# Ceratopogonid flies of *Culicoides* (*Trithecoides*) (Diptera: Ceratopogonidae) of Indian subcontinent

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**Taxonomy, faunistics, new species, key, Diptera, Ceratopogonidae, *Culicoides*, *Trithecoides*, India**

**Abstract.** Indian species of *Culicoides* Latreille, subgenus *Trithecoides* Wirth & Hubert, 1959 are revised with addition of 3 new species, *C. forcepifinis* sp. nov., *C. inciderus* sp. nov. and *C. tympanus* sp. nov. Diagnoses of the subgenus, seven known species and revisions of the known and new species are presented in conjunction with the new keys for easy perusal of the species.

## INTRODUCTION

Wirth & Hubert (1959) assured the subgeneric status of *Trithecoides* in the genus *Culicoides* after its type, *Culicoides flaviscutatus* Wirth & Hubert (1959) for possessing three well-developed spermathecae and long 2nd radial cell. The authors reviewed 20 Oriental species with inclusion of 10 species under 6 species groups, *anophelis, flavescens, tenuipalpis, fulvithorax, macfie* and *raripalpis* followed by establishment of another group, *acanthostomus* raising the number of groups to 7 with 37 oriental species therein. The members of the subgenus were recorded from aquatic leaf axils of *Colocasia indica* in Java (Johanssen 1931; Wirth & Hubert 1989), stems and bases of rotting banana and plantain plants in Africa (Hopkins 1952) and India (Das Gupta & Ghosh 1956). There are 60 global species of *Trithecoides* with 7 species, *C. anophelis* Edwards, *C. inornatithorax* Das Gupta, *C. insolens* Choudhuri & Das Gupta, *C. macfiei* Causey, *C. palpifer* Das Gupta & Ghosh, *C. parararipalpis* Das Gupta and *C. raripalpis* Smith from India (Borkent 2015).

This paper revises 7 previously known Indian species which equate broadly to the subgenus and describes 3 new ones from India. A comparative study of morphometric data (Table 1) and number and distribution of SCo (Table 2) are presented.

## MATERIAL AND METHODS

Adults were collected in the light traps using a trace amount of glacial acetic acid as attracting agent. Specimens were mounted on glass slides following Wirth & Marston (1968) and were identified after Wirth & Hubert (1989). Morphology and terminology follow as in Nandi & Mazumdar (2014). Measurements are expressed in millimeters (mm) with mean value before parentheses while minimum and maximum value suffixed by "n" denoting the number of specimens considered within parentheses. Photographs were taken under a Magnüs MLX-TR compound microscope with Instavision MVV3000 digital camera.

All specimens, including the types are provisionally retained with the Collection of Diptera at the Department of Zoology, University of Burdwan (BUENT) and will be deposited to the National Zoological Collections (NZSI), Kolkata.

Abbreviations:

AR = Antennal Ratio; CR = Costal Ratio; P/H = Proboscis to head ratio; SCo = Sensilla Coeloconica; SCh = Sensilla Chaetica; TR = Tarsal Ratio; WL = Wing Length.

USNM = United States National Entomological Collection, USA; NZSI = National Zoological Collection, Zoological Survey of India, Kolkata.

## SYSTEMATIC ACCOUNT

### *Culicoides* subgenus *Trithecoides* Wirth & Hubert, 1959

*Culicoides*, subgenus *Trithecoides* Wirth & Hubert, 1959: 2; 1989: 77; Borkent 2015: 26.

Type species: *Culicoides flaviscutatus* Wirth & Hubert, 1959 by original designation.

**Diagnosis** (Revised after Wirth & Hubert 1989).
Female. Head. Eyes broadly contiguous, bare; SCo in flagellomeres 1, 9-13, often absent in 9 or 10, or 9 and 10 or on 13 or present in flagellomeres 5 (as in *C. insolens*). Maxillary palpus slender, palp segment III with capitate sensilla scattered or within sensory pit. Thorax. Mesonotum pale yellow or dark brown, scutellum and post-scutellum dark brown. Legs brown to dark brown, usually with pale bands; hind tibial comb usually with 4-5 spines; tarsal claws of female simple and pointed except *C. anophelis* with bifid tip. Wings with two well developed radial cells, 2nd radial cell broad and long; two distinct pale spots, anterior one covering r-m crossvein and the other over apex of 2nd radial cell; large distinct pale areas often at the base and the extreme tip, other pale areas indistinct; veins more or less infuscate; macrotrichia if present, sparse and concentrated towards tip and along the vein $M_1$. Abdomen. Brown in color. Spermathecae always three, well sclerotized, more or less pyriform or sausage-shaped, equal to subequal with a small sclerotized ring.
Male. Genitalia. Tergum IX with distinct apicolateral processes and deep caudomedian cleft; sternum IX nonspiculate; gonocoxite with greatly reduced ventral root, dorsal root slender; aedeagus usually with short basal arch and simple blunt tip; parameres small, separate or fused for a short distance near base with short basally swollen stem narrowed down to simple, slender tip.

**Species known from India.** *C. anophelis* Edwards, *C. forcepifinis* sp. nov., *C. inornatithorax* Das Gupta, *C. inciderus* sp. nov., *C. insolens* Choudhuri & Das Gupta, *C. macfiei* Causey, *C. palpifer* Das Gupta & Ghosh, *C. parararipalpis* Das Gupta, *C. raripalpis* Smith and *C. tympanus* sp. nov.

## DESCRIPTION OF SPECIES

### *Culicoides anophelis* Edwards, 1922

*Ceratopogon* sp. Fearnside 1900: 129; *Culicoides* sp. Gravely 1911: 45; Lalor & O'Groman 1912: 42; Stanton 1912: 64; Annandale 1913: 247.
*Culicoides anophelis* Edwards 1922: 161; Sinton & Little 1925: 45; Macfie 1932: 493; 1934: 214; 1937: 114; Smith & Swaminath 1932: 183; Galliard & Gaschen 1937: 320; Causey 1938: 409; Okada 1942: 140; Laird 1946: 158; Arnaud 1956: 91; Das Gupta & Ghosh 1956: 122; 1957: 26; Amosova 1957: 273; Sen & Das Gupta 1959: 108; Wirth & Hubert 1959: 8; 1989: 80; Chastel *et al*, 1966: 151; Debenham 1978: 191; Howarth 1985: 18; Borkent 2015: 26.

**Material examined:** 2 ♀♀, Srilanka: Colombo (received from Late W.W. Wirth, USNM and now in NZSI ); 2 ♀♀, 1 ♂, Calcutta, March, 1957, Coll. Dr. S.K. Das Gupta; 5 ♀♀, 3 ♂♂, Chinsura, 21.iii.1999, Coll. P.K. Chaudhuri; 2 ♀♀, Habra, 22.iii.2004, Coll. S. Nandi.
**Remarks.** Fearnside (1900) described the unnamed species under *Ceratopogon* Meigen

(1803) from Malaysia and India followed by several authors in *Culicoides* Latreille (1809) from various parts of the world. Edwards (1922) named the species which is now in use. The present specimens are in conformity with those of W.W.W. Wirth (USNM) and S.K. Das Gupta (Calcutta) which may be diagnosed by the following combination of characters: 1) large curved mandibular teeth with larger proximal one, 2) clypeus greatly enlarged, 3) hind tibial comb with 4 spines, 4) tarsal claws bifid, 5) typical pale spot on costa, 6) capitate sensilla scattered at the distal half of palp segment III, 7) gonostylus with small ventral roots, 8) parameres narrowly fused at the middle, each with large knob at the base, basal part bent laterally, tapering abruptly to slender, laterally curved and simple point.

## ***Culicoides forcepifinis* sp. nov.**

(Figs. 1A-I, Plates $1A_1$-$A_2$, 2A)

**Type locality.** India, West Bengal, Habra.

**Type specimens.** Holotype ♀ (slide-mounted specimen): "India, West Bengal, Habra, 12.vi.1968, Coll. S. K. Das Gupta". Paratypes: the same data as Holotype, (5 ♂♂, 4 ♀♀, slide-mounted specimens).

**Description.** Female. Head. Frontovertex dark brown with about 7 SCh. Eyes bare and broadly contiguous to a distance equal to diameter of 3-4 facets. Antenna (Fig. 1A) brown with two SCo each on flagellomeres 1, 9-13, length ratio of flagellomeres: 20-15-15-15-15-15-15-15-21-20-24-26-40, total length 0.786 (0.77-0.80, n=8), AR 1.04 (1.02-1.06, n=8). Maxillary palpus (Fig.1B) dark brown, palp segment III slender, swollen sub-apically with 8-9 scattered capitate sensilla, sensory pit indistinct; length ratio of palp segments I-V: 7-15-18-9-9, PR 2.71 (2.70-2.73, n=8). P/H 1.59 (1.58-1.61, n=8). Mandible (Fig. 1C) with 17 unequal teeth, basal larger and apical smaller.

Thorax. Yellowish brown. Mesonotum darker.

Legs (Fig. 1D) brown in color. Femora with pale apices, fore femur with narrow dark proximal band, mid and hind femora with dark band at the middle nearly double in length than that of fore femur; fore tibia darker towards distal half, mid tibia with distal 2/3$^{rd}$ and hind tibia with dark area towards distal end except a narrow pale area at the extreme end; hind tibial comb (Fig. 1E) with of 4 spines, second from the spur longest. TR of hind leg 2.18 (2.16-2.22, n=8).

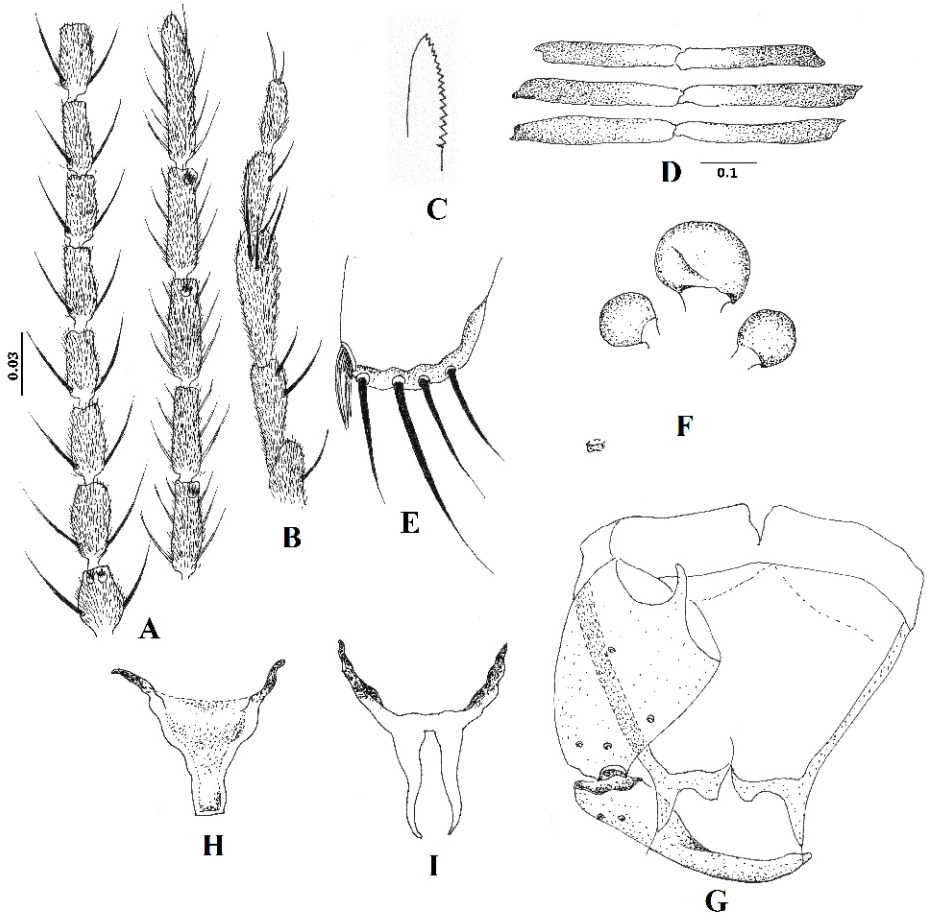
Wing (Plate $1A_1$) brown with broad pale area on r-m crossvein covering 1$^{st}$ radial cell mostly, post-stigmatic one covering distal 2/3$^{rd}$ of 2$^{nd}$ radial cell, cells $m_1$ and $m_2$ pale except darker streak at distal of veins $M_1$ and $M_2$, cell $cua_1$ with triangular pale area broadly meeting the wing margin, anal cell pale except for a narrow region extended to cell $m_2$; macrotrichia scanty; halter pale. Wing length 1.07 (0.98-1.09, n=5), breadth 0.54 (0.54-0.56, n=5); CR 0.68 (0.67.0.72, n=5).

Abdomen brown in color. Spermathecae (Fig. 1F, Plate 2A) unsclerotized, somewhat hemispherical, larger one 0.028x0.025 and smaller two 0.02x0.018 and 0.019x0.017 with long and broad necks joining together before opening, ring narrow.

Male. Similar to female with usual sex differences and distribution of SCo on antenna. Wing (Plate $1A_2$) length 0.86 (0.86-0.88, n=4), breadth 0.41 (0.40-41, n=4), CR 0.68 (0.67-0.72, n=5). Genitalia. (Fig. 1G) Tergum IX with a deep caudomedian notch flanked by stiff, acuminate apicolateral processes; sternum IX almost flat or hardly perceptible caudomedian excavation and ventral membrane nonspiculate; gonocoxite broad and narrowed distally with developed dorsal root and greatly reduced ventral roots; gonostylus slender incurved past middle and attenuated to a delicate hooked tip; aedeagus (Fig. 1H) massive with shallow arch, prominent arms and stem, apex blunt; parameres (Fig. 1I) separated except at the base and distal part long filiform more or less surgical forcep-like end.

**Etymology.** The name, *'forcepifinis'* derives from forcep like distal end of parameres.

**Differential diagnosis.** The species draws affinities with *C. iliensis* Gutsevich & Smatov (1966), *C. konglinensis* Yu & Kong (In Xue *et al.*, 1992) and *C. kaffongensis* Yu (1982) in legs, sclerotization of spermathecae and male genital features. The new species shows closeness to *C. anophelis* Edwards, *C. pendleburyi*, *C. albibasis*, *C. allantothecus* and *C. barnetti* described by Wirth & Hubert (1989) in narrowly jointed basal regions of parameres but differs in possession of forcep-like end. It bears similarity with *C. albibasis* and *C. parabarnetti* described by Wirth & Hubert (1989) in structure of spermathecae but some unusual features like: 1) palp segment III swollen sub apically with 8-9 scattered capitate sensilla, 2) mandible with 17 teeth, basal larger, thicker, apical smaller, 3) distributional pattern of pale areas on wing, 4) gonocoxite with greatly reduced ventral root, 5) parameres jointed at the base and distal part long filiform more or less surgical forcep like end favour for its consideration as a new member of *Culicoides (Trithecoides)*. This species may be placed into the *Raripalpis* group due to its possession of larger number of mandible teeth and shape of the spermathecae.




Figs. 1 A-I. Adult of *Culicoides forcepifinis* sp. nov.: A- antenna; B- maxillary palpus; C- mandible; D- legs; E- hind tibial comb; F- spermathecae; G- male genitalia; H- aedeagus; I- parameres.

### *Culicoides inciderus* sp. nov.

(Figs. 2A-I, Plates $1B_1$- $B_2$, 2B)

**Type locality.** India, West Bengal, Habra.

**Type specimens.** Holotype ♀ (slide-mounted specimen): "India, West Bengal, Habra, 08.iv.1980, Coll. Dr. P. P. Choudhuri". Paratypes: "West Bengal, Habra, 22.vi.1980, Coll. Dr. S. K. Das Gupta", (4♂♂, 3♀♀, slide-mounted specimens).

**Description.** Female. Head. Frontovertex dark brown with 8 SCh. Eyes contiguous, bare to a distance equal to diameter of 4 facets. Antenna (Fig. 2A) brown, SCo on flagellomeres 1,9-13, ultimate one pear like; length ratio of flagellomeres: 19-15-15-15-16-16-16-16-21-21-21-22-39, total length 0.74 (0.72-0.76, n=4), AR 0.96 (0.95-0.97, n=4). Maxillary palpus (Fig. 2B) dark brown, palp segment II elongated, III long, swollen towards apex with a shallow sensory pit bearing 6-7 capitate sensilla, IV and V smaller with apical sensilla; length ratio of palp segments I-V: 6-21-20-10-9, PR 2.7 (2.68-2.72, n=4). Mandible (Fig. 2C) with 11 small, subequal teeth.

Thorax dark brown in color. Mesonotum uniformly colored.

Legs (Fig. 2D) brown to dark brown in color. Fore femur with a narrow pale apical and distal area, tibia dark except at the base, mid femur brown with narrow proximal and distal broad pale area, tibia dark brown with pale basal areas, hind femur with brown with narrow pale proximal end, tibia brown, dark at middle, pale at both ends; hind tibial comb (Fig. 2E) with 4 spines, first one longest; TR of hind legs 2.4 (2.3-2.6, n=4).

Wing (Plate $1B_1$) mostly dark brown with pale spots as: proximal one at r-m crossvein extending to the bases of veins R and $M_1$, proximal post-stigmatic one covering distal 1/3$^{rd}$ of 2$^{nd}$ radial cell and a pale oblique area along cell $r_3$, pale streaks along cells $m_1$ and $m_2$, cell $cua_1$ with a pale area towards apex touching wing margin, anal cell with one large spot near the apex of cell $cua_2$; macrotrichia along the costal margin and apex of cell $r_3$; halter knob light brown. Wing length 1.08 (1.07-1.10, n=3), breadth 0.52 (0.5-0.54, n=3). CR 0.74 (0.73-0.75, n=3).

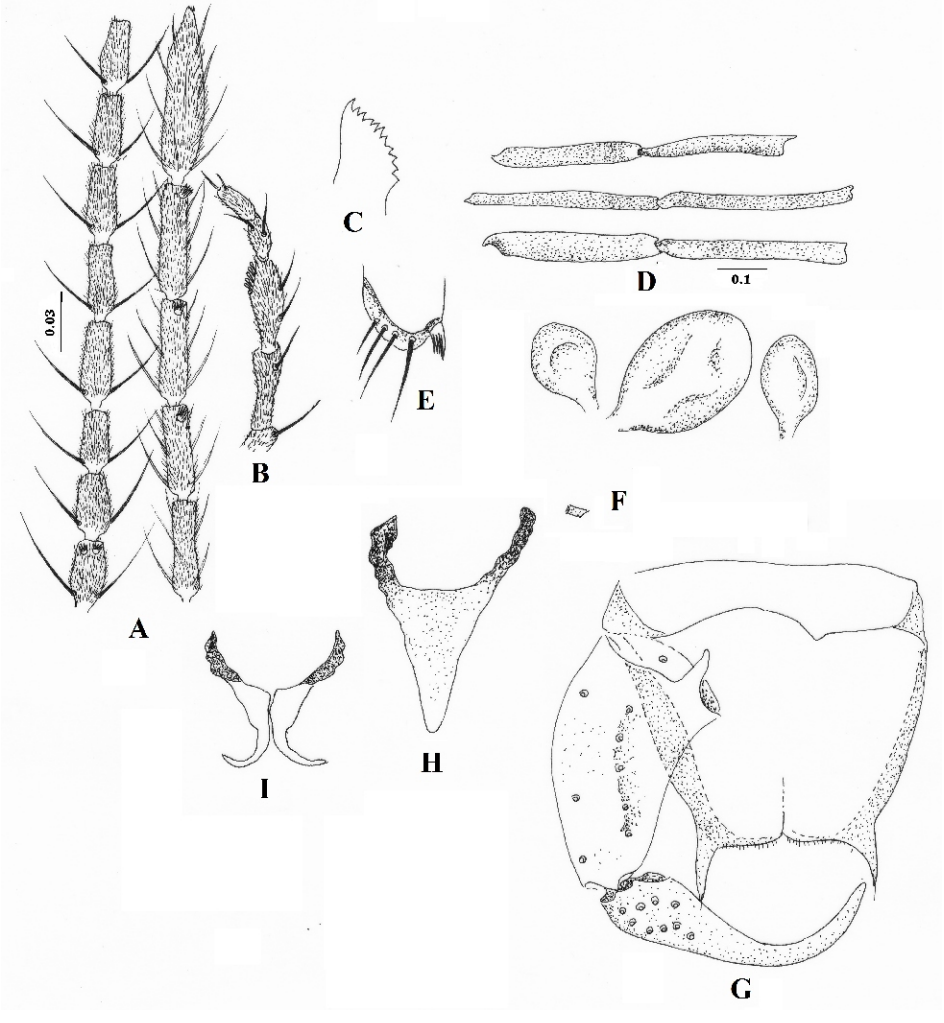
Abdomen dark brown in color. Spermathecae (Fig. 2F, Plate 2B) well sclerotized, unequal, ovoid, larger one measuring 0.032x0.026 and smaller two subequal measuring 0.020x0.016 and 0.016x0.014 with unsclerotized narrow necks, rudimentary one indistinct, ring narrow.

Male. Similar to female in wing structure (Plate $1B_2$) with usual sex differences and distribution of SCo on antennal segments. Wing (Plate $1A_2$) length 0.88(0.85-0.89, n=4), breadth 0.42(0.41-0.43, n=3), CR 0.73(0.72-0.74). Genitalia (Fig. 2G) Tergum IX sub rectangular with a median cleft at the caudal margin and two distinct horn-like apicolateral processes; sternum IX with a fairly deep caudomedian excavation and ventral membrane extended and spiculate; gonocoxite long, slender, little in-bent with dorsal root, ventral root reduced; gonostylus with swollen base and strongly incurved past middle, ending in a blunt, slender tip; aedeagus (Fig. 2H) lance like with long, slender incurved basal arms, body stout with conically narrowed to a blunt caudal tip; parameres (Fig. 2I) narrowly separated, each with swollen sub-conical base and the distal part slender and out-curved, terminating by a blunt tip.

**Etymology.** The name, *'inciderus'* derives from Latinized version of lance-like aedeagus.

**Differential diagnosis.** The new species resembles *C. culiciphaga* Wirth et Hubert (1959) and *C. raripalpis* Smith (1929) in distal flagellomeres, palp segment III, structure of mandible and more or less in wing pattern. In genital features, the new species bears similarities with that of *C.*

*palpifer* Das Gupta & Ghosh (1956) and *C. variatus* Liu, Yan & Liu (1996). It bears closeness with C. *manhauensis* Yu (1982) in eyes and its extension, spines of hind tibial comb, characteristic wing and leg coloration. It looks similar to *C. anophelis* in maxillary palpus, pattern of mandibular teeth, spermathecae, apicolateral process of tergum IX, gonostylus and aedeagus. The combination of characters such as: 1) 11 unequal mandibular teeth, 2) unicolorous mesonotum, 3) distribution of pale spots in wing, macrotrichia only along the costal margin and apex of cell r3, 4) horn-like apicolateral processes in tergum IX, 5) lance-like aedeagus with long, slender incurved basal arms and 6) narrowly separated parameres with swollen base and slender and out-curved, distal part ending in a blunt tip are different from previously known species for which the species may be proposed as a new member of subgenus *Trithecoides* from India. The species may be put in *Anophelis* group due to its larger number of teeth and pyriform spermathecae with slender neck.




Figs. 2 A-I. Adult of *Culicoides inciderus* sp. nov.: A- antenna; B- maxillary palpus; C- mandible; D- legs; E- hind tibial comb; F- spermathecae; G- male genitalia; H- aedeagus; I- parameres.

### *Culicoides inornatithorax* Das Gupta, 1963

*Culicoides inornatithorax* Das Gupta 1963: 36; Borkent 2015: 26.

**Differential diagnosis.** The species described by Das Gupta (1963) from Sikkim may be diagnosed by the following characters: palp segment III shorter than segment II with imperfect sensory pit, 2) mandible with 11 more or less equal teeth, 3) macrotrichia restricted to cells $r_3$, $m_1$ and $m_2$ ; two hyaline in cell $r_3$, one each on cell $cua_1$, anal cell and a linear pale streak along cell $m_2$, 4) hind femora dark, 5) Spermathecae well developed, spherical with unsclerotized ducts ,6) tergite IX without ventral root,7) parameres swollen below middle, thickened at base and stem tapered steadily to slender, simple, curved tip and 8) broad aedeagus with parallel-sided having flat tip. This species may be placed in the *Raripalpis* group for its number of mandible teeth and shape of the spermathecae.

### *Culicoides insolens* Choudhuri & Das Gupta, 1986

*Culicoides insolens* Choudhuri & Das Gupta, In Choudhuri *et al.*, 1986: 54; Borkent, 2015: 26.

**Differential diagnosis.** Choudhuri *et al.* (1986) described the species from the montane areas of India. The diagnostic character of the species are: 1) structure of flagellomeres and SCo on flagellomeres 1,5,9-13, 2) sensory pit small, 3) mandible with 7 subequal, stout, incurved teeth, 4) unequal tarsal claws with spine-like empodium and 5) wing with hyaline areas restricted to a large blotch at base, one covering the part of radial cells. This species may belong to *Anophelis* group (Choudhuri, Das Gupta, Bose & Chaudhuri 1986) for sharing the common features.

### *Culicoides macfiei* Causey, 1938

*Culicoides macfiei* Causey 1938: 411; Sen & Das Gupta 1959: 625; Wirth & Hubert 1959: 22; 1989: 101; Howarth 1985: 28; Borkent 2015: 26.

**Specimens examined.** "India, West Bengal, Kanchrapara, April, 1999, Coll. Bhuiyan" (1 ♀, slide mounted specimen)".

**Differential diagnosis.** Causey (1938) first described the species from Thailand followed by Sen & Das Gupta (1959), Wirth & Hubert (1959, '89) and Howarth (1985) from India and South East Asian countries. Re-examination of the identified material received from S.K. Das Gupta and W.W. Wirth (USNM) confirm its systematic status in the *Macfie* group with the following diagnostic characters: 1) palp segment III stout, swollen with distally scattered capitates sensilla, 2) mandible with 7 teeth, 3) dark brown scutum, 4) small distinct pale area over r-m cross vein, apex of 2nd radial cell, wing tip pale, 5) spermathecae unequal, 6) apicolateral process long, slender, 7) tergite IX with small ventral root and 8) parameres with prominent basal arms and short broad base and gradually narrowed to stout and outwardly bent sharply pointed tip.

### *Culicoides palpifer* Das Gupta & Ghosh, 1956

*Culicoides palpifer* Das Gupta & Ghosh 1956: 122; Wirth & Hubert 1959: 25; 1989: 107; Tokunaga 1959: 246; 1963: 136; Delfinado 1961: 668; Howarth 1985: 29; Borkent 2015: 27.

**Specimens examined.** "India, West Bengal, Kanchrapara, April, 1999 Coll. Bhuiyan" (5 ♀♀, 1 ♂, slide mounted specimens).

**Differential diagnosis.** Das Gupta & Ghosh (1956) first described the species from India followed by Wirth & Hubert (1959, '89), Tokunaga (1959, 1963), Delfinado (1961), and Howarth (1985) from South East Asia and Australia. Examination of the identified materials of S. K. Das Gupta confirms its status and may be recognized by: 1) mandibles with 7 teeth, 2) scutum entirely yellowish, 3) wing with pale areas at the base of r-m crossvein, along cells $m_1$, $m_2$, $cua_1$ and anal cell, veins darker and 4) gonocoxite with reduced ventral root. This species belongs to the *Macfie* group due to its reduced number of teeth, colouration of thorax and wing spot pattern.

### *Culicoides parararipalpis* Das Gupta, 1963

*Culicoides parararipalpis* Das Gupta 1963: 41; Borkent, 2015: 27.

**Differential diagnosis.** Das Gupta (1963) described the species from Sikkim may be identified by the following combination of features: 1) SCo indistinct in flagellomeres, 2) mandible with 14 teeth, 3) dark mesonotum without markings, 4) fore femur with indistinct pale apical band, fore tibia with sub basal pale bands, hind tibia with subbasal and preapical pale bands, other femora and tibiae dark, 5) wing pale with dark brown spots covering apex and base of 1st and 2nd radial cells, one triangular pale spot and a linear streak along vein $M_1$, linear dark streak along apex of vein $M_2$ and in cell $m_2$; 6) halter with pale knob and 7) dark brown abdomen with spermathecae having short necks. This species may be placed into the *Raripalpis* species group for its resemblance with the species, *C. raripalpis*.

### *Culicoides raripalpis* Smith, 1929

*Culicoides raripalpis* Smith 1929: 256; Macfie 1932: 493; 1937: 115; Causey 1938: 409; Wirth & Hubert 1959: 29; 1989: 148; Das Gupta 1963: 38; Borkent 2015: 27.

**Differential diagnosis.** The species was first described by Smith (1929) followed by Macfie (1937), Causey (1938), Wirth & Hubert (1959, '89) and Das Gupta (1963) from several places of South East Asian Countries. Dr. S.K. Das Gupta affirms its systematic position in the *Raripalpis* group with the following characters: 1) SCo on flagellomeres 1,10-13, sometimes absent on 11 or 13, 2) mandible with 12 teeth, 3) intensely dark brown scutum, scutellum and post-scutellum, 4) relatively dark wing with darkly infuscated veins, macrotrichia scanty, restricted mainly to the distal half of cells $r_3$ and $m_1$ and 5) gonocoxite with slender dorsal root and small, pointed ventral root.

### *Culicoides tympanus* sp. nov.

(Fig. 3A-I, Plates $1C_1$-$C_2$, 2C)

**Type locality.** India, West Bengal, Jhargram.

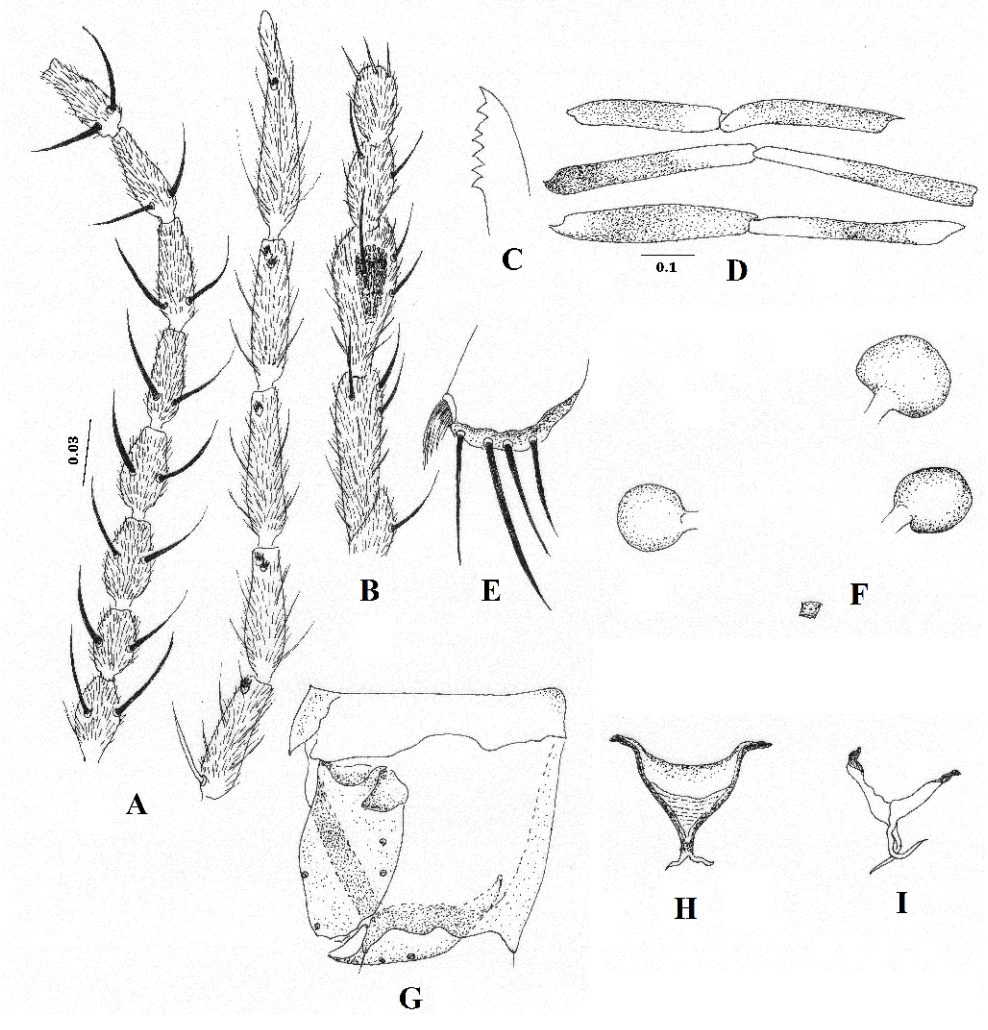
**Type specimens.** Holotype ♀ (slide-mounted specimen): "India, West Bengal, Jhargram, 02.vi.1979, Coll. S. K. Das Gupta". Paratypes: "West Bengal, Jhargram, 04.ix.1979, Coll. P. P. Choudhuri" (2 ♀, 1 ♂, slide-mounted specimens); "West Bengal, Jhargram, 11.iii.2004 and 04.ix.2006, Coll. D. Ray" (10 ♀, 6 ♂, slide-mounted specimens).

**Description.** Female. Head. Frontovertex yellowish brown with 2 large and 6 small scattered SCh. Eyes bare and broadly contiguous to a distance equal to diameter of 3 facets. Antenna (Fig. 3A) yellowish, SCo on flagellomeres 1,9-13, ultimate one narrowed down to apex ending in a narrowed nipple-like process; length ratio of flagellomeres: 17-14-15-15-16-17-18-17-23-23-

22-22-39, total length 0.76 (0.75-0.77, n=8), AR 0.99 (0.99-1.00, n=8). Maxillary Palpus (Fig. 3B) yellow studded with profuse setae, palp segment III long, swollen distal end with thimble like sensory pit bearing a bunch (13-14) of capitate sensilla, segment V short with 3 apical sensilla; length ratio of palp segments I-V: 7-20-19-10-9, PR 2.2 (2.1-2.4, n=8), P/H 2.07 (2.05-2.08, n=8). Mandible (Fig. 3C) with 7 large, incurved teeth.

Thorax brown. Mesonotum yellowish brown without pattern.

Legs (Fig. 3D) brown to dark brown. Fore femur brown with paler at both ends, tibia dark brown with proximal pale area; mid femur dark brown with pale apical area and tibia brown with paler proximal half; hind femur dark with small pale base, hind tibia with pale basal and apical areas; hind tibial comb (Fig. 3E) with 4 spines, second longest. TR of hind legs 2.33 (2.31-2.34, n=8).




Figs. 3 A-I. Adult of *Culicoides tympanus* sp. nov.: A- antenna; B- maxillary palpus; C- mandible; D- legs; E- hind tibial comb; F- spermathecae; G- male genitalia; H- aedeagus; I- parameres.

Wing (Plate 1C$_1$) yellowish brown with pale spots on basal arculus, on r-m crossvein extending to the costal margin and covering proximal half of 1$^{st}$ radial cell, post-stigmatic proximal spot covering most of the 2$^{nd}$ radial cell, cell r$_3$ with another pale spot diagonally covering the wing margin, cells m$_1$ and m$_2$ with narrow pale streak originating away from the base and reaching the wing margin; cell cua$_1$ with a large spot touching wing margin; anal cell with two separate pale areas: basal more or less triangular and another near apical margin; macrotrichia sparse, along costal cell and a few in cell r$_3$; halter yellowish throughout. Wing length 1.16 (1.11-1.18, n=10), breadth 0.54 (0.54-0.56, n=10), CR 0.68 (0.66-0.69, n=10).

Abdomen dark yellowish brown. Spermathecae (Fig. 3F, Plate 2C) well sclerotized, unequal, globular, larger one 0.023x0.022 and the other two 0.019x0.017 and 0.018x0.017 with unsclerotized necks joined together to form common vagina, a ring visible.

Male. Similar to female with usual sex differences, distribution of SCo on antenna and narrower wing (Plate 1C$_2$). Wing length 0.94 (0.92-0.94, n=4), breadth 0.41 (0.4-0.42, n=4), CR 0.67 (0.67-0.68, n=4). Genitalia. (Fig. 3G) Tergum IX with a medial notch and a pair of small apicolateral processes; sternum IX with a shallow caudomedian excavation; gonocoxite drum-like with a slender with imperceptible dorsal root and without ventral root; gonostylus mostly stout with a narrow incurved beak-like apex; aedeagus (Fig. 3H) body massive with small, slender basal arms, stem narrow, short and slender bare bifurcated in filiform processes; parameres (Fig. 3I) separated, stem flap-like, extended into a long, bare simple out-curved terminal ends.

**Etymology.** The name, *'tympanus'* derives from the Latin meaning of 'drum' like gonocoxite.

**Differential diagnosis.** The species bears affinity with *C. sarawakensis* Wirth & Hubert (1959) in structure of mandible and pale markings of wing. In palp segment III and sensory pit, the species comes nearer to *C. culiciphagus* Wirth & Hubert (1959). Similarly, *C. albibasis* Wirth & Hubert (1959) shows closeness with the new species in respect to spermathecae, apicolateral processes, gonostylus and parameres. The new species approximates to *C. macfiei* in number of mandibular teeth and to *C. anophelis* in the shape of spermatheca. The diagnostic features of the species are: 1) ill-formed shallow sensory pit with stray capitate sensilla, 2) 7 large, incurved teeth of mandible, 3) drum like gonocoxite, with imperceptible dorsal root and without ventral root, 4) massive aedeagus with short and slender bare bifurcated tip bearing filiform tip, differ from the previously known species favoring for its consideration as a new member of *Culicoides* (*Trithecoides*) under *Macfie* group from India.

Table 1: COMPARATIVE MORPHOMETRIC DATA OF THE THREE NEW SPECIES

| Sl. No. | Name of the species | Sch on frontovertex | AR | Distribution of SCo | PR |
|---|---|---|---|---|---|
| **1** | ***C. anophelis*** | 24-25 | 0.91-1.10 | 1,9-13 | 1.6-2.3 |
| **2** | ***C. forcepifinis sp.nov.*** | 8 | 1.02-1.06 | 1,9-13 | 2.70-2.73 |
| **3** | ***C. inciderus sp.nov.*** | 8 | 0.72-0.76 | 1,9-13 | 2.68-1.72 |
| **4** | ***C. macfiei*** | - | 1.14 | 1,9-13 | 2.0 |
| **5** | ***C. palpifer*** | 14-16 | 0.91-1.05 | 1,9-13 | 1.7-2.6 |
| **6** | ***C. parararipalpis*** | - | 0.94 | - | 2.1 |
| **7** | ***C. raripalpis*** | - | 1.05 | 1,10-13 1,9,11-13 | 2.25 |
| **8** | ***C. tympanus sp.nov.*** | 8 | 0.99-1.00 | 1,9-13 | 2.1-2.4 |

| Sl. No. | Name of the species | P/H | Mandibular teeth | Wing length |
|---|---|---|---|---|
| **1** | ***C. anophelis*** | 0.35-0.40 | 12-14 | 0.93-1.09 |
| **2** | ***C. forcepifinis sp.nov.*** | 0.58-0.61 | 9 | 0.98-1.09(f) 0.86-0.88(m) |
| **3** | ***C. inciderus sp.nov.*** | 0.86 | 11 | 1.07-1.10 |
| **4** | ***C. macfiei*** | 0.64 | 7 | 1.0 |
| **5** | ***C. palpifer*** | 0.58 | 6-8 | 0.80-1.07 |
| **6** | ***C. parararipalpis*** | - | 14 | 0.97 |
| **7** | ***C. raripalpis*** | - | 12 | 0.81 |
| **8** | ***C. tympanus sp.nov.*** | 2.05-2.08 | 7 | 1.11-1.18(f) 0.92-0.94(m) |

| Sl. No. | Name of the species | CR | TR of hind leg | Spines on hind tibia | Measurements of spermathecae |
|---|---|---|---|---|---|
| **1** | ***C. anophelis*** | 0.67-0.71 | 2.0 | 4 | 0.039×0.033<br>0.040×0.033<br>0.038×0.031 |
| **2** | ***C. forcepifinis sp.nov.*** | 0.67-0.72 | 2.16-2.24 | 4 | 0.028×0.025<br>0.020×0.018<br>0.019×0.017 |
| **3** | ***C. inciderus sp.nov.*** | 0.73-0.75 | 2.3-2.6 | 4 | 0.032x0.026<br>0.020x0.016<br>0.016x0.014 |
| **4** | ***C. macfiei*** | 0.68 | 2.2 | 4 | 0.052x0.047<br>0.041x0.036<br>0.041x0.036 |
| **5** | ***C. palpifer*** | 0.67-0.71 | 2.4 | 4 | 0.030×0.030<br>0.023×0.022<br>0.023×0.022 |
| **6** | ***C. parararipalpis*** | 1.5 | - | 4 | 0.035 0.030<br>0.026 0.023<br>0.024 0.021 |
| **7** | ***C. raripalpis*** | 0.85 | 1.86 | 4 | 0.034×0.030<br>0.027×0.023<br>0.023×0.022 |
| **8** | ***C. tympanus sp.nov.*** | 0.67-0.69 | 2.30-2.34 | 4 | 0.023×0.022<br>0.019×0.017<br>0.018×0.017 |

Table 2: Distribution of SCo on flagellomeres

| Sl. No. | Species | | Flagellomeres | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sex | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| **1** | ***C. anophelis*** | **F** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| **2** | ***C. forcepifinis sp.nov.*** | **F** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 |
| | | **M** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 |
| **3** | ***C. inciderus sp.nov.*** | **F** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 |
| | | **M** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 |
| **4** | ***C. macfiei*** | **F** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| **5** | ***C. palpifer*** | **F** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | | **M** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 |
| **6** | ***C. tympanus sp.nov.*** | **F** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 2 | 1 |
| | | **M** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

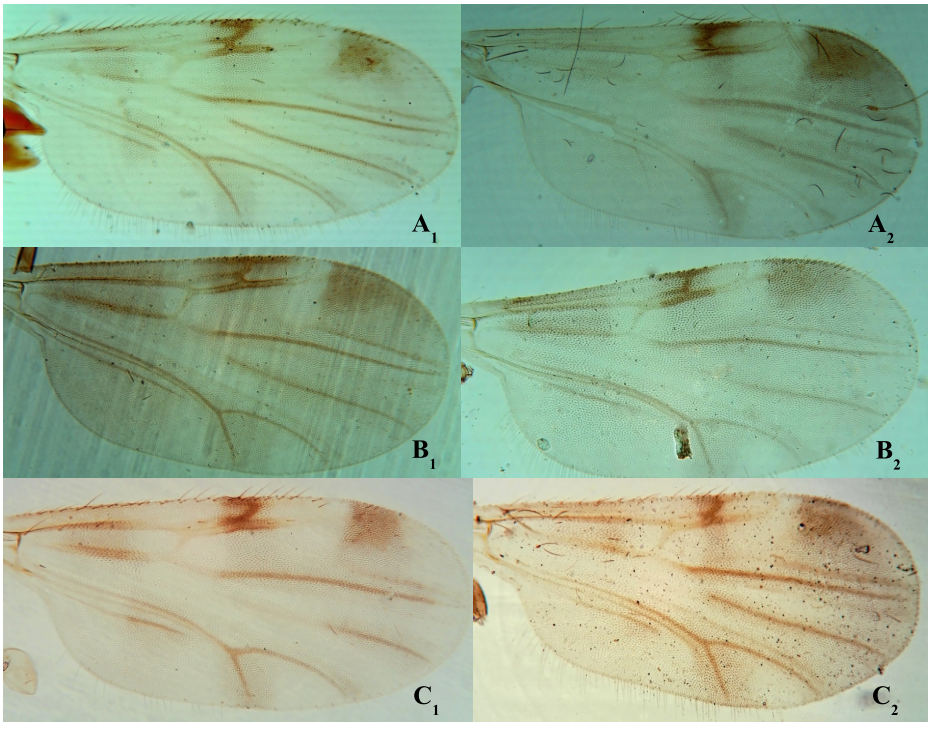



Plate 1. Wings: Female. $A_1$-$A_2$ *C. forcepifinis* sp. nov.: $A_1$ female, $A_2$ male; $B_1$-$B_2$ *C. inciderus* sp. nov.: $B_1$ female, $B_2$ male; $C_1$-$C_2$ *C. tympanus* sp. nov.: $C_1$ female, $C_2$ male.

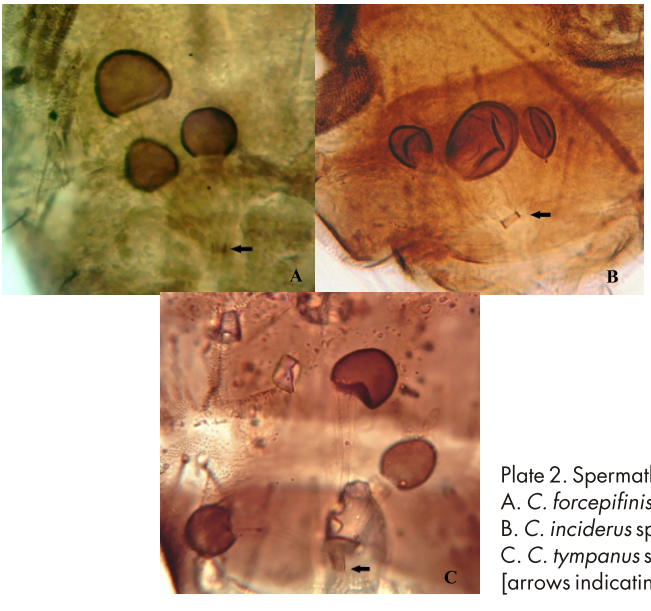



Plate 2. Spermathecae:
A. *C. forcepifinis* sp. nov.,
B. *C. inciderus* sp. nov.,
C. *C. tympanus* sp. nov.
[arrows indicating the rings]

## KEY TO THE FEMALES OF INDIAN SPECIES OF *CULICOIDES (TRITHECOIDES)*

1. Mandible teeth 8-16..... 2
   Mandibular teeth 7..... *Macfie* group..... 8
2. Spermathecae unequal, one large and two subequal, small with broad necks..... *Raripalpis* group..... 3
   Spermathecae equal or subequal, pyriform with slender necks..... *Anophelis* group..... 6
3. Wing with a pale area at the apex of cell $r_3$..... 4
   Wing without any pale area at the apex of cell $r_3$..... 5
4. Anal cell almost entirely pale..... *forcepifinis* sp. nov.
   Anal cell brown except a small distal pale area at or near the posterior wing margin..... *inornatithorax* Das Gupta
5. Pale species with SCo on distal flagellomeres except 11 or 12; pale spot on r-m cross-vein without touching costa..... *raripalpis* Smith
   Darker species without any SCo on distal flagellomeres; pale spot on r-m cross-vein touching costa..... *parararipalpis* Das Gupta
6. SCo distributed on flagellomeres 1, 9-13..... 7
   SCo distributed on flagellomeres 1, 5, 9-13..... *insolens* Choudhuri & Das Gupta
7. Cell $r_3$ with pale apex, dark marking on $CuA_2$ narrow..... *anophelis* Edwards
   Cell $r_3$ without pale apex, dark marking on $CuA_2$ broad..... *inciderus* sp. nov.
8. Pale area on r-m extended greater than half length of cell $r_1$, slightly angled before meeting anterior wing margin narrowly ..... *tympanus* sp. nov.
   Pale area on r-m extended lesser than half length of the cell $r_1$, straightly meeting anterior wing margin..... 9
9. Mesonotum dark brown..... *macfiei* Causey
   Mesonotum yellow..... *palpifer* Das Gupta & Ghosh

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## REFERENCES

AMOSOVA I. S. 1957: Some new or little known *Culicoides* Latreille (Diptera: Heleidae) from Ussuri Land [in Russian, English summary]. *Entomologicheskoe Obozrenie* 36: 233-247.

ANNANDALE N. 1913: Indian blood-sucking midges. *Records of Indian Museum* 9: 246-247.

ARNAUD P. 1956: The heleid genus *Culicoides* in Japan, Korea and Ryukyu Islands (Insecta: Diptera). *Microentomology* 21: 84-207.

BORKENT A. 2015: The Subgeneric Classification of Species of *Culicoides* - thoughts and a warning. Available in the website: http://www.inhs.illinois.edu/research/FLYTREE/**Culicoides** Subgenera.pdf. 1-39. (Downloaded on 11th February, 2015)

CAUSEY O. R. 1938: *Culicoides* of Siam with descriptions of new species. *American Journal of Hygiene* 27: 399-416.

CHASTEL P. C., RAGEAU J. & ABONNENC E. 1966: Présence de *Culicoides anopheles* Edwards, 1922 (Diptera: Ceratopogonidae) au cambodge. *Bulletin de la Sociėtė de Pathologie exotique* 59: 151-155.

CHOUDHURI P. P., BOSE M., DAS GUPTA S. K. & CHAUDHURI P. K. 1986: *Anophelis* group of *Culicoides* Insects (Ceratopogonidae: Diptera) of India. *Burdwan University Journal of Science* 3(1): 52-55.

DAS GUPTA S. K. 1963: Report on a collection of Sikkim *Culicoides* (Diptera: Ceratopogonidae). *Proceedings of the Zoological Society* (Calcutta) 16(1): 33-43.

DAS GUPTA S. K. & GHOSH S. M. 1956: Notes on *Culicoides palpifer*, a new species (Family Ceratopogonidae, Order Diptera). *Bulletin of the Calcutta School of Tropical Medicine and Hygiene* 4: 122.

DAS GUPTA S. K. & GHOSH S. M. 1957: *Culicoides anophelis* Edw. as an ectoparasite of culicine mosquitoes. *Bulletin of Calcutta School of Tropical Medicine* 5: 26-27.

DEBENHAM M. L. 1978: An annotated checklist and bibliography of Australasian Region Ceratopogonidae (Diptera: Nematocera). *School of Public Health and Tropical Medicine, University of Sydney and Commonwealth Department of*

*Health* Monograph Series. Entomology Monograph 1, xiv + 671 pp.
DELFINADO M. D. 1961: The Philippine biting midges of the genus *Culicoides* (Diptera: Ceratopogonidae). *Fieldiana Zoology* 33: 627-675.
EDWARDS F. W. 1922: On some Malayan and other species of *Culicoides*, with a note on the genus *Lasiohelea*. *Bulletin of Entomological Research* 13: 161-167.
FEARNSIDE C. J. 1900: Parasites found on mosquitoes. *Indian Medical Gazette* 35: 129.
GAILLARD H. & GASCHEN H. 1937: Parasitisme d'*Anopheles hyrcanus* par les *Culicoides* au Tonkin. *Annales De Parasitologie Humaine Et Comparee* 15: 320-322.
GRAVELY F. H. 1911: Mosquito sucked by a midge. *Records of Indian Museum* 6: 45.
GUTSEVICH A. V. & SMATOV Z. S. 1966: New and little-known blood-sucking midges (Diptera: Ceratopogonidae) of Kazakhstan. *Trudy Instituta Zoologii Akademii Nauk Kazakhskoi SSR* 25: 65-77. [In Russian]
HOPKINS C. A. 1952: Notes on the biology of certain *Culicoides* studied in the British Cameroons, West Africa, together with observations on their possible role as vectors of *Acanthocheilonema perstans*. *Annals Tropical Medicine & Parasitology* 46: 165-172.
HOWARTH F. G. 1985: Biosystematics of the *Culicoides* of Laos (Diptera: Ceratopogonidae). *International Journal of Entomology* 27: 1-96.
JOHANNSEN O. A. 1931: Ceratopogoninae from the Malayan Subregion of the Dutch East Indies. *Archiv für Hydrobiologie* 9: 403-448.
LAIRD M. 1946: A ceratopogonine midge (*Culicoides anophelis* Edwards, 1922) sucking engorged blood from a mosquito (*Armigeres lacuum* Edwards, 1922) at Palmalmal, New Britain. *Transaction Proceedings Royal Society of New Zealand* 76: 158-161.
LATREILLE P. A. 1809: *Genera crustaceorum et insectorum secundum ordinem naturalem in familias disposita, iconibus exemplisque plurimis explicate*, Paris and Strasbourg, 4: 399 pp., 4 pls.
LALOR N. & O'GROMAN P. 1912: Note on a parasitic fly which infests malaria carrying *Anopheles* in Lower Burma. *Paludism* 5: 42-43.
LIU J. H., YAN G. & LIU G. P. 1996: The Biting Midge from Hainan Island [In Chinese, English summary]. *Military Medical Science Press*, Beijing. vi + 184 pp.
MACFIE J. W. S. 1932: Some new or little known Ceratopogonidae. *Annals and Magazine of Natural History* 9(10): 485-499.
MACFIE J. W. S. 1934: Fauna Sumatrensis. Bijdrage no. 75. Ceratopogonidae (Diptera). *Tijdschrift Voor Entomology* 77: 202-231.
MACFIE J. W. S. 1937: Notes on Ceratopogonidae (Diptera). *Proceedings of Royal Entomological Society of London* 6: 111-118.
MEIGEN J. W. 1803: Versuch einer neuen Gattungseintheilung der europäischen zweiflügligen Insekten. *Magazin für Insektenkunde* 2: 259-281.
NANDI M & MAZUMDAR A. 2014. Revision of the subgenus *Diphaomyia* Vargas of *Culicoides* Latreille from India with description of a new species (Diptera: Ceratopogonidae). *Zootaxa* 3793(4): 465-474.
OKADA T. 1942: Notes on a biting midge parasitic on Anopheline mosquito with a revision of its allies (Diptera: Heleidae). *Transaction of Natural History Society of Formosa* 32: 137-146.
SEN P. & DAS GUPTA S. K. 1959: Studies on Indian *Culicoides* (Ceratopogonidae: Diptera). *Annals of the Entomological Society of America* 52: 617-630.
SMITH R. O. A. 1929: Two species of *Culicoides* which feed on man. *Indian Journal of Medical Research* 17: 255-257, pl. 13.
SMITH R. O. A. & SWAMINATH C. S. 1932: Notes on some *Culicoides* from Assam. *Memoirs of Indian Medical Research* 25: 182-186, 1 pl.
SINTON J. A. & LITTLE C. S. H. 1925: The occurence of *Culicoides* as an ectoparasite of anophelines. *Journal of Royal Army Medical Corps* 45: 45-47.
STANTON A. T. 1912: A *Ceratopogon* parasitic upon anopheline mosquitoes. *Palaudism* 5: 64.
TOKUNAGA M. 1959. New Guinea biting midges (Diptera: Ceratopogonidae). *Pacific Insects* 1: 177-314.
TOKUNAGA M. 1963. Supplementary study of New Guinea biting midges of the genus *Culicoides* (Diptera: Ceratopogonidae). *Plant Protect Bulletin* 5: 119-143.
WIRTH W. W. & HUBERT A. A. 1959: *Trithecoides*, a new subgenus of *Culicoides* (Diptera: Ceratopogonidae). *Pacific Insects* 1(1): 1-38.
WIRTH W. W. & HUBERT A. A. 1989: The *Culicoides* of Southeast Asia (Diptera: Ceratopogonidae). *Memoirs of the American Entomological Institute* 44(i-iv): 1-508.
WIRTH W. W. & MARSTON N. 1968: A method for mounting small insects on microscope slides in Canada balsam. *Annals of Entomological Society of America* 61: 783-784.
XUE J., KONG F. J. & YU Y. X. (1992): Two new species of *Culicoides* from Qufu, Shandong, China (Diptera: Ceratopogonidae). *Chinese Journal of Parasitic Disease Control* 5: 52-53. [In Chinese, English summary].
YU Y. X. (1982): The identification of important biting midges of China. Chapter III. *Manual of Important Chinese Insect Vectors of Animal Disease*. 178-224, 945-951. Beijing: People's Health Publishing House. [In Chinese]