STUDIES ON THE FAUNA OF SURINAME
AND OTHER GUYANAS: No. 38.

ANAX LONGIPES VERSUS ANAX CONCOLOR

Notes on Odonata of Suriname X

by

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In an attempt to determine the South American species of *Anax*, the question whether *A. concolor* Brauer is a race of *A. longipes* Hagen or a separate species, became urgent. Since HAGEN (1890) did not accept *A. concolor* as a good species but interpreted it as a southern race of *A. longipes*, in which he was followed by MARTIN (1908) and the American odonatologists, the problem remained untouched. This is probably due to insufficient material of the species in collections.

To solve the question, I studied the types of both species, but the difficulty was that the holotype of *Anax longipes* is a female and that of *Anax concolor* a male. Both species are doubtless close relatives, characterized by the green unmarked frons. The renewed study of the species in discussion was made possible by fundamental material in all stages of *A. concolor* and by sufficient comparable specimens both imagines and larvae of *A. longipes*. The result is that I consider *A. concolor* a good species and not a race of *A. longipes*, for which the reasons are discussed in the following chapters.

This study was made possible by the help of the following persons and authorities. Through the kindness of Dr. W. SAUTER, curator of the "Entomologisches Institut der Eidg. Technischen Hochschule in Zürich (Switzerland), I was able to examine the female holotype of *Anax longipes* Hagen, still present in the collection of Mr. Escher Zollikofer. I am much indebted to Dr. DOUGLAS ST. QUENTIN in Vienna for his intercession and to Prof. Dr. M. BEIER, Director of the Zoological Section of the "Naturhistorisches Museum" in Vienna for the loan of the holotype of *Anax concolor* Brauer. Dr. MINTER J. WESTFALL, Jr. of the University of Florida Collections,

Gainesville, Florida, was kind enough to supply additional material, both imagines and larvae of *Anax longipes* Hagen from the U.S.A. and a series of males of *Anax concolor* from different places in the neotropics. Mr. J. BELLE, now in Arnhem, The Netherlands, has put at my disposal his reared specimens of *Anax concolor* from Suriname, for which I am most thankful. Dr. M. A. LIEFTINCK, curator of Odonata in the Leiden Museum, always was helpful in the study of the literature and has kindly reviewed the MS. My thanks are also due to Prof. Dr. L. D. BRONGERSMA, Director of the Leiden Museum for the extended hospitality and the Netherlands Foundation for the Advancement of Tropical Research (WOTRO) in The Hague for the grant to study this neotropical material.

Anax longipes Hagen

1861 HAGEN, Syn. Neur. N. Am.: 18 (♀ Georgia).
1867 HAGEN, Verh. zool. bot. Ges. Wien *17*: 35 (same, ad. notes).
1874 MAC LACHLAN, Ent. M. Mag *10*: 227 (♂ Georgia, lacking abd. segm. 7–10).
1883 MAC LACHLAN, The Entomologist's Monthl. Mag. *20*: 129 (add. notes ♂).
1890 HAGEN, Psyche *5*: 303 (♂ ♀ Massachusetts).
1905 CALVERT, Biol. Centr. Am. Odon.: 176 (notes and fig. ♂ app.).
1908 MARTIN, Coll. Selys Aeschnines *18*: 12 (short diagn. and fig. ♂ app.).
1909 CALVERT, Ann. Carn. Mus. *6*: 221 (♂ record Bahamas).
1927 GARMAN, Conn. Geol. Nat. Hist. Surv. Bull. *39*: 179 (short diagn., fig. ♂ app.).
1929 NEEDHAM & HEYWOOD, Handb. Dragonflies N. Am.: 129 (short diagn.).
1930 BYERS, Univ. Florida Publ. Biol. Sc. Ser. *1*: 81 (short diagn.).
1934 CALVERT, Proc. Am. Phil. Soc. *73*: 39 (larva).
1953 BICK, Ent. News *64*: 229 (distr.).
1955 NEEDHAM & WESTFALL, Manual Dragonflies N. Am. (Anisoptera): 272 (short diagn.).
1966 PAULSON, Quat. Journ. Florida Acad. Sc. *29*: 100–102 (discussion *concolor-longipes*).

HISTORICAL NOTES

In addition to the original descriptions of a female (holotype) by HAGEN (1861, 1867) and an incomplete male by MC LACHLAN (1874), both collected by ABBOT [1]) in Georgia U.S.A., HAGEN (1890) supplies the description of two live males and one female of *Anax longipes* collected by himself at Woods Hole, Mass., Aug. 25, 1875. He says of these: "abdomen with the two segments inflated green, first segment with two brown spots on the basal thoracical impression; second segment with a transversal dark median stripe, a darker anteapical spot and two round apical-reddish green spots; the trans-

[1]) HAGEN (1863), Stett. Ent. Zeit *24*: 369–378, has drawn attention to the drawings of ABBOT and his collection of Neuroptera (s. l) from Georgia.

versal median stripe is interrupted in the middle by a granulose somewhat triangular plate; the following segments of a beautiful brick-red, segment 3–5 with a brown triangular apical spot, less marked in 6, and a triangular basal brown spot on 4 and 5; all of these spots disappear in the dead insect, and the color of the abdomen becomes an indifferent reddish brown; last segment above with a narrow impressed rim at the middle of the base; ...". Of the living female he noted: "second segment with a transversal brownish median stripe on each side, a darker anteapical spot, and two apical blue ones; abdomen from the third segment brown, segments 3–9 with two apical blue spots, segments 3–7 with two basal blue spots, and segments 4–6 with two intermediate blue spots; ... Two females from Florida are a little smaller, the color and pattern are similar, the last segment is light brown."

CALVERT (1905) remarks on this species that it has a bright green thorax and a bright red abdomen when living. The same thing is mentioned by NEEDHAM & WESTFALL (1955) after a field note of ELSIE BROUGHTON KLOTS who describes the flying insect as having an emerald green thorax and a blood red abdomen with a striking flash of white at the base of the abdomen.

No more characteristics are to be found in the literature published subsequently, except for a note by PAULSON (1966) on the colour pattern of the abdomen. The male appendices are figured three times, but those of the female are not illustrated.

The larva is described and details are figured by CALVERT (1934) from two male exuviae from Pennsylvania, while five male and five female exuviae from Florida were examined.

DESCRIPTION

Male. Mouthparts and face green (pale yellow in dried specimens), ends of mandibles towards the large black dents and apical margin of labrum brownish. Frons very large, upper part prominent, without darker markings. Vertex and antennae black. Occipital triangle black, base flat, margins erect. Rear of head pale yellow except for a dark streak in the upper part under occipital triangle and down to halfway along the eye margin.

Prothorax dark brown with a pale fore- and hind margin, the last one fringed with long hairs.

Synthorax and first abdominal segments green, with a black spot at ventral side of mesepimeron, metepisternum and metepimeron. Legs and especially hind femora

very long, reaching backward end of segm. 2 or to base of abd. segm. 3. For measurements see Table 1. Femora redbrown, apical ends blackened; tibiae and tarsus black. Underside of fore femora lighter, innerside darker; outer angle of hind femora densely beset with a row of small triangular black spines, the tops directed backward, the last three or four spines twice as large as the other ones. Outer ventral angle of hind tibiae armed with 7–8 large black spines, but shorter than the distance between each other. Claws very long, endhook thin and sharp, tooth at ventral side distinct, sharp pointed and located at nearly halfway length of claw. Wings clear, in adults uniform brownish tinged, costa yellow, pterostigma light brown, membranula dark grey, white at base, four or five cells long. For venation see Table 3, for measurements see Table 1.

Abdomen: segm. 1 and 2 inflated, segm. 3 constricted, segm. 4–10 parallel sided. Middorsal carina starts at segm. 2 in a rectangular yellow raised part between the brown median transverse carina. This granulose part forms the upper end of a square spiny area, covering dorsum of distal half of segm. 2 (Fig. 92a). The middorsal carina runs over the other abd. segments to the beginning of segm. 8, the granulose row wider on segm. 3 and at base of segm. 4 than on the other segments. Base of segm. 3 with a large white lateral spot, otherwise this and the remaining abdominal segments brick red (in life) or redbrown (in dried condition) with no paler spots, or with an indication of lighter postdorsal spots on segm. 3, with antero-median and post-dorsal spots (not confluent) on segm. 4 and with antero- and medio-dorsal spots on segm.5.[1]

Appendices pale brown, app. superiores straight, narrow at base than rapidly dilated to its maximum at about 3/5 of their length, gradually narrowed to the end, concave inner side densely beset with fine stiff hairs. Apex rounded on the inner margin, outer corner ending in a short triangular point. Midrib of app. sup. well developed. Seen from the underside, the inner margin along the dilation elevated and armed with fine black spines to the broadest point at level of the end of app. inf. App. inferior broad and short, rectangular, reaching to approximately 1/3 the length of app. sup., end corners on top each with two short black dents (Fig, 88 a, b, c).

Genitalia on second abd. segm.: lamina anterior with black tipped dents parallel to each other, directed caudad to half way base of hamular process. Dents of hamular process small, directed forward to hardly the end of basement of lam. ant. Genital fossa with the outer margins of the thickened hollow enlargements beset with small black spines, followed at the pointed end by a dot of about 6–20 such spines on the ventral hind corner of the segment. Sometimes also a small spot of spines on both sides of this carina at midlength. Structure of penis see Fig. 91.

Female. Similar to male except for the dark brown abdomen dotted with lighter spots. The differences in other parts are: occipital triangle black with a light brown spot in the median or on each side. Prothorax dark brown, hind margin pale, fringed with long hairs. Legs long, hind femur reaching backward to the end of abd. segm. 2 or the beginning of segm. 3. Wings hyaline, pterostigma and costal vein yellow. As seen from the underside, the following crossveins are yellow: antenodals and crossveins between *R* and *M*, under half of arculus, crossveins in supertriangle, first

[1]) According to HAGEN (1890) live specimens have reddish green post-dorsal spots on segm. 2, such spots but brown on segm. 3–6 and basal brown spots on segm. 4–5.

3–4 crossveins between M_{1-3} and M_4 and Cu to Cu_1, in the lower angle of triangle and cubito anal crossveins. Membranula a little more than 3 cells long, dark grey, white at base. For venation see Table 3.

Abdomen: first two segments swollen, segm. 3 slightly constricted. Dilated middorsal carina on segm. 2 continued on segm. 3 in a less widened form and on segm. 4 starting in a rounded basal spot and slightly widened in the middle; the middorsal carina ends in segm. 7 or in basal third of segm. 8. Supplementary carina present on segm. 4–8, lateral carina on segm. 4–7, weakly curved in S-form (Fig. 90 upper row).

The first two inflated segments green, the remaining segments dark brown with lighter spots as follows: dorsum of segm. 3–9 with a pair of yellow or blue posterodorsal spots on each segment, largest on segm. 7 where they reach to halfway the segment length [1]). The middorsal part between these spots darker than more proximad. On segm. 4–6 two small medio-dorsal spots. Segm. 3 has a large white antero-lateral spot, enlarged along the ventral carina to the end of segment. Segm. 4–8 shows a yellow antero-lateral spot between the supplementary and the lateral carina. Segm. 10 unspotted, brown. In dried specimens most of these spots are no more visible.

Appendices broad lanceolate, as long as the last two segments, 5.5 mm long largest wide at 1/3 of the length, tip bluntly pointed (Fig. 89a). Underside of segm. 10 armed with about five or six rows of flat triangular sharp pointed black spines. Gonapophyses not prominent, underside flattened, the narrow grooved halves not reaching the end of segm. 9.

For measurements see Table 1.

I was able to examine the holotype female from Georgia. It is still in perfect condition, provided with two written labels, one (red): "Vgl. Proc. Boston Soc. Nat. Hist. 16.16, 350 1874 leg. Abbot, aus Georgia," and the second one: "Anax longipes nov. sp." in black handwriting of HAGEN. It agrees with the descriptions of HAGEN (1861, 1867), but I found the length of hind femur 15 mm instead of 12 as given by HAGEN. The measurements and the venation of this type are noted in Table 1 and 3 resp., the left appendix sup. and the lateral carina on segm. 4–7 are given in Fig. 89 and Fig. 90.

Material studied.

GEORGIA: U.S.A.: 1 ♀ (holotype), in coll. Escher Zollikofer, Ent. Inst. Eidg. Techn. Hochschule, Zürich.

FLORIDA: 1 ♂, in coll. Selys, Brussels Museum; 1 ♂ Enterprise, 22.IV.1921, J. H. Williamson, in Brussels Mus.; 1 ♂ Florida; 1 ♀ Alachua Co., Gainesville; 1 ♂ Alachua Co., Gainesville, 19.IV.1925, C. Francis Byers; 1 ♂ Alachua Co., Gainesville, 30.V.1928, C. Francis Byers; 1 ♂ Orange County, Winter Park,

[1]) PAULSON (1966) says that the abdomen of teneral reared females (from N. Carolina) are spotted exactly as in the San Salvador (*concolor*) male except that the spots are blue on segm. 3 to 8 and yellowish to greenish on nine.

9.IV.1937, J. A. Fluno; 1 ♂ Seminole County, Wekiwa River, 18.III.1939, E. M. Davis; 1 ♂ Highlands Co., 1.1 mi E U.S. 27 on Flo 70, 4.VI.1961, D. R. Paulson.
NORTH CAROLINA: 1 ♂ Transylvania County, Brevard, 13.VII.1939, M. J. Westfall Jr.; 1 ♂ Transylvania County, Brevard, 15.VII.1942, M. J. Westfall Jr.
ARKANSAS: 3 ♂ Washington County Pond on Odell Mt., 26.VII.1962, W. H. Whitcomb.
TENNESSEE: 1 ♂, Blount County, Laurel Lake near Townsend, 14.VIII.1960, R. P. Trogdon.
MASSACHUSETTS: 1 ♂ Flashy Pond, Cape Cod, 3.VII.1951, R. H. Gibbs, in Leiden Museum.
All specimens in University of Florida Museum, Gainesville, unless otherwise stated.

Distribution: Eastern U.S.A. from Massachusetts and Ohio to Florida, the Mississippi, Eastern Texas, the middle of Mexico, Hispaniola (Haiti), and Bahamas.

The distribution of *A. longipes* is discussed by BICK (1953) who mentions that: "its presence along the Atlantic coast from Massachusetts to Florida seems quite certain, and the Ohio and the Mississippi records indicate that it is probably present throughout the Eastern United States." Concerning its presence outside the United States of America, HAGEN (1890) records two males from Jalapa, Mexico, one male from Amula, Guerrero, Mexico and one male from Haiti. These data are set apart from the records of his variety *concolor*, of which he has seen three males and one female from Mato Grosso in Brazil. His remark that: "the number of males now before me makes it certain that *A. concolor* is only a southern race of *A. longipes* ..." suggests that the specimens from Mexico and Haiti actually belong to *A. longipes* s. str. In this connection it is of interest to note that CALVERT (1905) reports a female of *A. longipes* captured at sea, lat. 14°40′ N, long 97°40′ W about 60 miles off shore, July 10th 1873 USS "Benicia," i.e. in the Pacific south of the mouth of the Rio Peñoles, Oaxaca, Mexico. Furthermore CALVERT (1909) records one male *A. longipes* from Eleuthera Island in the Bahamas. DONNELLY (1966) found the species in Eastern Texas.

So far as is known today *A. longipes* is a North American species, living in the eastern States along the Atlantic coast and the Gulf States, ranging in the south to the Bahamas on one side and into

Mexico and the Greater Antilles (Hispaniola) on the other side (Fig. 101, map of distribution).

Anax concolor Brauer

1865 BRAUER, Verh. zool. bot. Ges. Wien *15*: 508 (latin descr. ♂).
1866 BRAUER, Novara-Exp. Neuropteren *1*: 60 (key), 66 (descr. ♂ type) pl. 1 fig. 15 (app. ♂).
1890 HAGEN, Psyche *5*: 304 (short diagn. ♂ ♀).
1905 CALVERT, Biol. Centr. Am. Odon.: 176 (distr.).
1908 MARTIN, Cat. Coll. Selys *18*: 13 (short diagn. ♂ ♀).
1934 CALVERT, Proc. Am. Phil. Soc. *73*: 38 (larva) pl. 1 fig. 19–20 (mentum), pl. 2 fig. 32 (lateral lobe), fig. 37 (app. ♂).
1966 PAULSON, Quat. J. Florida Acad. Sc. *29*: 100–102 (colour pattern abd. and distr.).

HISTORICAL NOTES

The original latin description of BRAUER (1865) is repeated in the "Neuropteren" (1866), where it is completed at length with a German description and with a figure of the male appendices on a too small scale. There are some contradictory points in the characteristics in BRAUER's key to the species of *Anax* and those given in the description, viz. app. inferior 1/3 the length of the app. sup. (1/4 in the description); pterostigma dark brown instead of yellowish brown. Furthermore BRAUER describes the red colour of the middle femur as extending from the base to half-way the length on the upper side and that on the hind femur to the end, but I found that in both femora only the apical end gradually darkens to black.

HAGEN (1890) gives a short description of three males and one female of this species, collected in Mato Grosso, Brazil. He found it "entirely similar to *A. longipes* though a little smaller, the abd. segm. 3–10 not red but dark brownish black with a pattern of large yellowish spots". The measurements of abdomen and wings are listed in comparison to those of *A. longipes*. His conclusion is that "the number of males (10) now before me makes it certain that *A. concolor* is only a southern race of *A. longipes* having the pattern of the abdominal spots of the female also preserved in the male." CALVERT (1905), following HAGEN in mentioning also Mato Grosso and Rio Negro in Brazil, had apparently not seen South American specimens. MARTIN (1908) also followed HAGEN in placing *concolor* as a "race"

of *A. longipes*. He records one male *A. longipes* and one male of race *concolor* in SELYS's collection. When inspecting the material at Brussels in July 1966, I found two males *A. longipes*, both from Florida, and one male *A. amazili* from Argentina identified as *A. concolor*.

One male *concolor* was captured at Manaos by J. H. WILLIAMSON and this was compared by CALVERT (1934) with two males *longipes*, one from Staten Island N.Y. and one from Florida. In the Manaos male the wing membranule is brown with no white, otherwise: "the three males are very similar except that the two males from the United States have a longitudinal blackish line on middorsum of segm. 3–7, due chiefly to the black denticles located there, while the Manaos male has a longitudinal middorsal brown band .5–1.5 mm in width." On the other hand CALVERT says that this male from Manaos corresponds throughout with BRAUER's detailed description of 1868 (should be 1866), but remarks that "Hagen although without having seen Brauer's type, considered *concolor* as a race of *longipes* Hagen."

Recently PAULSON (1966) discussed the question *concolor* and *longipes* after the discovery of *concolor* on the island of San Salvador in the Bahamas. He considers the two forms "allopatric representatives of one another" and expresses their relationship by the use of trinomials. He restricts *longipes* to the U.S.A., *concolor* to the West Indies (probably) and from Mexico through Central America to Brazil. Notes on the colouration of the (San Salvador) male in life were: "frons and thorax lime green, abdominal segments 1 and 2 same color, 2 porcelain blue distally; 3 to 10 blackish with pale green spots (small transverse ones on anterior third and larger rhombic ones on posterior third of middle segments); appendages brown; femora reddish, remainder of legs black. The female was quite similar, although lacking the blue on the second segment."

The larva of supposed *concolor* is briefly described and partly figured by CALVERT (1934). Two male and five female exuviae from Manaos, showing slightly longer appendices, were measured and minutely compared to Costa Rican exuviae (of *A. amazili*).

DESCRIPTION

Male. Mouthparts and face green (yellowish in dried specimens), external margin of labrum in the concave middle part dark brown. Frons prominent, upper part unmarked; base between frons and vertex a little darkened. Antennae dark brown. Vertex black, granulose and slightly curved. Occipital triangle black, raised hind border pressed down in the median. Rear of head black along the upper eye margins and downward to the centre, otherwise pale yellow.

Synthorax and the first two abdominal segments green (yellowish in dried specimens), a black spot at the underside of meso- and metepimeron on both sides of stigma. Legs and especially hind legs very long, hind femur reaching to base of segm. 3, femora red brown, underside of fore femora pale brown, apical end of femora, tibiae and tarsus black.

Wings hyaline, in hind wings a diffuse yellow spot from the first row in *Mspl* under M_4 down to wing margin, passing the narrow end of cubital area. Costa and most of the crossveins in the costal, subcostal and median area yellow, including cubital crossveins before triangle. Pterostigma light brown, in fore wing 4.5 mm, in hind wing 5 mm long. Membranule dark grey with a white base, covering 3 to 4 cells of the last anal cellrow. Venation see Table 4, measurements see Table 2.

Abdomen: first two segments inflated, segm. 3 constricted, segm. 4–7 gradually widened, triangular in cross section, with a distinct middorsal carina, segm. 8–10 flattened, no dorsal carina. Segm. 1 and 2 green, dorsum of segm. 2 in the middle with two brown transverse stripes just behind a yellow ridge, which in the median is pointed backward into a triangular granulose area, covering two apical brown spots (Fig. 92b). Colourpattern (in holotype from Rio Negro Brazil) on segm. 3–10 as follows: segm. 3 with a large white latero-basal spot, on dorsum two smaller yellow spots at base, in the median and in the apical part. The same is repeated on segm. 4–6, the basal side spot smaller and yellow, the medio-dorsal and the postero-dorsal spot on segm. 5 larger, the last two confluent on segm. 6–8 the basal spot disappearing on segm. 7–8. Segm. 9 with only the postero-dorsal spot present. Segm. 10 uniform brown, appendices light brown.

In the Surinam males the paler spots on dorsum of abdomen are greenish (alive) or yellowish brown (in dried specimens), in the Brazilian male from Piracicaba the spots are blue. This is also mentioned by PAULSON (1966) for the *concolor* male from San Salvador. After a live male from Dominica I noted: "Face, synthorax and abd. segm. 1 and 2 dark green, eyes on top dark brown, blue spotted, legs brown, tibiae and tarsus black, abd. segm. 3 with a large silvery light blue basal spot, dorsum of segm. 3–10 dark brown, appendices lightbrown". In the males from Guadeloupe the abdominal spots are still visible and my field notes are: "abdomen with light yellow brown spots, appendices brown".

Supplementary carina on segm. 4–9, straight; lateral carina on segm. 4–8 curved. Appendices sup. red brown, straight, basal fourth narrow, abruptly widened along the inner margin to its maximum just behind the end of app. inferior at about 1/3 the total length, the remaining part tapering to the more or less rounded end, the stiff bristled middle part slightly concave, outer end pointed in a black tipped dorn. Midrib strongly developed and raised. As seen from the underside, the app. sup. is beset with a row of fine black spines along the curled inner margin of the widened part. In profile view the end of app. sup. is small lanceolate, the tip somewhat lifted. App. inferior short, rectangular, reaching to 1/4 the length of the app. sup., outer dorsal corner armed with two black dents each side (Fig 88 d, e, f).

Genitalia second segm.: the two spines of lamina anterior relatively short, directed caudad and reaching to the first half of the hamular process, the end point black tipped. Base of hamular process rounded, dents not sharply pointed and directed forward to the level of the base of anterior lamina. Ventral margins along the genital fossa enlarged to a narrow hollow rim, surrounded by two raised margins, of which the outer (lateral) one bears a row of minute black spines. Behind the pointed end of this rim, there are two to four minute black spines between this point and the apical segment margin. For the structure of the penis see Fig. 91.

A careful examination of the male type of BRAUER proved it to be identical to my Surinam males. The pin of the holotype bears the following 6 labels: a small blue paper with the characters N.C.Y. (written); a white label with "Anax concolor Br. Bras. ♂" (in handwriting of Brauer); a small white paper indicating in red ink "Type" (probably written by BRAUER); three partly printed labels, one with "Brasilien," the second (written) "concolor" and "det. Brauer" (printed), the third (written) "longipes v. concolor", (printed) "det. H. Zerny."

Female. As no description of the female exists, one is given here of an adult female from Charlesburg, Paramaribo.

Mouthparts light brown, postclypeus and frons pale yellow green. Frons very prominent without darker markings. Vertex, antennae and occipital triangle black. Rear of head mostly pale coloured, dotted with brown behind the eyes; upper part as far as widened along the eye margin pitch black, followed by two orange stripes on top of the incised flattened pruinose parts lower down.

Prothorax dark brown, fore and hind margin pale, the last one with a fringe of long hairs. Synthorax and first two abdominal segments pale green with no dark markings, except for a black spot at base of mesepimeron and metepimeron. Legs long and black, femora dark brown, first pair on the underside pale coloured, hind femora reaching to the end of abd. segm. 2.

Wings hyaline, costa and stigma yellow as well as the following crossveins: subcostals (second series), those between R and M and the first 5–6 between M_3 and M_4; in the supra triangle and the cubito anals. Wing venation see table 4. Membranule dark grey, somewhat lighter at base, reaching to half way the last cell in the adjacent anal cellrow.

Abdomen dark brown, spotted with lighter basal and dorso-median and apical spots. The first two segments green, second segm. on dorsum with two darker transverse stripes, separated by a granulose middorsal stripe which is broadened over the two apical brown impressions midway between the transverse stripes and the hind margin of the segment. Segm. 3 hardly constricted, the white baso-lateral spot small, otherwise the dorsal pale spots as in the male, segm. 10 with a fine middorsal dark stripe, the remaining parts light brown as are the appendices. These lanceolate and pointed at the end, 5 mm long and 1 mm wide, (as long as segm. 9 + 10) (Fig. 89b). Underside of abdomen with lateral carina on segm. 4–7 irregularly curved (Fig. 90 lower row).

Genitalia: valves not prominent, underside flattened, the distal part concave, the end pointed and curved up- and outward, not reaching the apical margin of segm. 9. Underside of segm. 10 covered with 6–7 rows of small flat triangular spines. For measurements see Table 2.

I have seen one other female of *concolor*, a teneral reared specimen from Zanderij, Suriname. It agrees with the adult specimen described but is smaller in wing size and hind femur, while of the abdominal segments no exact measurement can be given.

Material studied.

BRAZIL: 1 ♂ (holotype) Amazonas, Rio Negro, in Naturh. Mus. Vienna; 1 ♂ Piracicaba, São Paulo, ex coll. Bergamini, Esc. Sup. Agric., XII.1954, in coll. Geijskes; 1 ♂ State of Santa Catarina, Rio Vermello, XI.1945, A. Maller (Univ. Flor. Coll.); 1 ♂ Santa Catarina, Corupa, III.1946, A. Maller (Univ. Flor. Coll.).
BOLIVIA: 1 ♂ Dept. Cochabamba, Prov. Chapare, Road to Cochabamba, Alto Palmar, 32 km from Villa Tunari, Lake below Hotel "Yungas del Chapare", 23.X.1959, R. B. Cumming (Univ. Flor. Coll.); idem, 1 ♂ "at lake", 24.X. 1959, R. B. Cumming (Univ. Flor. Coll.).
SURINAME: 1 ♂ Paramaribo, Charlesburg, 8.IV.1957, D. C. Geijskes; 2 ♂ Charlesburg, 6.V.1957, J. Belle; 4 ♂ 1 ♀ Charlesburg, 8.V.1957, Belle; 1 ♂, Zanderij, savanna, 14.VIII.1962, Belle; 1 ♀, Zanderij, savanna, reared from larva, 17.IX.1962, Belle; 1 ♂, idem, 19.IX.1962, Belle; 1 ♂, idem, 28.IX.1962, Belle; 1 ♂, Kraka, pool in savanna, 27.III.1966, G. F. Mees.
MEXICO: 1 ♂ Veracruz, pond 17.6 mi N & E Huatusco 2800', 11.VIII.1965, D. R. Paulson (Univ. Flor. Coll.).
DOMINICA: 1 ♂ Fresh Water Lake, 2200 ft., 31.V.1965, D. C. Geijskes.
GUADELOUPE: 6 ♂ Basse Terre, Grand Étang, 9.VI.1965, D. C. Geijskes & J. Bonfils.
SAN SALVADOR, Bahamas: 1 ♂ 6.6 mi S. Cockburn Town, 1.I.1964, D. R. Paulson (Univ. Flor. Coll.).
All specimens in the Leiden Museum, unless otherwise stated.

Distribution: Brazil (Santa Catarina, São Paulo, Mato Grosso, Rio Negro in Amazonas), Bolivia, Suriname; Lesser Antilles (Dominica and Guadeloupe). According to PAULSON also in Costa Rica, Mexico and the Bahamas (San Salvador) (Fig. 101).

BIOLOGICAL NOTES

In Suriname *A. concolor* is found on temporary pools in shell ridges near Paramaribo. The water is clear, calcareous, the bottom overgrown with *Chara*-algae, the borders covered with a vegetation of *Heleocharis*, *Paspalum* and some Cyperaceae. On the other hand the species is also found on pools in the white sand savannas (Zan-

derij, Kraka) with oligotrophic water. In both environments imagines and larvae are found. Imagines fly in the daytime mostly over the water, males often in search of females along the vegetation of the border. At the same places *Anax amazili* occurs but is seldom observed by day, appearing mostly at twilight and is sometimes taken at light. On the Antillian Islands of Dominica and Guadeloupe, imagines of *concolor* were observed flying during daytime over old crater lakes in the mountains up to 2200 ft high. On Guadeloupe an adult larva was found in a cistern at an elevation of about 1000 m.

It is possible that in Suriname two generations a year occur, dependent on the rainy seasons (in Dec.–Jan. and May–Aug.). Imagines are found in the months: March, April, and May and again in August, September and October, covering the dry seasons. Exuviae have been picked up in March, June, July and September, whereas larvae in the last instar were reared to imago at the end of September. No exact data are known concerning the length of the larval period, but it is possible that the development from egg to imago is passed through within five months.

DIFFERENCES BETWEEN THE IMAGINES OF *Anax longipes* AND *Anax concolor*

	longipes	*concolor*
Total length	75–83 mm	67 –77 mm
Abdomen incl. app.	53–59 mm	48 –55 mm
Hind wing	47–52 mm	41 –49 mm
Hind femur	14–16 mm	11.3–14 mm
Dorsum abd. segm. 2, spiny middorsal carina between transverse lines	broad rectangular	pointed
Dorsum male abd. segm. 3–9	brick red, without paler spots	dark redbrown to black, with yellow green or blue spots
Lateral marginal suture on abd. segm. 3–7 in female	nearly straight	distinctly curved
Male app. sup., dilated part widest	at 3/5 length	at 1/3 length
App. inf. reaching to	1/3 app. sup.	1/4 app. sup.
Male genital fossa, apical end of enlarged margins	bluntly pointed	sharply pointed
Penis	lateral lobes end joint quadrangular, cleft in middle piece narrow	lobes rounded to triangular, cleft wide
Female app. sup.	bluntly pointed	sharply pointed

	longipes	*concolor*
Wings	clear or smooth, brownish	yellowish spotted, clear at base
Crossveins behind pterostigma		
Fore wing	7–12 (mostly 9)	6–9 (mostly 7)
Hind wing	7–11 (mostly 8)	5–10 (mostly 7)
Bridge crossveins		
Fore wing	2–5 (mostly 3)	2–3 (mostly 3)
Hind wing	2–4 (mostly 3)	2–3 (mostly 3)
Number of cells in triangle		
Fore wing	4–7 (mostly 6)	4–6 (mostly 5)
Hind wing	4–6 (mostly 5)	4–5 (mostly 4)
Rows of cells between Cu 1 and Cu 2		
Hind wing upper double row	2–8 (pref. 7)	3–7 (pref. 4 and 5)
Hind wing lower double row	2–8 (pref. 6)	3–7 (pref. 3 and 4)
Hind wing single row	7–12 (mostly 8)	6–12 (mostly 9)
Distribution	Eastern U.S.A. and Gulfstates, Mexico, Haiti, Bahamas	Tropical S. Am., Lesser Antilles, Bahamas, Centr. Am. into Mexico

LARVAE

History

CALVERT (1934) has described the larva of *Anax longipes* from the exuviae of 2 males from Pennsylvania and 3 males and 5 females from Florida. Measurements are given of different parts of the body and a description of the mask.

Of *Anax concolor* the larva is described also by CALVERT (1934) under *A. amazili* after 2 male and 5 female exuviae from Manaos, Brazil. These were minutely compared with reared exuviae of *amazili* from Costa Rica. CALVERT found only the inferior appendages in both sexes to be slightly longer, in the females the cercoids (cercus) slightly longer, the ratio of length of cercoids to that of inferior appendages (paraprocts) slightly lower and the width of the apex of male projection slightly less. But CALVERT was not convinced that the larvae from Manaos belonged to *concolor*, witness his assertion that: "Since the exuviae from Manaos are so similar to those of *amazili* from Costa Rica, while the imago from the same place is very close to *longipes*, it is evident that at least two species of *Anax* occur at Manaos."

Anax longipes Hagen – larva

DESCRIPTION

The head as measured across the eyes is more broad than long (10:8 mm), the U-formed vertex more or less parallel sided, the shortest distance of the eyes at the occiput is about 2 mm, the postocular lobes are rounded, showing about seven small rows of short spines along the outer distal margin (Fig. 93a).

Length of antenna 3.8 mm, the first two joints (scapus and pedicellus) short and thick, of about equal size, inner side covered with short hairs; 3rd joint (first of flagellum) the longest, 4th joint the shortest, the last three joints of equal length. Ratio of joints from first to seventh: 5, 5, 9, 4, 6, 6, 6 (Fig. 93a).

Mouthparts: labrum simple, hoe-shaped, external corners sharply rounded. Mandibles biramous, the outer incisor lobe strongly toothed, the inner molar lobe flat, chisel-like; R. mandible with 5 incisors on top and two small teeth on both sides of inner ramus; L. mandible with 4 such incisors on top and only one on outer corner of molar lobe. Along the ventral side ot the molar lobe in both, left and right mandible, a row of short stiff and curved hairs (Fig. 94a–b). Maxillae with 7 long and sharp pointed slightly curved teeth at the inner lobe, arranged in two rows, four on the dorsal side (the last one divided in two) and three on the ventral side; outer lobe (max. palpus) covered with long soft hairs and curved to a bluntly pointed top, ending between the last and fore last incisor; left and right maxilla very similar (Fig. 95a).

Labium with the prementum twice as long as broad, the distal margin of median lobe convex, beset with piliform setae; the median cleft deep, reaching to the chord of the arc. Lateral lobe short and stout, distal margin truncated, the upper end rounded and the lower end with a distinct end hook; serrations are present on the distal margin of lateral lobe (about six) and along the inner margin (about 20). Movable hook long and sharply pointed, passing distal margin of lateral lobe by more than half its length, upper side beset with a row of about 18 short spiniform

setae. There are a few of such setae (5–6) on the inner basal part of the lateral lobe (Fig. 96a).

On thorax, wing pads of hind wing reaching to middle of abd. segm. 4, of fore wing to middle of abd. segm. 3. Legs long, especially the hind femur; end of tibia and all joints of tarsus on the underside beset with trident setae. Claws very large, hook-shaped. In fore leg femur shorter than tibia. The measurements in mm of the different parts of the legs are:

LEGS	*female*	I	II	III
Femur		7	10	13
Tibia		8–8.5	9	11–12
Tarsus		4	5	6
Total length		19–19.5	24	30–31

Abdomen with lateral spines on segm. 7–9, sides of preceding segments armed with spiniform setae only. The lateral spines long, sharp pointed, the last one (segm. 9) reaching to half way segm. 10, the point slightly directed outward (Fig. 97a). Female genitalia (gonapophyses) on abd. segm. 9 a little longer than wide (5:4), reaching to 3/4 the segment length, terebra as long as the lateral valves including styli (Fig. 98a).

Appendices as long as the last three segments. Cercus thin and very sharp pointed, nearly reaching to half way paraproct (in ratio 7:15.5); epiproct nearly as long as paraproct (in ratio 13.5:15.5), dorsal carina well developed from the beginning of the slender part (Fig. 99a). I have seen only the two female exuviae from Massachusetts, but CALVERT (1934) has figured the appendices of a male exuvia from Pennsylvania, showing the male projection at base of epiproct emarginate on top, covering epiproct in ratio 7:37. The ratio of cercus to paraproct is 19:43.

Total length 62 mm; abd. with app. 42 mm; appendices 8 mm.

Described after two female exuviae from Hyannis, Massachusetts, collected by E. M. DAVIS Aug. 4, 1941 (in Univ. Florida coll.).

The measurements of five male exuviae (two from Pennsylvania and three from Florida) as given by CALVERT (1934), vary in total length from 56.5–62 mm; in abdomen 40–43 and in five females from Florida: total length 57–60 mm; abd. 39–42 mm. From these data the conclusion could be drawn that towards the North the larvae become larger.

Anax concolor Brauer – larva

DESCRIPTION

Very similar to the larva of *longipes* with the following differences. Clypeus with middorsal groove, shortest distance of eyes at occiput (dorsal view) less than 2 mm, postocular lobes less prominent, on the outer corners beset with about 15 rows of short spines.

Length of antenna 3.4 mm, scapus and pedicellus of about equal length, innerside

with short hairs; first joint of flagellum the longest, second joint the shortest, remaining three segments of equal length. Ratio of joints from first to seventh: 5, 5, 8, 3, 5, 5, 5. (Fig. 93b).

Mouthparts: labrum, mandibles and maxillae as in *longipes* but smaller (Fig. 94c–d; Fig. 95b); labium with prementum about twice as long as broad, sides with a row of minute spiniform setae, distal margin of median lobe slightly convex and beset with piliform setae, median cleft small, by far not reaching to the chord of the arc. Distal margin of labial palp truncated, upper end rounded, lower end with a sharp pointed somewhat upcurved endhook; serrations on distal margin about 10 and along inner margin about 30. Movable hook long and sharp pointed, passing distal margin of lateral lobe by one and a half times its length, upper side showing a row of 35–38 spiniform setae. On the lateral lobe near base of movable hook, 5–7 very short spiniform setae (Fig. 96b).

Thorax with wingpads of hind wing reaching to base of abd. segm. 4, those of fore wing to the middle of segm. 3. Legs long, hind femur reaching backward to base of abd. segm. 5; apical end of tibia and underside of all joints of tarsus, beset with trident setae, sometimes mixed with some short blunt simple setae at the end of tibiae and first tarsus joints. Claws very large, hook-shaped, sharply pointed. In fore leg femur shorter than tibia. The measurements in mm of the different parts of the legs are:

LEGS	*male*	I	II	III	*female*	I	II	III
Femur		6	8.5	11		6	9	11.5
Tibia		6.5	7.5	10		7	8	10
Tarsus		3.5	4	5		3.5	4	5
Total length		16	20	26		16.5	21	26.5

Abdomen, segm. 7–9 with sharp pointed, black tipped lateral spines, those of segm. 7 not passing hindmargin of the segment, those of 8 reaching base of 9, those of 9 to half way or nearly to the end of 10, endpoints straight, not bent outward (Fig. 97b).

Dorsum with some colour pattern, marked by two pale stripes along the darker middorsal band, which in segm. 3–7 is divided in the middorsal line by a fine yellow stripe, widened after the median transverse stripes and not reaching apically to the end of the segments; darker side bands interrupted by paler spots, the area along the side margin pale.

Female genitalia (gonapophyses) on ventrum of abd. segm. 9, a little longer than wide (4.5:4), 3/4 segment length, terebra as long as lateral valves inclusive styli (Fig. 98b).

Appendices long, as long as segm. 10,9 and apical half of 8, cercus (cercoid) thin and sharply pointed, nearly half as long as paraproct (ratio 7:15); epiproct a little shorter than paraproct (ratio 12:15), dorsal carina present on the slender part (Fig. 99b). Male appendices: paraproct and epiproct a little shorter than in female, male projection short and top concave (Fig. 100a–b).

Total length male 49–54 mm; female 50–53 mm; abd. incl. app. male 33–38 mm; female 34–37 mm; appendices male/female 6.5–7 mm. Measured after eight male and six female exuviae from Suriname.

Material studied.

SURINAME: 1 ♂ 1 ♀ exuviae, Paramaribo, Charlesburg, 7.VI.1958, D. C. Geijskes; 1 ♂ exuvia, Zanderij, pool in savanne, 22.VI.1946, Geijskes; 1 ♂ exuvia, idem, 3.VII.1952, Geijskes; 2 ♂ 2 ♀ exuviae, idem, 18.III.1962, J. Belle; 3 ♂ 2 ♀ exuviae, idem, 13.IX.1962, Belle; 3 ♂ 1 ♀ ult. larvae, idem, hatched 17.IX. 1 ♀, 19.IX. 1 ♂, 28.IX. 1 ♂, 29.IX. 1 ♂, Belle.

DIFFERENCES BETWEEN THE LARVAE OF *Anax longipes* AND *Anax concolor*

	longipes	*concolor*
Antenna, ratio of joints	5, 5, 9, 4, 6, 6, 6	5, 5, 8, 3, 5, 5, 5
Labium, distal margin, median lobe	distinctly convex	slightly convex
Median cleft	deep, reaching to the chord of arc	minute, not reaching chord of arc
Lateral lobes, serrations		
on distal margin	about 6	about 10
on inner margin	about 20	about 30
Movable hook, spiniform setae	18–20	35–38
Length of legs I, II, III (♀)	19, 24, 30	16.5, 21, 26.5
Lateral spine on abd. segm. 10, endpoint	slightly directed outward	straight directed distad
Total length exuv.	♂ 56–62; ♀ 57–62	♂ 49–54; ♀ 50–53
Length abd. + app.	♂, 40–43; ♀ 39–42	♂ 33–37; ♀ 34–37
Length app.	♂?; ♀ 8	♂ 6.5–7; ♀ 6.5–7

CALVERT (1934) in rearing larvae of *Anax junius* from the first instar to adult, is of the opinion "that the ontogenetic change in the shape of the endhook of the labial palp of *Anax junius* from truncated to rounded, suggests that those species of this genus which possess the truncated form in the last larval instar, are phylogenetically older". In this respect both *longipes* and *concolor* would belong to the older type. As a result of his experiments with larvae of *junius* and *amazili*, CALVERT (1934) considers the deeper secondary ligular cleft in the prementum as to represent a younger condition, because of its ontogenetically late appearance. If this is true, *concolor* would be phylogenetically older than *longipes*.

SUMMARY

Of the American species of *Anax* characterized by an unmarked frons, *A. longipes* Hagen (1861) was described from U.S.A. and *A. concolor* Brauer (1865) from the Amazon in Brazil. But soon after their description HAGEN (1890) was of the opinion that *concolor* Brauer was only a variety of *longipes*, in which according to him the odonatologists have taken the same stand. This conception is probably due to the fact that insufficient material of both species is studied.

The motive for a reexamination of the two species was a comprehensive material of *Anax concolor* mostly collected in Suriname and on the Lesser Antilles. Additional specimens of *A. longipes* from the U.S.A. were received for comparison. The type specimens of both species could be examined but the difficulty was that the types of both species belong to different sexes. New descriptions of the imagines and of the larvae in their last instar are made, with a comparison of the most striking differences between the two species. Beside the morphological points of controversy in both imagines and larvae, there proved to be also a marked difference in their distribution: *A. longipes* occurs in U.S.A. entering Mexico, the Greater Antilles and Bahamas, while *A. concolor* occupies tropical South America to the Lesser Antilles and the Bahamas, and Central America.

This study has demonstrated that *Anax concolor* is not a variety of *A. longipes*, but that both forms belong to different species.

TABLE 1

MEASUREMENTS of *Anax longipes* Hagen (in mm)

Localities	Sex	Total length	Length abd. + app.	Length wings		Length pterostigma		Length h. femur
				f.w.	h.w.	f.w.	h.w.	
Mass., Cape Cod	♂	80	57	53.5	52	5.5	5.5	15
N. Car., Transsylv. Co	♂	81	58	54		5.5	5.5	16
N. Car., Transsylv. Co	♀	78	56	52	50	5.5	5.5	14
Tennessee, Blount Co	♂	82	57	53	52	5.5	5.5	15
Georgia (holotype)	♀	81	57	52	50	5.5	5.5	15
Arkansas, Wash. Co	♂	82	59	53	52	5.5	5.5	16
Arkansas, Wash. Co	♂	81	58.5	51.5	50	6	6	16
Arkansas, Wash. Co	♂	82	58	53	52	6	6	15.5
Florida, Highlands Co	♂	78	58	51.5	50	5.5	5.5	15
Florida, Alachua Co	♂	78.5	55	52	51	5.5	5.5	15
Florida, Alachua Co	♂	75	53	51	50	5.5	5.5	15
Florida, Alachua Co	♀	83	59	52.5	52	6	6.5	15
Florida, Enterprise	♂	82	59	50	48	5	5	14.5
Florida, Orange Co	♂	79	56	51	49	5.5	5.7	15
Florida Seminole Co	♂	80	57	51	50	5.5	5.5	14
Florida	♂	76	55	49	47	5	5.2	15.5
Florida	♂	80	57	51.5	50	5.5	6	15
Range min.–max.	14 ♂	75–82	53–59	49–54	47–52	5–6	5–6	14–16
(mostly)		(82)	(57–58)	(51)	(50)	(5.5)	(5.5)	(15)
Range min.–max.	3 ♀	78–83	56–59	52–52.5	50–52	5.5–6	5.5–6.5	14–15
(mostly)		(81)	(57)	(52)	(50)	(5.5)	(5.5)	(15)

TABLE 2

MEASUREMENTS of *Anax concolor* Brauer (in mm)

Localities	Sex	Total length	Length abd. + app.	Length wings		Length pterostigma		Length h. femur
				f.w.	h.w.	f.w.	h.w.	
Mexico, Veracruz	♂	70	50	47	46	4.5	4.5	13
Bahamas, San Salvador	♂	70	50	48	47	4.5	5	13.1
Guadeloupe, Gr. Étang	♂	76	52	50	49	4.2	4.5	13.5
Guadeloupe, Gr. Étang	♂	73	52	49	48	4.2	4.5	13.5
Guadeloupe, Gr. Étang	♂	73	52	49	48	4	4	13
Guadeloupe, Gr. Étang	♂	73.5	53	49	48	4.5	4.5	14
Guadeloupe, Gr. Étang	♂	72	51	48	47	4.2	4	13
Guadeloupe, Gr. Étang	♂	72.5	51	49	48	4	4	13.5
Dominica, Freshw. Lake	♂	77	55	49	48	4.5	4.5	14
Suriname, Paramaribo	♂	71	51	48	47	4.5	4.5	13.5
Suriname, Paramaribo	♂	71	50.5	47	47	5	5	13.5
Suriname, Paramaribo	♂	70	50.5	47	46	4.5	4.7	13
Suriname, Paramaribo	♂	70.5	50	47	46	4.2	4.5	13.5
Suriname, Paramaribo	♂	73	52	47	46	5	5	13.5
Suriname, Paramaribo	♂	72	52	48	47	4.5	4.7	13.5
Suriname, Paramaribo	♂	72	52	48	47	4.7	5	13.5
Suriname, Paramaribo	♀	72	51	50	48	4.7	4.7	13.5
Suriname, Zanderij	♂	72	51	46.5	46	4	4.5	13.5
Suriname, Zanderij	♀			47	46	4.5	4.5	13
Suriname, Kraka	♂	70.5	51	46	45.5	5	5	13.5
Brazil, Rio Negro (type)	♂	70	50	45	45	4.5	4.7	13
Brazil, Piracicaba	♂	69	49.5	46	45	4	4.5	13
Brazil, S. Catarina	♂	69	49	46	45	4	4.5	14
Brazil, S. Catarina	♂	67	48	42	41	4	4	11.3
Bolivia, Alto Palmar	♂	70	50	48	47	4.5	4.7	13
Bolivia, Alto Palmar	♂	71	50	47.5	46.5	4.5	4.7	12.7
Range min.–max.	24 ♂	67–77	48–55	42–50	41–49	4–5	4–5	11.3–14
(mostly)		(72)	(52)	(49)	(47–48)	(4.5)	(4.5)	(13.5)
Range min.–max.	2 ♀	72–?	51–?	47–50	46–48	4.5–4.7	4.5–4.7	13–13.5
(mostly)		?	?	?	?	?	?	?

TABLE

WINGVENATION in

Localities	Sex	Antenodal crossveins		Subcostal crossveins		Postnodal crossveins		Poststigmal crossveins		Substigmal crossveins	
		f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.
Massachusetts, Cap Cod	♂	18–20	14–15	14–15	10	8	10–11	9	8–11	2–4	3–4
Florida	♂	17	12–13	13	11	7–9	9	9	8–10	2–3	2–3
Florida, Enterprise	♂	19	12	13	11	9	12	7–9	8		
Georgia (holotype)	♀	19	13–15	13–15	11	7–9	10–11	8–9	9	2	2–3
N. Car., Transsylv. Co	♂	18	13	15	11	8	11	11–12		3–4	3
N. Car., Transsylv. Co	♀	16–17	11	13	10	8–9	10	7	7	3	2–3
Tennessee, Blount Co	♂	18	14	13–14	10–11	8–9	9–11	9–10	7	3	3
Arkansas, Wash. Co	♂	20	15–16	14–15	10–11	8–9	11	9	8	3	2–3
Arkansas, Wash. Co	♂	16–17	12–13	12–15	11	8–9	11	9–10	8–9	2	2–4
Arkansas, Wash. Co	♂	17–18	11–12	13–14	10–11	8–10	10–11	8–10	8–10	2	2
Florida, Highlands Co	♂	18	11	14	10	7–8	10–11	8–9	7–8	2–3	2–3
Florida	♂	18–19	12	14–15	10	8	10–11	8–9	7–9	3	3
Florida, Alachua Co	♂	19	14	16	11–12	7–9	11–12	8	10	3	3
Florida, Alachua Co	♂	17	12	13–15	10	8	11–12	9–10	9–10	2	3
Florida, Alachua Co	♀	18–19	13	14–15	10	8–9	10	9–10	9	2–3	3
Florida, Orange Co	♂	18	12	13	10	8	10–11	7	7	2–3	2–3
Florida, Seminole Co	♂	18	12–13	14–15	11	8–9	10	8–9	8–9	3	2
Range min.–max.	14 ♂	16–20	11–16	12–16	10–12	7–10	9–12	7–12	7–11	2–4	2–4
(mostly)		(18)	(12)	(14–15)	(11)	(8)	(11)	(9)	(8)	(3)	(3)
Range min.–max.	3 ♀	16–19	11–15	13–15	10–11	7–9	10–11	7–10	7–9	2–3	2–3
(mostly)		(19)	(13)	(13–15)	(10)	(9)	(10)	(9)	(9)	(2–3)	(3)

3

Anax longipes Hagen

Bridge crossveins		Triangle cells		Supra-triangle crossveins		Cubital crossveins		Rspl cellrows		Mspl cellrows		Cu_1–Cu_2 cells		Analloop cells	
f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	h.w.l	h.w.r	h.w.l	h.w.r
3–4	3	5–7	6	4	3–4	4	4	6	6	4–5	5	9 $\frac{8}{8}$	$\frac{7}{7}$ 8	12	13
2–3	2	4–6	5	4	3	4	4	6	6	5	5	7 $\frac{6}{6}$	$\frac{6}{5}$ 8	10	10
4–5	4	6–7	6	3–4	3	4–5	4					8 $\frac{7}{6}$	$\frac{7}{7}$ 8	13	14
3	3–4	6–7	5–6	3	2–3	5–6	4	5	6	4	4	8 $\frac{6}{5}$	$\frac{5}{4}$ 9	11	11
3	3	5	4–5	4–5	3	4	4	5	6	4	4–5	8 $\frac{7}{6}$	$\frac{6}{7}$ 8	14	14
3	3	6	4	3	3	4	4	5	6	4	4	7 $\frac{7}{6}$	$\frac{8}{7}$ 8	12	12
3	3	6	6	3–4	3	4–5	4	5	6	4	3–4	9 $\frac{7}{6}$	$\frac{7}{7}$ 9	13	13
3	2–3	6–7	5	4	2–3	4–5	4	5	5	4	4–5	7 $\frac{8}{6}$	$\frac{6}{6}$ 10	12	13
3	2	6	6	3	3	4	4	5–6	6	4	4	7 $\frac{8}{6}$	$\frac{7}{6}$ 9	13	13
3	3	6	4	3	3	4	4	5–6	6	4	4	8 $\frac{6}{7}$	$\frac{7}{7}$ 7	12	12
3	2	5–6	5	3–4	3	4–5	4	5–6	6	4	4–5	12 $\frac{2}{2}$	$\frac{2}{2}$ 12	12	12
3–4	3	6	6	3–4	3	4	3–4	5–6	6	4	5	8 $\frac{7}{6}$	$\frac{7}{7}$ 9	12	11
3	3	6–7	5	4	3	5	4	5	6	4	4–5	11 $\frac{5}{5}$	$\frac{5}{5}$ 11	14	14
3	2–3	4–7	5	3	2–3	4	4	5	5	4	4	11 $\frac{4}{4}$	$\frac{3}{2}$ 12	11	11
3	2	5–6	5–6	3–4	3	4	4–5	6	6	3–4	4	10 $\frac{4}{4}$	$\frac{7}{7}$ 10	12	11
3	2–3	5	5	4	2–3	4	4	5	5	3–4	4	10 $\frac{3}{3}$	$\frac{4}{4}$ 9	11	10
3	3	5	4	3	2–3	4	4	5	5–6	3–4	4	8 $\frac{6}{6}$	$\frac{4}{4}$ 9	11	12
2–5	2–4	4–7	4–6	3–5	2–4	4–5	3–4	5–6	5–6	3–5	3–5	7 $\frac{2-8}{2-8}$	12	10–14	10–14
(3)	(3)	(6)	(5)	(4)	(3)	(4)	(4)	(5)	(6)	(4)	(4)	(8 $\frac{7}{6-7}$	9)	(12)	(13)
3	2–4	5–7	4–6	3–4	2–3	4–6	4–5	5–6	6	3–4	4	7 $\frac{4-8}{4-7}$	10	11–12	11–12
(3)	(3)	(6)	(5–6)	(3)	(3)	(4)	(4)	(5)	(6)	(4)	(4)	(7 $\frac{4-8}{4-7}$	10)	(12)	(11)

TABLE

WINGVENATION in

Localities	Sex	Antenodal crossveins		Subcostal crossveins		Postnodal crossveins		Poststigmal crossveins		Substigmal crossveins	
		f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	h.w.
Mexico, Veracruz	♂	18	12–14	14	10–11	8–9	10–12	8–9	7–8	2	2
Bahamas, San Salvador	♂	17	13	13–15	9–11	9–10	10–12	7	5–6	2–3	2–3
Guadeloupe, Gr. Étang	♂	19–20	12–14	12–14	10	10–11	11–13	7–8	7–8	2	2
Guadeloupe, Gr. Étang	♂	17	12–14	14	9–10	8–10	11	6	5–6	2	2
Guadeloupe, Gr. Étang	♂	17–19	13–14	14–15	10	9	11–12	7	7–8	2	2
Guadeloupe, Gr. Étang	♂	18–20	13	12–14	10	9	10–11	6–7	6	2	2
Guadeloupe, Gr. Étang	♂	17–19	12	12–13	10	8	9–11	7	6	2	2
Guadeloupe, Gr. Étang	♂	18–19	13	13	10	9–10	11–13	7–8	6–8	2	2
Dominica, Freshw. Lake	♂	16–17	11	11–14	11	9	11	6	7	2–3	2
Suriname, Paramaribo	♂	19–20	11–12	14	10–11	8–9	11	7–8	7–6	2	2
Suriname, Paramaribo	♂	17–18	10–11	12–14	9–10	9	10–11	7	7	2	2
Suriname, Paramaribo	♂	16	10–11	12	8–9	7	9	7–8	7	2	2
Suriname, Paramaribo	♂	17–18	12–13	12	9	9	11	7–9	7–9	2	2
Suriname, Paramaribo	♀	18–19	12	13	9	10	11	8–9	8	2	2
Suriname, Zanderij	♂	18	12	13–14	10	9	9–11	8	7	2	2
Suriname, Zanderij	♀	17	13	14–15	10	9	12–13	7	7	2	2
Brazil, Rio Negro	♂	17–19	12–14	13–14	10	9	11	8–9	6–8	2	2
Brazil, Piracicaba	♂	17	11	13	9–10	9–10	11	7	7–8	2–3	2
Brazil, S. Catarina	♂	18	12–14	13–14	9	9	10–11	8	7–8	2	2
Brazil, S. Catarina	♂	15–16	10	11–12	8–9	8	9–10	7–9	8–9	2	2
Bolivia, Alto Palmar	♂	17–18	11	13	9–10	8	9–10	8	7	2	2
Bolivia, Alto Palmar	♂	17–18	11–12	12–13	10	9	9–10	8–9	9–10	2	2
Range min.–max.	20 ♂	15–20	10–14	11–15	8–11	7–11	9–13	6–9	5–10	2–3	2–3
(mostly)		(17)	(12)	(14)	(10)	(9)	(11)	(7)	(7)	(2)	(2)
Range min.–max.	2 ♀	17–19	12–13	13–15	9–10	9–10	11–13	7–9	7–8	2	2
(mostly)		(17)	(12–13)	(13)	(9–10)	(9–10)	(11)	(7)	(7–8)	(2)	(2)

4

Anax concolor Brauer

Bridge crossveins		Triangle cells		Supra-triangle crossveins		Cubital crossveins		Rspl cellrows		Mspl cellrows		Cu_1–Cu_2 cells		Analloop cells	
f.w.	h.w.	f.w.	h.w.	f.w.	h.w.	f.w.	-h.w.	f.w.	h.w.	f.w.	h.w.	h.w.l	h.w.r	h.w.l	h.w.r
3	2–3	5	5	3–4	2	5	4	5	5	3	4	12 $\frac{4}{3}$	$\frac{3}{4}$ 10	11	12
2–3	2	4	4	2–3	2	4	4	5	5	3	4	9 $\frac{4}{4}$	$\frac{3}{4}$ 11	10	11
2–3	2–3	5–6	4–5	3–4	2–3	4	4	4–5	5–6	4	5	8 $\frac{6}{7}$	$\frac{7}{5}$ 10	10	10
2–3	2–3	5	4	3	2–3	4	3–4	5	5	3	4	11 $\frac{3}{3}$	$\frac{3}{3}$ 11	12	12
2–3	3	4–5	4–5	3–4	2–3	4	4	4–5	5	3	3–4	9 $\frac{5}{4}$	$\frac{7}{6}$ 8	11	12
2–3	2–3	5	4–5	3–4	2–3	4	4	5	5	3	4	9 $\frac{5}{4}$	$\frac{5}{5}$ 10	11	11
3	3	5	5	3–4	3	4	4	5	6	3–4	4	9 $\frac{5}{4}$	$\frac{3}{3}$ 10	11	11
3	3	5	4	3–4	2	4	4	5–6	6	4	4	9 $\frac{5}{5}$	$\frac{4}{3}$ 10	12	12
3	3	6	4–5	3–4	2	4	3–4	5	5	4	4	9 $\frac{5}{5}$	$\frac{7}{6}$ 10	11	12
3	3	5	5	3	2	4	4–5	5–6	6	3	4	10 $\frac{4}{4}$	$\frac{4}{3}$ 10	10	11
3	3	5	4	4	2–3	4	3–4	4–5	5	3–4	4	6 $\frac{6}{5}$	$\frac{5}{6}$ 6	11	10
2–3	3	4	4	2–3	2	4	4	4	5	3–4	4	9 $\frac{3}{3}$	$\frac{4}{4}$ 9	10	11
3	3	5	4	3	2	4	4	5	5	3	4	9 $\frac{4}{4}$	$\frac{3}{3}$ 11	11	11
3	3	4–5	5	4	2	4	4	5	5	3	4	11 $\frac{3}{3}$	$\frac{4}{4}$ 10	11	12
2–3	2	4–5	4	3	2	4	4	5–6	5	3–4	4	11 $\frac{4}{4}$	$\frac{4}{4}$ 10	11	11
2–3	2	6	5–6	3–4	2	5	4	5	5	3	4	9 $\frac{5}{5}$	$\frac{4}{5}$ 9	11	12
2	3	5	4	3–4	2–3	4	4	5	5	3	4	7 $\frac{6}{6}$	$\frac{6}{6}$ 8	12	12
3	3	5	4–5	3–4	2	4	4	5–6	5–6	3	4	10 $\frac{4}{3}$	$\frac{3}{3}$ 11	11	11
3	3	5–6	4	3	2	4	4	5	5	3	4	8 $\frac{5}{5}$	$\frac{5}{5}$ 8	11	11
2–3	3	4	4	2	2	4	3–4	5	5	3	4	8 $\frac{4}{4}$	$\frac{3}{3}$ 9	10	10
2–3	2–3	4–5	4	3	2	4	4	5	5	4	4	11 $\frac{4}{4}$	$\frac{6}{5}$ 9	11	11
3	3	6	4–5	3–4	3	4	4	5	5	3	4	10 $\frac{4}{4}$	$\frac{4}{3}$ 11	11	12
2–3	2–3	4–6	4–5	2–4	2–3	4–5	3–4	4–6	5–6	3–4	3–5	6 $\frac{3-7}{3-7}$	12	10–12	10–12
(3)	(3)	(5)	(4)	(3)	(2)	(4)	(4)	(5)	(5)	(3)	(4)	9 $\frac{4-5}{3-4}$	10	(11)	(11)
2–3	2–3	4–6	5–6	3–4	2	4–5	4	5	5	3	4	9 $\frac{3-5}{3-5}$	11	11	12
(3)	(2–3)	(6)	(5)	(4)	(2)	(4–5)	(4)	(5)	(5)	(3)	(4)	(9 $\frac{4}{5}$	11)	(11)	(12)

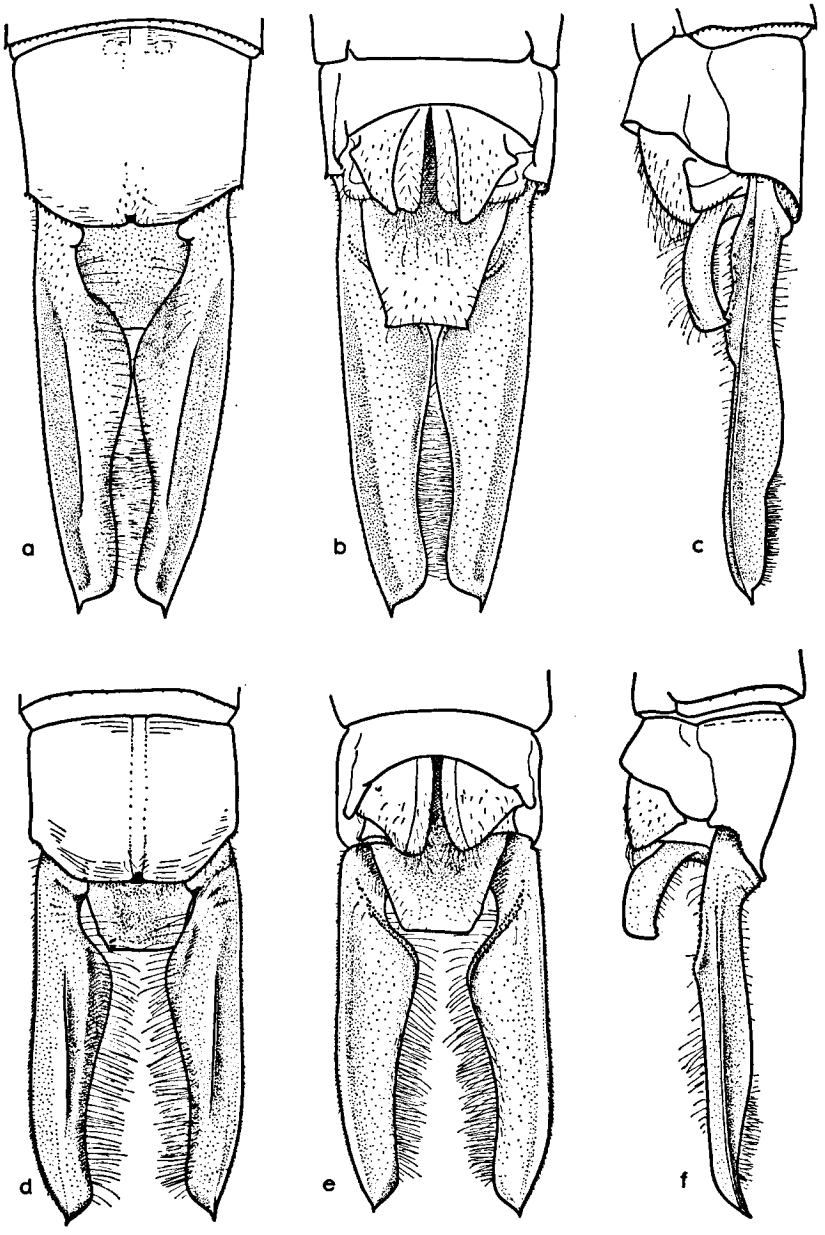


Fig. 88. Male appendices in dorsal, ventral and lateral view of *Anax longipes* from Massachusetts (a, b, c), and of *Anax concolor* (holotype) from Rio Negro (d, e, f).

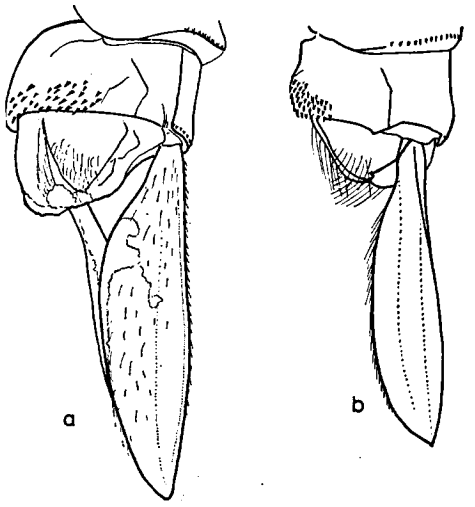


Fig. 89. Female appendices, left lateral view, of *Anax longipes* (holotype) from Georgia (a), and of *Anax concolor* from Suriname (b).

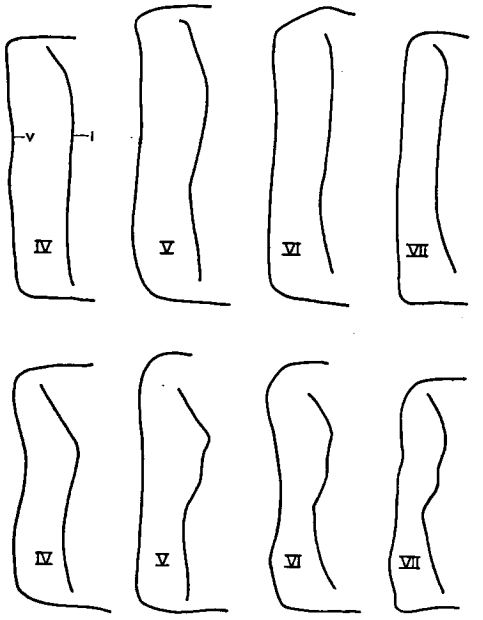


Fig. 90. Lateral (l) and ventral (v) carina (left side) on abd. segm. 4–7 of female of *Anax longipes* (holotype) from Georgia (upper row) and of *Anax concolor* from Suriname (lower row).

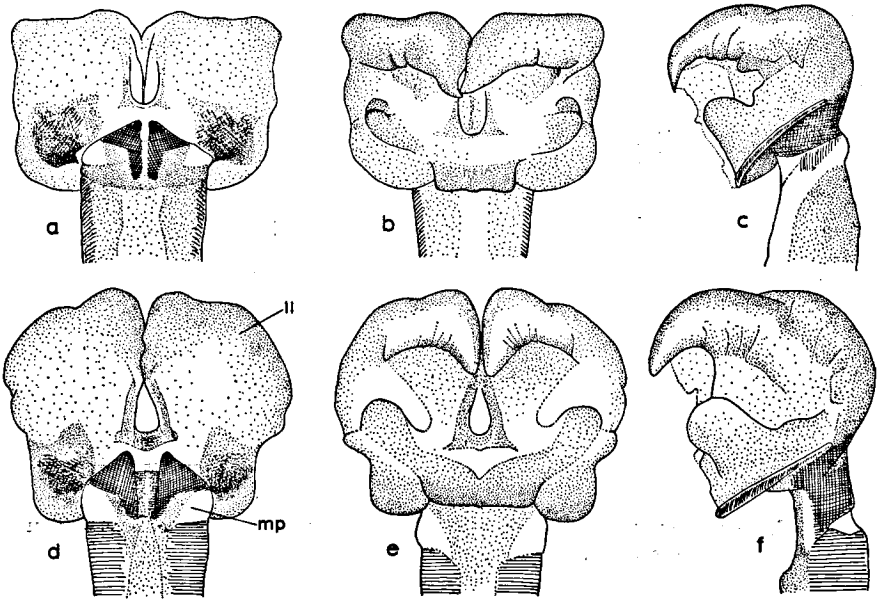


Fig. 91. Last segment of penis in ventral, dorsal and left lateral view of *Anax longipes* from Massachusetts (a, b, c) and of *Anax concolor* from Suriname (d, e, f); ll lateral lobe, mp middle piece.

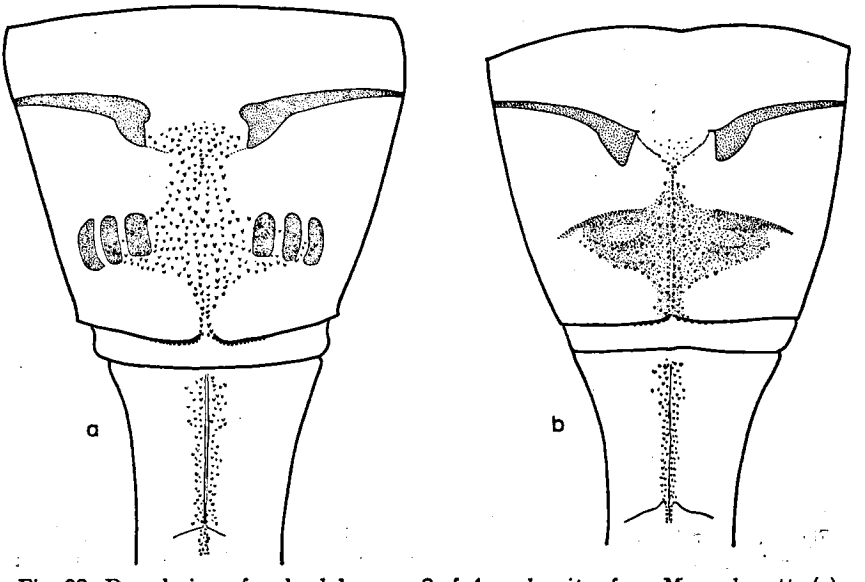


Fig. 92. Dorsal view of male abd. segm. 2 of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (b).

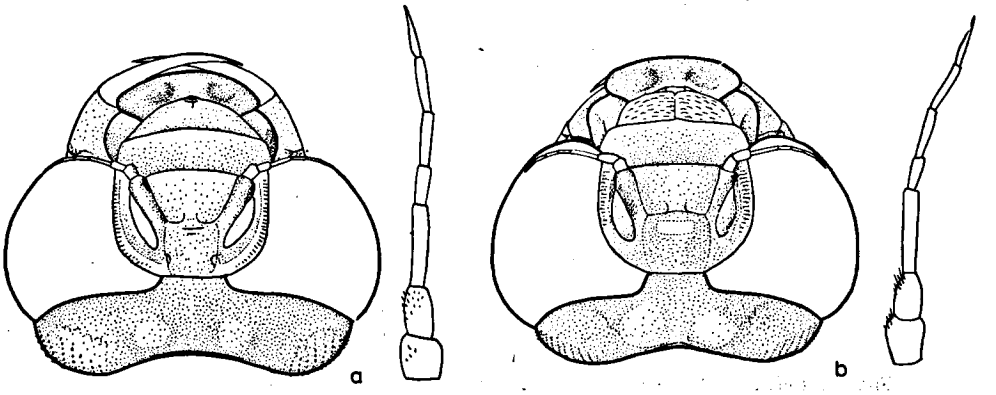


Fig. 93. Head and right antenna of female exuvia of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (b).

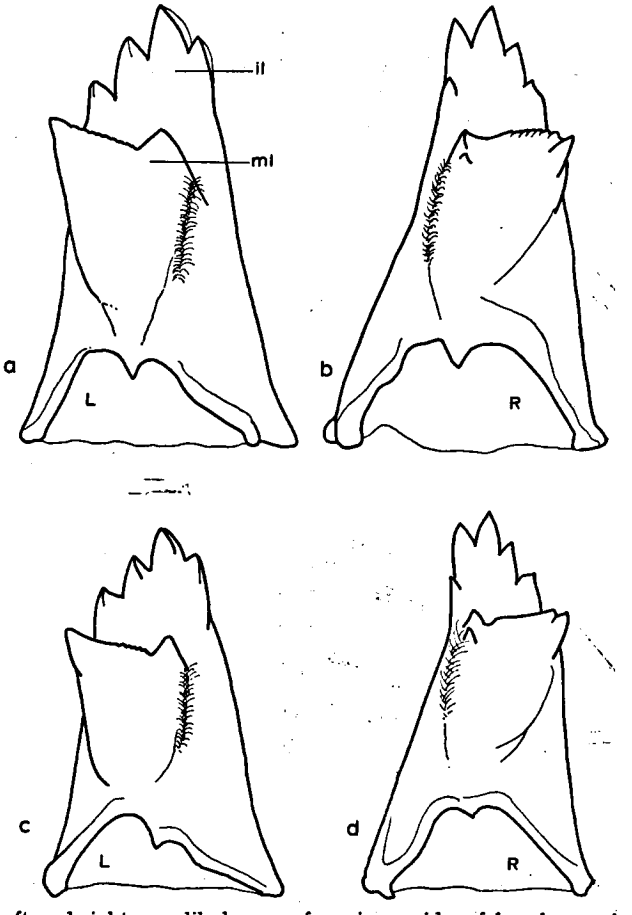


Fig. 94. Left and right mandibula, seen from inner side, of female exuvia of *Anax longipes* from Massachusetts (a, b) and of *Anax concolor* from Suriname (c, d); il incisor lobe, ml molar lobe.

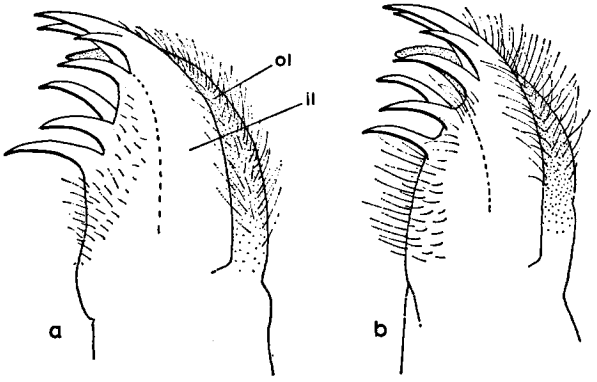


Fig. 95. Left maxilla, ventral view, of female exuvia of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (b); ol outer lobe (palpus max.), il inner lobe.

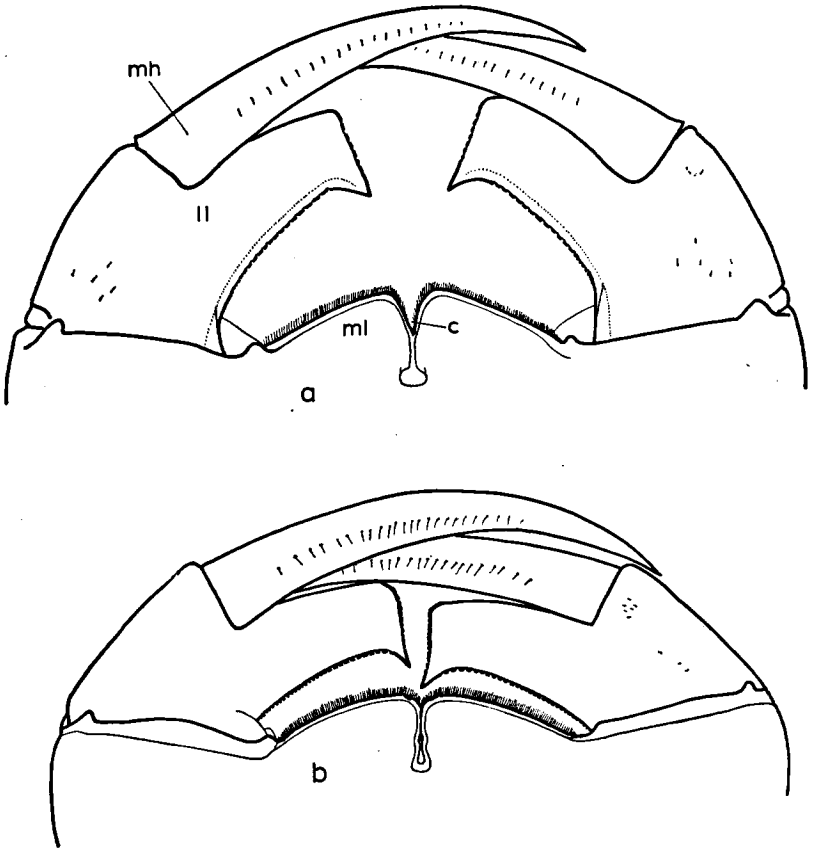


Fig. 96. Distal end of prementum (inner side) of female exuvia of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (reared specimen) (b); ml median lobe, c median (ligular) cleft, ll lateral lobe, mh movable hook.

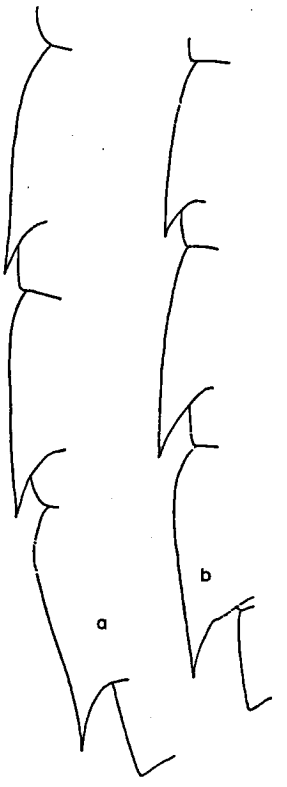


Fig. 97. Lateral spines on abd. segm. 7–9 (left side) of female exuvia of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (b).

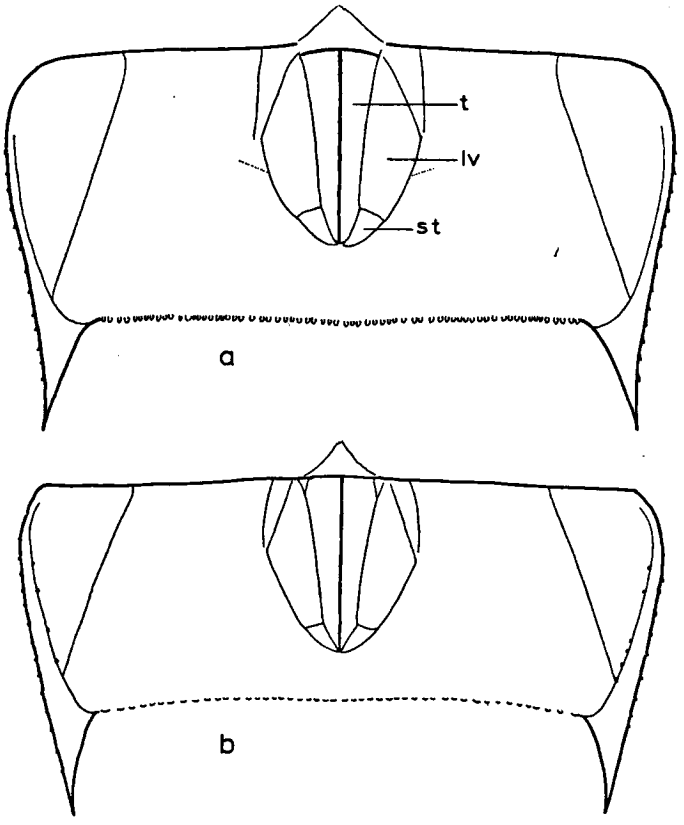


Fig. 98. Gonapophyses on abd. segm. 9 of female exuvia of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (b); t terebra, lv lateral valve, st. stylus

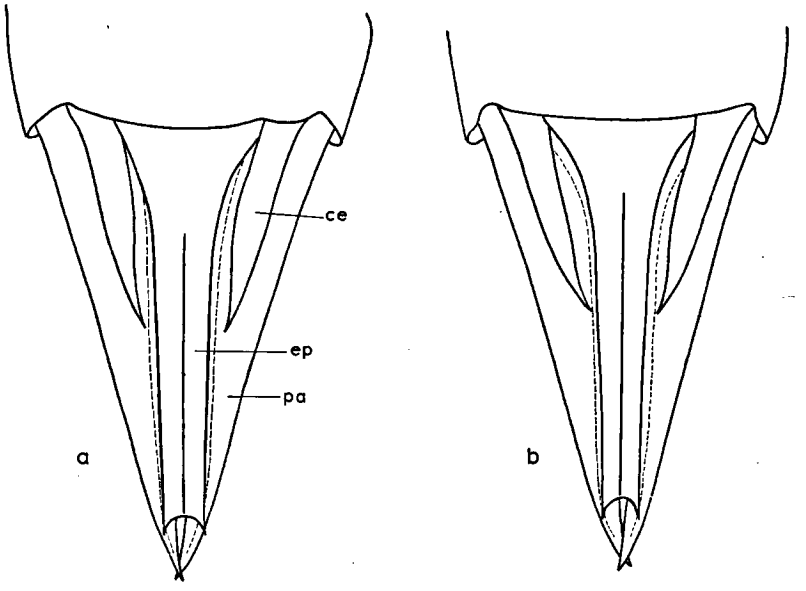


Fig. 99. Appendices (dorsal) of female exuvia of *Anax longipes* from Massachusetts (a) and of *Anax concolor* from Suriname (b); ce cercus (cercoid), ep epiproct, pa paraproct.

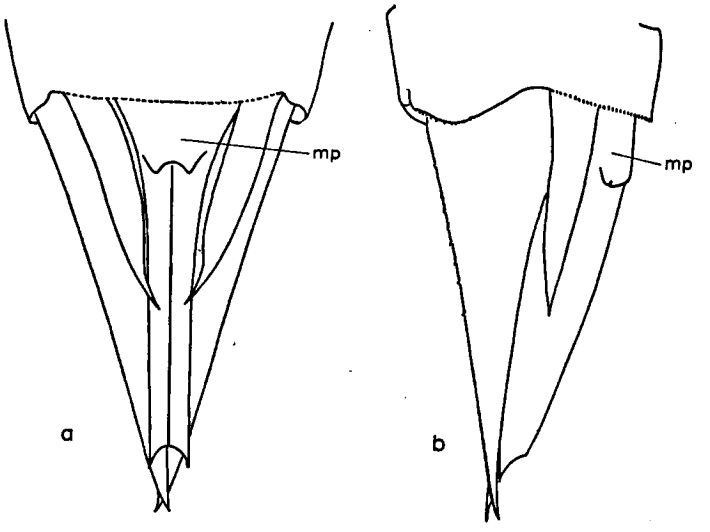


Fig. 100. Appendices, dorsal (a) and lateral view (b), of male exuvia of *Anax concolor* from Suriname (reared specimen); mp male projection.

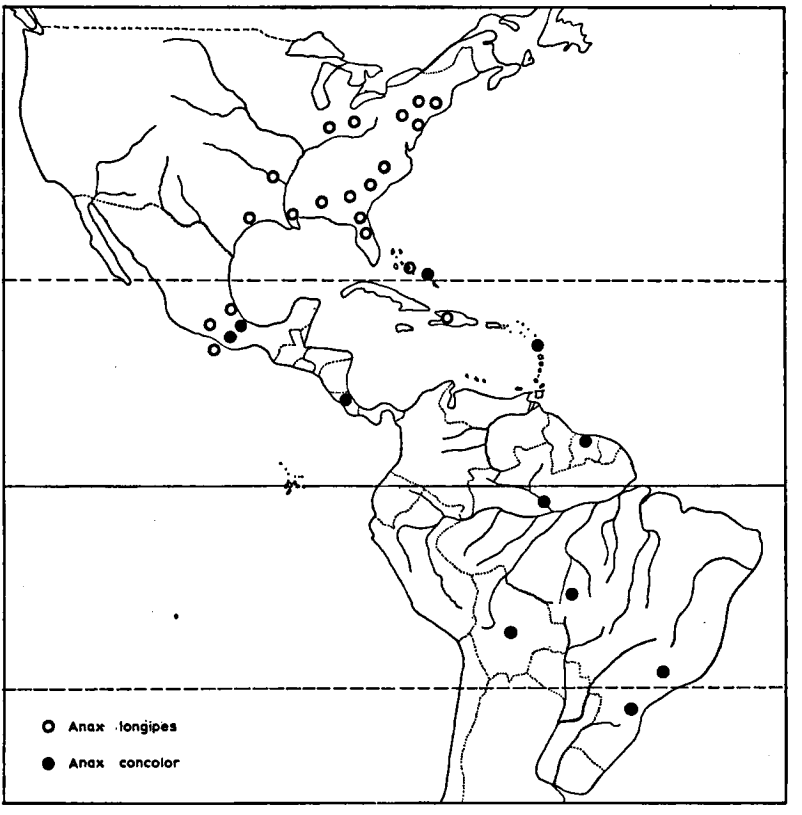
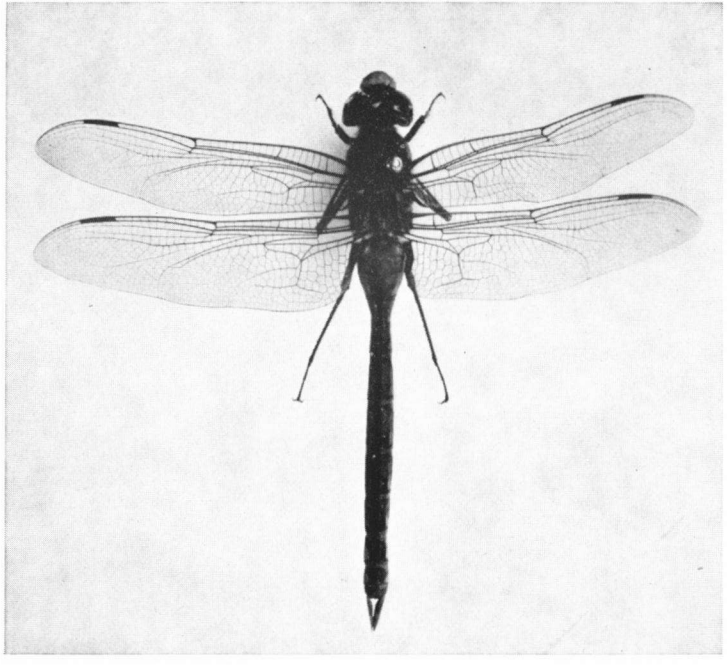


Fig. 101. Map of distribution of *Anax longipes* Hagen and of *Anax concolor* Brauer.



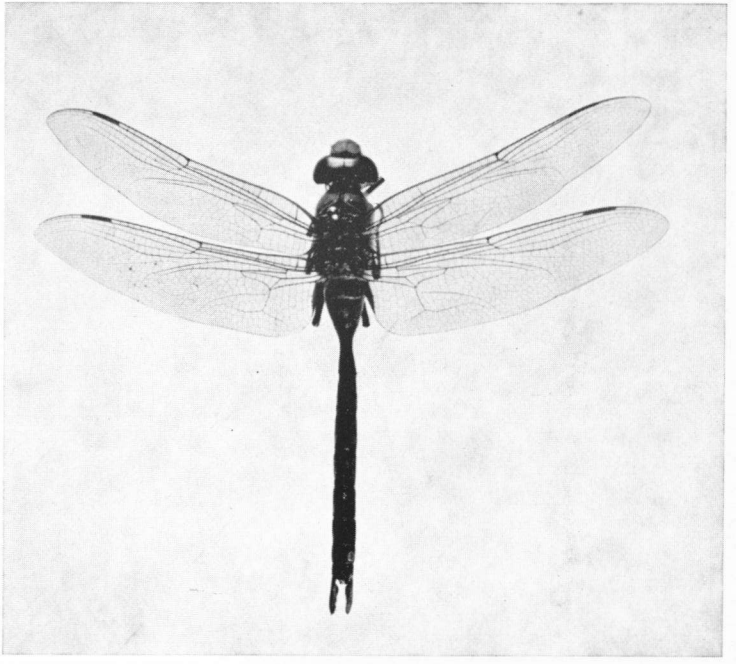


PLATE Ia. *Anax longipes* ♀, holotype from Georgia, U.S.A.

Ib. *Anax concolor* ♂, holotype from Rio Negro, Brazil.