacramento and the San Joaquin Valleys was widely scattered away from water.

15. SYMPETRUM SEMICINCTUM (Say).

About the sloughs.

16. TRAMEA LACERATA Hagen.

Several seen about the slough between the river and the city.

AUBURN, PLACER COUNTY, CALIFORNIA.

At Auburn I collected, July 18 and 19, in the small stream south of the town, which may be termed the "town drain," as it carried the sewage and run-off of the entire community; also on the American River, which at this place flows at the bottom of a V-shaped gorge over 1,000 feet deep. The sides of this canyon are scantily clad with digger pines and scrub oaks, and the stream, 200 feet wide and 3 feet deep, flows over a bed of hydraulic tailings, mainly drifting coarse gravel and stones of all sizes. A few spring streams trickle down the steep sides of the canyon.

1. HETAERINA AMERICANA (Fabricius).

Common along the river, apparently having emerged from the main stream.

2. LESTES UNCATUS Kirby.

Several captured on the "town drain."

3. ARGIA AGRIOIDES Calvert.

Common on the "town drain."

4. ARGIA EMMA Kennedy.

Occasional on the rocks below the dam in the river.

5. *ARGIA VIVIDA* Hagen.

Very abundant on the spring streams trickling down the sides of the gorge.

6. *ENALLAGMA CARUNCULATUM* Morse.

Common on the "town drain," where the next also occurred.

7. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional along the edges of the river.

8. *TELEBASIS SALVA* (Hagen).

Occasional on the "town drain."

9. *ISCHNURA CERVULA* Selys.

On "town drain." Rare.

10. *ISCHNURA PERPARVA* Selys.

Tenerals common on "town drain."

11. *CORDULEGASTER DORSALIS* Hagen.

One male was seen at close range on the river bank. It was the only time I have seen this species except on or near swift mountain torrents. He persisted in alighting on various bushes and so may have been lost from his usual haunts.

12. *OPHIOGOMPHUS OCCIDENTIS CALIFORNICUS* Kennedy.

Three females were caught on the river bank below the dam. A fourth individual was seen. These were unusually yellow, the dark pattern being very pale and restricted (see p. 543).

13. *OCTOGOMPHUS SPECULARIS* (Hagen).

One male was seen at close range while he was seated. This was on a very small spring stream, the whole flow of which could pass through a 2-inch pipe.

14. *AESHNA MULTICOLOR* Hagen.

One male was taken. Several *Aeshna*, probably of this species, were seen.

15. *AESHNA PALMATA* Hagen.

One taken.

16. *MACROMIA MAGNIFICA* Mc Lachlan.

A male, the only one seen, was taken on the river above the dam.

17. *LIBELLULA NODISTICTA* Hagen.

Common on the "town drain." In the morning the individuals of this species were easily captured while seated on brush and weeds in the sunny openings along the stream. Copulation was as usual among *Libellula*. A female observed ovipositing flew about 2 feet above the water and made several quick swings downward, tapping the water with her abdomen just once for each swing. This species appears to have a restricted distribution in California. So far there are no records except for the foothills of the Sierra; in other words, a zone along the west side of the Sierras between about 500 feet altitude and 3,000 feet. It has not been recorded from the Sacramento or San Joaquin Valleys proper or from west of them, or from the wooded crest of the Sierras.

18. *LIBELLULA PULCHELLA* Drury.

Several were taken about a pool on the river bank in the bottom of the gorge.

19. *LIBELLULA SATURATA* Uhler.

Occasional in the gorge with the preceding.

20. *PLATHEMIS LYDIA* (Drury).

Several were seen on a spring stream in the gorge.

21. *SYMPETRUM ILLOTUM* (Hagen).

Abundant on the "town drain." Usually the female of this species oviposits unaccompanied by the male but here I observed a pair working together. These copulated on the wing, then rested half a minute in copulation on a branch, when they flew about over the water, the male holding the female by the thorax, the pair making tentative dives from an elevation of about 2 feet. After a half minute they dropped 2 inches above the water when with a swinging motion the female dipped her abdomen in the water about 30 times, after which they made a sudden upward flight and separated, each to seat itself on a twig.

22. *SYMPETRUM SEMICINCTUM* (Say).

Common on the "town drain."

BEAR VALLEY, EMIGRANT GAP, PLACER COUNTY, CALIFORNIA.

On July 21 I collected in Bear Valley, which has an elevation of 4,500 feet, and lies about 1,000 feet below the railroad station of Emigrant Gap. This small valley is a hay meadow with a level floor about 1 mile long and a fourth mile broad. Bear Creek flows through it and where tributary streamlets cross it there is boggy ground. Such places contain willow thickets. The sides of the valley, where not occupied by granite outcrops, are covered by a sparse growth of cedar and fir interspersed with thickets of various shrubs.

1. *LESTES CONGENER* Hagen.

Common.

2. *LESTES DISJUNCTUS* Selys.

Occasional.

3. *ENALLAGMA CARUNCULATUM* Morse.

Not common.

4. *ENALLAGMA CALVERTI* Morse.

Two collected.

5. *COENAGRION RESOLUTUM* (Hagen).

Several taken about a spring-fed pool.

6. *AMPHIAGRION SAUCIUM ABBREVIATUM* Selys.

Not common.

7. *ISCHNURA CERVULA* Selys.

Not common. Several taken about the same pool as *Coenagrion*. One male had the front of the thorax solid black, no blue spots being present.

8. *ISCHNURA PERPARVA* Selys.

Occasional.

9. *CORDULEGASTER DORSALIS* Hagen.

One male taken. Several observed on the small spring streams tributary to Bear Creek. This is the highest (4,500 feet) and most easterly record for this species. This was a surprise, as I had associated this species with the warm torrents of the Coast Ranges. But while the railroad is protected with snowsheds at Emigrant Gap, which is 1,000 feet higher than Bear Valley, it is possible that the floor of the valley enjoys a warmer climate. The following species in this list would indicate a fairly moderate climate: *Enallagma carunculatum* Morse, *Ischnura cervula* Selys, *Ischnura perparva* Selys, *Cordulegaster dorsalis* Hagen, *Anax junius* (Drury), *Aeshna multicolor* Hagen, and *Libellula pulchella* Drury.

10. *ANAX JUNIUS* (Drury).

An *Anax* was observed patrolling a large pool in Bear Creek. Probably this species.

11. *AESHNA MULTICOLOR* Hagen.

One taken. Common.

12. *AESHNA INTERRUPTA NEVADENSIS* Walker.

Several observed. One teneral captured at the head of the valley.

13. *AESHNA PALMATA* Hagen.

Several were easily netted, as they flew in short beats among the willow thickets to escape the wind. This species in such a situation is very easily victimized by the collector. They fly low and slowly and are very bull-headed about keeping to their short protected beat, two or three passes with the net sometimes failing to drive one away.

14. *LIBELLULA PULCHELLA* Drury.

Several seen. One collected.

15. *LIBELLULA QUADRIMACULATA* Linnaeus.

Common. This was the lowest elevation at which I took this mountain species.

16. *PLATHEMIS LYDIA* (Drury).

Several seen. Two collected.

17. *SYMPETRUM OBTRUSUM* (Hagen).

Several collected. Not abundant.

18. *SYMPETRUM PALLIPES* (Hagen).

One male, a teneral, taken.

19. *SYMPETRUM SCOTICUM* (Donovan).

Several seen. Two taken.

20. *LEUCORRHINIA GLACIALIS* Hagen (?).

A Leucorrhinia was seen. Probably this.

The following series of lists are concerned with the drainage east of the crest of the Sierras. Two stream systems are included. Truckee River rises in Lakes Tahoe, elevation 6,000 feet, and Donner, elevation 5,000 feet. It flows down the abrupt east slope of the Sierras and empties into the salt Pyramid and Winnemucca Lakes in the Nevada desert. The other system concerned is that of the Humboldt River, which rises in the mountains in eastern Nevada and, flowing west, empties into the great shallow alkaline lake called Humboldt Sink. These are two fragments of the old Lake Lehontin System.

DONNER LAKE, NEVADA COUNTY, CALIFORNIA.

From July 23 to 26 I collected about Truckee and Donner Lake, which lies 3 miles west. This clear blue lake, 3 miles long and a half mile wide, when it mirrors in its glassy surface the green, pine-clad mountains which rise almost from its pebble beach, is one of the most beautiful of the Sierra lakes. The east shore is a gravel beach. This changes gradually into the cobble beach along its north shore, which again at its west end merges into a short pure sand beach. At its eastern end the lake drains by Donner Creek, which meanders through a series of green meadows into Truckee River. In this narrow valley, just east of the confluence of Donner Creek with Truckee River, lies the town of Truckee. In the spring-fed boggy meadow near the town slaughterhouse were collected various species mentioned below. This high mountain region is characterized by its Canadian dragonflies, but, oddly enough, it has with this fauna a few species usually associated with lower, warmer altitudes. These are discussed as they occur in the list.

1. *LESTES CONGENER* Hagen.

Common everywhere there is standing water, but not found in Donner Lake.

2. *LESTES DISJUNCTUS* Selys.

Several were taken in a bog pool near the outlet of the lake.

3. *LESTES UNCATUS* Kirby.

Common in all swampy places.

4. *ARGIA EMMA* Kennedy.

Several were taken in the outlet. Probably because of the size and depth of Donner Lake its waters keep the creek running during the winter. This and the next species were surprises from a warmer fauna.

5. *ARGIA VIVIDA* Hagen.

Abundant about the lake shore, where it breeds in the numerous spring streams crossing the beaches.

6. ENALLAGMA CALVERTI Morse.

Several were taken on the beach.

7. ENALLAGMA CARUNCULATUM Morse.

One male was found among *Enallagma* collected on the beach.

8. ENALLAGMA CYATHIGERUM (Charpentier).

This species lives in the lake and in places fairly swarms along the beaches.

9. COENAGRION RESOLUTUM (Hagen).

Several were taken around a boggy pool near the lake outlet.

10. AMPHIAGRION SAUCIUM ABBREVIATUM Selys.

Occasional.

11. ISCHNURA CERVULA Selys.

Abundant in the lily pads near the outlet of the lake.

12. ISCHNURA PERPARVA Selys.

With the preceding, but less common. These two are at the extreme upper limit of their range.

13. OPHIOGOMPHUS MORRISONI Selys.

This was very abundant along the north shore on the finer gravel and also around the outlet. Over a hundred specimens were taken (see p. 534).

14. GOMPHUS DONNERI Kennedy.

This was abundant on the sandy beach at the west end of the lake. Probably it was past its season, as only two females were caught. This species, which is closely related to *Gomphus sobrinus* Selys, seems to be either peculiar to this lake or a species not yet recorded from elsewhere. It is one of the surprises, as most *Gomphi* live in the larger, warm rivers. Probably this is the highest elevation (5,940 feet) at which the genus has been recorded in North America.

15. ANAX JUNIUS (Drury).

One individual was seen several times on Donner Creek near the outlet to the lakes. This is on the extreme upper limit of this species' habitat.

16. AESHNA PALMATA Hagen.

Three males of this were caught on Donner Creek. It was not abundant. Exuviae were found in Donner Creek.

17. AESHNA INTERRUPTA NEVADENSIS Walker (?).

Females of *Aeshna interrupta* Walker were taken near the outlet of the lake. Probably these were of the variety *nevadensis* Walker.

18. TETRAGONEURIA SPINIGERA Selys.

Several were caught on the Donner Lake road.

19. LIBELLULA PULCHELLA Drury.

Several caught on Donner Creek. This is near the upper limit of this species.

20. *LIBELLULA QUADRIMACULATA* Linnaeus.

Common about the outlet. This is the common *Libellula* at this high altitude.

21. *SYMPETRUM CORRUPTUM* (Hagen).

Several seen near the outlet to the lake.

22. *SYMPETRUM OBTRUSUM* (Hagen).

Several caught near the outlet. Abundant near the Truckee slaughterhouse.

23. *SYMPETRUM PALLIPES* (Hagen).

Several caught among the willow thickets near the outlet. Emerging in large numbers in the boggy meadow near the slaughterhouse. *Pallipes*, *scoticum*, and *obtrusum* seem to be able to live in mud.

24. *SYMPETRUM SCOTICUM* (Donovan).

Both mature imagoes and teneral abundant near the slaughterhouse.

25. *LEUCORRHINIA GLACIALIS* Hagen.

One individual was caught near the outlet and three were taken near the Truckee slaughterhouse.

SQUAW CREEK AND TRUCKEE RIVER ABOVE DONNER CREEK, ELEVATION 6,000-6,500 FEET, PLACER COUNTY, CALIFORNIA.

1. *LESTES CONGENER* Hagen.

Not common.

2. *LESTES UNCATUS* Kirby.

Second most numerous species in Squaw Creek meadows.

3. *ARGIA EMMA* Kennedy.

Several taken on Truckee River near outlet of Lake Tahoe. This is the highest altitude for this species. It probably exists here because Tahoe does not freeze and so the Truckee River does not freeze.

4. *ARGIA VIVIDA* Hagen.

Occasional along the Truckee River. One or two were seen in the inlet at McKinney's Camp on Lake Tahoe. This is the highest California record for this species.

5. *ENALLAGMA CYATHIGERUM* (Charpentier).

Occasional in Squaw Creek meadows and on Truckee River.

6. *COENAGRION RESOLUTUM* (Hagen).

Occasional in Squaw Creek meadows.

7. *AESHNA INTERRUPTA NEVADENSIS* Walker (?).

Several female *interrupta* were taken along Truckee River, probably var. *nevadensis*. This species is abundant and in place at this altitude.

8. *AESHNA PALMATA* Hagen.

One male was seen at close range seated on a willow in Squaw Creek meadows. This as far as my data shows is the upper limit of

this species, excepting an exuvia, possibly of this species, found on McKinney Lakes, 7,000 feet altitude. *Palmata* certainly is not normally as common above 6,000 feet as below that height.

9. *SOMATOCHLORA SEMICIRCULARIS* (Selys).

Several were caught on sedgy sloughs along Squaw Creek and Truckee River. This is the lowest elevation at which I took this species in this region. In central Oregon (Bend) it is abundant at 4,000 feet, in Washington (Bumping Lake) at 3,500 feet, and in British Columbia at sea level.

10. *LIBELLULA PULCHELLA* Drury.

Two were seen on Squaw Creek. This is the highest record for this species in this region.

11. *LIBELLULA QUADRIMACULATA* Linnaeus.

Abundant over all marshes above 5,000 feet.

12. *SYMPETRUM RUBICUNDULUM DECISUM* (Hagen).

This brown faced species was the most abundant dragonfly on Squaw Creek.

13. *SYMPETRUM PALLIPES* (Hagen).

Emerging in numbers from grassy sloughs along Squaw Creek.

14. *SYMPETRUM SCOTICUM* (Donovan).

Occasional in Squaw Creek valley.

LAKE TAHOE, CALIFORNIA AND NEVADA.

This lake, 23 miles long by 10 broad, is surrounded by mountains, the lower slopes of those on the west shore covered by green pines, those of the east shore brown and barren. Its entire shore line, except for sand along the south shore and some bordering cliffs, is a clean pebble beach. Its water is marvelously clear. Fish are easily seen at a depth of 20 feet and every scratch in the paint on the keel of the lake steamer is so distinct that the boat gives one the idea of floating in the air. This lake is so deep that it does not freeze in winter. Its elevation is 6,225 feet.

Because of this unusual purity of the water and lack of mud on the beaches and bottom there is almost an entire absence of large aquatic vegetable life. Consequently all other forms of life based on this are in scanty numbers or entirely absent.

In three days collecting I saw only three species of dragonflies on the lake. *Argia vivida* Hagen occurred in a grassy inlet at McKinney. *Aeshna interrupta nevadensis* Walker was common but probably bred in the small lakes on the mountains about, and through its great propensity for wandering came to hunt along the Tahoe shores. *Ophiogomphus morrisoni* Selys was probably the only species actually spending its nymphal existence in the lake water. A single male which flew aboard the steamer in Emerald Bay is my only information on this species.

The United States Reclamation Service has recently dammed the outlet and raised the surface of the water several feet. This has covered many of the beaches and may account for part of the scarcity of aquatic insects.

AL TAHOE.

In the swamp at Al Tahoe at the southern end of the lake were taken *Lestes uncatatus* Kirby, *Lestes congener* Hagen, *Lestes disjunctus* Selys, *Enallagma cyathigerum* (Charpentier), *Aeshna interrupta nevadensis* Walker, *Libellula quadrimaculata* Linnaeus, *Sympetrum obtrusum* (Hagen), *Sympetrum pallipes* (Hagen), and *Sympetrum corruptum* (Hagen).

MCKINNEY LAKES, MCKINNEY LANDING, LAKE TAHOE, ELEVATION 7,000 FEET.

Four small lakes lie on the divide between McKinney Creek, which flows into Tahoe, and the Rubicon River, which flows into the American River or Pacific drainage. All are glacial lakes filled by sediment until very shallow, three of them being covered by lily pads and not over 4 feet deep. The open lake contains fish and so has little insect life. The other three fairly swarm with Odonata, in spite of their elevation and the crags carrying snow patches, which rise on either side of them. The water of these is surprisingly warm, in fact much too warm to drink with pleasure. This unusual warmth in the lake water at this altitude is probably due to the fact that the lakes are very shallow and have black, peaty bottoms which, with the long, clear summer season, permit the sun to raise the temperature of the water. However, all the flourishing species are truly Canadian, even the hardest of the lower forms existing at this elevation in scanty numbers.

1. LESTES CONGENER Hagen.

Not common. Three pairs taken.

2. LESTES UNCATUS Kirby.

Occasional.

3. ENALLAGMA CYATHIGERUM (Charpentier).

Rarely taken.

4. COENAGRION RESOLUTUM (Hagen).

This is the common damsel fly about the lakes.

5. CORDULIA SHURTLEFFI Scudder.

Common about the lakes.

6. SOMATOCHLORA SEMICIRCULARIS (Selys).

Common. This species is found only over patches of sedges standing in shallow water. Apparently the females oviposit in such sedge patches, and the males are there to find the females.

7. AESHNA INTERRUPTA NEVADENSIS Walker.

This is very abundant about two of these lakes. The exuviae hang on the sedges in vast numbers. (See p. 581.)

8. *AESHNA PALMATA* Hagen.

Among a series of exuviae collected here Dr. E. M. Walker found a single mutilated exuvia which he thought might be this species. No imagoes were seen. I doubt if it occurs other than as a straggler at this altitude.

9. *LIBELLULA QUADRIMACULATA* Linnaeus.

Common.

10. *SYMPETRUM OBTRUSUM* (Hagen).

One male caught. Rare.

11. *SYMPETRUM PALLIPES* (Hagen).

Not common.

12. *LEUCORRHINIA GLACIALIS* Hagen.

Fairly swarming over one of the lakes. The bushes about the shore were alive with pairs in copulation and numerous single individuals.

RENO, NEVADA.

Reno, at an elevation of 4,500 feet, lies in a small valley, whose level floor with its vivid green alfalfa fields is in striking contrast to the brown of the massive Sierra foothills which surround it. The Truckee River on its course eastward to the Nevada Desert passes through this valley but gives the most of its water to the irrigation canals which carry it to the alfalfa fields. Its bed is an almost continuous gravel bar and it supports but little odonate life. Back from the river are numerous sloughs of waste irrigating water, common in any overirrigated country, which fairly swarm with various pond species.

1. *LESTES CONGENER* Hagen.

Common about all sloughs.

2. *LESTES UNCATUS* Kirby.

Common about the sloughs.

3. *ARGIA EMMA* Kennedy.

One pair of *Argia* was seen on the river near the Asylum. Probably this species.

4. *ENALLAGMA ANNA* Williamson.

This was the only *Enallagma* taken in the valley, though two others probably occurred there. I had an excellent chance to observe its habits. It was very active and flew busily back and forth along the flowing irrigating ditches. Copulation lasted several minutes. In ovipositing, the females painstakingly put their eggs into the submerged stems of aquatic plants, at which task they were usually accompanied by the males until there was danger of submergence, when these left the females to themselves. Frequently females would be submerged for many minutes. Nymphs were common among the *Potamogeton* stems in the more weedy ditches. A large series of this species was taken.

5. AMPHIAGRION SAUCIUM ABBREVIATUM Selys.

Only one was seen.

6. ISCHNURA CERVULA Selys.

Common in restricted areas.

7. ISCHNURA PERPARVA Selys.

Occasional.

8. OPHIOGOMPHUS MORRISONI Selys.

Four exuviae were found on a gravel bar of the river. This is a species of elevated districts. I have it from the Deschutes River, at Bend, Oregon, elevation 4,000 feet; from Donner Lake, California, elevation 5,940 feet; and from Lake Tahoe, California, elevation 6,225 feet. Farther east on the Truckee River than Reno Valley it is displaced by *Ophiogomphus morrisoni nevadensis* Kennedy. *Morrisoni* is apparently a species of the upper border of the Transition Zone. *Ophiogomphus morrisoni* and *Argia emma* were the only species found on the river in the Reno Valley.

9. AESHNA PALMATA Hagen.

Aeshna was very abundant over the areas of tules or cattails in the sloughs. All of those captured were of this species. Probably *constricta* Say and *interna* Walker occur in this valley also.

10. LIBELLULA FORENSIS Hagen.

Very common. This was the only *Libellula* seen.

11. SYMPETRUM CORRUPTUM (Hagen).

Common.

12. SYMPETRUM COSTIFERUM (Hagen).

One captured. Several seen.

13. SYMPETRUM RUBICUNDULUM DECISUM (Hagen).

Common. The white faced *obtrusum* was not observed.

14. SYMPETRUM PALLIPES (Hagen).

Several observed.

15. SYMPETRUM SCOTICUM (Donovan).

The most abundant species.

16. LEUCORRHINIA GLACIALIS Hagen.

The type of this species came from Reno, but I saw none. However, I collected over only a small portion of the valley.

LOWER TRUCKEE RIVER, NEVADA.

In the few miles before the Truckee River empties into Pyramid Lake it meanders as a strongly alkaline stream over numerous gravel bars through the rich bottom land occupied by the Piute Indians. The Truckee through its lower course is well shaded by cottonwoods, willows, and alders. My collecting at this point and on Pyramid Lake, 4 miles distant, was made possible through the kindness of Mr. Oliver, the Indian agent, at whose home I stayed while there.

1. LESTES CONGENER Hagen.

Common in the willows.

2. ARGIA EMMA Kennedy.

Common. Exuviae numerous about the roots of trees overhanging the water.

3. ENALLAGMA CARUNCULATUM Morse.

Common.

4. ISCHNURA CERVULA Selys.

Abundant in sedgy spots. Local in its distribution.

5. OPHIOGOMPHUS MORRISONI NEVADENSIS Kennedy.

This was the first place I took this large yellow *Ophiogomphus*. It was associated on the riffles with the next species, the two species having identical habits. I saw a female ovipositing on a riffle, striking the water with her abdomen as she flew along (see p. 536).

6. ERPETOGOMPHUS COMPOSITUS Hagen.

This widely spread species occurred sparingly on the riffles of the lower Truckee. The males appeared to be more nervous and more touchy, flying farther for conflict with passing males than the males of *Ophiogomphus morrisoni nevadensis*.

7. AESHNA MULTICOLOR Hagen.

Abundant. One pair caught.

8. MACROMIA MAGNIFICA Mc Lachlan.

Several were observed on the river. At 5 o'clock in the afternoon a male and female were seen patrolling the road at the agency. The male was taken.

9. LIBELLULA PULCHELLA Drury.

Several seen along the river.

10. SYMPETRUM CORRUPTUM (Hagen).

Abundant. This species oviposits in the shallow edge of the river, the male holding the female. She taps the water from one to six times in close succession, then the pair fly 50 to 100 feet farther to the next shallow, this proceeding sometimes covering several hundred feet of shore. The female also oviposits alone, when she takes a much shorter flight, striking the water more frequently. The males were most abundant about the water, but the females were met in the fields or anywhere.

11. SYMPETRUM PALLIPES (Hagen).

The least common of the three species of *Sympetrum*.

12. SYMPETRUM SEMICINCTUM (Say).

Common along the agency ditch.

PYRAMID LAKE, NEVADA.

Pyramid Lake, at an elevation of 3,880 feet, with the exception of its twin, Winnemucca Lake, is the lowest of the several saline lakes which occur in the Nevada Basin and constitute the remnants of the once great Lake Lehontin. Pyramid Lake is even yet a great lake,

40 miles long and 10 broad. It is saline with a density of 1.0034, or about one-ninth that of sea water. It is a brilliant emerald green body of water, surrounded by rugged brown hills barren of any vegetation except sagebrush and the few desert plants that survive the extreme aridity of this region. The only green vegetation is that of the cottonwoods and alders in the delta of the Truckee River. The only conspicuous life is that of the grotesque pelicans which wade solemnly in single file along its beaches.

It has been shown by R. C. Osburn¹ that Odonata can not live comfortably in a density of sea water much over 1.003. I found the following four species breeding in the lake and the pools back of the beach line.

1. *ENALLAGMA CARUNCULATUM* Morse.

One male was found when I went over my Pyramid Lake material carefully. (In my notes in the Annals of the Entomological Society of America² I mentioned only two species in Pyramid Lake, *Enallagma clausum* and *Sympetrum corruptum*.) This species may breed in the lake in very limited numbers or it may be from the Truckee Delta, which was 1 mile west. This species is the most widely spread of all the western species of *Enallagma* and an alkali pond species, so it might be expected.

2. *ENALLAGMA CLAUSUM* Morse.

This bred in large numbers in the shallow edge of the lake. A species of *Potamogeton* grows sparingly along the shore of the lake, and to this are attached masses of filamentous algae. These masses break loose and are washed along the beach in quantity. In this litter two species of Odonata breed freely, *Enallagma clausum* and *Sympetrum corruptum*. Through the wave action the beach at the edge of the water is built into a low dyke over which storms force high waves that make a series of algae-filled pools from which both species emerge freely. Probably these individuals are washed into these pools from the lake when the pools are formed. On fence posts 50 feet from shore I found exuviae of both species.

Enallagma clausum has habits of alighting on the beach and flying quickly along the surface of the ground which are much like those of an *Argia*. Because of their nervous alertness and this habit of hugging the ground they are very difficult to capture, though they occur in large numbers. Copulation is on the wing or while seated on the beach or on the masses of algae. Emergence is at all hours, as I saw fresh teneral at 3 o'clock in the afternoon. The male holds the female during oviposition while she places the eggs in the masses of algae.

3. *ISCHNURA CERVULA* Selys.

One male was found among my material.

¹ Amer. Nat., vol. 40, 1906, p. 395.

² Ann. Ent. Soc. Amer., vol. 8, 1915, p. 297.

4. *SYMPETRUM CORRUPTUM* (Hagen).

This species is abundant all over the West, except above 5,000 feet. But here it fairly swarmed, occurring in far greater numbers than I had seen it anywhere else. Its exuviae hung on driftwood along the beach several deep.

HUMBOLDT RIVER, CARLIN, NEVADA.

August 6 to 10 was spent in a hurried trip up the Humboldt River. This strange river rises in the mountains on the east side of Nevada and runs west nearly across the State to flow out onto the Humboldt Flats, where it forms a large shallow lake called Humboldt Sink. Humboldt Sink is surrounded by miles of snow-white alkali flats. I did not get to it. The Humboldt River runs through a region of low mountains barren of vegetation except sagebrush and its usual accompaniments. The river is alkaline in most of its lower course and is strange in that no trees whatever grow along its banks. Instead, there are great stretches of dense thickets of slender willows, called "pin willows" by the cow punchers of the region. As these grow up to the edge of the perpendicular clay banks of the stream, following the course of the stream on foot along the bank for any distance is almost impossible. Humboldt River has the same fauna as the lower Truckee, the only other stream of the Lehontin Basin examined.

The river at Carlin, which was the farthest upstream examined, flowed over continuous gravel beds. In the bottoms were several sloughs from waste irrigating water. I collected here on August 6.

1. *LESTES CONGENER* Hagen.

Abundant.

2. *ARGIA EMMA* Kennedy.

Occasional on the river banks.

3. *ENALLAGMA CARUNCULATUM* Morse.

A few seen on a slough.

4. *ISCHNURA CERVULA* Selys.

Common about the sloughs.

5. *ISCHNURA PERPARVA* Selys.

About the sloughs.

6. *OPHIOGOMPHUS MORRISONI NEVADENSIS* Kennedy.

Several caught on the gravel bars, but collecting made difficult by a large flock of killdeers which flew ahead and disturbed the dragonflies.

7. *ERPETOGOMPHUS COMPOSITUS* Hagen.

Three males caught.

8. *AESHNA PALMATA* Hagen.

One male taken. Several seen among willow thickets near the sloughs.

9. *LIBELLULA FORENSIS* Hagen.

Several seen.

10. *LIBELLULA PULCHELLA* Drury.

More common than the last. About the sloughs.

11. *SYMPETRUM CORRUPTUM* (Hagen).

Common on the gravel bars of the river.

12. *SYMPETRUM RUBICUNDULUM DECISUM* (Hagen).

Occasional in the bottoms.

13. *SYMPETRUM MADIDUM* (Hagen).

Two males taken.

14. *SYMPETRUM PALLIPES* (Hagen).

Common, especially in the shade of the willows.

HUMBOLDT RIVER, GOLCONDA, NEVADA.

Humboldt Valley at this point is about 2 miles wide; its floor is a level alkali flat, thickly grown up to greasewood bushes, except along the banks of the river, where there are dense thickets of "pin willows." The elevation of the valley at this point is 4,391 feet. On both sides are the low barren sage-covered mountains characteristic of the Nevada. Several large, hot springs occur at Golconda, the Chinese laundry with characteristic oriental thrift using one. The largest is west of the hotel, and with its various subordinate springs irrigates an area of several acres. It has built up a mound one-eighth mile in diameter and 8 feet above the surrounding flat. The largest outlet is a pool 20 by 30 feet, too hot for living insects. At one end of this is a scum composed of dead beetles and other aquatic insects cooked to death. The subordinate springs have pools in various parts of this mound, which vary from cold to very hot. It is in the cooler pools, which support aquatic plants, that Odonata are found.

The river at Golconda is about a hundred feet wide and 6 feet deep in the channel. It meanders through the alkali flat with such intricate turns that I walked three hours along its bank and returned across lots to my starting point in 20 minutes. As the flat near the river has many areas of salt grass sod, wherever the river cuts into one of these, it undermines the heavy sod which falls off in great squares. Few gravel bars occur. The water is yellow with alkali mud, and it fairly swarms with carp. I collected here on August 7 and again on August 9.

1. *LESTES CONGENER* Hagen.

Breeding in the warm springs.

2. *LESTES UNGUICULATUS* Hagen.

Several caught around the warm springs. Probably breeding there.

3. *ARGIA EMMA* Kennedy.

One female was taken on the river. The only one seen.

4. *ENALLAGMA ANNA* Williamson.

One was found among the *Enallagma* caught about the springs.

5. *ENALLAGMA CALVERTI* Morse.

Occasional about the springs.

6. ENALLAGMA CARUNCULATUM Morse.

The most abundant species of *Enallagma*.

7. ENALLAGMA CLAUSUM Morse.

A single male found among those collected about the springs.

8. ISCHNURA CERVULA Selys.

Common about the springs.

9. ISCHNURA PERPARVA Selys.

Common. A male was taken which had the coloration of *Ischnura demorsa* (Hagen).

10. CELAENURA DENTICOLLIS (Burmeister).

About one warm spring this was numerous.

11. OPHIOGOMPHUS MORRISONI NEVADENSIS Kennedy.

A single male was caught on a gravel bar in the river, the only one seen.

12. GOMPHUS INTRICATUS Hagen.

Several individuals were caught on the river (see p. 550).

13. GOMPHUS OLIVACEUS NEVADENSIS Kennedy.

Common on the river (see p. 557).

14. ANAX JUNIUS (Drury).

One male caught in the "*Aeshna* swarm."

15. AESHNA CONSTRICTA Say.

Three females were taken here. These were verified by Dr. E. M. Walker. It is the farthest southwest record for this species. Except *Aeshna multicolor* Hagen, which was also taken around the warm springs, and one of the *constricta*, which was taken in a greasewood thicket, all the *Aeshna* were caught in the space of an hour near the large spring west of the hotel when at 6 p. m. they were flying in a large "*Aeshna* swarm" which was perhaps 200 feet in diameter. Hundreds of *Aeshna* were evidently feeding on some particular swarm of smaller insects and their numbers made the individuals fearless, so they were easily taken. About twenty, altogether, were caught. This was the only "*Aeshna* swarm" I have ever seen. It contained four species and thinned out after an hour's vigorous net work.

16. AESHNA INTERRUPTA INTERNA Walker.

Several males were caught in the *Aeshna* swarm. No *interrupta nevadensis* were taken at this place. They apparently belong to the damper and higher Sierra.

17. AESHNA MULTICOLOR Hagen.

Abundant about the warm springs. This is the abundant species at this point. Several were caught in the *Aeshna* swarm.

18. AESHNA PALMATA Hagen.

Several males were caught in the *Aeshna* swarm.

19. MACROMIA MAGNIFICA Mc Lachlan.

One male was observed on the river.

20. LIBELLULA FORENSIS Hagen.

Common about the springs.

21. *LIBELLULA NODICTICTA* Hagen.

One was caught on a fence back of the hotel. Not seen elsewhere.

22. *LIBELLULA PULCHELLA* Drury.

Common about the springs.

23. *PLATHEMIS SUBORNATA* Hagen.

One male was caught near a spring. This is the first record for this species west of Utah.¹ It was not common at this point.

24. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common about the pond east of the hotel.

25. *SYMPETRUM CORRUPTUM* (Hagen).

Occasional on the gravel bars in the river.

26. *SYMPETRUM COSTIFERUM* (Hagen).

Occasional about the pond east of the hotel.

27. *SYMPETRUM PALLIPES* (Hagen).

Common in the willow thickets along the river. This species seems always to prefer cool somewhat shaded places.

28. *SYMPETRUM SEMICINCTUM* (Say).

Common in the fields along the river. The males of this species sometimes go to sleep while seated in the sunshine, when they can be picked up by hand.

HUMBOLDT RIVER, WINNEMUCCA, NEVADA.

The Humboldt River at this point is about twice as large as at Golconda and twice as muddy. It has no gravel bars. "Pin willow" thickets made collecting impossible except near the town. Three hours on August 8 were spent here.

1. *LESTES CONGENER* Hagen.

Several seen along a ditch.

2. *ARGIA EMMA* Kennedy.

Several caught along the river.

3. *ENALLAGMA CARUNCULATUM* Morse.

Common along a ditch.

4. *GOMPHUS OLIVACEUS NEVADENSIS* Kennedy.

About 20 were caught in the willow thickets near the slaughter-house (see p. 557).

5. *AESHNA MULTICOLOR* Hagen.

Several seen. A male caught.

6. *MACROMIA MAGNIFICA* Mc Lachlan.

A single male was seen on the river.

7. *SYMPETRUM SEMICINCTUM* (Say).

Common in the willow thickets.

HUMBOLDT RIVER, LOVELOCKS, NEVADA.

At Lovelocks the Humboldt Valley widens out and has been put under irrigation. The river at this point flows through an earth-walled channel 20 to 40 feet deep. As nearly all the water is taken

¹ During August, 1915, I found this species of *Plathemis* abundant in Owens Valley, Inyo County.

out for irrigation, one can wade back and forth across the bottom of the river channel. Otherwise collecting at this point would be very difficult. I collected here on August 10.

1. *ENALLAGMA CARUNCULATUM* Morse.

Common on stagnant ditches.

2. *CELAENURA DENTICOLLIS* (Burmeister).

Occasional on ditches.

3. *ERPETOGOMPHUS COMPOSITUS* Hagen.

Several were caught along the river.

4. *GOMPHUS INTRICATUS* Hagen.

Abundant along the river. Several exuviae found (see p. 570).

5. *GOMPHUS OLIVACEUS NEVADENSIS* Kennedy.

Common along the river (see p. 557).

6. *LIBELLULA COMPOSITA* Hagen.

A single female of this rare species was caught while she was perched on the top of a greasewood bush. This is the only one of this species I have seen alive.¹ G. F. Ferris gave me a second female caught at Provo, Utah. The type was taken on the "Yellowstone." Others have been taken at Salt Lake City. This is the first record west of Utah. Its color fits the description given by Hagen² and also by Ris.³ In life its eyes were creamy white with a pearly luster. It is the only white-eyed dragonfly I have seen. The Provo female had a small nodal spot in each wing.

7. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common around ditches.

8. *SYMPETRUM COSTIFERUM* (Hagen).

Occasional.

9. *SYMPETRUM SEMICINCTUM* (Say).

Common about ditches.

SAN JOAQUIN VALLEY, CALIFORNIA.

From September 1 to 15, 1914, I made a trip down the San Joaquin River to Bakersfield, thence over the mountains to Los Angeles. This was very late in the odonate season, but some interesting data were obtained. The records obtained around Los Angeles will be reported on in my next paper, which will discuss the Odonata of southern California. The following lists concern the San Joaquin Valley.

Stretched lengthwise for almost 400 miles through the central part of California lies the great interior valley. Its floor, more level than a prairie and in many places from 30 to 50 miles wide, lies just above sea level. Shut off from the cool moist winds of the Pacific by the

¹ During August, 1915, I found *Libellula composita* common in Owens Valley, California.

² U. S. Surv. Terr. Colo. (1872), p. 728, 1873.

³ Collections Selys, fasc. II, Libellulinen, 1910, p. 267.

Coast Ranges it is a hot, dry region. In this interior valley several Mexican species reach their northernmost range.

The northern half of this valley is drained by the Sacramento River, which flows south into San Francisco Bay. The southern half is drained by the San Joaquin River, which flows north, emptying into the bay near the mouth of the Sacramento.

This southern half, usually called the San Joaquin Valley, may be divided into two quite different regions: The main valley, which is dry and sandy with no trees except along the river, and the delta at the north end, in which is located the city of Stockton.

STOCKTON, SAN JOAQUIN COUNTY, CALIFORNIA.

Stockton lies out in the level San Joaquin Valley, but several miles back from the river on ground above river floods. This region, which is roughly coextensive with San Joaquin County, is the delta of the San Joaquin River. It is a hot, level country which has been reclaimed by dredging the numerous winding channels of this river and by the building of great dikes along those channels which confine the early summer flood of snow water. There are said to be over 200 miles of these winding lateral channels of the San Joaquin River, which are navigable to the odd stern-wheel steamers that carry the produce of this fertile delta region down to San Francisco. These winding, placid streams, brown with mud, are everywhere fringed with green weeping willows, whose drooping branches give to the region the appearance of a languor such as the great humidity and heat produce in the observer. As much of this reclaimed land is actually below tide, this region has been aptly termed the "Holland of America."

The collecting was done on Mormon Slough, in the heart of Stockton, and along the river dikes west of the city.

1. *ENALLAGMA CARUNCULATUM* Morse.

Common on Mormon Slough.

2. *ISCHNURA CERVULA* Selys.

Common on Mormon Slough.

3. *GOMPHUS OLIVACEUS* Selys.

One female was caught on the river dike. This was the only one seen.

4. *ANAX JUNIUS* (Drury).

Occasional on the sloughs.

5. *AESHNA MULTICOLOR* Hagen.

Very abundant on the sloughs.

6. *AESHNA PALMATA* Hagen.

Two females identified by Dr. E. M. Walker as *palmata* were caught on the dyke along Calaveras Creek.

7. *MACROMIA MAGNIFICA* Mc Lachlan.

One female was caught on the dyke along Calaveras Creek. She was old, with frayed wings.

8. *LIBELLULA PULCHELLA* Drury.

Not common.

9. *LIBELLULA SATURATA* Uhler.

Not common.

10. *PLATHEMIS LYDIA* (Drury).

One male caught.

11. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Saw one female. Not common.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Common on the sloughs.

13. *SYMPETRUM ILLOTUM* (Hagen).

Scarce.

14. *SYMPETRUM SEMICINCTUM* (Say).

Scarce.

FRESNO, FRESNO COUNTY, CALIFORNIA.

Fresno, surrounded by its vineyards, lies near the great bend of the San Joaquin. East of Fresno the river comes down from the Sierras a swift, snow-fed mountain stream, but turning abruptly it flows away to San Francisco Bay in the north. In this lower, level portion of its course through the hot, dry San Joaquin Valley it is almost the opposite of a mountain stream. It meanders sluggishly over a bed of shifting white sand. Its waters become turbid and warm.

Collecting at Fresno was done at Fresno Beach, a city recreation park on the banks of the river, and at Friant, a few miles from Fresno, where the San Joaquin emerges from its Sierra canyon.

FRIANT, FRESNO COUNTY, CALIFORNIA.

The following list was taken September 4, 1914, at Friant, which is a village on the San Joaquin where the latter emerges from the great canyon through which it descends from the high Sierra. Here for a few miles before it reaches the level valley floor it is a swift stream 300 feet wide, from 1 to 5 feet deep, flowing over a bed of gravel.

1. *ARGIA EMMA* Kennedy.

Several seen.

2. *ERPETOGOMPHUS COMPOSITUS* Hagen.

This was very abundant and will be discussed fully in my next paper.

3. *ANAX JUNIUS* (Drury).

One or two observed.

4. *AESHNA MULTICOLOR* Hagen.

Several *Aeshna*, probably this, were observed.

5. *LIBELLULA SATURATA* Uhler.

Observed.

6. *SYMPETRUM CORRUPTUM* (Hagen).

Common as usual.

7. *BRECHMORHOGA MENDAX* (Hagen).

This graceful species was present here. In the course of the day's collecting I saw not less than a dozen individuals. These usually had short beats in the shade of the occasional large willow trees that grew on the gravel beaches. Several were caught.

8. *TRAMEA LACERATA* Hagen.

Several were caught among the willows in the mouth of the canyon.

FRESNO BEACH, FRESNO COUNTY, CALIFORNIA.

On September 5, 1914, the species in the following list were taken at Fresno Beach, a pleasure park 12 miles from Fresno. Here, excepting *Hetaerina americana* (Fabricius) and *Sympetrum corruptum* (Hagen), which were caught along the sandy banks of the river, the entire list was taken around a back-water slough near the river. This swarmed with pond species, though the water was thick with algae and almost entirely covered with duckweed.

1. *HETAERINA AMERICANA* (Fabricius).

Common along the willows overhanging the river.

2. *ENALLAGMA CARUNCULATUM* Morse.

Common about the slough.

3. *TELEBASIS SALVA* (Hagen).

This small bright red species was very abundant over the edges of the slough. They flew about quite commonly in pairs. The female oviposited while the male held her.

4. *ISCHNURA CERVULA* Selys.

Common.

5. *ISCHNURA PERPARVA* Selys.

Common.

6. *CELAENURA DENTICOLLIS* (Burmeister).

Common and associated with *Telebasis*.

7. *ANAX JUNIUS* (Drury).

This species was abundant and its habits more fully observed than I had been able to observe them elsewhere. The male seized the female on the wing and retained his hold on her head while she oviposited. The pair would alight on the floating masses of algae. The female would bend her abdomen down and forward making from three to ten thrusts in the loose mass of algae whereupon the pair would fly to another place. Apparently the eggs were merely extruded among the filaments of the algae.

8. *AESHNA MULTICOLOR* Hagen.

Common as usual.

9. *LIBELLULA SATURATA* Uhler.

Common.

10. *PLATHEMIS LYDIA* (Drury).

Several seen.

11. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Common. This was flying about the edges of the pond in company with *Pachydiplax*. It is bolder in its flight than *Pachydiplax*.

12. *SYMPETRUM CORRUPTUM* (Hagen).

Common.

13. *SYMPETRUM ILLOTUM* (Hagen).

Several seen.

14. *PACHYDIPLAX LONGIPENNIS* (Burmeister).

This was more common than I have seen it elsewhere in the West. It is a shore-line species of ponds, seldom straying from the edge of the water. Its habits are similar to those of *Erythemis*, with which it is always associated. However, it usually rests *Sympetrum*-like on the tips of snags and sedges at distances of one to 5 feet above the water while *Erythemis* alights most often as close to the surface as possible. The exuviae of *Pachydiplax* were common on logs and the bases of trees where the nymphs had crawled up from 1 to 3 feet above the surface of the water.

15. *PANTALA HYMENAEA* (Say).

Two individuals were caught flying with *Tramea* over a pasture near the pond. Not common.

16. *TRAMEA LACERATA* Hagen.

Tramea was more abundant here than I have ever seen it elsewhere. It was an interesting species because of its great dexterity on the wing. In the early morning *Tramea* was found flying high and wide, each on a short beat which was frequently changed. After 10 or 11 o'clock, when the heat of midday had increased their activity, they were found over the surface of the pond ovipositing. I saw an occasional female ovipositing unaccompanied by a male but usually every female had a very attentive male companion. As *Tramea* seldom alights, the male would catch the female on the wing. While holding her the pair would fly about over the surface of the pond, stopping occasionally to oviposit over the surface where this was free from the scum of algae and duckweed. The pair would poise about 6 inches above the surface of the water. The male would release the female and remain poised while she would drop to the surface, and with a short swing, tap the surface just once, when she would rise to the male who would instantly grasp her thorax with his claspers without first seizing her with his feet. This quick release and the almost immediate reclaspings of the female was one of the most dexterous performances I had ever observed in dragonflies.

Exuviae were common on the stumps and logs lying about the edges of the slough.

REEDLEY, FRESNO COUNTY, CALIFORNIA.

I spent September 6 collecting on Kings River near Reedley. Nothing was taken except *Aeshna multicolor* Hagen and *Macromia magnifica* McLachlan. This is interesting in being the farthest south record for *Macromia magnifica* in California.

BAKERSFIELD, KERN COUNTY, CALIFORNIA.

Bakersfield lies at the southern or head end of the San Joaquin Valley. It is on the Kern River, which is a tributary of the San Joaquin but only in exceptionally wet seasons. At other times the Kern is drained for irrigation shortly after reaching the level valley floor. The collecting was done in the bottoms near the oil field. The species are largely slough forms.

1. HETAERINA AMERICANA (Fabricius).

In the willows fringing the river.

2. ENALLAGMA CARUNCULATUM Morse.

Common.

3. ENALLAGMA CYATHIGERUM (Charpentier).

Several caught.

4. ISCHNURA CERVULA Selys.

Common along the irrigation canal.

5. CELAENURA DENTICOLLIS (Burmeister).

Common along a slough.

6. ANAX JUNIUS (Drury).

This species was very abundant, breeding in the sloughs. It was interesting to observe it about the ponds of black crude oil. Several individuals were caught that had been crippled by brushing their wings in the gummy oil. One female was found with the posterior segments of the abdomen soiled with oil. It was evident that they frequently mistook the glassy surface of these oil ponds for water.

Across the river, south from the oil field, was an abandoned well beside which was a small pond of fully hardened oil left when the well was deserted. This in portions was almost a continuous mass of dead *Anax* and water beetles. These were entirely covered with the oil so that I did not at first recognize what it was that caused the odd roughness of the surface as I walked over it. Hundreds and perhaps several thousand had been caught in this small pond. It would seem that *Anax* has no very keen sense of smell or these very odoriferous death traps would be avoided.

MODESTO, MARIPOSA COUNTY, CALIFORNIA.

The following list of species was taken by Mr. G. F. Ferris, of Stanford University, in the region of the San Joaquin Valley around Modesto. The elevation is less than 1,000 feet. These were caught during May and June, 1914. The specific localities are Pleasant Valley, Modesto, and Coulterville.

1. *LESTES CONGENER* Hagen.
One female, Pleasant Valley.
2. *ARGIA AGRIOIDES* Calvert.
One male, Pleasant Valley.
3. *HYPONEURA LUGENS* Hagen.
Three males and three females from Pleasant Valley.
4. *ARGIA VIVIDA* Hagen.
Six females, Pleasant Valley; one female, Bean Creek, at Coulterville.
5. *ENALLAGMA CYATHIGERUM* (Charpentier).
Pleasant Valley and Bean Creek, Coulterville.
6. *AMPHIAGRION SAUCIUM ABBREVIATUM* Selys.
Two males and a female from Bean Creek, Coulterville. This is the lowest altitude in California at which this species has been taken.
7. *ISCHNURA CERVULA* Selys.
A male and female from Modesto.
8. *ISCHNURA PERPARVA* Selys.
Three males and four females from Coulterville.
9. *PROGOMPHUS BOREALIS* Mc Lachlan.
One male, Pleasant Valley.
10. *GOMPHUS OLIVACEUS* Selys.
A male from Bean Creek, Coulterville. This is the farthest south record of this species in the San Joaquin Valley.
11. *OCTOGOMPHUS SPECULARIS* (Hagen).
Pleasant Valley and Coulterville.
12. *AESHNA MULTICOLOR* Hagen.
Pleasant Valley.
13. *LIBELLULA FORENSIS* Hagen.
One female, Coulterville.
14. *LIBELLULA NODISTICTA* Hagen.
A male and female, Coulterville.
15. *LIBELLULA PULCHELLA* Drury.
One female, Pleasant Valley.
16. *LIBELLULA SATURATA* Uhler.
A male and female, Pleasant Valley.
17. *PLATHEMIS LYDIA* (Drury).
Modesto and Coulterville.
18. *SYMPETRUM CORRUPTUM* (Hagen).
Two males and three females, Coulterville.
19. *SYMPETRUM ILLOTUM* (Hagen).
Modesto and Pleasant Valley.
20. *SYMPETRUM PALLIPES* (Hagen).
Pleasant Valley, one male.
21. *PACHYDIPLAX LONGIPENNIS* (Burmeister).
A male and female from Modesto.

THREE RIVERS, TULARE COUNTY.

The town of Three Rivers lies on the Kaweah River in the southern end of the San Joaquin Valley. The elevation is from 500 to 800 feet. The specimens listed below were collected during July and August, 1914 and 1915, by Mr. and Mrs. L. R. Reynolds, of San Francisco, and by Dr. J. C. Bradley on July 12-14, 1907. The latter are in the collection of Cornell University.

1. ARGIA AGRIOIDES Calvert.

Males and females by Mr. and Mrs. L. R. Reynolds. One male and two females by Dr. J. C. Bradley.

2. ARGIA EMMA Kennedy.

Collected by Mr. and Mrs. L. R. Reynolds.

3. ARGIA VIVIDA Hagen.

Several, Mr. and Mrs. L. R. Reynolds; two males and one female by Dr. J. C. Bradley.

4. ENALLAGMA CARUNCULATUM Morse.

Several by Mr. and Mrs. L. R. Reynolds.

5. TELEBASIS SALVA (Hagen).

Several by Mr. and Mrs. L. R. Reynolds; male and female by Dr. J. C. Bradley.

6. ISCHNURA PERPARVA Selys.

Collected by Mr. and Mrs. L. R. Reynolds.

7. CELAENURA DENTICOLLIS (Burmeister).

Collected by Mr. and Mrs. L. R. Reynolds.

8. CORDULEGASTER DORSALIS Hagen.

One female in the Cornell collection taken by Dr. J. C. Bradley.

9. OPHIOGOMPHUS BISON Selys.

These are the types of Miss Butler's *Ophiogomphus sequoiarum*. They are in the Cornell collection, having been taken by Dr. J. C. Bradley.

10. LIBELLULA SATURATA Uhler.

A male and female collected by Mr. and Mrs. L. R. Reynolds; four males collected by Dr. J. C. Bradley.

11. PLATHEMIS LYDIA (Drury).

Collected by Mr. and Mrs. L. R. Reynolds.

12. SYMPETRUM CORRUPTUM (Hagen).

Taken by Mr. and Mrs. L. R. Reynolds.

EXETER, TULARE COUNTY.

The following species are in the Cornell collection, having been taken by Dr. J. C. Bradley at Exeter, in the hot, southern end of the San Joaquin Valley.

1. CELAENURA DENTICOLLIS (Burmeister).

2. ERYTHEMIS SIMPLICICOLLIS (Say).

3. SYMPETRUM CORRUPTUM (Hagen).

4. PACHYDIPLAX LONGIPENNIS (Burmeister).

5. TRAMEA LACERATA Hagen.

SOUTHERN SIERRA NEVADA MOUNTAINS.

The following list is compiled from sources as follows:

Records on specimens in the collection of the California Academy of Science.

Records on specimens in Mr. Fordyce Grinnell's collection in the Southwest Museum of Los Angeles.

From a collection sent me by Mr. and Mrs. L. R. Reynolds of San Francisco, who had collected in the region of Sequoia National Park.

From a collection sent me by Mr. G. F. Ferris of the entomological department of Stanford University, who had collected in the region of Yosemite National Park.

From specimens collected by Dr. J. C. Bradley in the Mount Whitney region during July and August, 1915, and now deposited in the Cornell collection.

From specimens in the Cornell collection collected by Dr. J. H. Comstock in Tuolumne County and the Sequoia National Park, July 17-24, 1907.

The species are Canadian and the list agrees with those I collected at altitudes of from 5,000 to 7,000 feet in the region of Lakes Donner and Tahoe (see pp. 611-616 of this paper). The list is also repeated in the series of Canadian species I caught at 4,000 feet elevation near Bend, Oregon,¹ and agrees with the list² collected by R. C. Osburn.

As stated at the beginning of these locality lists, the eastern side of the State of California for nearly its entire length is occupied by the great upland of the Sierra Nevada Mountains. This rises gradually through a distance of 30 to 50 miles from the Sacramento and San Joaquin Valleys on its west side until an altitude of 7,000 to 10,000 feet is reached near the Nevada boundary. Above this tower the great peaks of Lyell and Whitney with their lesser but numerous companions. After reaching this great altitude along the eastern border of the State the Sierra drops suddenly by the greatest escarp in North America to the comparatively low elevation of 3,000 feet. Nearly the entire west slope from 2,000 feet up to 8,000 feet is covered with coniferous timber, which is usually sparse.

This great Sierra apparently forms a barrier to several Pacific coast species such as *Lestes stultus* Hagen, *Zoniagrion exclamationis* (Selys), *Ischnura erratica* Calvert, *Cordulegaster dorsalis* Hagen, *Ophiogomphus bison* Selys, *Octogomphus specularis* (Hagen), and *Aeshna walkeri* Kennedy. To a less extent it shuts interior forms away from the coast, such perhaps as *Enallagma clausum* Morse, *Libellula composita* Hagen, and *Plathemis subornata* Hagen.

The following list includes the majority of those interesting northern species which are able to maintain existence as far south as

¹ Proc. U. S. Nat. Mus., vol. 49, July, 1915, pp. 333-337.

² Ent. News, vol. 16, 1905, pp. 184-196.

central California by living in the swamps and lakes of this cool elevated region.

1. *LESTES CONGENER* Hagen.

One male, 2 females, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock.

2. *LESTES DISJUNCTUS* Selys.

Walker Lake, Mono County, 7,700 feet, Ferris. Male and female, Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock.

3. *LESTES UNCATUS* Kirby.

Yosemite Valley, 4,000 feet, Devils Post Pile, Yosemite Park, 8,000 feet, Ferris. Tuolumne Meadows, Tuolumne County, 8,500 feet, Reynolds, Ferris.

4. *ARGIA VIVIDA* Hagen.

Four males and one female. Giant Forest, Marble Fork, Kings River Trail, Sequoia National Park, 6,500 to 7,000 feet, Dr. J. C. Bradley. Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock. Probably living in springs at this high altitude.¹

5. *ENALLAGMA CALVERTI* Morse.

Walker Lake, Mono County, 7,700 feet, Ferris.

6. *ENALLAGMA CYATHIGERUM* (Charpentier).

Gem Lake, Mono County, 9,000 feet, Ferris. Tuolumne Meadows, Yosemite National Park, 8,600 feet, Ferris. Twin Lakes, Sequoia National Park, 10,550 feet, Reynolds. Crabtree Meadows, near Mount Whitney, 10,550 feet, two female *Enallagma*, probably this species, Dr. J. C. Bradley. One male, Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock. Cathedral Lake, Tuolumne County, 9,500 feet, Dr. J. H. Comstock.

7. *AMPIAGRION SAUCIUM ABBREVIATUM* Selys.

South Fork of Kings River, 6,300 feet, California Academy of Science, Tenaya Canyon. Yosemite National Park, 7,500 feet, Ferris. Ranger, Sequoia National Park, 8,250 feet, Reynolds.

8. *OPHIOGOMPHUS MORRISONI* Selys.

One female of typical *morrisoni*, Mount Whitney, Siberian Outpost, 9,000 to 10,000 feet, Dr. J. C. Bradley, July 31, 1915.

9. *OPHIOGOMPHUS MORRISONI NEVADENSIS* Kennedy.

Pumice Valley, Mono County, 6,800 feet, Ferris. Two females of *morrisoni* were sent in by Mr. Ferris. These were of the pale form *nevadensis*, though not as pale as females from Owens Valley and central Nevada. If this is *nevadensis* at this altitude the two forms probably intergrade.

10. *ANAX JUNIUS* (Drury).

Male and female, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock.

¹ Ann. Ent. Soc. Amer., vol. 8, 1915, p. 298.

11. AESHNA INTERRUPTA NEVADENSIS Walker.

Walker Lake, Mono County, 7,700 feet, Ferris. Elizabeth Lake, Yosemite National Park, 9,000 feet, Reynolds. Four males and one female, Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock.

12. AESHNA PALMATA Hagen.

One male, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. C. Bradley.

13. CORDULIA SHURTLEFFI Scudder.

Tuolumne Meadows, Yosemite National Park, 8,600 feet, Ferris. Dog Lake, Yosemite National Park, 9,000 feet, Reynolds.

14. SOMATOCHLORA SEMICIRCULARIS (Selys).

Cahoon Meadows, Giant Forest, 7,000 to 8,000 feet, August 15, 1915, Dr. J. C. Bradley.

15. LIBELLULA PULCHELLA Drury.

Yosemite Valley, 4,000 feet, Ferris. This species is an intermediate species. At extreme elevations *quadrifasciata* is the only *Libellula*.

16. LIBELLULA QUADRIFASCIATA Linnaeus.

Yosemite Valley, 4,000 feet, Ferris. This is almost as low as this species comes in middle California. Tuolumne Meadows, Yosemite National Park, 8,600 feet; Walker Lake, Mono County, 7,700 feet, Ferris. Harden Lake, Tuolumne County, 7,575 feet, Dr. J. H. Comstock.

17. LIBELLULA SATURATA Uhler.

Male and female, Giant Forest, Sequoia National Park, 6,500 feet, Dr. J. H. Comstock. This is the highest record for this species. The record appears to be correct. It is distinctly a hot valley species. See *Pachydiplax*, p. 635.

18. PLATHEMIS LYDIA (Drury).

One male, Giant Forest, Sequoia National Park, 6,500 feet, Dr. J. C. Bradley, July 17, 1907. The upper limit of this species. See *Pachydiplax*, p. 635.

19. SYMPETRUM CORRUPUM (Hagen).

Fresno County, 10,000 feet, California Academy. Mount Hutchings Ridge, 10,450 feet, Grinnell. Mono Lake, Mono County, California, Ferris. Crabtree Meadows, near Mount Whitney, 10,550 feet, Dr. J. C. Bradley. One female, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock. Most abundant from sea level up to 5,000 feet.¹

20. SYMPETRUM RUBICUNDULUM DECISUM (Hagen).

Kings River Canyon, 5,000 feet, California Academy. Kern River, 6,000 to 7,000 feet, Dr. J. C. Bradley.

¹ Ann. Ent. Soc. Amer., vol. 8, 1915, p. 300.

21. SYMPETRUM PALLIPES (Hagen).

Kings River Canyon, 5,000 feet, California Academy. One female, Giant Forest, Sequoia National Park, 6,500 to 7,100 feet, Dr. J. H. Comstock. One female, Sugar Pine, Tuolumne County, 5,000 feet, Dr. J. H. Comstock.

22. SYMPETRUM SCOTICUM (Donovan).

Walker Lake, Mono County, 7,700 feet, Ferris.

23. SYMPETRUM SEMICINCTUM (Say).

Yosemite Valley, August 17, 1915, Dr. J. C. Bradley. No altitude record on this specimen. It probably does not go often above 3,000 feet. One female, Giant Forest, Sequoia National Park, 6,500 to 7,100 feet, Dr. J. H. Comstock.

24. PACHYDIPLAX LONGIPENNIS (Burmeister).

One female, Giant Forest, Sequoia National Park, 6,500 to 7,100 feet, Dr. J. H. Comstock. This is the highest record for this species. The record appears correct though this is a species of the low hot valleys. This species, *Libellula satarata* and *Plathemis lydia* are in the Cornell collection, with labels indicating that all three were taken by Dr. J. H. Comstock, July 17, 1907, at an elevation of 6,500 feet. As these are the species most out of place in this list it is possible an error has been made in labeling. I am inclined to doubt their occurrence at this elevation.

25. LEUCORRHINIA GLACIALIS Hagen.

Tuolumne Meadows, Yosemite National Park, 8,600 feet, Ferris, Reynolds. Dog Lake, Yosemite National Park, 9,000 feet, Reynolds. Tenaya Canyon, Yosemite National Park, 7,500 feet, Ferris.

26. LEUCORRHINIA HUDSONICA (Selys).

Tenaya Canyon, Yosemite National Park, 7,500 feet, Ferris. This is the first California record for this species.