

Taxonomic notes on *Davidioides martini* Fraser, 1924 (Odonata: Gomphidae) and description of its female from Western Ghats, Peninsular India

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Research Article

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All relevant data are within the paper.

Abstract. A note on the rare dragonfly *Davidioides martini* Fraser, 1924, is provided with an update of its distribution range, status, ecology, and the description of its so far unknown female. This species is endemic to the Western Ghats of Peninsular India and seems to be a rare one as is indicated by the paucity of published records, some of which are shown to be doubtful and in need of corroboration.

Key words. Dragonfly, Anisoptera, Gomphoidea, Kerala, taxonomy, vesica spermalis

Introduction

Davidioides martini Fraser, 1924 is a monotypic species endemic to the Western Ghats (WG) of Peninsular India (Fraser, 1934; Kalkman et al., 2020; Subramanian et al., 2018). This taxon was described by Frederic C. Fraser based on a single male collected by him at Kunnoth, North Malabar, Kerala, on 19th May 1923 (Fraser, 1924). In addition to the type locality in the Coorg–Kannur landscape (Fraser, 1934), this species has otherwise been only reported from the Silent Valley National Park in the Nilgiri–Silent Valley landscape (Babu et al., 2013; Subramanian, 2007; Subramanian et al., 2018), Thattaekkad in the Lower Periyar region (Varghese et al., 2014), Aaralam WLS, Edamalayar, and Agasthyamalais (Subramanian, 2009) (Fig. 1). Nair et al. (2021) mentioned the above records and added three more, viz. Nelliampathies–Anamalais, Cardamom Hills, and Pandalam Hills. Records of this species from Nepal (Asahina, 1995; Subramanian et al., 2018) require corroboration, however. Not much has been documented on the ecology of this species, which is said to be found on the banks of montane streams and breed in hill streams (Subramanian et al., 2018). According to Fraser (1934), the female

of *D. martini* is unknown, hence the character of the armature of the femora in this sex was unavailable for determining the true taxonomic position of the genus in the family Gomphidae.

During a pre-monsoon expedition in May 2023, to the catchment areas of the Chaliyar River on the western slopes of the Nilgiri Hills in Kerala, the authors came across both sexes of the insect and witnessed its oviposition behaviour. Based on this field observation we here provide ecological notes on this species, a taxonomic re-description of the male, and the description of the female of this relatively rare and endemic taxon from WG.

Materials and methods

Samples of this insect were collected and preserved in absolute alcohol. The nomenclature used here follows Paulson et al. (2022) and Nair et al. (2021). Morphological terms for description follow Garrison et al. (2006). For a few structures specific to the Gomphoidea and for the description of the vesica spermalis (VS) in males, Chao (1990) and Fraser (1940) are also used to facilitate comparison with previous accounts. The known distribution of this species is adopted from Subramanian et al. (2018) and Nair et al. (2021). Measurements and morphological details of all species mentioned here are based on specimens in the voucher collection of the TORG. Photo-

graphs of specimens were taken with a Canon EOS 70D DSLR (Canon Inc., Japan) fitted with a 180-mm macro lens. Genitalia and anal appendages were dissected and studied by KS under a stereo zoom microscope (HEADZ Model HD81) and later preserved in glycerol. Illustrations were hand-drawn and digitalised by KS.

Abbreviations used

AL	Abdominal length
AH	Anterior hamule
asl	Above sea level
Ax	Antenodal cross-veins
CuA	Anterior cubitus
Cuii	second cubitus
FW	Forewing
FWL	Forewing length
GL	Genital lobe
HFL	Hind-Femoral Length
HW	Hindwing
HWL	Hindwing length
IA	First anal
IUCN	International Union for Nature Conservation
MP	Posterior median
NP	National Park
PH	Posterior hamule
Pt	Pterostigma
Px	Postnodal cross-veins



Figure 1. Map of southern India with spot records of *Davidioides martini* Fraser, 1924.

TNHS Travancore Nature History Society, Trivandrum, Kerala, India
 TORG TNHS Odonate Research Group
 TL Total length including the appendages
 WG Western Ghats
 VS Vesica spermalis

Results

Systematic account

Order Odonata Fabricius, 1793
 Superfamily Gomphoidea Rambur, 1842
 Family Gomphidae Rambur, 1842
 Genus *Davidioides* Fraser, 1924
 Type species: *Davidioides martini* Fraser, 1924

Diagnosis of the genus

Differentiated from all other genera of Gomphidae by the males having discoidal cells, hypertrigones, and the subtrigones of the forewing being always entire, anal triangle 4-celled, and discoidal cell of hindwing traversed by a nervure running from the costal to the distal side.

Head small, triangular; frons well-angulated, occiput simple, concave. Wings broad and long, nearly as long as abdomen, tornus markedly angulated, base of hindwing deeply excavated; membrane obsolete; anal triangle 3-celled; arc situated between the second and third antenodal nervures in FW; three cross nervures between bifurcation of radial sectors and anterior median (MA) in FW, only one in HW; sectors of arc well separated at origin, approximately parallel for some distance, especially in the hindwing; CuA and MP running parallel to rear border of wing; only 1 cubital nervure in all wings; no basal antenodal of 2nd series present; trigones (triangles) of forewing entire, that of hindwing traversed by one vertical nervure; pterostigma shorter than one quarter the distance between node and outer end of pterostigma; 4 rows of postanal cells in hindwing, 1 or 2 in forewings; legs moderately long, extending to apical border of Segment 1; anal appendages subequal, widely and equally divaricate, simple, without branches or ventral processes (Fraser, 1924, 1934)

***Davidioides martini* Fraser, 1924**

(Figs 2–5)

Davidioides martini – Fraser, 1924: 472–473, Fig. 2 (original description); Fraser, 1926: 419–420, Figs 3–6, Plate ii: Fig. 1; Laidlaw, 1930: 188; Fraser, 1931: 447; Needham, 1932: 226

Specimens examined

4 ♂♂ and 4 ♀♀. TORG #1023, ♂, Kakkadumpoyil, Nilambur, Malappuram District, Kerala, India, 28.v.2023, 850 m a.s.l., col. K. Sadasivan. TORG #1024 ♂, 30.v.2023; TORG #1025 ♂, 31.v.2023; TORG #1026 ♂,

30.v.2023; TORG #1027 ♀, 31.v.2023; TORG #1028 ♀, 30.v.2023; TORG #1029 ♀, 31.v.2023, and TORG #1030 ♀, 31.v.2023, all bearing the following collection details: Nadukaani, Nilambur, Malappuram District, Kerala, India, 30.v.2023, 700 m a.s.l., coll. K. Sadasivan.

Other specimens studied in the field (not collected)

2 ♂♂, and 2 ♀♀, from Thanuppan Chola, Nadukani, Nilambur, Malappuram District, Kerala, India, 30.v.2023, 700 m a.s.l., (K. Sadasivan and S. Pulikkal).

Description of male

(Figs 2, 4A–E, 4G–H, 5E–F)

Measurements (in mm) (n=4): TL 48–52, AL 32–37, FWL 35–38, HWL 32–33, HFL 5.

Head (Figs 2A–D). Eyes greenish blue, anterodorsally darker, and inferolaterally pale bluish white. Genae black. Mandibles pale lemon-yellow. Labium yellowish white posteriorly, and anteriorly including the teeth black. Labrum black, bearing two large triangular yellowish blue patches on each half, its entire free edge thickly bordered with black. Anteclypeus pale lemon-yellow. Postclypeus shiny black. Antefrons and postfrons shiny black throughout, with a large pale lemon-yellowish band in the upper area of the antefrons and expanding to the anterior area of the postfrons. The transverse band slightly concave in its middle. Vertex shiny black. Occipital bar slightly concave, matte black. Postocular lobe shiny black. Ocelli waxy white. Antennal flagellum and pedicel black, its scape ringed with yellowish white. Postgenae shiny black. Long pale amber-brown setae along the inferior border of the labrum and on the labium. Setae on the rest of the face black.

Prothorax (Figs 2A, B, D). The general colour is black, and marked with lemon-yellow spots. In dorsal view, anterior lobe centrally broadly marked with yellow and laterally black; middle lobe black with a pair of small round paradorsal yellow spots; posterior lobe entirely black with its mid-dorsal aspect bearing a large yellow triangular spot, whole medial margin sinuous. In lateral view, the lateral aspect of the middle lobe with a large yellow triangular spot as mentioned above. Proepisternum and proepimeron black with a brownish tinge. Forelegs generally black, but lateral aspect of coxae dirty yellow, and medial aspect of femur with a large oval yellowish white patch, rest of the leg including the spines and claws black.

Synthorax (Figs 2A–D). General colour black, marked with lemon-yellow stripes. In dorsal view, the mid-dorsal carina black, marked with yellow. Mesothoracic collar stripe yellow, well developed, passing over it and continuing to the other side; antehumeral stripes well developed, widely separated from the mesothoracic collar, minimally tapering towards the dorsum, L-shaped,

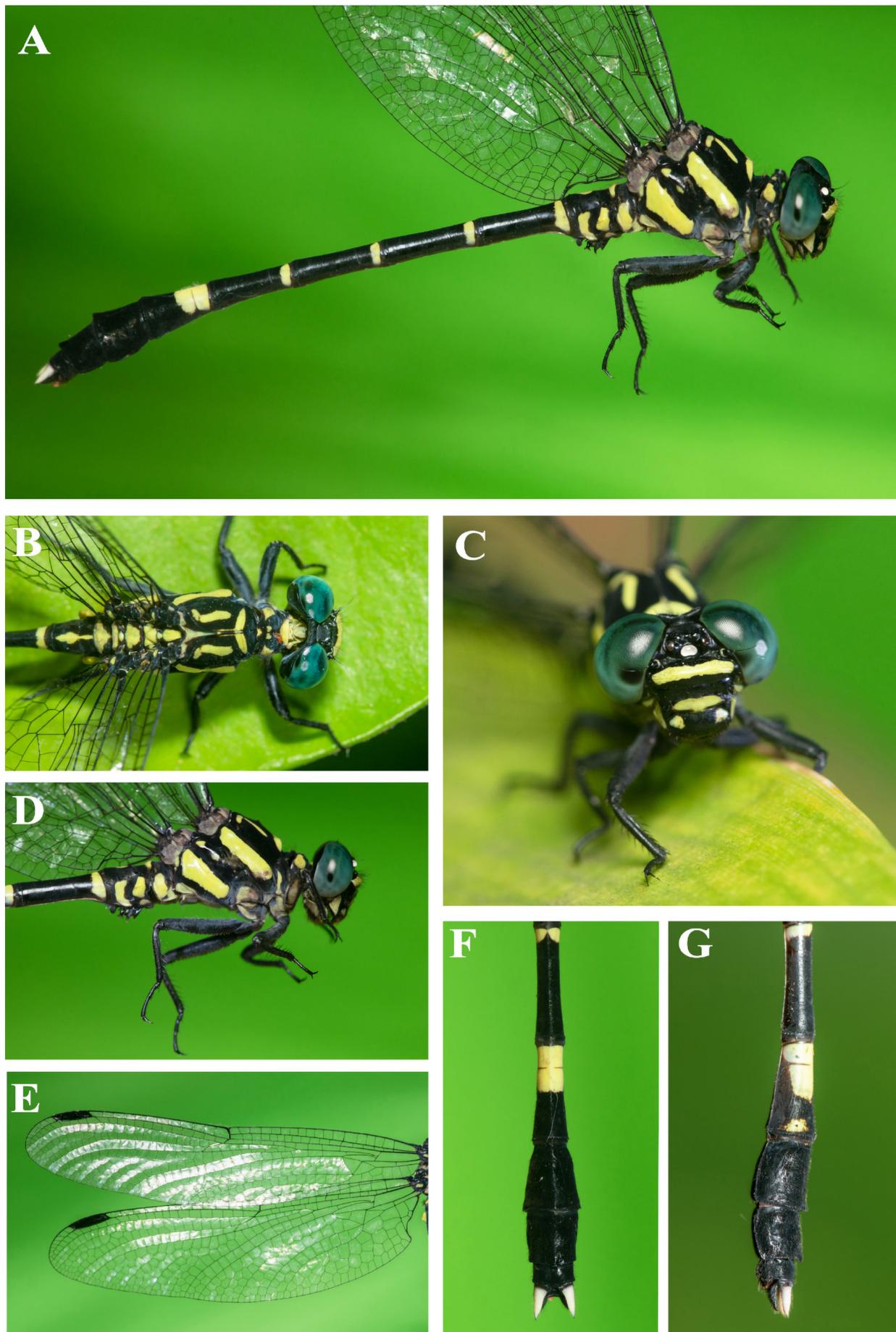


Figure 2. *Davidioides martini* Fraser, 1924, male. A – Lateral view; B – dorsal view of head, prothorax, and synthorax; C – close-up of head in frontal view; D – lateral close-up view of head, prothorax and synthorax; E – venation; F – dorsal view of terminal abdominal segments; G – lateral view of terminal abdominal segments.



Figure 3. *Davidioides martini* Fraser, 1924, female. A – Dorsolateral view of the whole insect; B – dorsal view of head, prothorax and synthorax; C – lateral close-up view of head, prothorax and synthorax; D – dorsal view of terminal abdominal segments; E – close-up of head from the front.

almost reaching the antealar sinus dorsally, but turning laterally at a right angle as a continuous streak for a distance for almost one third of its length. In lateral view, the mesepisternum black, bearing the yellow mesothoracic collar and the antehumeral stripes. Mesokatepisternum dorsally black and inferolaterally marked with a bold yellow oblique stripe. Mesepimeron black, bearing a large anterosuperior yellow stripe extending dorsally and almost reaching the wing base. Metepisternum black and marked with a thin L-shaped yellow stripe that may be reduced to two small yellow spots on the posterodorsal aspect in well-marked specimens (Fig. 2D). Metinfraepisternum mostly yellow, bordered with black. Metepimeron yellowish throughout save for a thin black circumferential border. Poststernum yellow. Antealar sinus black, the intervening acrotergite region yellow. Scutum, scutellum, and postscutellum mostly yellow bordered with black. All sutures black. Metathoracic spiracle brown. Mid- and hindleg coxae dirty yellowish white; trochanter, femur, and tibia and claws black. Hind femur long, reaching the junction of abdominal sternites S1 and S2.

Wings (Figs 2E, 5E–F). Hyaline; Pt of both wings black, parallelogram-shaped, occupying almost four cells; borders slanting laterally; inferior border curvilinear. Pt length four times its breadth in its middle. Trigones (triangles) of forewing entire (Fig. 5E), that of hindwing traversed by one vertical nervure (Fig. 5F). Anal triangle in HW 4-celled. Nodal Range in FW: Ax 14–16 & Px 10–12; HW: Ax 10–12 & Px 11.

Abdomen (Figs 2A, F, G). General colour shiny black, with pale lemon-yellow markings as follows: S1 dorsally on its distal border with a large triangular spot, the apex of which extends mid-dorsally towards the synthorax, and inferolaterally yellow. S2 bears a mid-dorsal spindle-shaped spot, two lateral yellow vertical streaks, a rounded triangular one enclosing the auricle, and another C-shaped, caudally convex one towards the posterolateral border. Another small spot antero-inferior to the yellow spot enclosing the auricle. Auricle yellow, its medial cranial border and the entire caudal border bearing the spine bordered with black. S3–6 marked with basal rings that end just short of the lateral carinae, ring with a width less than one eighth the length of the segments with posterior border excavated mid-dorsally by the black carina, often giving an appearance of paired spots in dorsal view. Dorsum of S7 marked with two yellow rings occupying just less than its basal half, these rings separated by a very narrow black streak dorsolaterally (Fig. 2F). The yellow rings are interrupted laterally and terminate well short of the lateral carina of S7. A pair of small triangular spots on the posterior paradorsal aspect of S7 (Fig. 2G). S8–10 unmarked.

Anal appendages (Figs 2F–G, 4C–E). General colour of cerci white in life (yellow in preserved specimens) with black basally and epiprocts entirely black; a little less than the basal fifth of the cerci and with five to six,

small, short, black teeth on its ventral side. Length of cerci a little longer than that of S10 in dorsal view. Cerci conical, divaricate and its lateral border slightly convex, medial border concave, and its tip pointed, directed posterolaterally. The whole surface bears short, bristle-like, brown setae. Lateral arms of the epiproct divaricate as the cerci, slightly shorter than the cerci, curved dorsolaterally, tips finely hooked. The whole surface bears blackish brown setae.

Secondary genitalia (Figs 4A–B, G–H). Colour black, setae brown. Cleft of anterior lamina (CAL) deep. Anterior hamule (AH) shorter than the posterior hamule in lateral view, long and narrow, flattened, with the tip rounded. Posterior hamule (PH) with body broader than AH, tapering and curved uniformly towards its tip and directed anteromedially. Genital lobe (GL) slightly broader, but shorter than the PH, truncated, and its tip slightly curved anteriorly. The structure of the VS is illustrated in Figures 4G, H. The median segment (S3) of the vesica spermalis in lateral view has a long digitiform extension directed ventroposteriorly, glans (S4) trumpet-like, with its tip expanded in the shape of a water lily leaf (Fig. 4H).

Variation in males

The metepisternum is black and marked usually with a thin yellow stripe, but this may be reduced to two serial small yellow spots on the posterodorsal aspect in well-marked specimens (one in four). The L-shaped extension of the antehumeral stripe may occasionally be discontinuous in some individuals, forming a separate spot, but is never absent. The numbers of black teeth under the cerci vary from four to eight and may even vary between sides in the same specimen. The usual pair of small triangular spots on the posterior paradorsal aspect of S7 (Fig. 2G) may be absent in heavily marked individuals. Venation is consistent in males with no variation in triangles observed, the FW is entire, and the HW triangle is always traversed.

Description of female

(Figs 3, 4F, I, 5A–D)

The female morphology is very similar to that of the males, the major differences are discussed below.

Measurements (in mm) (n=4). TL 52–55, AL 39–42, FWL 38, HWL 35–36, HFL 5–6.

Head (Figs 3A–C, E). Colour and structure of eyes and head as in males. Occipital bar more concave than in males.

Prothorax (Figs 3A–C). Colour and structure similar to those in males.

Synthorax (Figs 3A–C, E). General colour black, with pale lemon-yellow markings. Colour and pattern as in

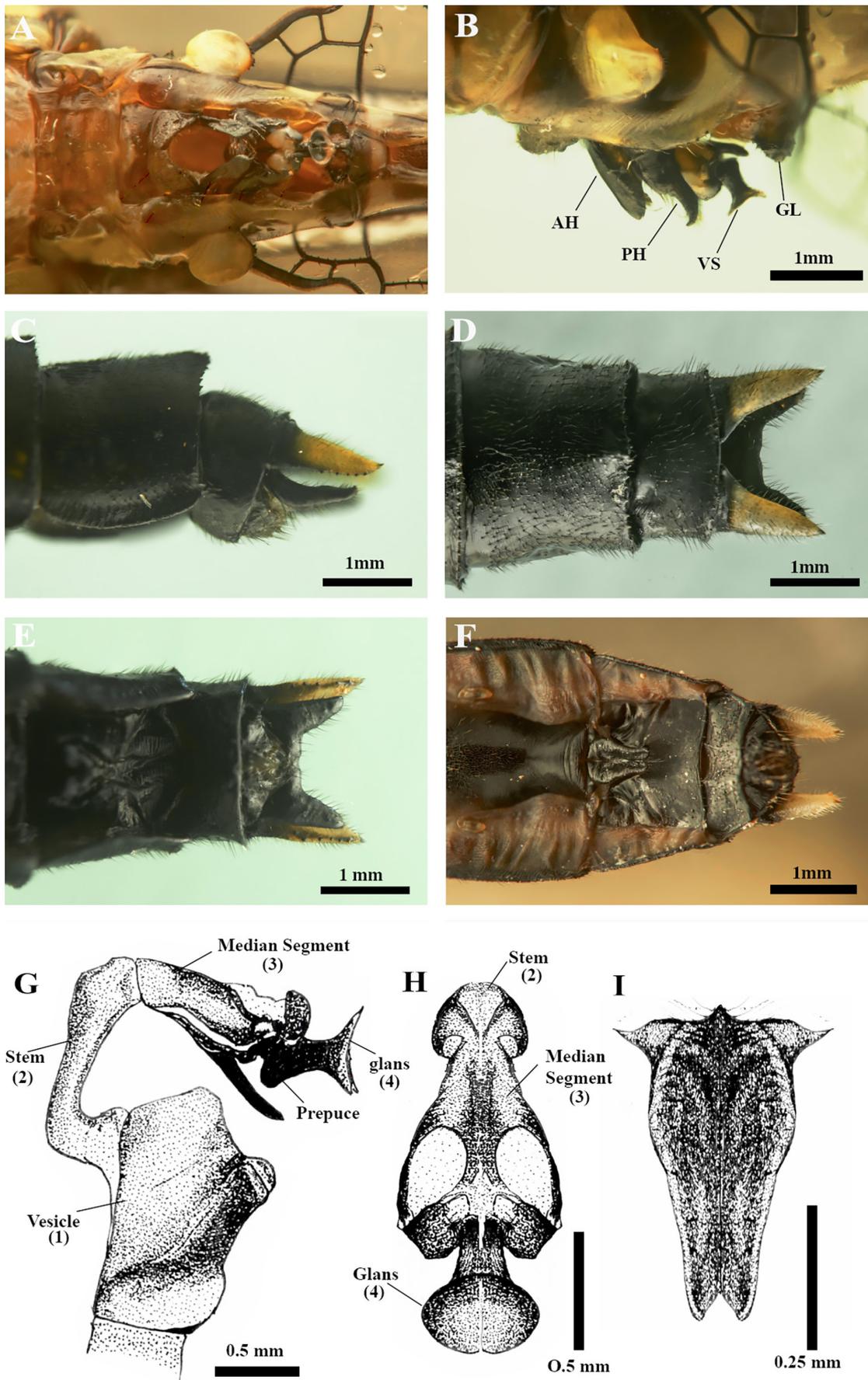


Figure 4. *Davidioides martini* Fraser, 1924, reproductive structures. A – Ventral view of male genital fossa; B – lateral view of male genital fossa; C – lateral close-up view of S9, S10 and anal appendages of the male; D – dorsal close-up view of S9, S10 and anal appendages of the male; E – ventral close-up view of S9, S10 and anal appendages of the male; F – ventral close-up view of S9, S10 and subgenital plate (vulvar scale) of the female; G – lateral view of the vesica spermalis of the male; H – ventral view of terminal segment of the vesica spermalis of the male; I – subgenital plate (vulvar scale) of the female.

the males. Mesothoracic collar stripe yellow, well developed, interrupted by the dorsal black carina. The extreme crest of the dorsal carina marked with yellow. Antehumeral stripes well developed, L-shaped, almost reaching the antealar sinus dorsally, but turning laterally at a right angle as a continuous streak for almost one third of its length. Metepisternum black and marked with a thin L-shaped yellow stripe that occupies its posterior part. Metathoracic spiracle dark brown, bordered with black. The mid- and hindleg coxae, trochanter, femur, and tibia are all black. Hind femur moderately long, reaching the junction of abdominal sternites S1 and S2.

Wings (Figs 5A–D). Hyaline; Pt as in males. Nodal range in FW: Ax 14–17 & Px 10–13; HW: Ax 9–11 & Px 10–12. Venation as in males, but sometimes the superior triangle on the FW may be traversed even if only on one side (Fig. 5B), and HW triangle not traversed (Fig. 5D).

Abdomen (Figs 3A, B, D, 4F, I). General colour shiny black, marked with pale lemon-yellow as in the males. Abdomen slightly stouter than that of males. Auricle less conspicuous. Segmental markings on S1–6 as in males. Basal ring in S7 as in males, but the continuous yellow ring greatly reduced to a mid-dorsal streak. Distal parts of S7, S8 and S9 broader than in males. Hind femora extending to just short of junction of S1 and S2 only. S9 slightly shorter than S8. Abdomen only slightly longer than HW. Ninth abdominal sternite not differentiated into sclerotised plates. Subgenital plate (vulvar scale/vulvar lamina) is a pair of long triangular process-

es that almost reach the ventral half of the length of S8 (Figs 4F, I).

Anal appendages (Figs 3D, 4F). General colour of cerci white and supra-anal plate black; cerci as long as S10, directed posteriorly, conical, tip with a small black tooth, the whole surface bearing white setae.

Variation in females

In females, the L-shaped extension of the antehumeral stripe may occasionally be disjunctive in some individuals but is never absent. The distal extension of the basal yellow annulus on S7 is sometimes reduced to a small triangular spot, but is always continuous with the basal annulus. The normal state of venation is non-traversed triangles in FW and traversed ones on HW (Figs 5A, C), but occasionally the FW triangle may be traversed, too (1 in 4 females, unilaterally) (Fig. 5B) and the HW triangle may not be traversed (1 in 4 females, unilaterally) (Fig. 5D). Two of the three females caught had this abnormal venation in their triangles. In preservative, the cerci may take on a yellow colour, which is otherwise white in life in both sexes.

Distribution

The species is a mid-altitude one at between 400 and 900 m a.s.l. (Fig. 1). Kerala: Nilgiri–Silent Valley region: Silent Valley NP (Babu et al., 2013, Nair et al., 2021; Subramanian, 2007; Subramanian et al., 2018), Nadukani in Nilambur (Kalesh Sadasivan & Sabari Janaki),

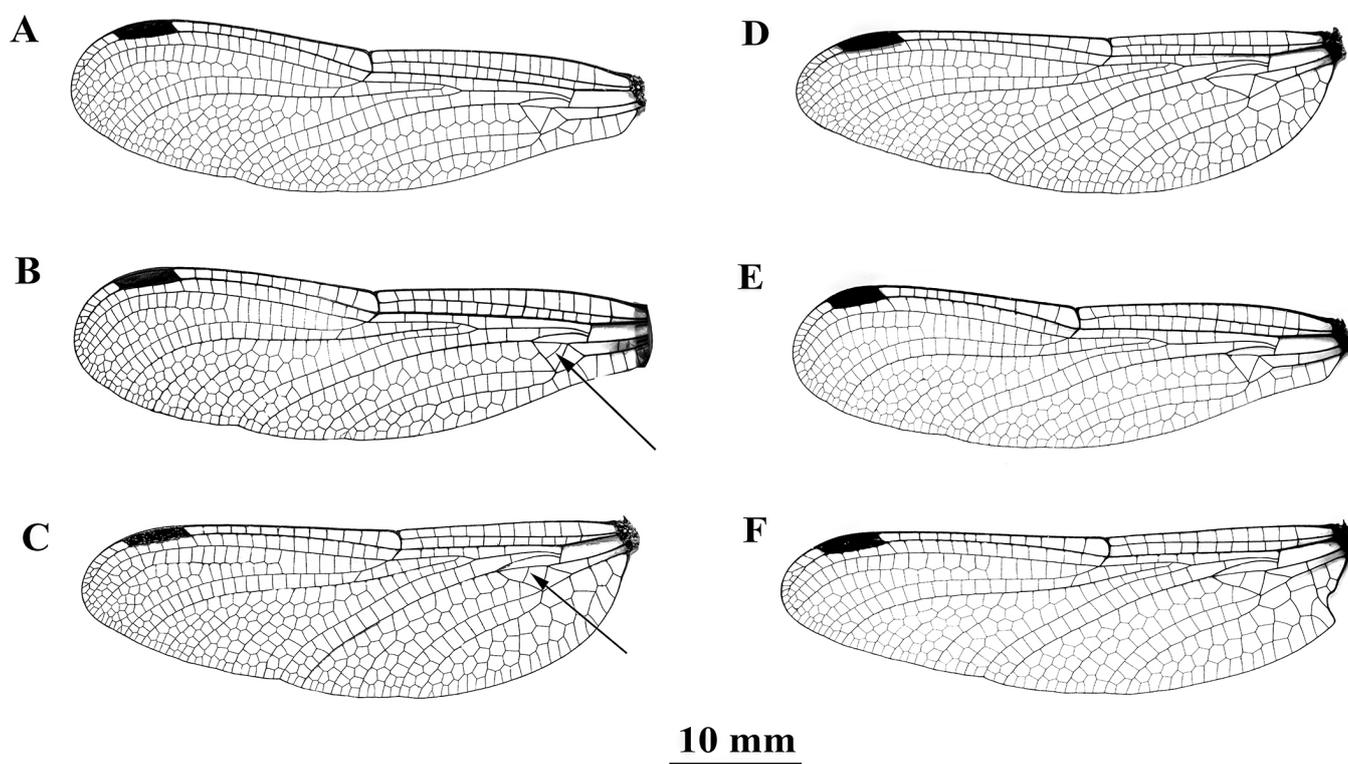


Figure 5. *Davidioides martini* Fraser, 1924, venation. A – Forewing of female; B – forewing of female in traversed state; C – hindwing of female in traversed state; D – hindwing of female in non-traversed state; E – forewing of male; F – hindwing of the male in traversed state.

Kakkadampoyil in Nilambur (Kalesh Sadasivan & Subash Pulikkal); Coorg: Kanichar (Vibhu Vijayakumaran), Kunnoth (Fraser, 1924), and Aaralam (Subramanian, 2009) in Kannur District. The visual records from the Lower Periyar area: Thattaekkad (Varghese et al., 2014), Edamalayar and Agasthyamalai in Agasthyamalais (Subramanian, 2009), and Nelliampathies-Anamalais, Cardamom Hills, and Pandalam Hills in Nair et al. (2021) need confirmation (Fig. 1).

Ecological notes

Males were spotted perching on rocks on the edges of hill streams in wet evergreen forests, basking in the morning sun. Some males were also seen inside shady jungle, sitting close to the ground on twigs and dead branches next to hill streams, with females perched on small twigs and rocks in the stream bed, busy ovipositing nearby. Egg-laying takes place in the clear water of small pools fed by seepages in these stream beds during the pre-monsoon season, in May and early June. Sympatric species observed were *Protosticta graveli* Laidlaw, 1915, *P. hearseyi* Fraser, 1922, *Asiagomphus nilgiriensis* Laidlaw, 1922, *Idionyx saffronata* Fraser, 1924, *Idionyx corona* Fraser, 1921, *Heliocypha bisignata* (Hagen in Selys, 1853), *Heliogomphus promelas* (Selys, 1873), *Heliogomphus kalarensis* Fraser, 1934, *Chlorogomphus campioni* (Fraser, 1924), and *Phylloneura westermanni* (Hagen in Selys, 1860).

Discussion

Being described based on a single male, with the female unknown has been making the taxonomic placement of the genus difficult (Fraser, 1934). *Davidius* is similar to *Davidioides* in having the discoidal cell of the hindwing traversed by a nervure from the costal to the distal side, but is distinguished by the IA and Cuii in hindwing being widely divergent at the border of the wing, and the latter being parallel in *Davidioides* (Fraser, 1934). The short hind femora readily separate *Davidioides* from *Merogomphus* Martin, 1904 (Chao, 1990). The similarity of the male cerci to *Euthygomphus* Kosterin, 2016 is interesting, but it is differentiated from *Davidioides* based on its long hind femora extending to the distal part of S2, and the non-traversed triangles in HW (Kosterin, 2016). The abdominal segment S9 being shorter than S8 differentiates it from *Macrogomphus* Selys, 1854 (Chao, 1990). The absence of sclerotised plates on S9 positions the genus closer to *Heliogomphus* Laidlaw, 1922, *Microgomphus* Selys, 1858, *Burmagomphus* Williamson, 1907, and *Asiagomphus* Asahina, 1985 (Chao, 1990), but the traversed triangle of the HW and the unique structure of the male VS in *Davidioides* eliminates the possibility of synonymy with all of them. The female examined here in detail for the first time, and based on the relatively short hind femora length, the ratio between S8 and S9 lengths, venation,

and structure of the subgenital plate, suggest that this genus might be closer to *Sinogomphus* May, 1935 and *Asiagomphus*, but, although the subgenital plate of the female is long and triangular like in *Sinogomphus*, the non-membranous state of sternite S9 and the non-traversed triangles in male HW render it clearly distinct (Chao, 1990).

Asahina (1995) described two males from Nepal as *D. martini*, but in these the triangles of HW were not traversed, the abdominal markings in S2, S7–9, and the male genitalia (GL and VS) were apparently very different (Asahina, 1995, figs 95–96) compared to WG specimens so that the identity of the species from Nepal had better be considered doubtful. It may in fact possibly be a new one and requires further investigation.

Davidioides martini is a rare dragonfly for which with very few published records exist (Nair et al., 2021). However, we found it to be not uncommon locally during May–June in the Nilgiri region. The overall colouration of the female is similar to that of females of *Asiagomphus* spp. from WG, which may cause some confusion in the field, but *Asiagomphus* females have black cerci instead of the white ones seen in *Davidioides*, and moreover the traversed triangles of the HW in *Davidioides* is diagnostic. It may be noted that the image of *Davidioides* in Subramanian (2009) and those hosted on the online platform <http://www.indianodonata.org> (Anonymous, 2023) are all females, misidentified as males. A closer examination of the image of ‘*Davidioides*’ in Varghese et al. (2014, Image 3) from Thattaekkad in the Lower Periyar area of southern WG revealed that it has long, interrupted, longitudinal, yellow streaks on the inferolateral aspect of S3–6 and lacks the L-extension of the antehumeral stripes, and also lacks the mid-dorsal spindle-shaped spot in S2. It is to be noted that the female of *Davidioides* never has lateral, longitudinal, yellow streaks, but instead has basal annuli in S3–7, S2 bears a mid-dorsal spindle-shaped spot, and the antehumeral stripe is L-shaped. Accordingly, the depicted female in Varghese et al. (2014) seems to be the female of some other gomphid, rather than the female of *Davidioides*; it follows that the Thattaekkad records need to be confirmed with fresh evidence. Considering the above, the exact distribution of this taxon in WG requires reassessment based on meticulous fieldwork.

Conclusion

Detailed morphological examination of males and females of *Davidioides martini* suggests that the taxonomic position of the genus *Davidioides* may be somewhat nearer to *Sinogomphus*, *Euthygomphus* and *Asiagomphus* than has been previously supposed. The variation in venation in females underscores the need to relook at the utility of characters like venation and femoral length in gomphid classification. The final position of this enigmatic genus may only be settled with molecular phylogenetic techniques.

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