https://doi.org/ 10.33307/entomon.v48i2.894
Entomon 48(2): 253-286 (2023)
Article No. ent. 48209

A review of *Macromia* Rambur, 1842 (Odonata, Macromiidae) of Western Ghats, with taxonomic notes on *Macromia miniata* Fraser, 1924 and *M. irata* Fraser, 1924

Kalesh Sadasivan[1,4*], Vinayan P. Nair[2,4] and K. Abraham Samuel[3,4]

[1]*Greeshmam, BN 439, Bapuji Nagar, Thiruvananthapuram 695011, Kerala, India.*
[2]*XV/446 A1, Nethaji Housing Colony, Trichambaram, Taliparamba, Kannur 670141, Kerala, India.*
[3]*Tropical Institute of Ecological Sciences (TIES), Ecological Research Campus, K.K Road, Velloor 686501, Kottayam, Kerala, India.*
[4]*TNHS Odonate Research Group (TORG), Travancore Nature History Society, MBRRA, Mathrubhumi Road, Vanchiyoor, Thiruvananthapuram 695035, Kerala, India.*
Email: kaleshs2002in@gmail.com, vinayanpnair@gmail.com, abrahamcms@gmail.com

ABSTRACT: A review of the genus *Macromia* Rambur, 1842 (Odonata, Macromiidae) of Western Ghats of Peninsular India is presented with its updated distribution. An attempt is made to collate the scattered data in peer-reviewed literature published to date and is supplemented with field data gathered by the authors over two decades. Although *Macromia* is represented by nine species including six endemics in the Western Ghats, not much has been published on them from the region. *Macromia irata* Fraser, 1924 was described from Coorg but was rarely reported in peer-reviewed literature since its very brief original description by Fraser in 1924. The detailed morphology including that of the genitalia of *M. irata* is discussed. A revised classification based on the species groups and a key to the species of *Macromia* of the Western Ghats of Peninsular India is provided. To quantify the ratios of the number of the prenodal and postnodal veins in Odonata, a new nodal range expression called Standardised Species Nodal Range (SSNR) and a new index termed Standardised Species Nodal Index (SSNI) is also proposed.

KEY WORDS: Dragonflies, standardised species nodal index, morphometric index, revised classification

INTRODUCTION

Macromia Rambur, 1842 (Macromiidae Needham, 1903), are large to medium-sized dragonflies with large globular eyes and metallic blue or green pterothorax with yellow stripes (Fraser, 1936). The genus presently has about 80 species that range from Afrotropical (Madagascar), Oriental, Australian (Australia, Papua New Guinea), Nearctic, and Palearctic regions (Davies and Tobin, 1985; Paulson *et al.*, 2021). Even though they are primarily found in the Indo-Australian region, a few species are also found in Europe (Boudot, 2010) and North America (Paulson *et al.*, 2021). In India, the genus *Macromia* is represented by 14 species (Subramanian and Babu, 2017). Nine species have been recorded in the Western Ghats (WG) (Fig. 1) as per Fraser (1936), since then, no new species

* Author for correspondence

have been added (Subramanian *et al.,* 2018). *Macromia annaimallaiensis* Fraser, 1931, *M. bellicosa* Fraser, 1924, *M. cingulata* Rambur, 1842, *M. ellisoni* Fraser, 1924, *M. flavicincta* Selys, 1874, *M. flavocolorata* Fraser, 1922, *M. ida* Fraser, 1924, *M. indica* Fraser, 1924, and *M. irata* Fraser, 1924 are the known species from the WG of Peninsular India. Fraser (1924) described *M. miniata* from the WG but later synonymised it with *M. flavocolorata* (Fraser, 1936). These are rare insects, as evidenced by the paucity of records in published literature and compilations (Tiple *et al.,* 2013; Emiliyamma, 2014; Tiple and Koparde, 2015; Subramanian and Babu, 2017; Subramanian *et al.,* 2018; Tiple *et al.,* 2022). Recently, Nair *et al.* (2021) listed nine species in the WG, of which six are endemic to the area, and they updated the status and distribution of the species for Kerala. Odonates of the genus *Macromia* generally inhabit sub-montane streams and are seen above 600 m ASL, though some are found at the foothills of the WG, especially in the post-monsoon period. They all exhibit strong sustained flight manoeuvres and patrol territories along forest streams and paths (Fraser, 1936).

The *Macromia* species of the Oriental Region had been segregated into species-groups by Laidlaw (1922), based on the colour of the postclypeus, antehumeral stripe, and presence or absence of dorsal spine on S10. Fraser (1924) adapted this concept in his work on the Indian species and referred to the *cincta*, *cingulata,* and *calliope* groups. In the WG, the *flavicincta-bellicosa-irata* species belongs to the *cincta* group; the *indica-annaimallaiensis* cluster is of the *cingulata* group; and *ida-flavocolorata* species constitute the *calliope* group. According to Fraser (1924), the presence or absence of the following characteristics are useful for the species-level identification of *Macromia*– the yellow stripe across the postclypeus, the antehumeral stripe, the spine on the dorsum of segment 10, the spine on the outer side of the superior anal appendage and the shape of genital hamule and lobe of the males. The most useful diagnostic characteristic among them is the structure of the male genitalia (Fraser, 1936).

In this article, the scattered literature on the genus *Macromia* from the WG were presented together, updated the current distribution, provided additional taxonomic notes on species and species groups, illustrations of marking on abdominal segments 2, 7 and 8, and a revised key to the males of *Macromia* of WG. To quantify the ratios of the number of the prenodal and postnodal veins in Odonata, a new nodal range expression called Standardised Species Nodal Range (SSNR) and a new index termed Standardised Species Nodal Index (SSNI) is proposed.

MATERIALS AND METHODS

All published information on *Macromia* from Peninsular India has been reviewed, with additional data from the personal records of the authors. The current distribution is based on Emiliyamma (2014), Subramanian and Babu (2017), Subramanian *et al.* (2018), and Nair *et al.* (2021). Unless specified, all locality records are based on observations by the authors. The general taxonomy of *Macromia* follows Fraser (1936). The species group concepts and classifications from Laidlaw (1922) and Fraser (1924) are also used, and the taxonomic keys have been revised. The current checklist is based on Subramanian and Babu (2017), Nair *et al.* (2021), and Paulson *et al.* (2021). The morphological terminology follows Fraser (1936) and Garrison *et al.* (2006). Wing terminology is based on Riek and Kukalová-Peck (1984). Morphometric data are based on both field-collected specimens and Fraser (1924, 1936). High-resolution images of all *Macromia* holotypes, allotypes, and lectotypes were obtained from the Natural History Museum London (BMNH) online portal https://data.nhm.ac.uk/ as well as the Naturalis Biodiversity Centre, https://bioportal.naturalis.nl., of Leiden Museum.

The classical Nodal Index has been modified into a new concept termed – SSNR, to account for individual variability and thus include the highest and lowest values ever recorded for specimens of a species.

$$SSNR = \frac{\text{Postnodal Range}^{LFW}\text{: Prenodal Range}^{LFW}}{\text{Postnodal Range}^{LHW}\text{: Prenodal Range}^{LHW}} :: \frac{\text{Prenodal Range}^{RFW}\text{: Postnodal Range}^{RFW}}{\text{Prenodal Range}^{RHW}\text{: Postnodal Range}^{RHW}}$$

SSNR is further simplified into the concept of SSNI with the average value of range i.e. (Max +Min)/2, of pre/postnodals, rounded to the nearest integer, expressed as an index for the number of specimens of a species studied.

SSNI is thus the nodal ratios between the forewing and hindwing, expressed as follows:

$$SSNI = \frac{\text{Forewing (Prenodal Average : Postnodal Average)}}{\text{Hindwing (Prenodal Average : Postnodal Average)}}$$

Abbreviations:

BMNH –Natural History Museum, London; OD–Original Description; TNHS–Travancore Nature History Society; TORG–TNHS Odonate Research Group; WLS–Wildlife Sanctuary

RESULTS

Macromia Rambur, 1842

Type species: *Macromia cingulata* Rambur, 1842
OD: Rambur (1842). *Histoire Naturelle des Insectes. Névroptères*. Paris: Librairie Encyclopédique de Roret xvii 534 pp. 12 pls. [137].

Diagnosis: "Tibia of ♂ with a long membranous keel on the flexor surface; the base of hindwing angulated and eyes with a small sinuous projection towards the middle of the posterior border. The discoidal cell of the hindwing distal to the level of arculus, hindwing strongly angulated in ♂s. Discoidal cells on forewing and hindwing always entire and never traversed by veins and discoid field of cells in forewing begin with two rows of cells" *Macromia* can be easily differentiated from the closely resembling *Epophthalmia* Burmeister, 1839 in the WG, by the cell in forewing and hindwing being entire and not traversed by veins, while in *Epophthalmia* the cells in forewing are always traversed (Fraser, 1936).

Macromia annaimallaiensis Fraser, 1931

(Figs.1, 3:1A–C, 10A, 11A, 12C)

OD: Fraser (1931). *Macromia annaimallaiensis* Fraser, *Rec. Ind. Mus.* Vol. xxxiii pp.447, 452, 453 (1931)

Material studied: Images of Holotype, ♂; 013384048 NHMUK London, Mudis Hills, 12.v.29, S. India, F.C. Fraser; Allotype, ♀ 013384047 NHMUK London, Mudis Hills, 12.v.29, S. India, F. C. Fraser.

Measurements: ♂ abdomen 56–59 mm, hindwing 45–48 mm. ♀ abdomen 53–58 mm, hindwing 48–51mm.

Nodal Ratio and index: SSNR– 9:15/12:10:: 15:9/10:11; SSNI–15:9/10:12

Historical Distribution: Mudis Hills in *Anamalais*, May, Tamilnadu (Fraser 1931); Kallar and Shaliyar Rivers Kerala (Fraser, 1936). Confined to hills south of Palghat Gap (Fraser, 1936).

Recent records and Current Distribution: Ponmudi-Kallar near Rajakumari, Munnar, June 2013, 700m (Nair *et al.*, 2021). Thus, the current distribution is confined to the Anamalai Landscape, only in the southern WG.

Taxonomic group: cincta group.

Field Identification: Eyes bottle green; antehumeral stripe absent; S2 with a crown-shaped yellow spot on dorsum (Fig. 11A); S3–6 with paired mid-dorsal spots, S8 is unmarked (Fig. 12C), segment 10 with a dorsal robust obtuse spine.

Anal appendages: similar to that of *M. ellisoni* as per Fraser (1936).

Genitalia: with long hamules (Fraser, 1936).

Ecological notes: This is said to be the most dominant *Macromia* south of the Palghat Gap (Fraser, 1936). A high elevation species as per Subramanian *et al.* (2018). While patrolling, they

Table 1. Distribution and endemic status of *Macromia* species of Western Ghats

No.	Species	Distribution	Endemicity
1	*Macromia annaimallaiensis* Fraser, 1931	Anamalai hills south of Palghat Gap	Endemic to southern WG
2	*Macromia bellicosa* Fraser, 1924	Western Ghats south of Coorg	Endemic to southern WG
3	*Macromia cingulata* Rambur, 1842	Throughout the Western Ghats, Central India, Bengal, and parts of Eastern Ghats	Endemic to Peninsular India
4	*Macromia ellisoni* Fraser, 1924	Western Ghats south of Coorg	Endemic to southern WG
5	*Macromia flavicincta* Selys, 1874	Whole Western Ghats and parts of Eastern Ghats, Central India	Endemic to Peninsular India
6	*Macromia flavocolorata* Fraser, 1922	Peninsular India, Bengal, and Northeast India	None
7	*Macromia ida* Fraser, 1924	Western Ghats south of South Kanara	Endemic to WG
8	*Macromia indica* Fraser, 1924	Western Ghats north of Palghat Gap south of Coorg, Mumbai	Endemic to WG
9	*Macromia irata* Fraser, 1924	Whole Western Ghats from Maharashtra to Agasthyamalais	Endemic to WG

keep to the scrub side and are difficult to follow (Fraser, 1936). The species is a large one like *M. ellisoni*. It flies in the Anamalai hills in May (Fraser, 1931). The species is not strictly a jungle insect.

***Macromia bellicosa* Fraser, 1924**

(Figs. 1, 3: 2A–C, 8H, 10C, 11E, 12E, 15B)

OD: Fraser (1924). A survey of the Odonata (Dragonfly) fauna of Western India with special remarks on the genera *Macromia* and *Idionyx* and description of thirty new species, with Appendix I and II. *Rec. Indian Mus.,* 26: 453–454. (PI. XXV, fig. 9).

Material studied: 1) Images of Lectotype, ♂; 013322948 NHMUK London, India, Coorg, Cannanore Ghat, 28. v. 1923, F. C. Fraser. 2) Field specimens examined (not collected): ♂, Thirunelli, Wayanad Kerala, Broad-leaved Evergreen Forest, 2016 June, 600 m (KS).

Measurements: ♂ abdomen, 45–47 mm, hindwing 40–43 mm. ♀: Unknown.

Nodal Ratio and index: SSNR– 7:16/9:11::15:7/10:9, 7:14/9:10::14:7/10:10; SSNI–15:7/11:10

Historical Distribution: Kudremukh in South Kanara, Cannannore Ghats; Madapur, and Hatti River in Coorg (Fraser, 1924).

Recent records and Current Distribution: Thattaekkad, Kerala, <200 m, Secondary Forests-Tropical Evergreen Forest, 2014 (Aby P Varghese); ♂, Neriamangalam in Lower Periyar Valley, Kerala State, <200 m, Tropical Wet-Evergreen Forest in Varghese *et al.* (2014) as 'Image 10. Macromia annaimalaiensis'; ♂, Thirunelli, Wayanad Kerala, Broad-leaved Evergreen Forest, 2016 June, 600 m (KS); ♂, Coorg, Karnataka, 600 m, March 2018, (Daniel V Raju); Aryanad, Thiruvananthapuram (Chandran and Chandran, 2021); Aaralam Wildlife Sanctuary, Kannur (Nair *et al.,* 2021). Thus, the current range of its distribution includes Coorg, Wayanad, Annamalai, and Agasthyamalai Landscapes in the WG south of Coorg.

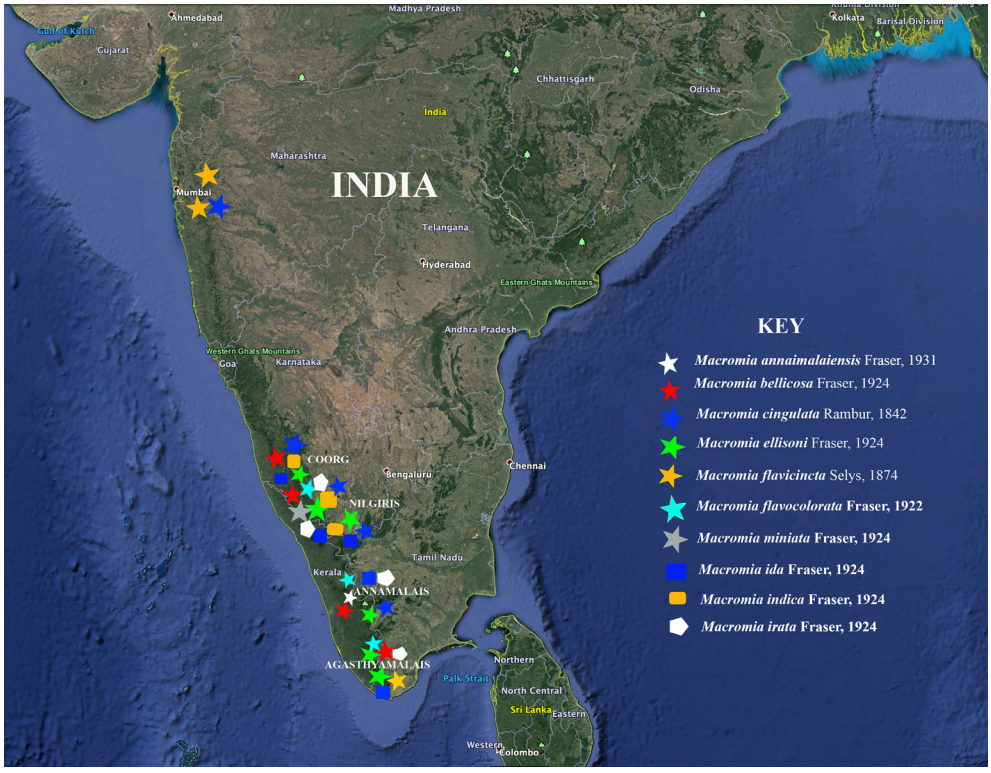

Fig. 1 Map of Western Ghats with current distribution of *Macromia* species

Taxonomic group: cingulata group.

Field Identification: A small species with wings less than 45 mm; face black marked by citron-yellow and black; antehumeral stripe present; S2 with whole of dorsum yellow, distal border bow-shaped, convex (Fig. 11E); S7 basal region up to jugum yellow, this yellow extends broadly across jugum, expands laterally forming a bilobed transverse patch; S8 with a bilobed transverse patch of yellow occupying basal third (Fig. 12E). Appendages ochreous. Restricted yellow markings and the shape of genitalia will distinguish it from *M. flavicincta.* Fraser (1936) mentioned that in specimens from Kanara, the basal annulus in S7 covers half, and S8 may be interrupted widely with a dorsal black line, separating the spots.

Anal appendages: Dark ochreous to reddish-yellow, of equal length. Superior, flattened, tapering to a fine point with a medial robust spine on outer side. A few small teeth beneath apex. Inferior curved gently up, narrowly triangular, faintly bifid apically (Fraser, 1924). Generally structured like that of *M. flavicincta* but more curved and more robust than lateral spine (Fraser, 1936).

Genitalia: Hamules broad at base, thinning to a robust long hook lying parallel to lobe, its end curved like a button hook; lobe tiny, lying in same sinuous line as ventral border of segment, not angulated out at all to latter, produced backward and well angulated with an apical border of segment (Fraser, 1924). Resembles that of *M. flavicincta*, however, ventral border of segment 2 in same straight line as lobe, hamules as long as lobe.

Ecological notes: Jungle insect of submontane streams (Subramanian *et al.,* 2018). The flight period is May.

***Macromia cingulata* Rambur, 1842**
(Figs.1, 8A, 9C,D, 10B, 11D, 12G, 15F)

OD: Rambur (1842). Ins.Névrop.P.137;

Material studied: Field specimens examined (not

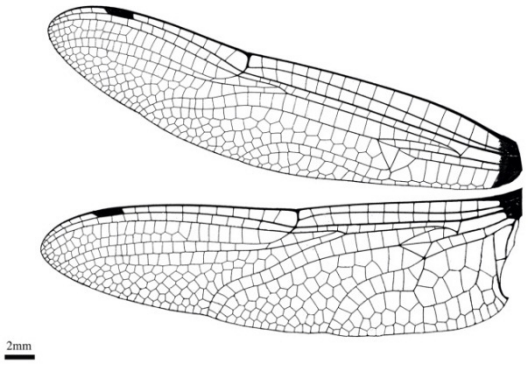

Fig. 2 *Macromia* wing venation. Drawn based on *Macromia irata* Fraser, 1924 **(**TORG 1006). © Kalesh Sadasivan

collected): ♂, Ponmudi, Munnar, Kerala, 800 m, June 2013 (KS).

Measurements: ♂ abdomen 39–45 mm, hindwing 32–36 mm. ♀ abdomen 42–43 mm, hindwing 38 mm.

Nodal Ratio and index: SSNR– 5:12/6:7::12:6/7:6, 7:14/9:8::14:6/8:8; SSNI–13:6/8:7

Historical Distribution: Mullah canal and Byrobah nullah in Poona. Distributed all along the WG from Khandala to Coorg. Mahableshwar, Cauvery River, Fraserpet, Coorg (Fraser, 1924). Hasanur on Mysore border, Coimbatore, Totapalle in Agency Tracts (Eastern Ghats?) (Fraser, 1936).

Recent records and Current Distribution: ♂, Ponmudi, Munnar, Kerala, 800 m, June 2013; ♂ (Teneral), Palghat, Kerala, 50 m March 2020 (Sharan Venkatesh); ♂, Kovilakathumuri in Nilambur, Kerala, 40 m, Teak Plantation, October 2015 (Divin Murukesh), Aryanad, Thiruvananthapuram (Chandran and Chandran, 2021) and November 2020 at Attingal, Thiruvananthapuram (KS). Thus, it is seen in the northern WG, Coorg, Wayanad, Nilgiris, Anamalais, and Agasthyamalais landscapes in the WG. It has been recorded from Bhor Wildlife Sanctuary, Wardha, Maharashtra (Tiple, 2020), Jabalpur, Madhya Pradesh (Tiple *et al.*, 2022), Amboli-Chaukul-Parpoli region of Maharashtra (Sawant *et al.*, 2022), Purulia, West Bengal (Dawn, 2021) and Bankura district, West Bengal (Roy *et al.,* 2022). Hence, the current distribution is Peninsular India, narrowly reaching up to the north-eastern plains.

Taxonomic group: cingulata group.

Field Identification: A small species with wings less than 45 mm; face black marked by citron-yellow and black; antehumeral stripe present; S2 with dorsum yellow, proximal margin bow-shaped with a central concavity, paradorsally yellow extends as small triangular extension distally (Fig. 11D); S7 with basal yellow annulus that extends distally on carina as a diamond-shaped yellow spot, S8 basal annulus with convex distal border, centrally trilobed, annulus grossly resembling a crown (Fig. 12G). Anal appendages black.

Anal appendages: "Black, as long as segment 9, superiors tapering to a point, directed straight back, inner border straight, outer border slightly convex with a robust spine nearer to apex than to base, followed by a row of teeth below. Inferior appendage paler, narrowly triangular, apex slightly upturned, overlapping apex of superiors" (Fraser, 1936).

Genitalia: Basal three-fourths wider and flat, with distal fourth hooked. Genital lobes long, triangular, and sharp-tipped (Fig. 8A).

Ecological notes: This is a species of low-mid-elevation jungle streams, seen on territorial patrols along streams and river edges. Males may be seen hanging on shrubs and trees, sunning themselves at the edges of forests. Flight is usually long and sustained, going back and forth along the same region of the river every 5 minutes or so, usually on bright sunny mornings and afternoons. This is probably the commonest of all *Macromia* as per our field data. They prefer slow-flowing, shallow, pebble streams. The flight period is April-November.

***Macromia ellisoni* Fraser, 1924**

(Figs.1, 3: 3A,B, 8C, 9A,B, 10D, 11F, 12B, 15E)

OD: Fraser (1924). A survey of the Odonata (Dragonfly) fauna of Western India with special remarks on the genera *Macromia* and *Idionyx* and

description of thirty new species, with Appendix I and II. *Rec. Indian Mus.,* 26: 457–458. (PI. XXV, fig. 3).

Material studied: 1) Images of Holotype, ♂, 013384050 NHMUK London, 4,000 ft., Sigur, Nilgiris, Mysore Ditch, S. India, 7. x. 21, F.C. Fraser. 2) Field specimens examined (not collected): ♂, Pandipathu in Peppara Agasthyamalais, Kerala, 700 m, Broad-leaved Evergreen Forest, April 2013 (KS); ♂, Kalakkad, Tamilnadu, Broad-leaved Evergreen Forest May 2013 (KS).

Measurements: ♂ abdomen 49-52 mm, hindwing 47-49 mm. ♀abdomen 54-56 mm, hindwing 53-59 mm.

Nodal Ratio and index: SSNR– 12:17/12:11::18:11/12:12, 9:16/13:11::15:10/11:11: SSNI– 17:11/12:12

Historical Distribution: Coorg (Sampaji River) Karnataka and Nilgiris (Sigur, Devalashola), Nilgiri-Wayanad (Fraser, 1924). It is recorded that *M. ellisoni* is rare in the Nilgiris and more common in Coorg (Fraser, 1936).

Recent records and Current Distribution: ♂, Pandipathu in Peppara, Agasthyamalais, Kerala, 700 m, Broad-leaved Evergreen Forest, April 2013 (KS); Edamalakudi, Mangulam, May 2022 (Nair *et al., in press*); ♂, Kalakkad, Tamilnadu, Broad-leaved Evergreen Forest May 2013 (KS); Kurichi in Konni Forest Division, Kerala, November 2014 (Pradeepkumar *et al.,* 2014); ♂, Pampadum Shola National Park, Kerala, May 2015, Montane Temperate Forest, 2000 m (KS); and Aaralam, Kannur, Kerala, October 2016 (Palot and Kiran, 2016). Thus, from Coorg, Wayanad, and Nilgiris Landscape, the range is extended further southward to include Anamalais and Agasthyamalais. Hence the current landscape distribution is from Agasthyamalais to Coorg.

Taxonomic group: cingulata group.

Field Identification: Eyes brilliant bluish emerald green; well-defined yellow humeral stripe, antehumeral stripe present; abdomen in dorsal view–S2, with a central diamond-shaped black patch that interrupts yellow on its dorsum (Fig. 11F); S3–S6 paired middorsal spots, S7 basal annulus dorsally not extending beyond jugum. S8 unmarked, anal appendages black.

Anal appendages: "Cerci and inferiors of equal length, superior tapering, pointed, without external spine at middle, a few minute spines beneath middle third. Inferior narrowly triangular, almost straight, curving a little up at apex" (Fraser, 1924). "Cerci longer than segment 10, straighter than in *M. indica*, apex not curled up as in *M. indica*, small spine on outer border almost vestigial, a row of small teeth below, which extends to base of appendage. Inferiors shorter than superiors resemble that of *M. indica"* (Fraser, 1936). *Macromia ellisoni,* according to Fraser (1924), does not have a spine on lateral aspect of cerci, however, in all specimens studied as well as in figure 53 (page 170) of Fraser (1936), the rudimentary lateral tooth on cerci is discernible.

Genitalia: Hamules very stout and tumid, not tapering but with a tiny spine springing abruptly from the apex, lobe short and rounded, directed ventrad (Fraser, 1924), (Fig. 8C).

Ecological notes: Adult males were seen far away from water, patrolling forest paths at mid-elevations in the sunny and humid forenoons. They also hang on bushes and shrubs in the late afternoons and overcast weather. Fraser (1936) conversely comments that they are seldom seen away from water. They prefer fast-flowing forest streams.

Macromia flavicincta **Selys, 1874**
(Figs. 1, 3:4A–C, 8B, 11C, 12J, 15D)

OD: Selys (1874). Bull. Acad. Belg. (2) Vol. xxxvii p. 25.

Material studied: Images of Lectotype: ♂ 013322958 NHMUK, London, Allotype: ♀ 013322941 NHMUK, London.

Measurements: ♂ abdomen 47"50 mm, hindwing 41"43 mm. ♀abdomen 50"53 mm, hindwing 43"44 mm.

Nodal Ratio and index: SSNR– 6:14/10:10:: 16:7/10:9; SSNI–15:7/10:10

Historical Distribution: The type locality is Bengal,

it was recorded from Mahableshwar and Poona in Maharashtra (Fraser, 1924), Padera in Agency Tracts (Eastern Ghats?), Andhra Pradesh.

Recent records and Current Distribution: The species is restricted to suitable localities in Peninsular India and adjoining areas of Bengal. It has been reported from Ponmudi Hills, in Agasthyamalais (KS); Nagpur city (Tiple *et al.*, 2013); Bhankura District, West Bengal (Roy *et al.*, 2022) and Bhor Wildlife Sanctuary, Wardha, Maharashtra (Tiple, 2020). The current distribution is thus northern WG, Bengal, Eastern Ghats, and Agasthyamalais.

Taxonomic group: cingulata group.

Field Identification: A small species with wings less than 45 mm; face ferruginous/reddish brown/ amber-brown, and yellow, with a 'T' shaped mark on crest of frons; Antehumeral stripe present; S2 broadly yellow with distal mid-dorsal end bifid (Fig. 11C); S8 with basal yellow annulus/spot; anal appendage dull ochreous. Genital lobe much more angulated with caudal margin of S2 than its ventral margin. As per Fraser (1936), S7 has a broad annulus covering more than half of basal part, S8 with a similar ring occupying less than basal half, and S9 with a small basolateral transverse spot; this is evident in the Lectotype ♂ 013322958 NHMUK, London (Fig. 12J). Field specimens vary in the pattern of colour. S7 has a basal yellow annulus with a broad extension beyond jugum, this extension tends to spread transversely in some specimens forming a short transverse band. Annulus on S8 usually replaced by a pair of small yellow paradorsal basal streaks separated by a wide black area along carina in southern specimens; while samples from drier eastern slopes much yellower with boldly marked annuli. S9 unspotted dorsally with basolateral transverse spot on each side (Fig. 15D).

Anal appendages: "Dull ochreous; cerci as long as segment 9, inner surface slightly concave, outer border nearly straight with a robust spine at its middle tipped with black, apex of appendage curved out but directed straight back as seen in profile, a row of small teeth below following lateral spine" (Fraser 1936).

Genitalia: Genitalia similar to that of *M. bellicosa,* however, with posterior border of genital lobe more angulated. Hamule similar to that of *M. bellicosa,* however, distal two-thirds are rather straight (Fig. 8B).

Ecological notes: After *M. cingulata,* this seems to be a common species, though not much is known about its habits and breeding ecology. It may be seen resting at noon on shrubs, sometimes in small, loose groups.

Macromia flavocolorata **Fraser, 1922**

(Figs. 1, 4:1A,B, 5A,B, 5C,D, 5E,F, 6B,D, 11J, 12I)

OD: Fraser (1922b). JBNHS. Vol. XXVIII, p.702, fig.2 (♀, as *Macromia flavocolorata* Fraser, 1922). Fraser (1922a). New and rare Indian Odonata in the Pusa collection. Mem. Dept. Agric. India (Ent.), 7: 67–68. (♂, as *Macromia atuberculata*)

Material studied: 1) Images: Holotype, ♂ NHMUK 013384052; NHM London, Hasimara, Duars, Bengal, 20. x.21, H. V. O'Donel as per type label; Allotype: ♀NHMUK 013384051, Hasimara T. E., Duars, Bengal, 7. viii.31, H. V. O'Donel, as per type label and Kimmins (1966); Allotype: ♂ NHMUK013322959 as *M. atuberculata* Fraser, 1932, collected by C.M.Inglis without a date as per original description in Fraser, F.C. 1922a. (C.M. Inglis coll. 1920 from Hasimara, Duars, [Bengal], as per Kimmins 1966); Images of Lectotype, ♂, RMNH.INS.JVT.3858 Leiden Museum, Coorg, Somwarpet, 1.vii.23.

2) Field Specimens examined (not collected): ♂, Thenmalai, Kerala, 200 m (Fig. 15G), November 2013 (KS); Thirunelli in Wayanad, Kerala, Broad-Leaved Evergreen Forest, May 2016 (KS).

Measurements: ♂Abdomen 44–47 mm. Hindwing 37 mm. ♀Abdomen 43 mm. Hindwing 38 mm.

Nodal Ratio and index: SSNR– Holotype ♂ NHMUK 013384051– 6:15/7:9::15:6/9:9; Allotype ♀NHMUK 013384052– 9:18/10:11::16:8/10:11, ♂ NHMUK 013322959– 8:15/9:10::15:6/11:8; SSNI– 16:8/11:10; Lectotype, ♂, RMNH.INS.JVT. 3858 Leiden Museum– 7:16/11:9: :14:6/10:11; SSNI– 15:7/ 10:11

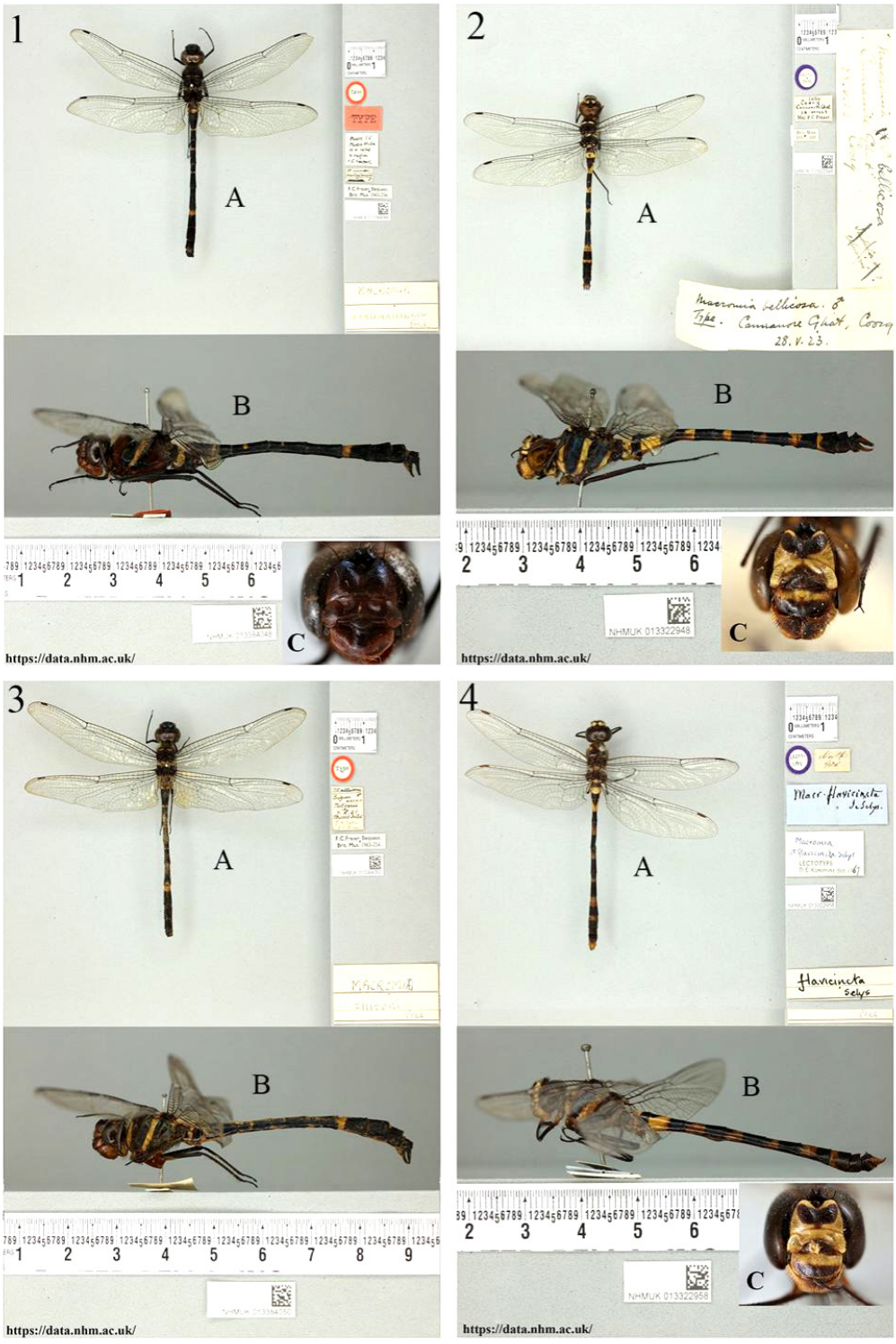

Fig. 3 NHMUK Holotype and Lectotype Images**:** 1–*Macromia annaimallaiensis* Fraser, 1931 Holotype: A–dorsal view, B–lateral view, C–Head front view; 2–*Macromia bellicosa* Fraser, 1924 Lectotype: A: dorsal view, B–lateral view, C–Head front view; 3–*Macromia ellisoni* Fraser, 1924 Holotype: A–dorsal view, B–lateral view; 4–*Macromia flavicincta* Selys, 1874 Lectotype: A–dorsal view, B–lateral view, and C–Head front view. All images © Natural History Museum London

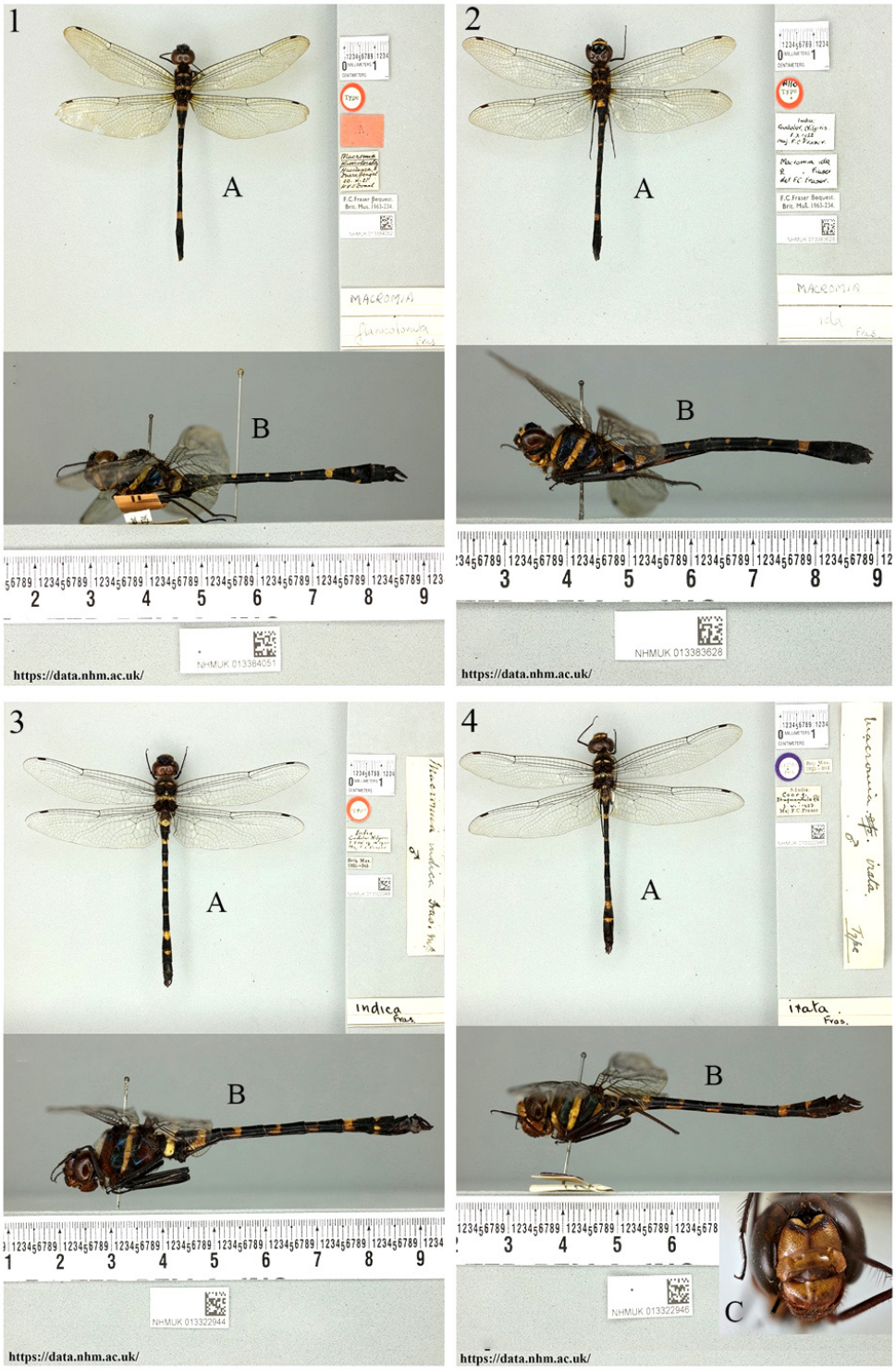

Fig. 4 NHMUK Holotype, Allotype, and Lectotypes: 1–*Macromia flavocolorata* Fraser, 1922, Holotype: A–dorsal view, B–lateral view; 2–*Macromia ida* Fraser, 1924 Allotype: A–dorsal view, B–lateral view; 3–*Macromia indica* Fraser, 1924 Holotype: A–dorsal view, B–lateral view; 4–*Macromia irata* Fraser, 1924 Lectotype: A–dorsal view, B–lateral view, C–Head front view. All images © Natural History Museum London

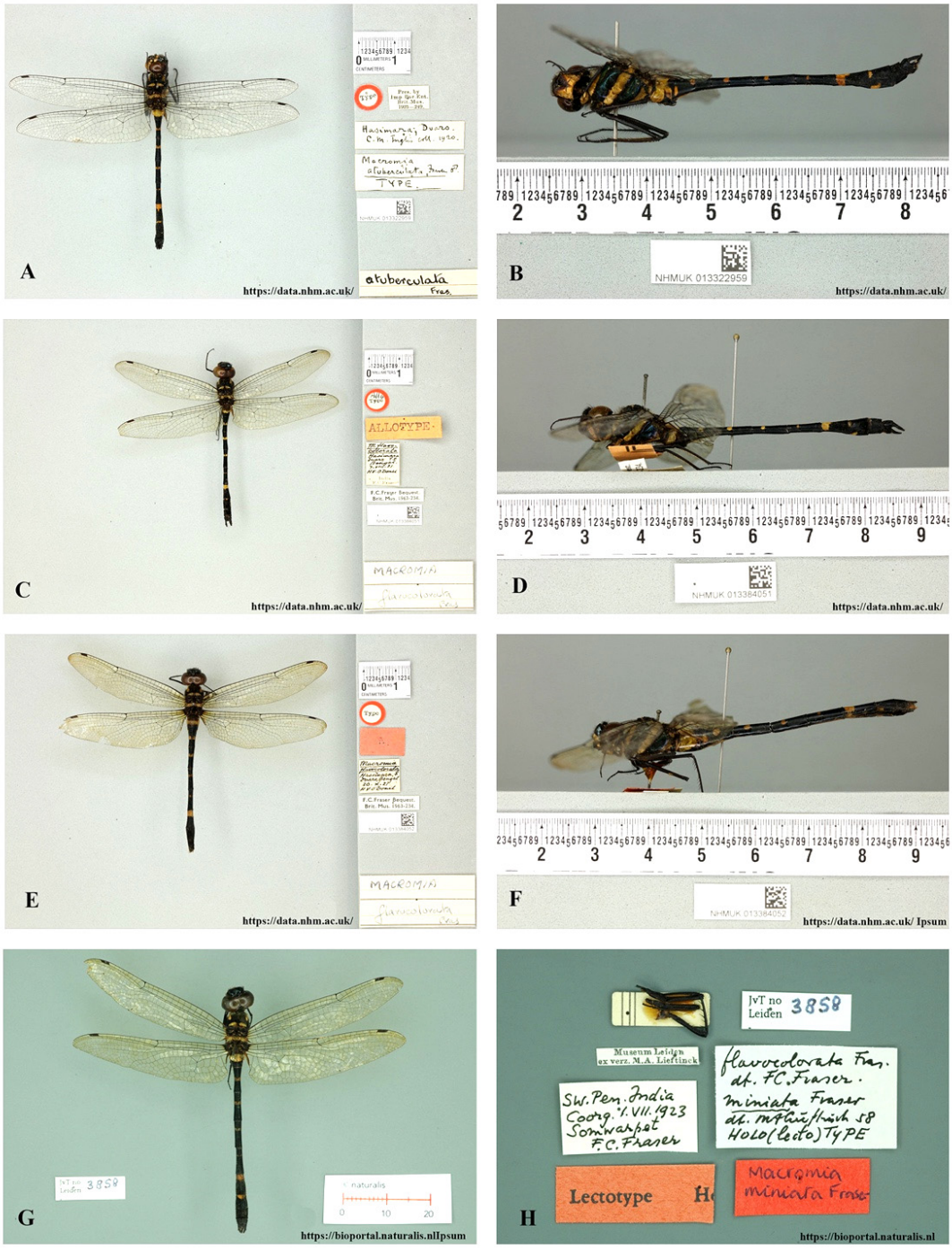

Fig. 5 A and B–Holotype ♂ *M. atuberculata* Fraser, 1932 (*Macromia flavocolorata* Fraser, 1922) NHMUK 013322959; C, D–♂ *Macromia flavocolorata* Fraser, 1922 NHMUK 013384051; E, F–Holotype ♂ *Macromia flavocolorata* Fraser, 1922, NHMUK 013384052; G, H–*Lectotype*: ♂ *Macromia miniata* Fraser, 1924 (*M. flavocolorata* Fraser, 1922) RMNH.INS.JVT.3858 ©A–F images © Natural History Museum London and G, H - RMNH Leiden Museum

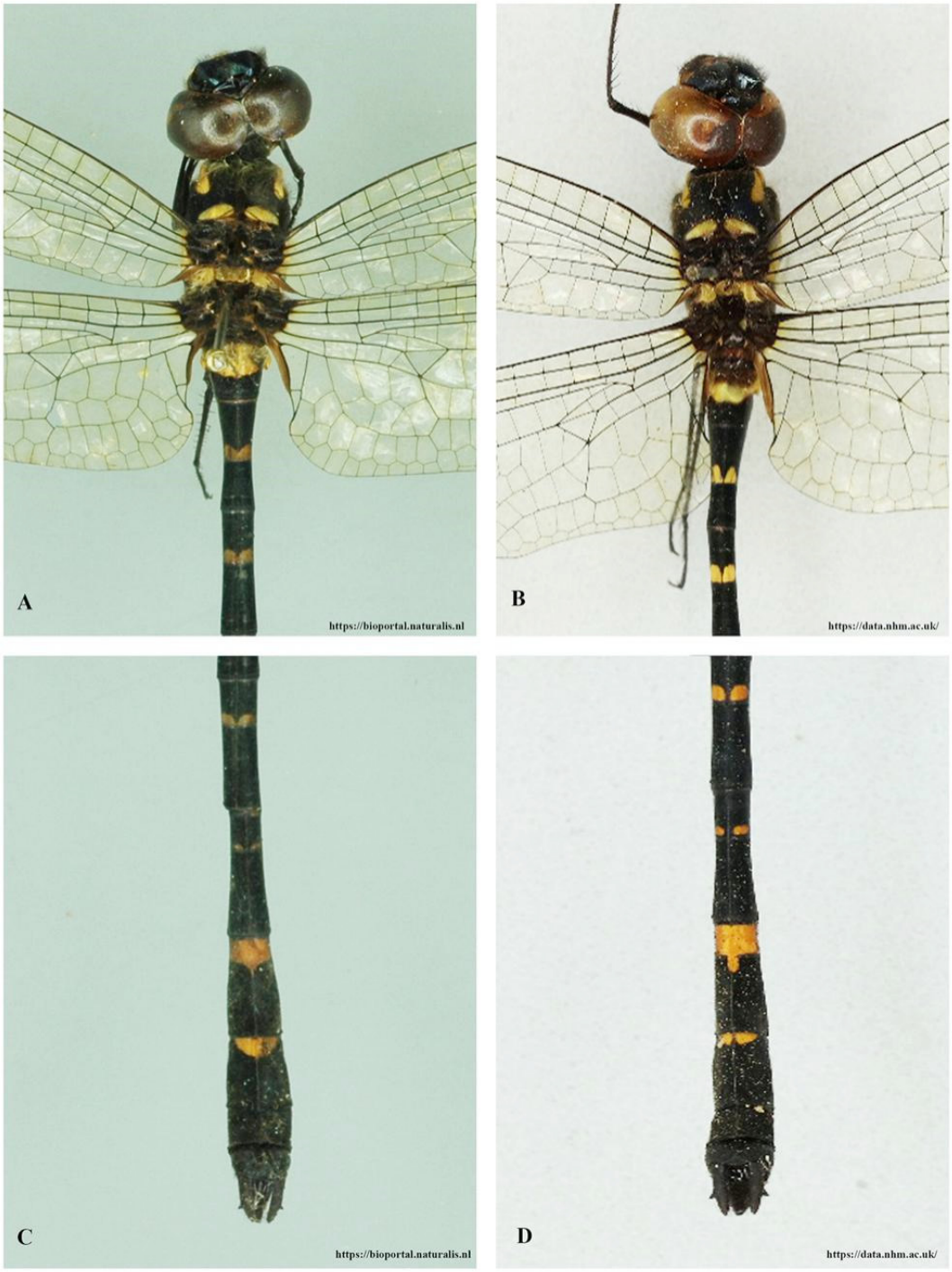

Fig. 6 A–Dorsum of proximal abdomen of *Macromia miniata* Fraser, 1924 (*M. flavocolorata* Fraser, 1922) RMNH.INS.JVT.3858; B–Dorsum of proximal abdomen of *Macromia flavocolorata* Fraser, 1922 ♂ NHMUK 013384051; C–Dorsum of terminal abdominal segments of *Macromia miniata* Fraser,1924 RMNH.INS.JVT.3858; D–Dorsum of terminal abdominal segments of *M. atuberculata* Fraser, 1932 (*M. flavocolorata* Fraser, 1922), holotype ♂ NHMUK 013322959. © Natural History Museum London and RMNH Leiden Museum

Historical Distribution: Somwarpet in Coorg Karnataka; Cannannore Ghat, Kerala (Fraser, 1924); the whole of the west coast of Peninsular India north of the Palghat Gap and rarely southwards. Anamalai and Malabar "in synonymy with *M. miniata* Fraser, 1924 (Fraser, 1936). Somwarpet in Coorg, Karnataka and Cannannore Ghat, Kerala (Fraser, 1924)

Recent records and Current Distribution: ♂, Thenmalai, Kerala, 200 m (Fig.15G), November 2013 (KS); Kanichar, Kannur June 2021 (Nair *et al.*, in *press*); Thirunelli in Wayanad, Kerala, Broad-leaved Evergreen Forest, May 2016 (KS); ♂ Mukkali, Silent Valley, secondary forest. Kerala (Fig. 15C), June 2012 (Biju PB), and Aryanad, Thiruvananthapuram (Chandran and Chandran, 2021). The current distribution is the WG from Agasthyamalais to Coorg, Nilgiris, Bengal, Maharashtra, further eastwards to Laos and Vietnam as per Fraser (1936) and Sawant *et al.* (2023).

Taxonomic group: calliope group (see below under *M. miniata* Fraser, 1924 for taxonomic comments).

Field Identification: Small size and restricted markings will separate it from all other *Macromia*, except *M. ida* which is similar (Fraser, 1924). Eyes emerald green; base of labium ochreous, borders diffusely dark brown, two colours gradually blending; antehumeral stripe well-developed extending beyond halfway to dorsum of pterothorax and superior edge well-defined; Abdomen dorsal view-S2 dorsum generally yellow, this may be reduced in some specimens, as in NHMUK 01338405; this yellow interrupted with black from sides at base, one-third of distal marking always bilobed (Fig. 11J); S3–S6 with paired mid-dorsal spot; S7 dorsal basal spot extends into carina as a tongue-shaped yellow carinal band; S8 with paired small basal paradorsal yellow triangular spot (Fig. 12 I); S10 without dorsal spine; ♂ genitalia posterior hamule with apical two-thirds narrow; anal appendages black. The specimens from the WG have some differences as follows: abdomen in dorsal view-S2 with single large dorsal yellow shield-shaped patch having mid-border produced distally into a small triangular extension (Fig. 11I); S3–S6 with paired mid-dorsal spots; S8 with single basal dorsal yellow triangular spot (Fig. 12 H).

Anal appendages: Described as *M. atuberculata* in Fraser (1922b). Superior anal appendages black, armed with a robust spine at outer side of apical third. Inferior black, subtriangular, curling up at apex. S10 smooth, without spine. No illustrations were given by Fraser (1922b), (Fig. 10E). "Anal appendages black, equal in length, superior tapering but slightly, ending in a fine point turned slightly outward. Outer border a little distal to middle of the appendage, with a very robust tooth. Inferior appendage triangular, concave above as seen in profile, its apex turning up between superiors" (Fraser, 1924).

Genitalia: Posterior hamule of ♂ genitalia with apical two-thirds narrow. Posterior hamules tumid at base but rapidly thinning and drawn out into a very long attenuated spine running parallel with genital lobe, reaching its apex. Genital lobe small, triangular, directed straight back (as in *M. miniata* in Fraser, 1924). It was not mentioned or illustrated in the original description of *M. atuberculata* Fraser, 1932.

Ecological notes: May–July is the flight period otherwise not much is known about its ecology.

Taxonomic comments:

Macromia miniata was described by Fraser from ♂ specimens in 1924, from Coorg and Cannannore. Later in 1936, he synonymised it with *M. flavocolorata*. *Macromia flavocolorata* was originally described from Bengal based on a ♀ specimen (Fraser, 1922a), the ♂ was later described in the same year from Bengal as *M. atuberculata* in Fraser (1922b). The description of the ♂ did neither include description or illustration of the genitalia nor illustration of the anal appendage. Under *M. atuberculata,* Fraser mentioned that the superior anal appendage was black, armed with a robust spine at the outer side of the apical third, inferior black, sub-triangular, and curling up at its apex.

Fraser (1936), mentions some morphological differences between the Bengal and South Indian specimens of *M. flavocolorata* that the latter are generally darker with fewer yellow marks and the former have more yellow markings. In the males - 1) segment 2 basal half is citron-yellow in South Indian specimens (Fig. 6A) while in Bengal and Burmese specimens, basal three-fourth is citron-yellow (Fig. 6B); 2) a large quadrate black spot that interrupts the annulet just above the oreillet in segment 2 is present in South Indian specimens and absent in Bengal and Burmese samples; 3) S8 with large triangular dorsal basal spot (Fig. 6C), and a quadrate spot at the base on each side in South Indian specimens, while the mid-dorsal basal spot is replaced by paired spots in specimens from Bengal and Burma (Fig. 6D). In the case of the ♂ specimen as per Fraser (1936), the S2 yellow markings, though variable in females, was restricted in South Indian form and was very broad in Bengal specimens with only a small apical black margin; and S3 with very large confluent spots in Burmese specimen, while south Indian specimens have distinct paired dorsal spots adjoining the jugum and basolateral triangular spots.

The images of *Lectotype* ♂; RMNH.INS. JVT.3858 Leiden Museum were compared with ♂ NHMUK 013384052, ♂NHMUK 013384051, and ♂ NHMUK 013322959 at NHM London. The original descriptions of Fraser (1922a, b) and Fraser (1924) were also compared. The male abdomen was slightly longer in *M. miniata* (47mm) compared to 44 mm in *M. flavocolorata.* Hindwing length was equal in both specimens at 37mm. Labium was brownish yellow at the base, broad black at the borders in *M. miniata,* and brown in *M. flavocolorata.* There are some differences in the venation. The hypertrigones are traversed thrice in forewing and twice in hindwing in *M. miniata*, while 3–4 times in forewing and two times in hindwing in *M. flavocolorata.* The anal loop in hindwing is 6–7 celled in *M. miniata* (007519114-RMNH), while it is 13–14 celled in ♀ NHMUK 013384052, 6 celled in NHMUK 013384051, and 6–7 celled in NHMUK 013322959 of *M. flavocolorata*. The nodal index in *M. miniata* (007519114-RMNH) is 7:14/9:10::15:6/11:9 and 7:16/11:9:: 14:6/10:11 in the original description (could be the data for the lost Cannannore Ghat specimen). The nodal index for ♀ NHMUK 013384052 is 9:18/10:11::16:8/10:11, NHMUK 013384051 is 6:15/7:9::15:6/9:9 and NHMUK 013322959 is 8:15/9:10::15:6/11:8. The SSNR for *M. miniata* male is thus 7:15/10:9.5::14.5:6/10.5:10 (7:15/10:10::15:6/11:10) and for *M. flavocolorata* males are 7:15/8:8::15:6/10:8.5 (7:15/8:8::15:6/10:9), thus, lower nodal counts for the hindwings in the latter.

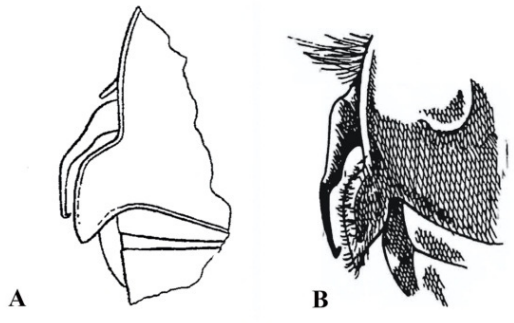

Fig. 7 Comparison of original illustrations of *M. flavocolorata* Fraser, 1922 (A) from Fraser (1936) and *M. miniata* Fraser, 1924 (B), adapted from Fraser (1924)

The colouration of the abdomen in *M. miniata* is also different from that of *M. flavocolorata.* S2 basal half is citron-yellow with its distal border trilobed, while it is bilobed in *M. flavocolorata* males. S3–S5 has a pair of fused sub-dorsal spots in *M. miniata,* while subdorsal triangular spots are almost separate in *M. flavocolorata.* S6 spots in both taxa are separately represented by yellow spots. S7 basal third has a yellow annule with a short tongue-shaped extension to the jugum in *M. flavocolorata,* while its basal third with a yellow annulus with a short linear extension to the dorsal carina in *M. miniata.* S8 with a pair of small baso-dorsal triangular spots in *M. flavocolorata,* while these spots are fused across the midline to form a large triangular base-dorsal yellow spot *in M. miniata.* The cerci are black in both taxa. The lateral tooth is robust, placed on the outer border a little distal to the middle in *M. flavocolorata* while it is less robust and placed on the junction of middle

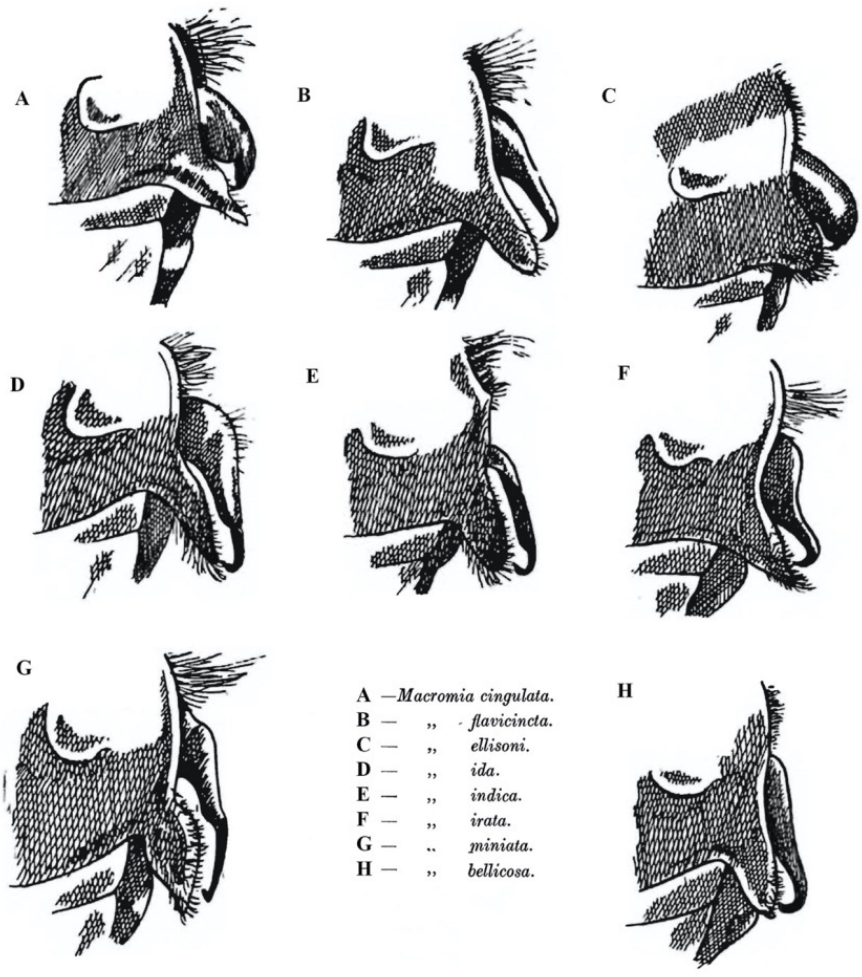

Fig. 8 Genitalia of *Macromia*, adapted from Fraser (1924)

and distal third in *M. miniata.*

The yellow dorsal spot in S2 is shield-shaped with distal end convex or pointed, in *M. miniata* (Fig. 11I); while it occupies the whole segment in well-marked individuals of *M. flavocolorata* and the distal margin is bilobed (Fig. 11J). The markings on S7–8 are very different between the two insects. The S7 in *M. miniata is* having a basal annulus with a sharp dorsal extension along the carina, while it is a broader tongue-shaped extension in *M. flavocolorata.* The S8 has a single yellow basal triangle in *M. miniata*, while it is broken into smaller triangles in *M. flavocolorata.*

Fraser (1936), did not mention any significant difference in male genitalia or appendages. The drawing of the male genitalia of *M. flavocolorata* in Fraser (1936) has differences from that of *M. miniata*, illustrated in Fraser (1924). The hamule is much longer in *M. miniata* while shorter in *M. flavocolorata.* The genital lobe posterior border is leaf-shaped, sharp-tipped, and clefted in *M. miniata,* while it is shallowly angulated in *M. flavocolorata* (Fig. 7).

Fraser had given one male syntype of *M. miniata* Fraser, 1924 to M. A. Lieftinck synonymising it with *M. flavocolorata*. Dr. Lieftinck who examined this specimen considered *M. miniata* Fraser, 1924, to be distinct from *M. flavocolorata* according to Kimmins (1966). The whereabouts of the second syntype (taken from Cannanore) are unknown (Kimmins, 1966). Lieftinck (1971) considered the

species valid and the Somwarpet male specimen was designated as the Lectotype, with southern Peninsular India, Coorg, Somwarpet, 1. VIII. 1923, F.C. Fraser as the specimen data. Since there were no types in the Fraser collection, the description was enclosed in square brackets and it was designated as the Lectotype of *M. miniata* Fraser, 1924 (Kimmins, 1966). Van Tol (1992) referred to this taxon as *M. flavocolorata* Fraser, 1922, which was followed by later authors.

The taxon *M. flavocolorata* Fraser, 1922, is widely distributed from south India to Laos, and this might indicate that it is a species complex. Examination of the original and subsequent descriptions (Fraser 1922 a, b, 1924, 1936), and the analysis of type specimen images, shows that there are some morphological differences between the type specimens from NHMUK and Leiden Museum. This, together with the biogeographical aspects of the collection localities (Coorg in the WG vs Bengal) and substantiated by the taxonomic comments by Lieftinck in Kimmins (1966), might indicate that the WG taxon might be a good species. It is possible that the WG congener of this species complex was possibly described as *M. miniata* Fraser, 1924. The morphological similarities between the specimens later led to Fraser (1936), synonymising *M. miniata* Fraser, 1924 with *M. flavocolorata* Fraser, 1922**.** Integrated taxonomic studies with fresh specimens are needed to confirm the status of *M. flavocolorata* and *M. miniata* in the WG of Peninsular India.

Macromia ida **Fraser, 1924**
(Figs.1, 4: 2A,B, 8D, 11H, 12A)

OD: Fraser (1924). A survey of the Odonata (Dragonfly) fauna of Western India with special remarks on the genera *Macromia* and *Idionyx* and description of thirty new species, with Appendix I and II. *Rec. Indian Mus.,* 26: 449–450. (PI. XXV, fig. 4).

Material studied: Images of Lectotype, ♂ 013322952 NHMUK London, India, Gudalur, Nilgiris, 3,500 ft., 20. ix. 1922, F. C. Fraser; Allotype: ♀013383628 NHMUK London, Gudalur, Nilgiris, 1. x. 1922, F.C. Fraser.

Measurements: ♂ abdomen 42 mm, hindwing 38 mm. ♀abdomen 41 mm, hindwing 35 mm.

Nodal Ratio and index: SSNR– 8:16/10:11::17:7/10:11; SSNI–17:8/11:11

Historical Distribution: Gudalur, Nilgiri-Wayanad, Tamil Nadu, and Bhagmandala in Coorg and S. Kanara in Karnataka (Fraser, 1924).

Recent records and Current Distribution: The WG both north and south of the Palghat Gap, up to south Kanara (Subramanian *et al.*, 2018). Kanichar, Kannur June 2021 (Nair *et al.*, in *press*); Peppara WLS of Agasthyamalais in June 2020 at 200m elevation (KS); Aryanad, Thiruvananthapuram (Chandran and Chandran, 2021). Thus, distributed in Coorg, Nilgiris, Anamalai, and Agasthyamalai Landscapes.

Taxonomic group: calliope group.

Field Identification: Eyes emerald green; base of labium bright chrome-yellow with borders jet-black, two colours being sharply defined; antehumeral stripe well-developed with superior edge well-defined; abdomen in dorsal view-S2 with a butterfly-shaped patch on dorsum, which may be reduced to fine spots in some specimens (Fig. 11H); S3–S6 with paired middorsal spots; S7 dorsal basal spot with convex distal border, not extending beyond jugum (Fig. 12A); S10 without dorsal spine; appendages black; genitalia with posterior hamule broad at base up to distal 3/4th, abruptly narrow distally.

Anal appendages: "Anal appendages black, of equal length. Superiors sloping strongly down and back, tapering to a fine point, parallel, and with a robust external spine situated slightly apicad to the middle of the segment. Inferior triangular, convex dorsally its apex curling gently up between apices of superiors" (Fraser, 1924).

Genitalia: Lobe rather long, truncate, sinuous, pointed; hamules foliate, tumid in basal two-thirds, then abruptly narrowed into a long fine spine with an imbricated apex extending slightly beyond apex of lobe (Fraser, 1924). Hamules basal two-thirds

very broad, lobe is sinuous and attenuated (Fraser, 1936).

Ecological notes: Nothing is known about the ecology of the species except that it is a species of mid-high elevation jungles. They fly over shallow submontane streams with gravel bottoms. The habits resemble that of *M. flavocolorata* and the flight period is October-December.

Macromia indica **Fraser, 1924**

(Figs.1, 4: 3A,B, 5E, 8E, 10A, 11B, 12D)

OD: Fraser (1924). A survey of the Odonata (Dragonfly) fauna of Western India with special remarks on the genera *Macromia* and *Idionyx* and description of thirty new species, with Appendix I and II. *Rec. Indian Mus.,* 26: 448–449. (PI. XXV, fig. 5).

Material studied: Images of Holotype, ♂ 013322944 NHMUK London; India, Gudalur, Nilgiris, 3,500', 14. ix. 1922, F. C. Fraser.

Measurements: ♂ abdomen 57–58 mm, hindwing 45–46 mm. ♀ abdomen 52–56 mm, hindwing 46–50 mm (Fraser, 1924).

Nodal Ratio and index: SSNR– 8:15/11:10 ::15:10/9:10; SSNI–15:9/10:11

Recent records and Historical Distribution: Sigur, Gudalur, Pandy River and Burliyar, Nilgiris Tamilnadu; Cauvery River, Fraserpet in Coorg-Mysore Frontier in Karnataka (Fraser, 1924). Thus, confined to the WG North of the Palghat Gap (Fraser 1936).

Current Distribution: ♂, Karaekattai, Kudremukh National Park, Karnataka, Broad-leaved Evergreen Forest, (Emiliyamma and Radhakrishnan, 2007); the WG north of Palghat Gap according to Subramanian *et al.* (2018). Thus, the current distribution is Coorg, Wayanad, and Nilgiris Landscapes of the WG north of the Palghat Gap.

Taxonomic group: cincta group.

Field Identification: Segment 10 with a dorsal tooth; antehumeral stripe absent; S2 with dorsal distal border convex; abdomen in dorsal view " S2 with a minaret-shaped mark on distal end with lateral extensions along distal margin (Fig. 11B); S3–6 with mid-dorsal yellow annuli; S7 with basal yellow annulus and a large triangular extension through carina across jugum; S8 with dorsal basal yellow triangular spot (Fig. 12D), base of which may extend laterally as a thin annulus (Fig. 15A). Broad annuli on the abdomen and the dark black-brown rays at the base of the wing diagnostic amongst the congeners (Fraser, 1936).

Anal appendages: "Similar to that of *M. moorei* Selys 1874 (Fraser 1936), black, equal in length. Superior a little compressed, sloping and tapering to a fine point turned up and a little out, inner border slightly concave, outer bearing a minute spine at its middle, some fine teeth beneath the apex. The superiors are upturned abruptly and the lateral spines are situated slightly nearer to the apex. Inferior triangular, concave above as seen in profile, its apex turning slightly up between the superiors" (Fraser, 1924).

Genitalia: Similar to that of *M. annaimalaiensis* as per Fraser (1936). Hamules long, fine, tapering, a little tumid at base, apex with a fine imbricated point that extends to extreme apex of lobe, latter directed almost straight back, very narrow, tongue-like (Fraser, 1924) (Fig. 8E).

Ecological notes: The males were seen patrolling stream edges and were always seen along similar water bodies. The flight period is November–December.

Macromia irata **Fraser, 1924**

(Figs.1, 4: 4A–C, 8F, 9E,F, 10F, 11G, 12F, 13, 14)

OD: Fraser (1924). A survey of the Odonata (Dragonfly) fauna of Western India with special remarks on the genera *Macromia* and *Idionyx* and description of thirty new species, with Appendix I and II. *Rec. Indian Mus.,* 26: 454–455. (PI. XXV, fig. 6).

Material studied: 1) Images of *Lectotype,* ♂; 013322946 NHMUK London; S. India, Coorg, Bhagmandala Road, 3. vi.1923, F.C. Fraser; Allotype: ♀013322940 NHMUK London, Napoklu Road, Coorg, 18.v.1924, F.C. Fraser. 2) Field

specimens examined: 4 males, Thenmalai, Kollam District, Rubber Estate, 200 m May 2018 (KS) (TORG 1006, 1007, and 1008, voucher specimens in TNHS); Chatancode in Peppara, Kerala, Semi-Evergreen Forest, 200 m (KS) (not collected).

Measurements: ♂ abdomen 47 mm, hindwing 43 mm. ♀abdomen 46 mm, hindwing 46 mm.

Nodal Ratio and index: SSNR– 9:17/10:12::18:8/12:13, 7:17/10:12::17:8/13:1; SSNI–18:9/13:12

Historical Distribution: Confined to Coorg, Bhagmandala (Fraser, 1924), South Kanara, Bettaferi (Bhasin, 1953) all in Karnataka, Vythiri, Malabar Wayanad, Kerala, May (Fraser, 1931and1936); the WG above the Palghat Gap till Coorg (Subramanian *et al.*, 2018). Reported from Central India by Tiple *et al.* (2013) and Tiple and Koparde (2015), and Amboli, Maharashtra (Swant *et al.,* 2023). Thus, all records are north of the Palghat Gap.

Recent records and Current Distribution: 4 males, Thenmalai, Kollam District, Rubber Estate, 200 m May 2018 (KS); Chatancode in Peppara, Kerala, Semi-Evergreen Forest, 200 m (KS); Vallakadavu, in Periyar, Kerala, May 2016, Tropical Wet-Evergreen Forest, 600 m (Abraham Samuel); Thenmalai, Kollam District, May 2018 (KS); Kanichar, Kannur June 2021 (Nair *et al.*, in *press*); Aryanad, Thiruvananthapuram (Chandran and Chandran, 2021). Thus, the range extends to the south of Palghat Gap, the current distribution is the southern WG south of the Coorg landscape including Nilgiris and Agasthyamalais.

Taxonomic group: cingulata group.

Field Identification: A smaller species with wings less than 45 mm; face ferruginous/reddish brown/amber-brown, and yellow; antehumeral stripe present; genital lobe angulated well with ventral margin of S2 than its caudal margin; characteristic twin diamond-shaped saddle markings on S2 (Fig. 11G) narrowly transected by dorsal carina (Fraser, 1936); S7 with a fan-shaped expansion of dorsal basal yellow spot; S8 with basal yellow annulus/spot; a butterfly spot in S8 finely bisected by a black line along carina (Fig. 12F). The antehumeral stripe is sometimes very rudimentary and represented by only a dirty brown spot, in which case the abdominal markings– the fan-shaped expansion on S7 and butterfly spot in S8 are diagnostic.

Anal appendages: "Anal appendages are generally black but in some the inferior dark reddish-brown. Superior tapering to a fine point turned slightly out and upwards and bearing a sharp, robust spine at the middle of its outer border. The sub-apical fine teeth are not at all evident. Inferior narrowly triangular, curved up as seen in profile and extending slightly but distinctly beyond the superiors" (Fraser, 1924). Superiors as long as segment 10, with a robust spine on its outer border, apex very acute and turned slightly out, similar to *M. flavicincta* Selys, 1874. Inferiors markedly longer than superiors, narrowly triangular, apex gently curved up (Fraser, 1936).

Genitalia: Genitalia is very similar to that of *M. bellicosa*, differing only in the shape of the loop which is of the same small size but is strongly angulated out from the ventral border of the segment and in nearly the same straight line as the apical border, i. e. exactly the opposite condition to that found in *M. bellicosa* (Fraser, 1924). Genitalia is also very similar to *M. flavicincta* Selys, 1874 (Fraser, 1936) (Fig. 8F).

Ecological notes: A considerable number of these insects were seen by Fraser towards the end of April 1923, all flying high and often resting on the uppermost branches of the tallest forest giants. Several males were subsequently seen hawking over a neighbouring stream (Fraser, 1924). It was described as the commonest *Macromia* on the West Coast (of Peninsular India) by Fraser (1936) but had escaped scientific documentation until 1953 (Bhasin, 1953), since its original description in 1924. These are exceptions to the general rule of distribution of the genus as being commoner on lower elevations (<200 m) compared to others of the genus. They prefer stagnant shallow water around Myristica Swamps in shade in the Agasthyamalais. It flies in May (Fraser, 1931). The flight period is from April to June.

Endemicity of *Macromia* in the WG and Kerala

The known distribution of *Macromia* in the WG is given in Table 1, based on all available sources mentioned above.

Species Groups in *Macromia* of Western Ghats

The *Macromia* of the WG is classified according to the principles laid down by Laidlaw (1922), which was followed by Ris (1916). And later, Lieftnick (1929) followed them both in his treatment of the Malayan *Macromia*. The grouping was based on– 1) The colour of the postclypeus, which may be yellow, or may agree with that of the rest of the front of the head which may be reddish-brown or dark brown, 2) The presence or absence of a humeral stripe on the pterothorax; note that a lateral oblique stripe of yellow is present in all Oriental species of the genus, and 3) the presence or absence of a flattened, pointed, triangular process on the dorsum of S10 in ♂.

Laidlaw (1922) classified Oriental *Macromia* into three groups.

I. Group of *M. westwoodi* Selys: Segments 2–6 of abdomen unicoloured, all with a more or less metallic lustre. The front of the head is uniformly dark brown, but the pyramidal processes of the frons metallic green or violet. Males with a pointed triangular process on the dorsum of the tenth segment of the abdomen. Pterostigma small (2 mm or less).

II. Group of *M. cincta* Rambur: Segments 2–6 of abdomen black or brownish-black without metallic lustre. Segments 2–3 at least with yellow markings on the dorsum. Front of head very dark brown, pyramids of frons black, slightly metallic. No definite humeral band on the dorsum of pterothorax. Costal nerve black. Males with the pointed triangular process on the dorsum of segment 10 of the abdomen. Pterostigma about 3 mm.

III. Group of *M. calliope* Ris: Pterothorax black, with a rich metallic lustre, with a humeral band incomplete above. Frons black with metallic lustre, anteclypeus- black or dark brown, postclypeus yellow. The costal nerve is usually entirely black. Segments 2–6 of abdomen black (or in one or two species metallic), the second segment at least with yellow markings on the dorsum. Segment 10 without dorsal process. In most species, the upper anal appendages are straight or incurved apically.

Fraser (1924), classified Indian *Macromia* into four groups–

Group 1–*westwoodi*: Segments 2 to 5 metallic coloured, the humeral band present or absent, no well-defined yellow stripe on face, spine on the dorsum of 10th abdominal segment present. No Indian representatives.

Group 2–*cincta*: Segments 2 to 5 matt black, marked with yellow, humeral band absent, no well-defined yellow stripe on face, spine on the dorsum of 10th abdominal segment present (*M. indica*).

Group 3– *calliope:* Segments 2 to 5 matt black, humeral band present, a well-defined yellow stripe on face, spine on 10th abdominal segment absent (*M. ida; M. flavocolorata*).

Group 4–*cingulata:* Segments 2 to 5 matt black, humeral band present, no well-defined yellow stripe on face, spine on 10th abdominal segment present (*M. cingulata, M. flavicincta, M. irata, M. bellicosa, M. ellisoni*).

Fraser (1936) comments that S2 and S3 in *M. ellisoni* have metallic reflux. This is also clearly evident in live field specimens where segments 2 and 3 and the proximal aspect of S4 and S5 also have a metallic green sheen. Going by Laidlaw (1922), it is seen that S2–S6 must be unicoloured all with more or less metallic lustre for the *westwoodi* group. In *M. ellisoni,* S2–S6 is not unicoloured and is marked in yellow. Group of *M. cincta* according to Laidlaw (1922) must have S2–S6 black or brownish-black without metallic lustre and no definite humeral band on the dorsum of pterothorax, which is not true in the case of *M. ellisoni* which, has a metallic lustre and a humeral band. It does not fall in the group of *M. calliope*

because S10 has a dorsal process in *M. ellisoni,* which must be absent in that group. The front of the head is uniformly dark brown, but the pyramidal processes of the frons metallic green or violet, according to Laidlaw (1922), is a character of the *westwoodi* group. All the species in the cingulata group of Fraser (1924), namely *M. cingulata*, *M. irata, M. flavicincta,* and *M. bellicosa* have non-metallic colours on the pyramid of frons in strict contrast to metallic greenish of *M. ellisoni.* The length of pterostigma is more than 2 mm in *M. ellisoni.* Thus, in summary, *M. ellisoni* has more features of the *westwoodi* group than that of the *cingulata* group. Group 4 of Fraser (1924) had no well-defined yellow stripe on the face according to Fraser (1924) but, Fraser (1936) contradicts it under the description of *M. cingulata* on page 180, *M. flavicincta* on page 172 which states that the postclypeus is citron-yellow in both the species. Thus, the relations among the species in the cingulata group are still unresolved. The Group of *M. moorei* has no representatives in the WG.

Considering the above, a revised classification for *Macromia* species of the WG and Peninsular India is proposed as follows–

Group 1–*ellisoni group*: Segments 2 to 5 with metallic lustre and yellow markings; well-defined humeral band; Front of head uniformly dark brown, but the pyramidal processes of the frons metallic green or violet, postclypeus not yellow; males with S10 dorsal spine *(M. ellisoni).*

Group 2–*cincta group*: Segments 2 to 5 matt black, marked with yellow, humeral band absent; postclypeus not yellow, front of head very dark brown, pyramids of frons black, slightly metallic; males with S10 dorsal spine (*M. indica, M. annaimalaiensis).*

Group 3–*cingulata group*: Segments 2 to 5 matt black, humeral band present; postclypeus citron/ chrome-yellow, the pyramid of frons non-metallic; males with S10 dorsal spine. The anal appendages are closer to the calliope group in *M. cingulata* and anal appendages structurally similar to cincta group *in M. flavicincta, M. irata,* and *M. bellicosa.*

Group 4–*calliope Group*: Segments 2 to 5 matt black; antehumeral band present; Frons black with a metallic lustre, postclypeus yellow; Spine on S10th absent (*M. ida; M. flavocolorata). M. flavicincta, M. irata* and *M. bellicosa* have a similar scheme of genitalia and anal appendage. *M. cingulata* has a scheme of the anal appendages and male genitalia slightly different from others of the same group.

Based on anal appendages, *Macromia* of the WG falls into four groups. *M. ida-flavocolorata* group has a lateral spine at the junction of the distal and middle third, distal third rapidly tapers and angulated inwards but the tip directed outwards. *M. bellicosa-flavicincta-irata* cerci with the lateral robust spine at the middle third, the distal half of cerci knife-shaped, tapering gradually and the distal half of the cerci directed inwards but angulated outwards. *M. indica-annaimallaiensis* is similar to the *M. bellicosa-flavicincta-irata* group. *M. ellisoni* has a spine at the junction of the distal and middle third and the distal third is directed outwards. *M. cingulata* is interesting with the spine in the junction of the distal and middle third, distal third rapidly tapering and angulating inwards.

Based on the anal appendage structure, considering the morphology of the genital lobe and the hamulus, the following five groups are evident. *M. bellicosa-flavicincta-irata* group with the triangular genital lobe and the elephant trunk hamulus. *M. indica-annaimallaiensis* has a triangular genital lobe with a convex anterior border and a hamulus with a constriction at the junction of the proximal and middle third. *M. ida-flavocolorata* group has the tongue-shaped genital lobe with a convex anterior margin and a swollen base of the hamulus with a sinuous end. *Macromia ellisoni* has a rounded genital lobe with a very broad hamulus with a short-curved tip. *Macromia cingulata* has a triangular genital lobe with a sharp extension and a broad hamulus with an angulated distal third and hook at the end.

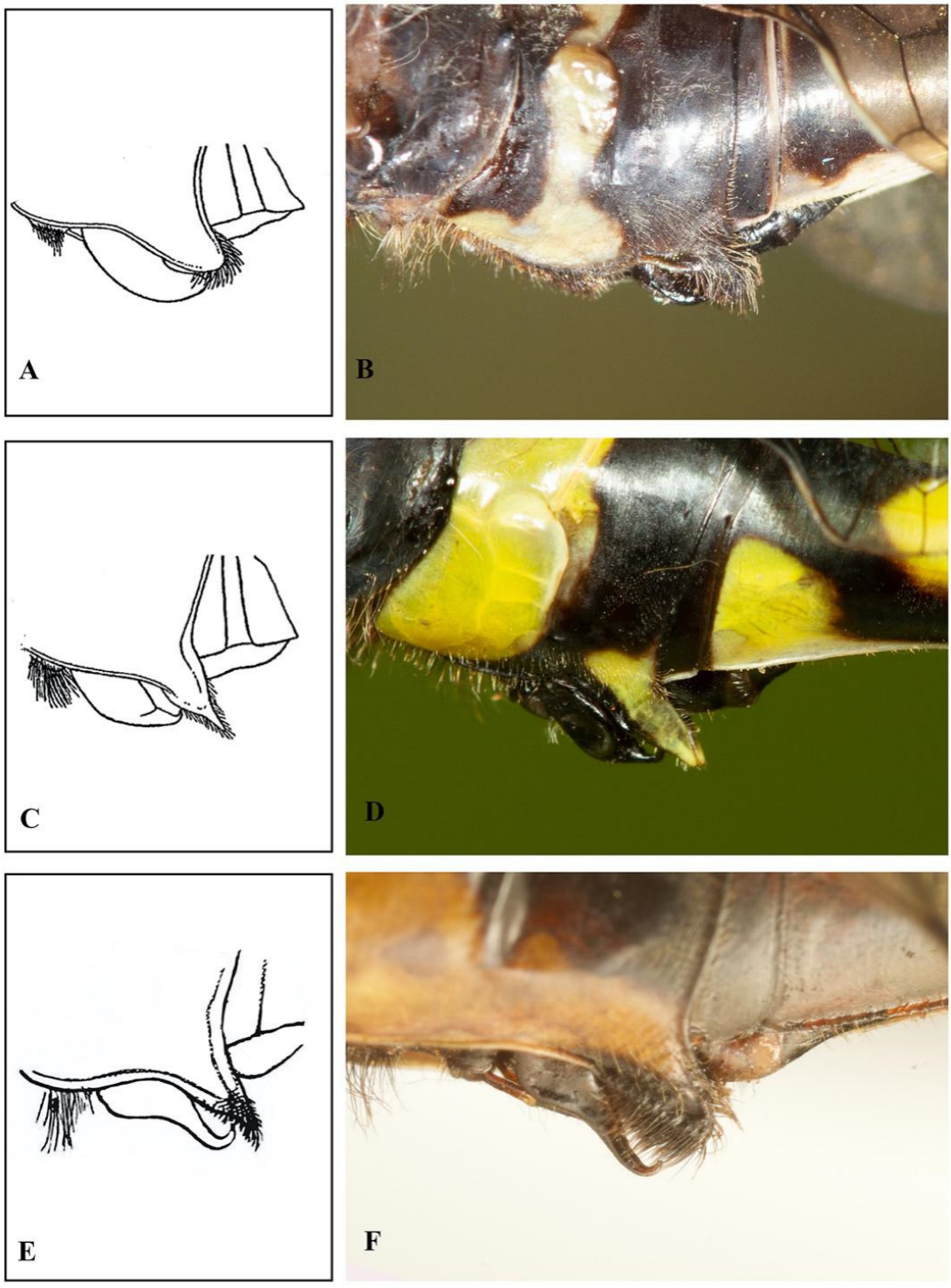

Fig. 9 Genitalia of *Macromia: M. ellisoni* Fraser, 1924 (A, B); *M. cingulata* Rambur, 1842 (C, D); *M. irata* Fraser, 1924 (E,F)

The exact status, composition of these species groups, and their interrelations need to be investigated and ascertained by molecular techniques and integrated taxonomy.

***Notes on Macromia irata* Fraser, 1924**
(Figs.1, 8F, 9E,F, 11G, 12F, 13,14)

Material examined:

1. TORG 1006–♂, dry pinned specimen, India, Kerala, Thenmalai, Kollam District, 50 m ASL., 5th June 2018, Private Rubber estate, collected by the authors, deposited in the collection facility at the TNHS, Trivandrum, India.

2. TORG 1007–♂, dry pinned specimen from the same locality as TORG 1006, collected by the authors on 5th June 2018 deposited in the collection facility at the TNHS, Trivandrum, India.

3. TORG 1008–♂, Wet specimen in 100% Alcohol, from the same locality as TORG 1006, collected by the authors on 5th June 2018 with the same data as the Holotype.

Measurements (in mm)

TORG 1006: Total length 62; length of abdomen 45; length of cerci 2; Fw 40; Hw 39.

TORG 1007: Total length 63; length of abdomen 46; length of cerci 2; Fw 42; Hw 42.

TORG 1008: Total length 63; length of abdomen 46; length of cerci 3; Fw 42; Hw 41.

Description of male

Head. Labium brown, bases of mandible amber yellow; labrum inferior half dark amber-brown, superior half yellow without a sharp demarcation. Anteclypeus brown, postclypeus orange-yellow. Frons yellow, with its medial margin of apices broadly black-bordered. Interface between yellow and black a narrow amber-brown band. Lateral aspect of frons yellow. Dorsal aspect of frons bordering vertex with a yellow triangular patch, one on each side. Vertex dark metallic black with a dark metallic blue reflex. Epicranium, antennae, and occiput black. Eyes bright emerald green anteriorly, bordered with brilliant blue and turquoise laterally. Orbits are black superiorly, yellowish-brown inferiorly, bordered with black laterally near sinuous projection at middle of posterior border.

Prothorax: Simple, as in the genus, without spines or other structure.

Pterothorax. General colour dark metallic green, with two lateral stripes on Epm2 and Epm3, tiny rudiment of antehumeral stripe pale citron-yellow. Underside brown. In dorsal view, dorsal carinae black, crest lined by a thin coppery line that expands into a coppery brown triangle with base caudally. Ante-alar ridge black, thicker medially, ante-alar sinus white. Episternum (Eps2) metallic green on medial half; on coppery brown in lateral half, in the region of the antehumeral stripe. Notum N2, N3 black, post-notum PN2 pale yellowish-white. In lateral view, antehumeral stripe reduced to a small pale citron-yellow rounded triangular spot on either side of suture between episternum (Eps2) and infra-episternum (Ips2); rest of Ips2 brown. Epimerum (Epm 2) metallic green in its superior third, inferior third yellow. This metallic green band on Epm2 wider inferiorly. Superior part of yellow stripe finely spotted in reddish-brown. Eps3 metallic green. Ips3 dark brown. Superior third of Epm3 metallic green, inferior third pale citron-yellow. Metallic green band on Epm3 wider superiorly.

Legs. Coxae brown, whole of trochanter, initial part of femora on extensor aspect brownish-black, rest of legs black.

Wings. Hyaline, edges effumed, pterostigma small covering two cells (2 mm in both wings); proximal border, parallel to preceding cross vein, its distal margin being oblique. Membrane white, eight cells in anal loop, hypertrigones traversed 4 times in forewings, twice in hindwing; six cubital nervures in forewing, four in hindwing. Nodal Index: forewing with 16 prenodal and hindwing with 11, forewing 7 postnodal and hindwing 10 postnodal. Discoidal field two-celled in forewing up to four cells before the node level and extends to eight cells distally and in hindwing it is one cell, to begin with, extends to three cells. Base of hindwing deeply excavated, tornal angle prolonged inwards

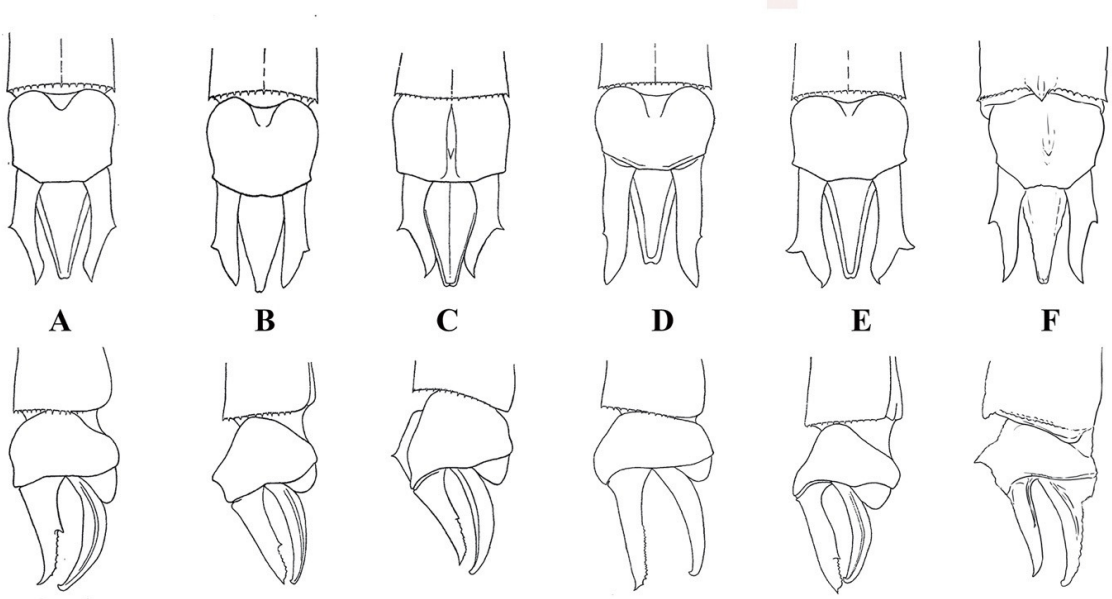

Fig. 10 Anal appendage schemes of *Macromia* of Western Ghats from Fraser (1936). A–*M. annaimallaiensis* Fraser, 1931 & *M. indica* Fraser, 1924; B–*M. cingulata* Rambur, 1842; C–*M. bellicosa* Fraser, 1924 & *M. flavicincta* Selys, 1874; D–*M. ellisoni* Fraser, 1924; E–*M. flavocolorata* Fraser, 1922, *M. miniata* Fraser, 1924 & *M. ida* Fraser, 1924; F–*M. irata* Fraser, 1924. Illustrations © Kalesh Sadasivan

markedly. Anal triangle two-celled.

Abdomen. Black marked with yellow. Segment 1 black; dorsal aspect of segment 2 predominantly black except for pair of pale yellowish-green spots paradorsally. In lateral view, its anteroinferior half, region immediately adjoining genitalia pale citron-yellow. Segments 3–6 black with a pair of mid-segmental paradorsal spots, decreasing in size caudally from segments 2–6. Mid-ventrally S3 bears a large triangular yellow spot at its junction with segment 2. In S4–S6 this triangular spot is reduced to a yellowish-brown streak. Segment 7 has a thick yellow almost annular ring at its base and mid-dorsally this ring forms a small contiguous yellow spot. Width of yellow basal ring almost one-fourth dorsal length of S7. Abdomen widest at segment 8, which is black, dorsally with a butterfly-shaped yellow spot and ventrally with a pair of rudimentary yellowish spots. Segment 9 tergite wholly black, sternite dark brownish-black except near junction with S2 sternite, which has a small ill-defined quadrangular yellow spot. Mid-dorsally caudal end of carina on segment 9 produced into a small tooth. Segment 10 on dorsum, at its middle, with a robust spine; whose cranial border is convex and caudal border with keel concave.

Genitalia. Posterior hamulus resembles an elephant's head and trunk. Basal third spatulate tapers off into an inwardly directed hook at its apex. Genital lobe tooth-like. Posterior hamule slightly longer than genital lobe (Fig. 8F, 9E, F).

Anal appendages. Cerci black, epiproct dark brownish-black, with a robust lateral spine at its middle, directed posterolaterally. Cranial junction of spine with appendage convex, caudal junction concave. Tip of cerci directed posterolaterally. Epiproct dark brown dorsally and its tip blunt, minimally bifid in dorsal view. In lateral view, lateral margined portion of cerci extends till its middle, till lateral spine. Epiproct slightly longer than cerci. Both cerci and epiproct gently curved dorsally.

Variation: Segment 6 sometimes lacks yellow mid-segment dorsal spots otherwise not much variability is observed. Segment 7 with the small contiguous spot on basal annulus can be oval or diamond-shaped. Compared to the types and specimens from

north of the Palghat Gap, the southern specimens are much more extensively marked in black. The frons was marked with black in the upper fourth in northern specimens, while it was more extensive and covered almost the upper third in the southern examples. The sulcus of the frons was marked with a thin black line and the adjacent slopes were fully yellow in Coorg specimens; while the black line in the sulcus was thicker, slopes black enclosing a small yellow triangular spot with the apex directed to the floor of sulcus on each side, on the slope nearer the border with the vertex. In the case of venation, the hypertrigones are traversed 3–4 times in forewings and 2–3 times in hindwings in Coorg specimens while in Agasthyamalai specimens it is 4 in forewings and 2 in hindwings. The SSNR for Coorg specimens 8:17/10:12::18.5:8/12.5:12 and SSNR for Agasthyamalai specimens 7:17.5/10.5:11.5::17.5:7/11.5:10. The abdominal markings have some variations. The ventrobasal streaks in Coorg specimens are well-defined and prominent in contrast to the Agasthyamalai specimens with a narrow annulus which is laterally touching the ventrobasal streak in S8 in Coorg while it is disjunct in Agasthyamalai specimens. S10 spine location is at the mid-dorsum on Coorg specimens and slightly distal to it in Agasthyamalai specimens. The insects are otherwise similar including the genitalia of the ♂. The variations may be a clinal one and do not qualify for a separate subspecies taxon. However, this needs to be investigated in molecular terms.

Habitat and Ecology: This species was observed flying at the bases of the foothills of Agasthyamalais, below 200 m above ASL, in the southern WG. The flight period is May to June after the onset of southwest monsoon rains in Kerala. The males were seen patrolling along 2 m wide streams throughout the day in a largely shaded rubber plantation at the edge of a Myristica swamp forest, in sunny mornings and afternoons. The streams have gravel and rubble in the bottom and the depth was less than 50 cm. Each male was seen defending an area of 8–10 m of the stream in its patrol flight at about

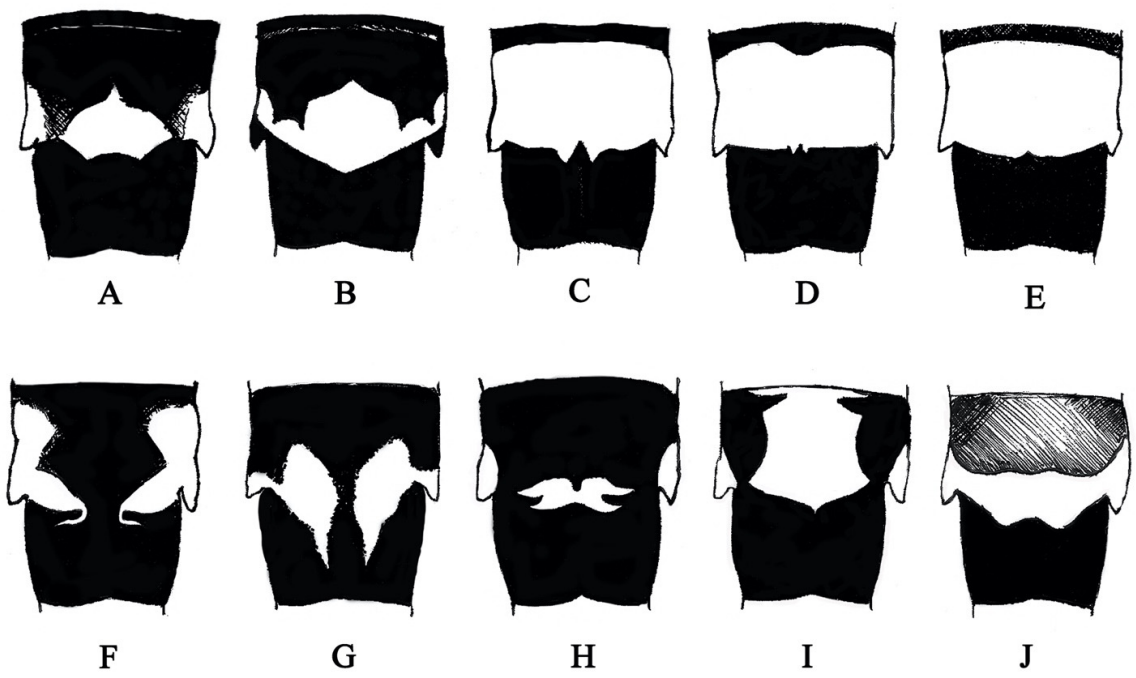

Fig. 11 Dorsal view of abdominal segment 2 of *Macromia* based on museum types: A–*M. annaimallaiensis* Fraser, 1931; B–*M. indica* Fraser, 1924; C–*M. flavicincta* Selys, 1874; D–*M. cingulata* Rambur, 1842; E–*M. bellicosa* Fraser, 1924; F–*M. ellisoni* Fraser, 1924; G–*M. irata* Fraser, 1924; H–*M. ida* Fraser, 1924; I–*M. miniata* Fraser, 1924 (*M. flavocolorata* Fraser, 1922); J–*M. atuberculata* Fraser, 1932 (*M. flavocolorata* Fraser, 1922). Illustrations © Kalesh Sadasivan

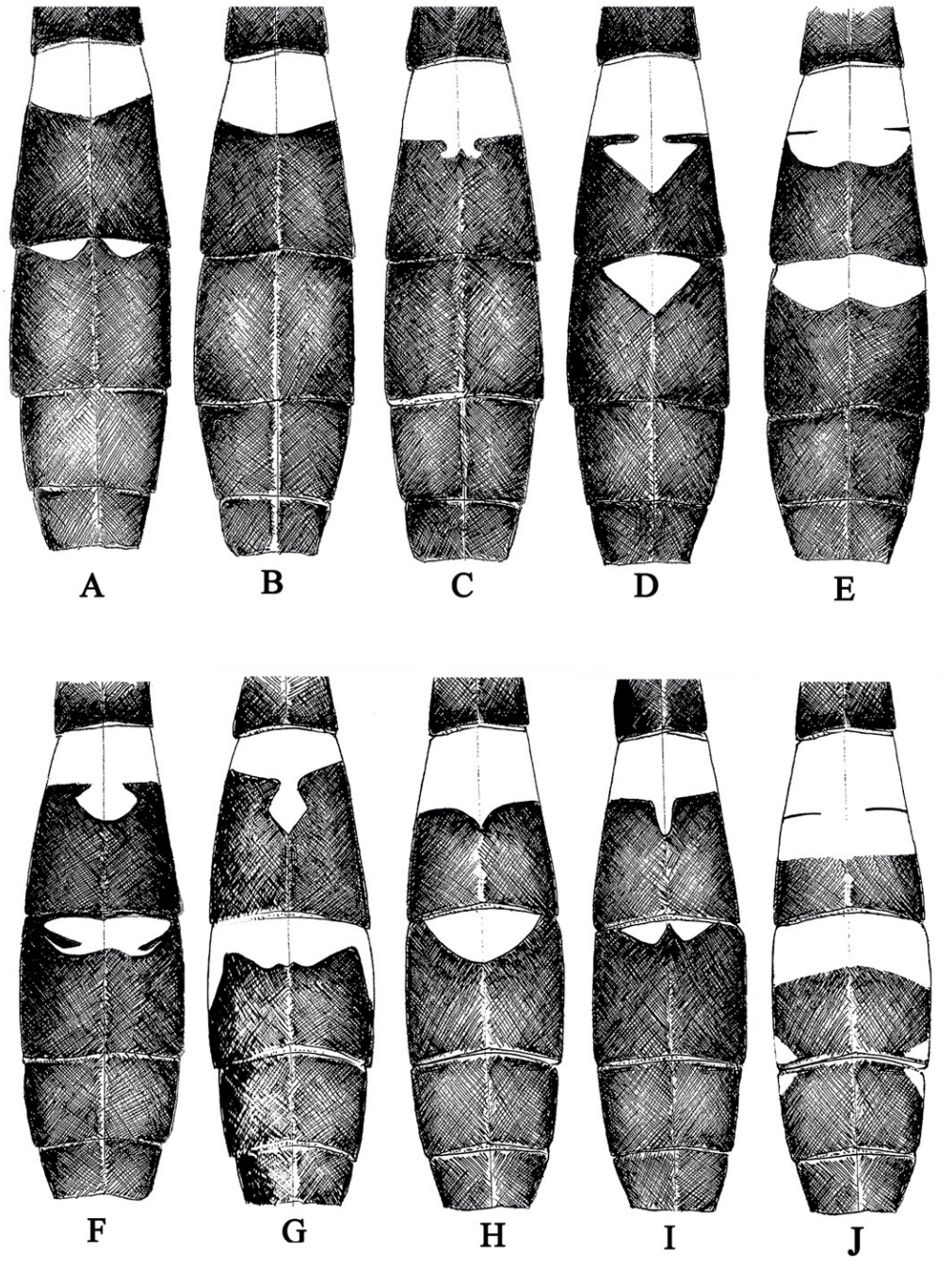

Fig. 12 Dorsal view of abdominal segments 7 and 8 of *Macromia* based on museum types: A–*M. ida* Fraser, 1924; B–*M. ellisoni* Fraser, 1924; C–*M. annaimallaiensis* Fraser, 1931; D–*M. indica* Fraser, 1924; E–*M. bellicosa* Fraser, 1924; F–*M. irata* Fraser, 1924; G–*M. cingulata* Rambur, 1842; H–*M. miniata* Fraser, 1924 (*M. flavocolorata* Fraser, 1922); I–*M. atuberculata* Fraser, 1932 (*M. flavocolorata* Fraser, 1922); J–*M. flavicincta* Selys, 1874. Illustrations © Kalesh Sadasivan

3 feet height from the water surface. Four individuals were engaged in patrolling a 250 sqm of water surface.

Differential Diagnosis: *M. irata* shows an affinity to two possibly monophyletic groups of *Macromia* in the WG considering the similarities in anal appendage and genitalia. These are the *cingulata-flavicincta-bellicosa* cluster forming the *cingulata* group and the *indica-annaimallaiensis* cluster forming the *cincta* group of *Macromia.*

The cingulata group: The three species, *M. flavicincta, M. bellicosa,* and *M. irata,* have well-developed but short or reduced antehumeral stripes and also consider the scheme of anal appendage and genitalia to form a natural group. The general structure of the anal appendage and the colour is dull ochreous (*M. flavicincta)*, reddish-brown (*M. bellicosa*), and black with epiproct dark reddish-brown (*M. irata*). The S10 dorsal spine is more prominent and acute in *M. irata* compared to the other two species. *M. flavicincta* has a well-defined broad antehumeral stripe changing to red-brown, labrum black-bordered, ante-alar sinus bright citron-yellow, tibial keels conspicuously yellow, segment 8 base with a complete annular yellow ring, segment 7 lacks the contiguous yellow spot while in *M. irata* the anal appendage is dark brownish-black, segment 8 has a butterfly-shaped yellow spot and the yellow annuli at the base of segment 7 has a mid-dorsal extension as a contiguous yellow spot. S10 bears a spine near its mid-dorsum slightly towards the apex while the spine is exactly at the middle or a little distal in *M. irata*. The male genitalia is similar to *M. irata* but the hamule is much shorter and the apex of the genital lobe is more rounded, posterior margin of the genital lobe is much concave in *M. flavicincta.* The tip of the lobe is rounded in *M. flavicincta* while it is acute in *M. irata. Macromia bellicosa* has a short but well-defined antehumeral stripe, labium bright yellow, labrum, anteclypeus, lower postclypeus black and rest of face is bright citron-yellow; while labium is brown, labrum inferior half dark amber-brown and superior half yellow in *M. irata*, anteclypeus is brown and postclypeus is orange-yellow. The underside of pterothorax black in *M. bellicosa* while it is brown in *M. irata*. Segment 7 with the basal half yellow while in *M. irata* the basal third is yellow with the dorsal contiguous yellow spot. S8 has a narrow annule in this species while in *M. irata* it is reduced to a butterfly-shaped basal spot. S10 bears a spine near its mid-dorsum slightly towards the apex while the spine is exactly in middle in *M. irata*. The anal appendage is similar to *M. flavicincta* (but more curved, and S10 spine is more robust). The colour of the anal appendage is reddish-yellow in contrast to blackish-brown on *M. irata*. The genitalia are slightly different from the similar *M. bellicosa* in that the genital lobe is strongly angulated from the ventral border and it is nearly in a straight line as the caudal border, and vice versa in *M. irata*. The labrum in *M. irata* is superiorly yellow and inferiorly brown and distinguishes it clearly from the black-bordered labrum of *M. flavicincta* and the fully black labrum of *M. bellicosa* and *M. flavicincta. Macromia bellicosa* has ochreous to reddish-brown appendages with more inwardly angular cerci with a mid-lateral spine while *M. irata* has dark brownish-black appendages with less angled cerci with a tooth-like mid-lateral spine. The lateral spine is almost perpendicularly directed with respect to the long axis of the cerci in *M. flavicincta* and *M. bellicosa,* while it is at a postero-lateral acute angle to it in *M. irata.* The cranial junction of the mid-lateral spine with the cerci is concave in *M. flavicincta* and *M. bellicosa,* while it is convex in *M. irata.* The curvature of cerci and the lateral angulation of the tip of the cerci are smooth and gradual in *M. irata*, in contrast to *M. flavicincta,* while in *M. bellicosa* the curve is more angular and the tip of the cerci abruptly deviates outwards in relation to the inner margin. The shape of the anterior and posterior hamulus and its relative length with respect to the lobe distinguishes this species from the closely similar *M. flavicincta.* and *M. bellicosa* (Figs. 8 B,H)

Other similar species groups are the *ellisoni* group and the *cingulata* subgroup of *cingulata* group. *Macromia ellisoni,* a large species, has a well-developed citron-yellow antehumeral stripe, a less robust spine on S10, and the genitalia is much different with a broader hamulus. Anal appendage with shorter epiproct compared to the cerci, and

the rudimentary lateral spines on the cerci, located more towards the apex and the ends of cerci are diverging. The *cingulata* subgroup has a different anal appendage with a rudimentary spine on the distal third of the lateral aspect of the cerci, the distal third of which is directed inwards; while in *M. irata* the spine is in the middle of the lateral aspect of the cerci and tips of the tapering cerci are directed outwards. *M. cingulata* also has a broad hamulus in comparison with *M. irata.*

The callipoe group: M. ida and *M. flavocolorata* are easily diagnosed from *M. irata* by the absence of a dorsal spine on S10 and the structure of the hamule (Figs. 10 E,F).

The cincta group: The general scheme of genitalia and the anal appendage has some affinity to the *indica-annaimallaiensis* group of *Macromia*. These species have a bluish metallic reflex on the anterior pterothorax instead of the dark green in *M. irata. M. indica* has a labrum edged with black; mid-dorsal yellow annules on S3–6, the lateral spines on cerci are slightly nearer to the apex and are more angular with the apex abruptly upturned. The genitalia of *M. indica* is similar to *M. annaimallaiensis* with a short hamulus in comparison with the genital lobe (Fig. 8E). *M. annaimallaiensis* lacks a butterfly-shaped yellow spot at the base of segment 8, has anal appendages similar to *M. indica*, and has a shorter, less angulated hamulus with a middle constriction, on genitalia compared to *M. irata.*

From other Indian Macromia species: M. moorei and *M. cupricincta* are two species similar to *M. irata* with respect to the general morphology of anal appendage and genitalia but are extralimital in distribution. In *M. moorei,* the labrum and clypeal region are reddish-brown, without antehumeral stripe, one lateral yellow stripe, a yellow ante-alar stripe, an anal loop with 7 cells, the absence of a robust spine on the dorsum of S10, and the short and much more angulated hamulus in comparison with the genital lobe. The lateral border cerci are more angulated inwards on the dorsal view, and the cerci and epiproct are more up-curved in *M. moorei*. The genital lobe has a rounded tip in contrast to the acute one in *M. irata.* This species is distributed from the Northeast Himalayas to the rest of Southeast Asia. *M. cupricincta* has a general cupreous-brown colour, bright citron-yellow ante-alar sinus, single citron-yellow stripe on lateral pterothorax, tibial keels conspicuously yellow, S7 basal half yellow, apical half S7–10 is coppery brown, and anal appendages dark ochreous. The genitalia, especially the genital lobe, and the shape and position of anterior hamules are very similar to *M. irata,* however, this species lacks the inferior concavity at the middle third, seen in the posterior hamule of *M. irata.* This species is distributed from Assam to Myanmar.

DISCUSSION

The species groups of *Macromia* of the WG of Peninsular India have been revisited and a revised scheme is suggested. The dependable characters for species identification of *Macromia* are the details of colouration of the face, especially the postclypeus; presence or absence of antehumeral stripes; structure of genital lobe and hamulus; markings on segment 2, 7, and 8; presence or absence of S10 dorsal spine, and the scheme of anal appendages. The variable characters are the length of the pterostigma and that of antehumeral stripes. Additional characters that may be useful are markings on the dorsum of S2, S7, and S8; the shape of the anal angle of the hindwing in males; tip structure of hamule and scales in male genitalia; and prothorax structure in females. A revised key to *Macromia* of the WG and Peninsular India is provided. The endemicity and distribution of all peninsular Indian taxa are updated.

Macromia irata, probably forms a monophyletic lineage with *M. flavicincta* and *M. bellicosa*, inside the *cingulata* group. The species is very distinct from *cincta* group which is possibly another closely related monophyletic group. The taxa *M. irata* has been re-described with details of variation and current distribution. *Macromia irata* can be easily differentiated from all the known taxa by the sulcus of frons black enclosing two triangular yellow spots, rudimentary antehumeral stripe, metallic green ground colour of the pterothorax, paler yellow colour instead of bright citron-yellow markings, S3–S6 with paired mid-dorsal spots, S7 with annulus and

a contiguous yellow dorsal spot, S8 with a butterfly-shaped dorsal spot, S9 with a dorsal carinal tooth at its caudal end, S10 with a robust dorsal spine, black anal appendages, relatively less angular cerci with a prominent spine at the middle of the lateral border, epiproct slightly longer than the cerci, and genitalia with hamulus as long as the genital lobe and caudal margin of the genital lobe being more angular than its ventral border with S2. As far as known, its present range is from Agasthyamalais in southern Kerala to the northern WG in Maharashtra.

Fraser (1931) remarked that not a single species of *Macromia* was found in Travancore, and the genus appears to become increasingly scarce south of the Palghat Gap, although extremely rich in species to the north of that barrier. But here *M. ellisoni*, *M. irata,* and *M. cingulata* are now reported from the Agasthyamalai region of old Travancore.

A revised key to males of *Macromia* of the Western Ghats

The key given by Fraser (1936) has some errors, for example, the third couplet second part says "Ground colour of pterothorax dark metallic blue at sides and upper part of the dorsum, dark reddish-brown at the lower part of dorsum; segment 10 without a dorsal spine". This is mentioned for *M. indica* and *M. annaimallaiensis*, which is misleading as both species have a strong keel that is developed to almost a tooth or spine on the dorsum of S10. Hence, the keys have been revised for males of *Macromia* of WG as given below. The location of the S10 dorsal spine may vary from the mid-dorsum to the distal end. The extension of the pterostigma varies even in a wing of a single specimen. The extent of the dorsal projection of the antehumeral streaks is variable. The colour of the eyes is reddish-grey and paler in the very short teneral phase. The robustness and position of the S10 spine were found to be variable even between individuals of a species. So, its presence or absence is a more useful character than its attributes. Other characteristics that may be useful are the shape of the tip of the hamulus and the anal angle of the hindwing in males.

1. Segment 10 with a dorsal tooth/spine 2

- S10 without dorsal spine……3
(Calliope Group: Eyes emerald green; Antehumeral stripe well-developed and superior edge well-defined, S3–S6 paired middorsal spots; Appendages black)

2. Antehumeral stripe present ……..4
(Cingulata Group: Antehumeral stripe may extend beyond halfway to the dorsum of pterothorax or may be reduced to less than halfway to the dorsum in which case it is usually continued thereof dorsally as a reddish band or vestigial yellow spots)

- Antehumeral stripe absent..…….....8
(*Cincta* Group)

3. Labium bright chrome-yellow basally, borders jet-black, the two colours sharply defined; in dorsal view, S2 with a yellow butterfly spot, S7 dorsal basal spot with convex distal border and does not extend beyond the jugum; S8 with a pair of small paradorsal basal triangular spots; posterior hamule broad at the base up to the distal 3/4th and abruptly narrow distally (Figs. 10E,11H, 12A)……
.....*M. ida* Fraser, 1924

- Labium ochreous basally borders diffusely dark brown, the two colours gradually merging; S2 with yellow annulus with trilobed distal dorsal border, S7 with dorsal spot extending into the dorsal carina as a small triangle; S8 single basal dorsal yellow triangular spot; posterior hamule with its apical two-thirds narrow (Figs. 10E, 11I, 12 H)…….....…….
.....*M. flavocolorata* Fraser, 1922

4. S8 unmarked, a large species with wings more than 45mm; Eyes brilliant bluish emerald green; in dorsal view, S3–S6 with paired middorsal spots, S7 yellow basal annulus dorsally not extending beyond the jugum (Figs. 10D, 12B)….....*M. ellisoni* Fraser, 1924

- S8 with basal yellow annulus/spot, small species with wings less than 45mm ….....…….5

5. Face black, marked by citron-yellow and black.....6

Fig. 13 *Macromia irata* Fraser, 1924 (TORG 1006): A–Lateral view; B–Close up of anterior pterothorax; C–Close-up of Head; D–Antero-lateral view of head and pterothorax, E–Lateral View of pterothorax.
Photographs © Kalesh Sadasivan

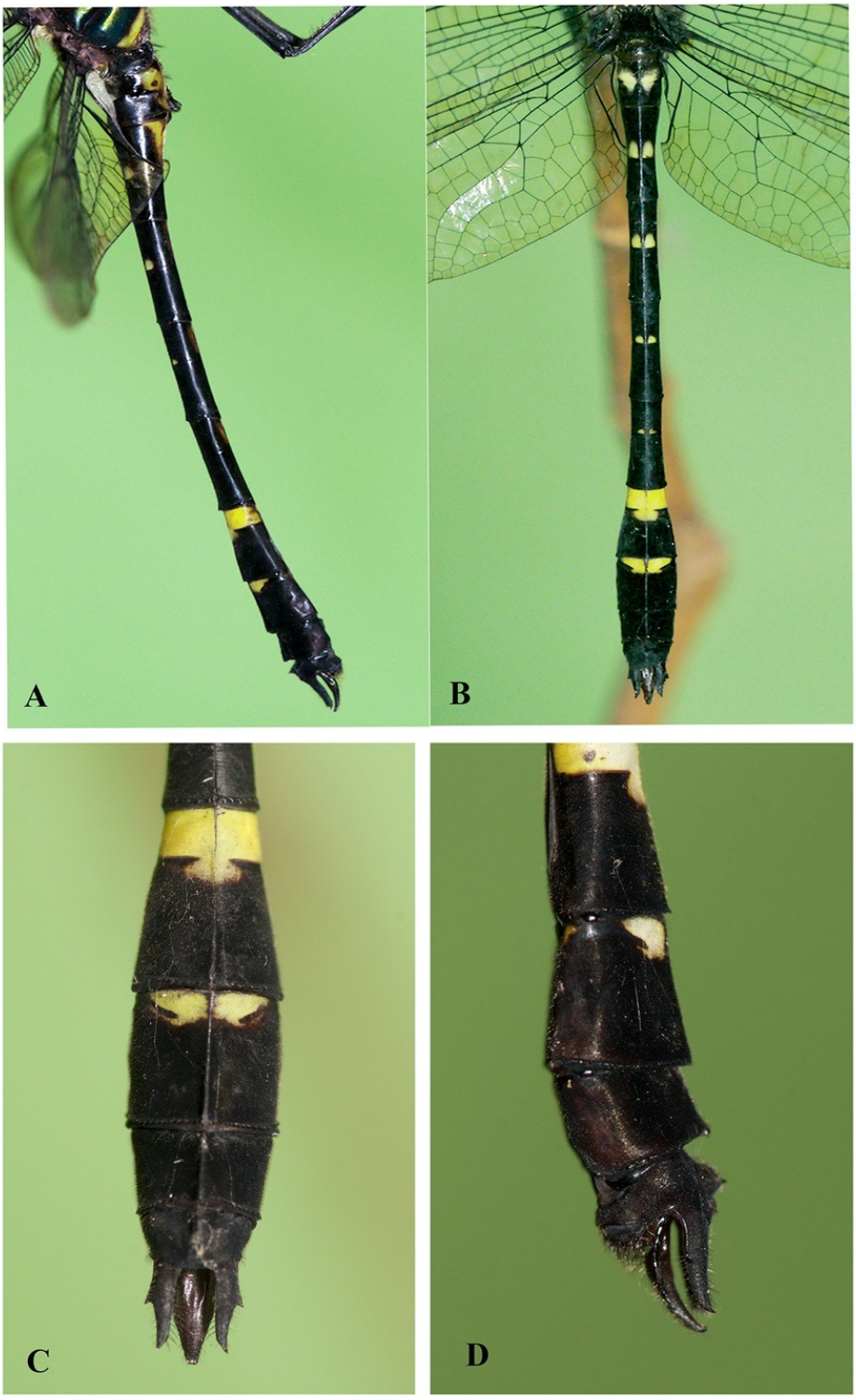

Fig. 14 *Macromia irata* Fraser, 1924(TORG 1006): A–Lateral view of abdomen; B–Dorsal view of abdomen; C–Dorsal view of anal appendage; D–Antero-lateral view of the anal appendage.
Photographs © Kalesh Sadasivan

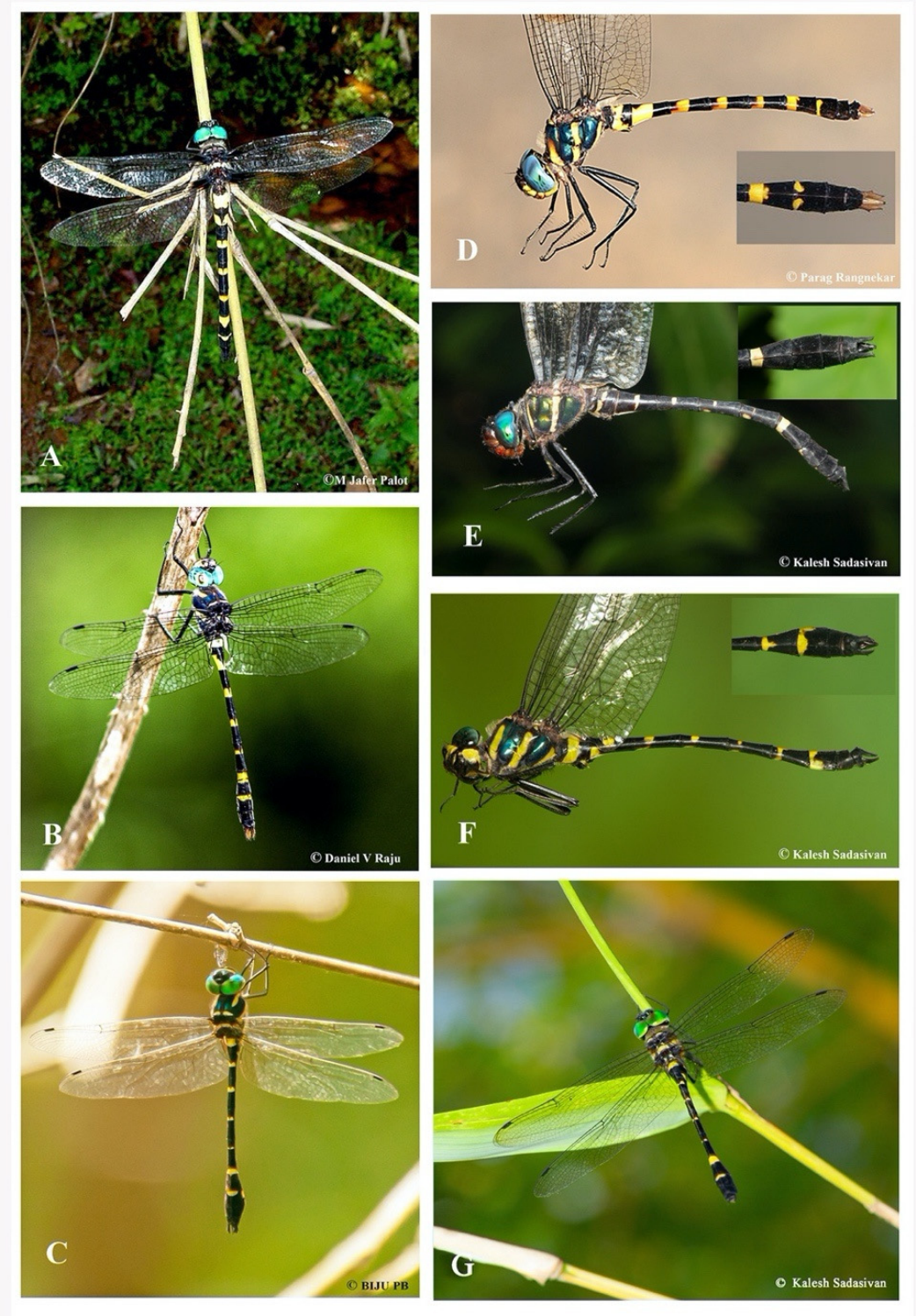

Fig. 15 Field images of *Macromia* from the Western Ghats**.** A–*M. indica* Fraser, 1924 © M. Jafer Palot from Kudremukh, Karnataka; B–*M. bellicosa* Fraser, 1924 by Daniel V Raju, from Coorg, Karnataka; C–*M. flavocolorata,* Fraser, 1922 (♂) © Biju PB, from Silent Valley, Kerala; D–*M. flavicincta* Selys, 1874 (♂) © Parag Rangnekar, from Maharashtra; E–*M. ellisoni* Fraser, 1924 (♂) © Kalesh Sadasivan, from Agasthyamalais, Kerala; F–*Macromia cingulata* Rambur, 1842 (♂) © Kalesh Sadasivan, from Munnar, Kerala, and G–*M. flavocolorata,* Fraser, 1922 (♂) © Kalesh Sadasivan, from Thenmalai, Kerala

- Face ferruginous/reddish brown/amber-brown and yellow.....7

6. Anal Appendages ochreous; Eyes green; Abdomen- S3–S6 with basal annuli, S7 dorsal basal spot expands to a transverse bilobed band beyond the jugum, thus yellow occupies a little less than half of the S7, S8 dorsal basal annulus distal border bilobed dorsal laterally and thus with a concave middorsal margin (Figs. 10C, 12E)…….....…....... .....*M. bellicosa* Fraser, 1924

- Anal Appendages black; Eyes pale blue; An inverted 'T' shaped mark on face formed by black spots on frons and the black stripe on the sulcus of frons; in dorsal view, S3 with paired middorsal spots, S4–S6 spots almost conjoint, S7 basal dorsal yellow spot with a short tongue/ elongated diamond-shaped extension beyond the jugum, S8 basal annulus crown-shaped with a convex distal border; Small species with wings less than 45mm (Figs. 10B, 12G)…….....*M. cingulata* Rambur, 1842

7. Anal appendages dull ochreous; Eyes bluish, 'T' shaped mark on crest of frons; S2 bilobed with dorsal distal border of yellow annulus, S3–S6 annuli, S7 with dorsal basal ring expanding into a transverse band beyond the jugum thus yellow occupies almost half of the S7, S8 with the butterfly wing spots separated with a broad black streak of the dorsal carina, or when well-marked joins across midline forming basal yellow annuli with dorsal concave distal margin, but always occupying less than half of S8, Genital lobe much evidently angulated with the caudal margin of S2 than its ventral margin (Figs. 10C, 11C, 12J)….....*M. flavicincta* Selys, 1874

- Anal appendages dark brownish-black; eyes emerald green; in dorsal view of abdomen, S2 with twin diamond-shaped spots; S3–S6 with paired middorsal spots, a butterfly spot in S8 finely bisected by a black line along the carina, S7 with the fan-shaped expansion of the dorsal basal yellow spot; Genital lobe angulated well with the ventral margin of S2 than its caudal margin (Figs. 10 F, 11G, 12F)…...……..…*M. irata* Fraser, 1924

8. S3–6 with mid-dorsal yellow annuli and S8 with dorsal basal yellow triangular spot; S7 with a triangular extension beyond the jugum (Figs. 10A, 12D).....……..*M. indica* Fraser, 1924

- S3–6 with paired mid-dorsal spots, S7 with a yellow basal annulus with a very short, broad but bifid mid-dorsal extension beyond the jugum, and S8 is unmarked (Figs. 10A,12C)..... .....*M. annaimallaiensis* Fraser, 1931

ACKNOWLEDGEMENTS

The authors are thankful to Vibhu V., Parag Rangnekar, Daniel V. Raju, Divin Murukesh, Sathrumithra, Biju P.B. and Aby P. Varghese for field images of *Macromia*; Ben Price, Subramanian K.A., Oleg Kosterin and Nancy Van der Poorten for help with literature; Satya Krishna Prakash and members of TNHS for field support.

REFERENCES

Bhasin G.D. (1953) A systematic catalogue of the main identified Entomological collection at the Forest Research Institute, Dehra Dun, Part 12- Order Odonata. Indian Forest Leaflet 121(3): 63–79.

Boudot J.P. (2010) *Macromia splendens*. The IUCN Red List of Threatened Species 2010: e.T12598A33 64642. doi:10.2305/IUCN.UK.20101.RLTS. T12598A3364642.en (Accessed on 14 March 2020).

Chandran R. and Chandran A.V. (2021) Dragonflies and Damselflies (Insecta: Odonata) of Aryanad Grama Panchayat, Kerala, India. Journal of Threatened Taxa 13 (14): 20153–20166. doi:10.11609/ jott.7342.13.14.20153–20166.

Davies D.A.L. and Tobin P (1985) The dragonflies of the World: A systematic list of the extant species of Odonata, Vol. I. Zygoptera, Anisozygoptera. Societas Internationalis Odonatologica, Rapid Communications (suppl.) 3: X+127p.

Dawn P. (2021) Dragonflies and damselflies (Insecta: Odonata) of West Bengal, an annotated list of species. Oriental Insects doi:10.1080/ 00305316.2021.1908188.

Emiliyamma K.G. (2014) Systematic studies on Odonata (Insecta) of Southern Western Ghats. Records of the Zoological Survey of India 114 (1): 57–87.

Emiliyamma K.G. and Radhakrishnan C. (2007) Insecta: Odonata. In: Fauna of Kudremukh National Park, Conservation Area Series. Zoological Survey of

India, Kolkata 32: 27–48.

Fraser F.C. (1922a) Notes on new and rare Indian Dragonflies. Journal of the Bombay Natural History Society 28: 698–702.

Fraser F.C. (1922b) New and rare Indian Odonata in the Pusa collection. Memoirs of the Department of Agriculture in India (Entomology) 7: 39–77.

Fraser F.C. (1924) A survey of the Odonata (Dragonfly) fauna of Western India with special remarks on the genera *Macromia* and *Idionyx* and description of thirty new species, with Appendix I and II. Records of the Indian Museum 26: 423–522.

Fraser F.C. (1931) Addition to the odonate (dragonfly) fauna of western India, with descriptions of nine new species. Records of the Indian Museum 33(4): 443–474.

Fraser F.C. (1936) The fauna of British India, including Ceylon and Burma. Odonata Vol. III. Taylor & Francis, London. XII + 461 pp., 2 pls.

Garrison R., von Ellenrieder N. and Louton J. (2006) Dragonfly Genera of the New World: An Illustrated and Annotated Key to the Zygoptera, The Johns Hopkins University Press. 368 pp.

Kimmins D.E. (1966) A list of Odonata Types described by F.C. Fraser now in the British Museum [Natural History]. Bulletin of the British Museum (Natural History) Entomology 18:173–227.

Laidlaw F.F. (1922) Some Notes on Oriental Dragonflies: The Genus "Macromia", Journal of the Straits Branch of the Royal Asiatic Society 85: 218–229.

Lieftinck M.A. (1929) A revision of the known Malaysian dragonflies of the genus *Macromia* Rambur, with comparative notes on species from neighbouring countries and descriptions of new species. Tijdschriftvoor Entomologie 72: 59–108.

Lieftinck M.A. (1971) A catalogue of the type-specimens of Odonata preserved in the Netherlands with a supplementary list of the Odonata types described by Dutch scientists deposited in foreign institutional collections. Tijdschriftvoor Entomologie 114: 65–139. Available from: http://biostor.org/49834.

Nair V.P., Samuel K.A., Palot M.J. and Sadasivan K. (2021) The dragonflies and damselflies (Odonata) of Kerala– Status, and Distribution. ENTOMON 46 (3): 185–238. doi: 10.33307/entomon.v46i3.609.

Nair V.P., SadasivanK., Vijayakumaran V., Nayakkan A., Palot M.J. and Samuel K.A. (in press). Further notes and updates to dragon files and damselfiles of Kerala - status and Distribution. Part I. ENTOMON

Palot M.J. and Kiran C.G. (2016) Dragonfly survey of Aralam Wildlife Sanctuary, Kerala- A report. Malabar Trogon 14 (1–3): 44–46.

Paulson D., Schorr M. and Deliry C. (2021) World Odonata List. https://www.pugetsound.edu/academics/academicresources/slatermuseum/biodiversity resources/dragonflies/world odonata–list2/ (Accessed on 7 July 2021).

Pradeepkumar T., Kakkassery F., Samuel A.K., Manoj P., Subash Rao P.S., Anvar M. and Kiran C.G. (2014) Report of the First Konni Odonate Survey. Divisional Forest Office, Konni & Tropical Institute of Ecological Sciences, Kottayam. 37pp.

Riek E.F. and Kukalová-Peck J. (1984) A new interpretation of dragonfly wing venation based upon Early Upper Carboniferous fossils from Argentina (Insecta: Odonatoidea) and basic character states in pterygote wings. Canadian Journal of Zoology 62: 1150–1166.

Ris F. (1916) H. Sauter's Formosa-Ausbeute. Odonata (Mit Notizen uber andere ostasiatische Odonaten). Supplementa Entomologica 5: 1–81.

Roy S., Singhamahapatra A. and Nayak A.K. (2022) Observations of Odonata (Insecta) from heterogeneous habitat patches in Bankura district with the first report of *Microgomphus torquatus* (Selys, 1854) from West Bengal, India. Journal of Animal Diversity 4 (2): 121–152. doi:10.52547/JAD.2022.4.2.8.

Sawant D., Ogale H. and Deulkar R.M. (2022) An annotated checklist of odonates of Amboli-Chaukul-Parpoli region showing new records for the Maharashtra State, India with updated state checklist. Journal of Threatened Taxa 14 (11): 22164–22178. doi:10.11609/jott.7715.14.11.22164–22178

Sawant D., Deulkar R.M., Ogale S. and Ogale H. (2023). Four new records of dragon files (Insecta, Odonata) from Amboli region of Western Ghats, Maharashtra, India. ENTOMON 48 (1) : 99–106. doi: 10.3330/entomon v 48i.850.

Subramanian K.A. and Babu R. (2017) Checklist of Odonata (Insecta) of India. Version 3.0. www.zsi.gov.in. (Accessed on 7 July 2021).

Subramanian K.A., Emiliyamma K.G., Babu R., Radhakrishnan C. and Talmale S.S. (2018) Atlas of Odonata (Insecta) of the Western Ghats.

Zoological Survey of India, Kolkata. 417 pp.

Tiple A.D. (2020) Dragonflies and Damselflies (Odonata: Insecta) of the Bor Wildlife Sanctuary, Wardha, Maharashtra, Central India. Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa" 63(2). 131-140. doi: 10.3897/travaux.63.e52922.

Tiple A.D. and Koparde P. (2015) Odonata of Maharashtra, India with Notes on Species Distribution. Journal of Insect Science 15 (1): 47. doi:10.1093/jisesa/iev028.

Tiple A.D., Andrew R.J., Subramanian K.A. and Talmale S.S. (2013) Odonata of Vidarbha Region, Maharashtra State, Central India. Odonatologica 42 (3): 237–245.

Tiple A., Sharma V. and Padwad S.V. (2022) Dragonflies and damselflies (Insecta: Odonata) of Jabalpur, Madhya Pradesh, India. Journal of Threatened Taxa 14(2): 2074020746. doi:10.11609/jott.7306.14.3.20740–20746.

Varghese A.P., Nikesh P.R. and Mathew J. (2014) Odonata (Insecta) diversity of Salim Ali Bird Sanctuary and its adjacent areas in Thattekkad, Kerala, India. Journal of Threatened Taxa 6(6): 5887–5893. doi:10.11609/JoTT.o3395.5887-93.

Van Tol J. (1992) An annotated index to names of Odonata used in publications by M.A. Lieftinck. Zoologische Verhandelingen, Leiden 279: 1–263.

(Received October 18, 2022; revised ms accepted June 06, 2023; published June 30, 2023)