

Figure 1. A: dorsal view of head capsule; B: lateral view of generalized tabanid larva; C: lateral view of generalized tabanid pupa; D: ventral view of anterior one-half of generalized tabanid pupa; E: slightly latero-oblique view of posterior end of generalized tabanid pupa (Abbreviations: a.l.-anal lobe; a.m.s.- anterior mesonotal seta; a.o.s.-anterior orbital seta; a.r.-antennal ridge; a.sp.-abdominal spiracle; a.sp.f.-anterior spinous fringe; an.r.-anal ridge; ant.-antenna; ant.pb.-anterior pubescence; ast.-aster; b.a.s.-basal alar seta; c.s.-callus seta; c.t.-callus tubercle; ceph.b.-cephalic brush; cly.-clypeus; ct.sp.-cephalothoracic suture; d.c.-dorsal comb; d.t.-dorsal tubercle of aster; ep.s.-epicranial suture; f.s.-frontal suture; f.t.-frontal tubercle; l.c.-lateral comb; l.o.s.-lateral orbital seta; l.t.-lateral tubercle of aster; max.p. & mx.p.-maxillary palp; md.-mandible; p.m.s.-posterior mesonotal seta; p.o.s.-posterior orbital seta; p.sp.f.-posterior spinous fringe; pb.ext.-pubescent extension; pl.-pleuron; pl.s.-pleural setae; post.pb.-posterior pubescence; pseu.-pseudopodium; pseu.pb.-pseudopodial pubescence; siph.-siphon; st.-sternite; st.sp.-stigmatal spine; sp.f.-spinous fringe; sp.p.-spiracular prominence; tb.1-first tibia; tb.2-second tibia; tg.-tergite; tg.s.-tergal setae; th.sp.-thoracic spiracle; v.c.-ventral comb; v.s.-vertexal seta; v.t.-ventral tubercle of aster; w.-wing).

shovel and placed in the wood-framed sieve. The sieve was partly submerged in water and agitated up, down, and from side to side to break up and flush particles through the bottom mesh. At 10-15

second intervals, until the sample had been thoroughly searched, the frame was elevated and searched for larvae. Each search included partly inverting the sieve to look for larvae that might be crawling through the wire mesh. All field-collected larvae were placed individually in small vials containing a small amount of water and/or material from their habitat for transport to the laboratory.

Larvae were reared in small, numbered, plastic bottles, the numbers corresponding to those in a rearing log containing habitat data. Two media were used: 1) non-nutrient agar-agar of slightly less than 1% concentration in water as described by Roberts (1966); and 2) moist sand. Larvae were generally not fed for the first 2-3 weeks in hopes that food deprivation might influence them to pupate. When feeding was required, small cubes of raw beef liver about 5 mm by 5 mm were provided once a week. About 24 hours after each feeding remaining liver was removed and discarded. In addition, larvae being reared in the agar-agar medium were transferred to clean medium after feeding as blood from the liver greatly reduced visibility.

All rearing bottles were checked daily. When a pupa was found, the larval exuviae were recovered. For specimens in agar-agar, the larval exuviae could be recovered with forceps without removing the pupa. For specimens in sand, the pupa was carefully, but temporarily, set aside so that the sand could be searched. Once the larval exuviae were recovered, sand was replaced in the rearing bottle, a small circular depression was made in the sand, and the pupa was placed head upward into this depression.

Each larval exuviae were placed in a small amount of water to clean away debris. After initial cleaning, the exuviae were placed in a petri dish containing 70% ethyl alcohol, and the petri dish was placed on the stage of a dissecting microscope. Using forceps and a blunt probe with the last 3-4 mm bent at an angle of about 30 degrees, the larval exuviae were teased and stretched lengthwise. The same instruments were then used to open the ecdysial slit. A syringe filled with 70% ethyl alcohol with a blunt-tipped needle was then used to 'inflate' the exuviae by slowly injecting alcohol into the exuviae through the ecdysial slit. The 'inflated' exuviae were stored in 70% ethyl alcohol in a vial bearing the same number as the rearing bottle from which the exuviae had come.

When an adult was found, it was set aside for 12-24 hours to allow integumental hardening and

coloration to occur. Adults were then killed, pinned, and labeled in the usual manner. The pupal exuviae were removed, rinsed in 70% ethyl alcohol to clean away debris, and placed in the vial with its corresponding larval exuviae.

Measurements of the larval head capsule and spacings between the integumentary striations were made using the larval exuviae. All other larval measurements were made using live larvae. All pupal measurements and counts of spines were made using the pupal exuviae.

### Larval and Pupal Morphology

Figures 1A-1E illustrate the larval and pupal morphological features used in the descriptions below. For a more detailed discussion of larval and pupal morphology please refer to one of the papers cited above in the first paragraph of Materials and Methods

### The Genus *Chrysops* Meigen

The genus *Chrysops* is well represented in Africa, South America, the entire northern hemisphere, and to a lesser degree in the Oriental Region, but it is poorly represented in the Australasian and Oceanian Regions where only six species are listed by Daniels (1989). Using Weber's line as the boundary between the Oriental Region and the Australasian/Oceanian Regions, Burger and Chainey (Burger, personal communication) recognize only four species of *Chrysops* in the Australasian and Oceanian Regions (*C. albicinctus* Wulp, *C. atrivittatus* Schuurmans Stekhoven, *C. australis* Ricardo, and *C. signifer* Walker). Burger and Chainey (Invertebrate Taxonomy, in press) are 'sinking' the subspecies of *C. australis* previously recognized from New Guinea.

Based on examination of larvae and pupae of 36 species, Teskey (1969) recognized two distinct larval forms, one form with a respiratory siphon having a stigmatal spine and the other lacking the spine. In all other aspects the larvae and pupae were sufficiently similar to allow Teskey (1969) to develop generic characterizations which are quoted below:

The larvae are characterized by the following features: length at maturity usually less than 18 mm; third antennal segment as long or longer than second; striations present dorsally and ventrally on all segments, although sometimes absent laterally; three pairs of pseudopodia on each of first seven



Figure 2. Lateral view of larva of *Chrysops albicinctus* Wulp.

abdominal segments; respiratory siphon on those species not bearing a stigmatal spine two to five times longer than its basal diameter; pubescence present on median lateral surfaces of anal segment.

The pupae may be diagnosed by: length usually less than 15 mm; two pairs of callus setae; antennal sheaths curved anterodorsally and exceeding epicranial suture; abdominal fringes on each segment composed of a single row of spines; absence of dorsal and lateral pairs of preanal combs. (Teskey 1969, p.22)

The larvae and pupae of Nearctic *Chrysops* are moderately well known. Larvae and pupae of only a few Afrotropical, Neotropical, Palaearctic, and Oriental species are known. To date, the immature stages of no Australasian or Oceanian species have been described. The larvae and pupae of both New Guinea species are described herein. Both larvae are of the type which lacks the stigmatal spine, and both conform readily to the generic characterizations cited above except that the pupa of one species (based on a single specimen) has only one seta on each callus tubercle, a condition previously noted for *C. brunneus* Hine, a Nearctic species (Goodwin, 1976).

### *Chrysops albicinctus* Wulp

Mature larva (Figure 2): Length 13-18 mm, whitish with contrasting pale brownish pubescent markings. Head capsule 1.73 mm long, greatest width 0.48 mm. Anal segment 2.16 mm long, ca. 1.5 times its greatest width. Respiratory siphon 0.6 mm long, ca. 3.6 times its basal diameter; stigmatal spine absent. Striations present on all non-pubescent aspects of all segments; striations separated 0.031-0.037 mm dorsally and ventrally, slightly more compressed laterally. Anterior pubescence narrowly encircles all thoracic and first four abdominal segments, absent midlaterally from abdominal segment V and midlaterally and midventrally from VI and VII; anterior annuli of thoracic segments not widened laterally and without posterior projections. Pseudopodial pubescence forming complete annuli on the first seven abdominal segments, united with anterior pubescence dorsolaterally on all seven and ventrolaterally only on first

four; pseudopodial pubescent annulus on abdominal segment VII with short dorsolateral and ventrolateral posterior projections reaching nearly to middle of segment. Posterior pubescence encircling abdominal segment VII where it is expanded anteriorly over most of lateral surface, crossing a little more than one-third length of segment. Anal segment entirely pubescent except for a narrow non-pubescent anterior ring dorsally from which a non-pubescent triangular area extends posteriorly, the non-pubescent area middorsally crossing 0.20-0.25 the length of the segment.

**Pupa:** Length 13-15 mm; yellowish-brown without obvious darkened areas. Antennal ridges not separated into median and lateral portions, only the former indicated by small protrusions elevated ca. 0.02 mm above wide notch at midline. Callus tubercles bisetose, irregularly triangular in basal outline, each tapering to a somewhat sinuous ridge that runs dorsolaterally; elevated 0.09-0.10 mm above general surface. Frontal tubercles absent. Antennal sheaths 0.47-0.51 mm long, 0.36-0.42 mm wide, exceeding epicranial suture. Thoracic spiracles ca. 0.46-0.51 mm long; spiracular prominence exceeding dorsal thoracic margin 0.16-0.18 mm. Abdominal fringes uniseriate, complete on segments II-VII; dorsal fringe on tergite VII of 44-50 spines. Ventral or ventrolateral preanal combs of 20-24 or 6-8 spines. Dorsal, lateral and ventral tubercles 0.10-0.12, 0.26-0.29, and 0.12-0.14 mm long, respectively; all tapered to pointed apices; dorsals directed dorsoposteriorly, laterals directed lateroposteriorly, ventrals directed ventroposteriorly.

**Collections and comments:** More than 50 larvae of this species were collected of which 41 were placed in containers for rearing. The others were preserved in 70% ethyl alcohol. Only 10 adults, including both sexes, were obtained. The pupal duration was noted for only 5 specimens and ranged from 5-7 days.

The first location was the crocodile rearing facility 6 km outside Lae along the Markham Highway. Apparently full-grown larvae were collected at this location in January, February, April and May of 1997. All larvae were found in highly organic, silty mud at the margin of a narrow, shallow, manmade drainage ditch which received the outflow water from crocodile rearing ponds and feeding pens. The water was rarely more than 20 cm deep. The surface of the stream was only 0.5-1.0 m wide. The margins of the ditch supported mainly grasses in the area where the larvae were found, but the larvae were in the silty mud and not

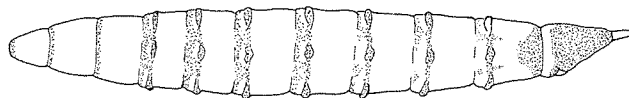


Figure 3. Lateral view of larva of *Chrysops australis* Ricardo.

associated with the root mats of the shoreline grasses.

The other two locations were on the Markham Ranch about 55 km outside of Lae along the Markham Highway. Apparently full-grown larvae were collected on the Markham Ranch only in September of 1997. One of these locations, the one yielding most of the larvae, was along the edge of a shallow, sluggish stream. The area yielding the larvae was sandy silt, richly organic, and completely devoid of vegetation. The other location, also along a sluggish stream, was bounded and shaded by trees, vegetation grew almost to the edge of the water, and the mud was firmer and not obviously sandy. As before, the larvae were in the mud and not associated with root mats.

### *Chrysops australis* Ricardo

**Mature larva (Figure 3):** Length 13-18 mm, yellowish-white with contrasting dark brownish pubescent markings. Head capsule 1.96 mm long, greatest width 0.46 mm. Anal segment 2.42 mm long, ca. 2.0 times its greatest width. Respiratory siphon 0.96 mm long, ca. 4 times its basal diameter; stigmal spine absent. Striations present on all non-pubescent aspects of all segments; striations separated 0.031-0.037 mm dorsally and ventrally, slightly more compressed laterally. Anterior pubescence narrowly encircles all segments except anal; prothoracic anterior annulus with a fan-shaped caudally directed projection on each side; meso- and metathoracic anterior annuli distinctly widened laterally but without distinct posterior projections. Pseudopodial pubescence forming complete annuli on all seven pseudopodial segments, united with anterior pubescence dorsolaterally and ventrolaterally on all. Abdominal segment VII entirely pubescent posterior to pseudopodial annulus laterally; dorsally the posterior one-half of segment is non-pubescent and ventrally the entire area behind pseudopodia is non-pubescent. Anal segment entirely pubescent except for a very narrow non-pubescent anterior ring.

**Female pupa:** length 13 mm; yellowish-brown without obvious darkened areas. Antennal ridges

not evident; the area usually occupied by antennal ridges swollen but not ridged; no median notch. Callus tubercles unisetose, oval in basal outline, irregularly ridged apically; elevated 0.13-0.14 mm above general surface. Frontal tubercles absent. Antennal sheaths 0.57 mm long, 0.38 mm wide, exceeding epicranial suture. Thoracic spiracles ca. 0.48 mm long; spiracular prominence exceeding dorsal thoracic margin 0.12 mm. Abdominal fringes uniseriate, complete on segments II-VII; dorsal fringe of tergite VII of 28 spines. Ventrolateral pre-anal combs of 6-7 spines. Dorsal, lateral and ventral tubercles 0.12, 0.18, and 0.14 mm long, respectively; all with pointed apices; dorsals directed dorsoposteriorly, laterals directed lateroposteriorly but with a distinct upward curve; ventrals directed ventroposteriorly.

Collections and comments: Only two larvae of this species were collected. The first died shortly after its collection in February of 1997. The second larva, collected on 24 May 1997, had a pupal duration of 6 days, pupating on 29 September and emerging on 4 October. Both larvae were collected from the habitat at the crocodile rearing facility noted above for *C. albicinctus*.

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