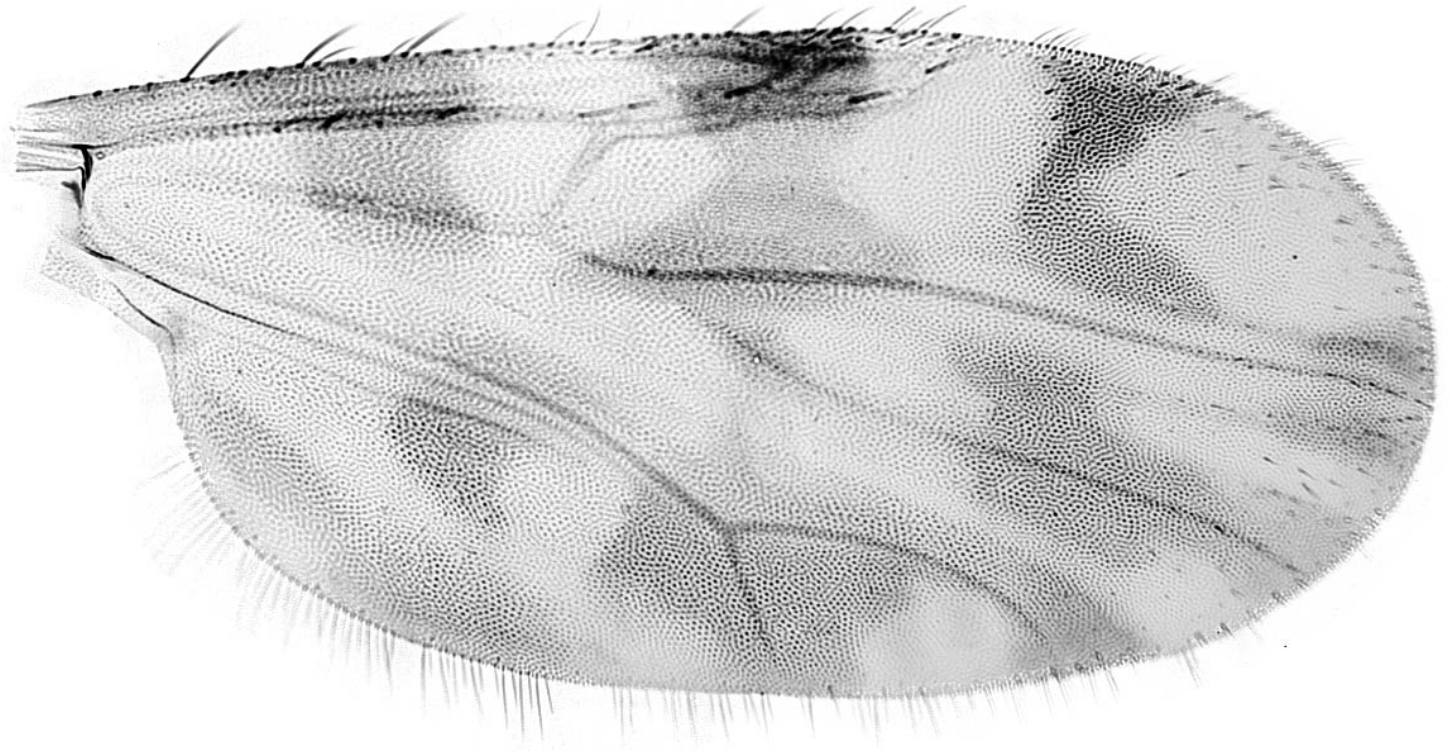
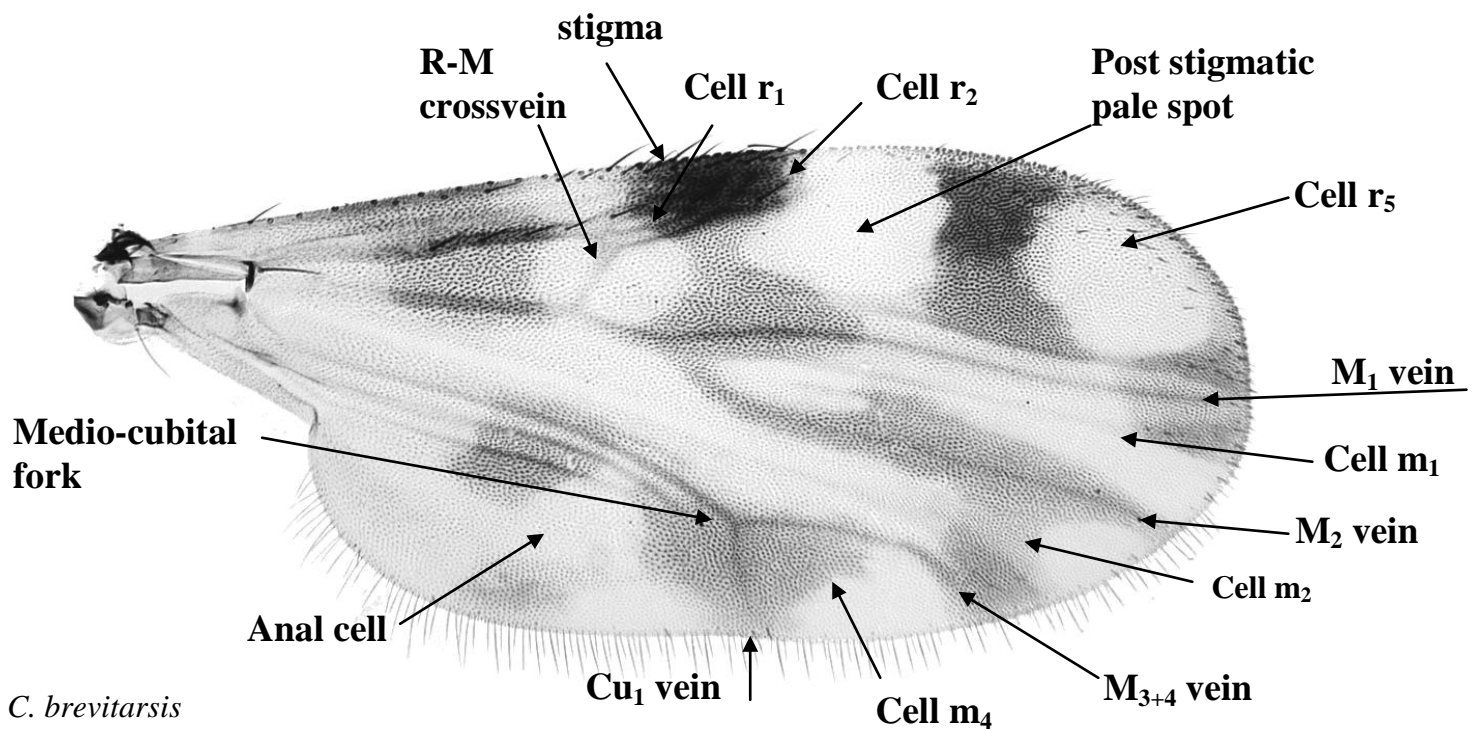
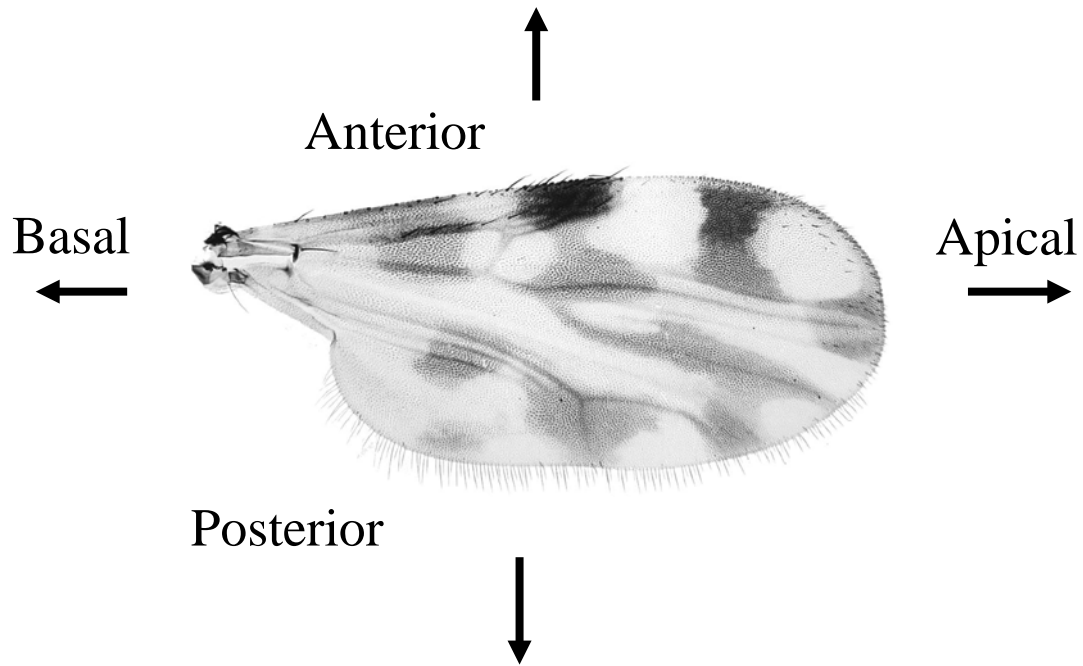


Key to females of economically important species of  
*Culicoides* subgenus *Avaritia* from India using characters  
visible under a stereomicroscope.



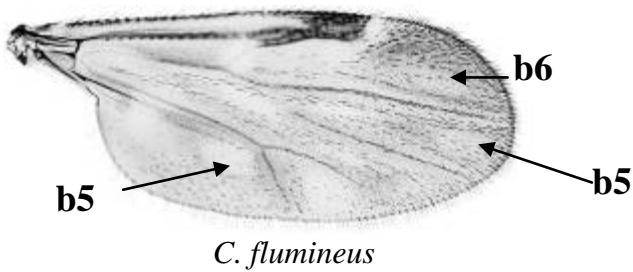
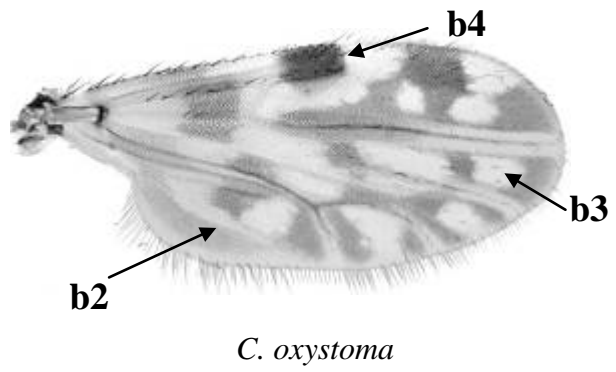
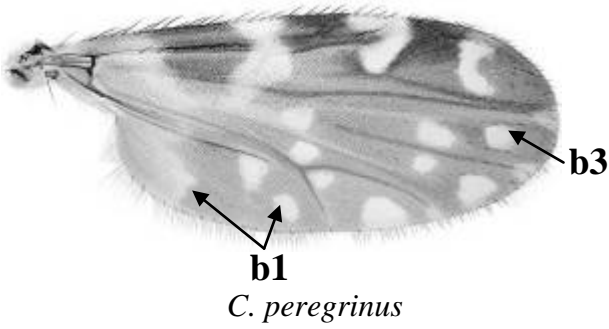
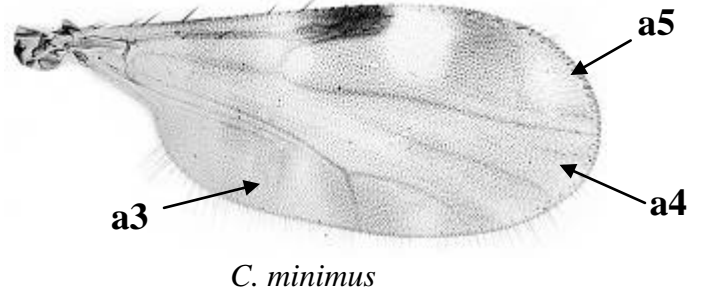
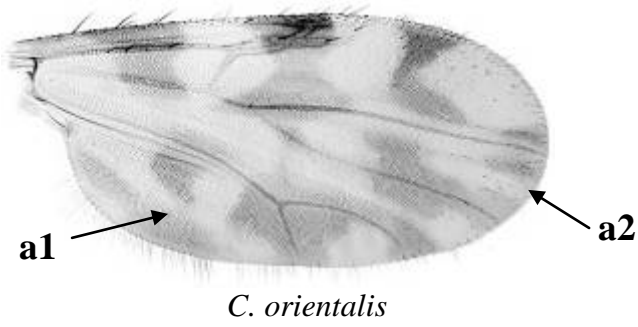
Glenn Bellis  
Department of Agriculture  
Northern Australia Quarantine Strategy  
PO Box 37846, Winnellie  
NT, 0821, Australia

## Orientation of a *Culicoides* wing



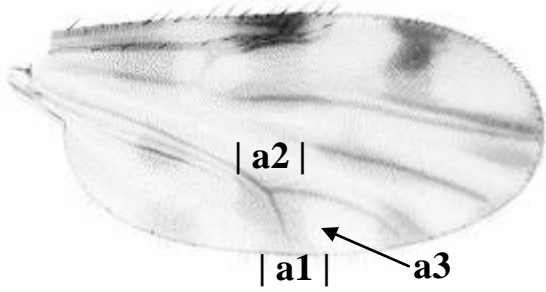
Note: This key aims to assist workers to separate the species belonging to *Culicoides* Subgenus *Avaritia* which are associated with livestock and have been reported to occur in India or neighbouring countries. It has been extracted and adapted from Bellis G, Anderson S & Halling L, A pictorial key to adult female *Culicoides* Latreille 1809 (Diptera: Ceratopogonidae) from the Northern Territory, Western Australia and South Australia, *Austral Entomology* (in press). It is not a comprehensive treatment of the entire *Culicoides* fauna of India as it does not include species belonging to other subgeneric groupings nor Indian species belonging to *C.* subgenus *Avaritia* that have not been associated with livestock. The species included in the key are: *C. actoni*, *C. asiatica*, *C. boophagus*, *C. brevipalpis*, *C. brevitarsis*, *C. dumdumi*, *C. flavipunctatus*, *C. fulvus*, *C. imicola*, *C. jacobsoni*, *C. minimus*, *C. orientalis* and *C. wadai*. The key is unable to distinguish between *C. actoni* and *C. minimus* as separation of these two species requires examination of antennal sensilla which are generally not visible under a stereomicroscope.

1. Anal cell with apical and basal pale spots joined by a pale strip (a1); apical pale spot in cell  $m_1$  reaching apex of wing (a2) in all species excepting *C. jacobsoni*; if pale spots in anal cell (a3) and cell  $m_1$  (a4) indistinct, then apical pale spot in cell  $r_5$  truncate basally and extending to margin of wing (a5) (subgenus *Avaritia*) ..... 2
- Apical and basal pale markings in anal cell not joined (b1); if uncertain (b2), then apical pale spot in cell  $m_1$  not reaching margin of wing (b3) and cell  $R_2$  entirely dark (b4), if pale spots in anal cell and/or cell  $m_1$  indistinct (b5) then pale spot in cell  $r_5$  not truncate basally and/or not extending to margin of wing (b6) ..... not *C. subg. Avaritia*

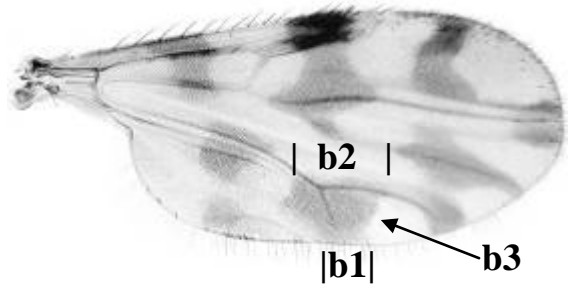


**Subgenus Avaritia**

2. Posterior edge of dark marking over  $Cu_1$  vein (a1) about as wide as anterior edge (a2); apical edge of dark marking over  $Cu_1$  vein (a3) more or less parallel to  $Cu_1$  vein or with apical edge indistinct (a4); legs with indistinct markings and pale knees (a5)..... 3  
 Posterior edge of dark marking over  $Cu_1$  vein (b1) distinctly narrower than anterior edge (b2); apical edge of dark marking over  $Cu_1$  vein (b3) distinct and not parallel to vein  $Cu_1$ ; legs with distinct pale banding and dark knees (b4)..... 4



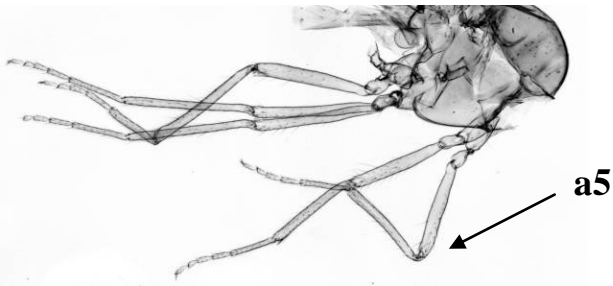
*C. brevipalpis*



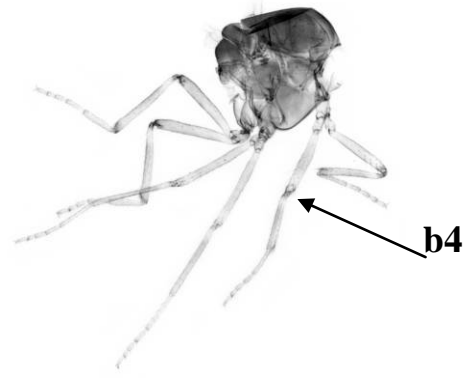
*C. fulvus*



*C. minimus*

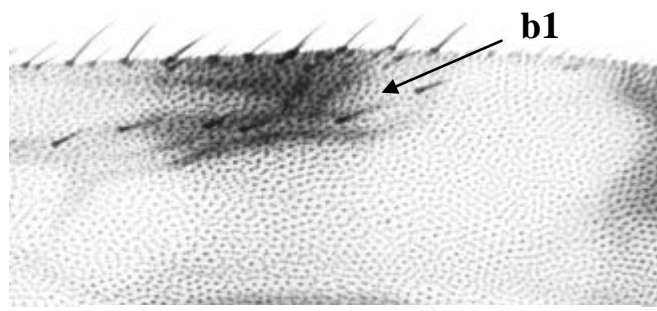
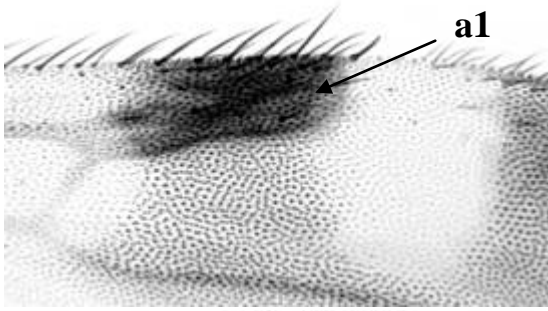


*C. brevipalpis*



*C. brevitarsis*

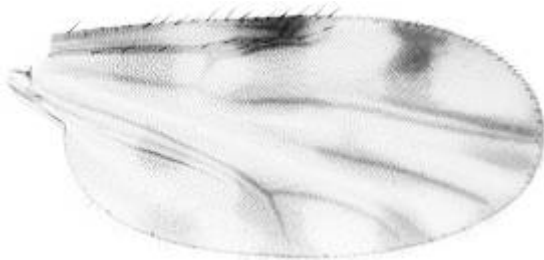
3. Cell  $r_2$  dark almost to apex, the pale post stigmatic spot not reaching the lumen of the cell (a1), thorax dark brown.....*actoni/minimus*  
 Cell  $r_2$  with about half of the lumen included in the post stigmatic pale spot (b1), thorax pale  
 .....*brevipalpis*



*C. minimus*

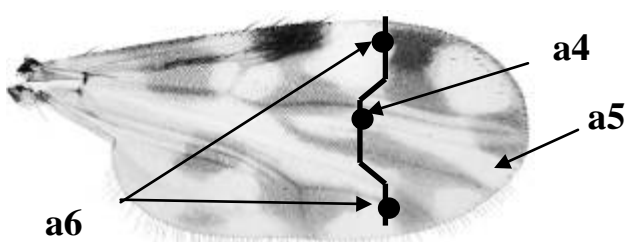
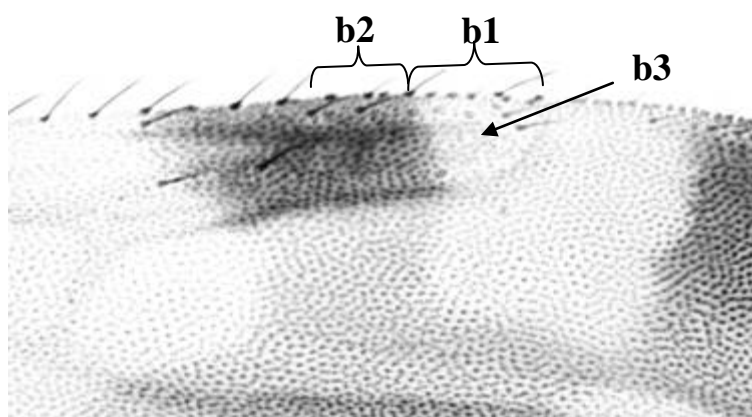
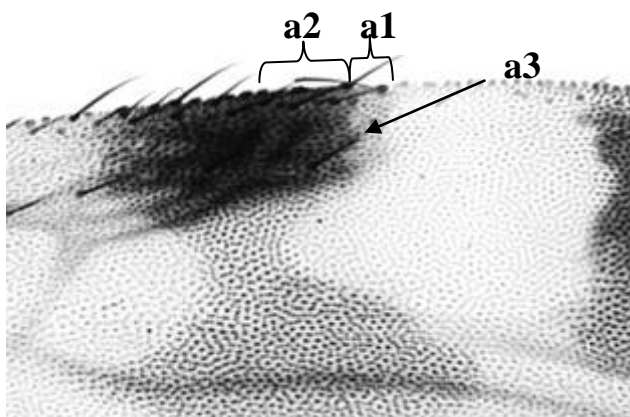


*C. actoni*

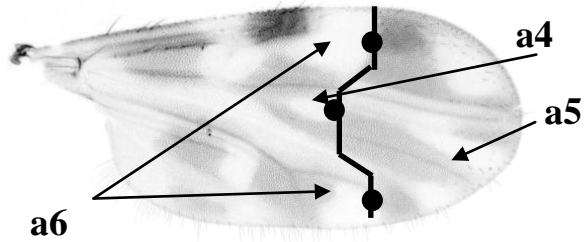


*C. brevipalpis*

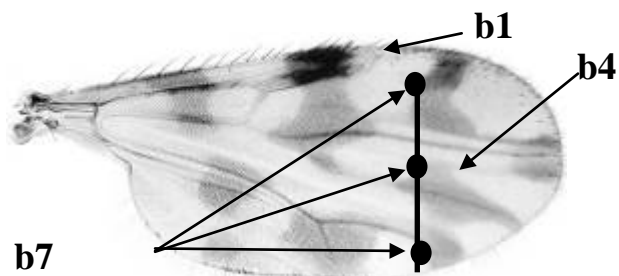
4. Pale portion of cell  $r_2$  (a1) less than half the length of the dark portion of the cell (a2) with only the very edge of the lumen of cell  $r_2$  included in the post stigmatic pale spot (a3), anterior edge of dark marking on vein  $M_2$  more or less straight from apical margin of basal pale spot in cell  $m_1$  (a4) to wing margin (a5), posterior edge of basal pale spot in cell  $m_1$  (a4) basal to posterior edge of both post stigmatic pale spot and pale spot in cell  $m_4$  (a6) ..... 5
5. Pale portion of cell  $r_2$  (b1) at least half the length of the dark portion of the cell (b2) with about half of the lumen included in the post stigmatic pale spot (b3), anterior edge of dark marking on vein  $M_2$  with either 90° bend apicad of basal pale spot (b4) and/or interrupted by a pale area (b5); posterior edge of basal pale spot in cell  $m_1$  (b4) either basal to posterior edge of both post stigmatic pale spot and pale spot in cell  $m_4$  (b6) or these three spots roughly in a line (b7) ..... 6



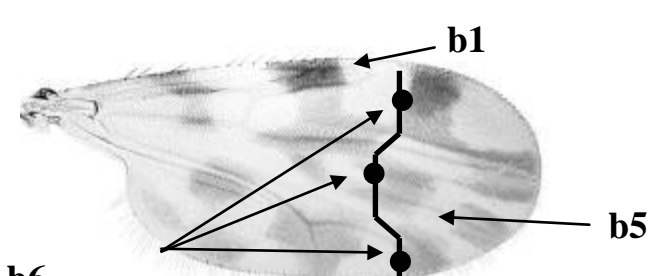
*C. brevitarsis*



*C. asiatica*

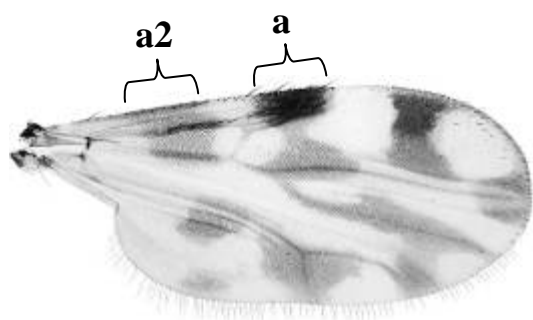


*C. fulvus*

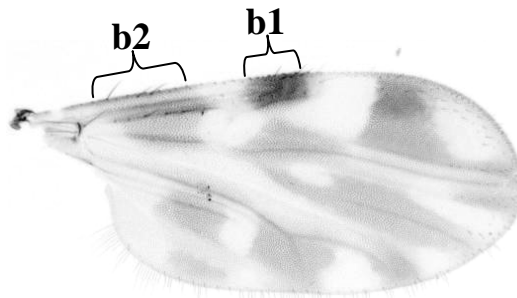


*C. wadai*

5. Wing with stigmatic dark spot (a1) of similar length to proximal dark marking on costa (a2) *brevitarsis*  
 Wing with stigmatic dark spot (b1) distinctly shorter than proximal dark marking on costa (b2) ..... *asiatica*

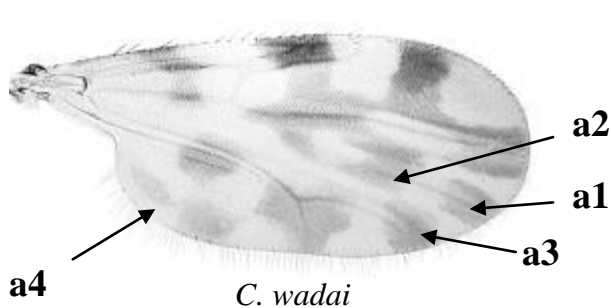


*C. brevitarsis*

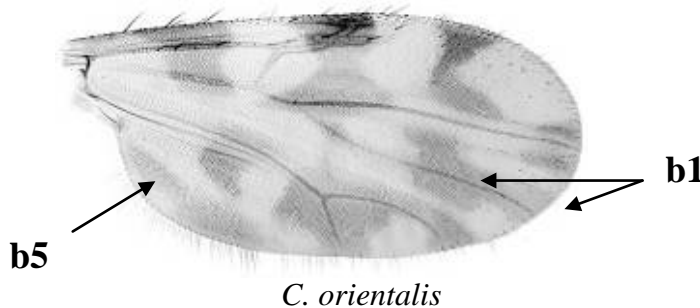


*C. asiatica*

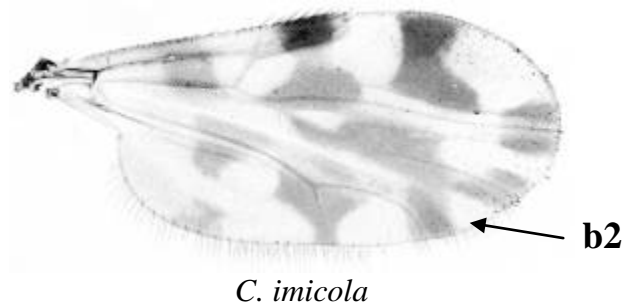
6. Dark marking at apex of vein  $M_2$  quadrate (a1) and not joined to dark areas at base of vein  $M_2$  (a2) or apex of vein  $M_{3+4}$  (a3); anal cell with dark longitudinal stripe basally (a4) ..... 7  
 Dark marking along vein  $M_2$  not quadrate and either continuous to apex (b1) and/or joined to dark marking at apex of vein  $M_{3+4}$  (b2), if apparently separate (b3) then not quadrate and distinctly narrower than quadrate dark marking at end of vein  $M_1$  (b4); anal cell with (b5) or without (b6) dark longitudinal stripe basally..... 8



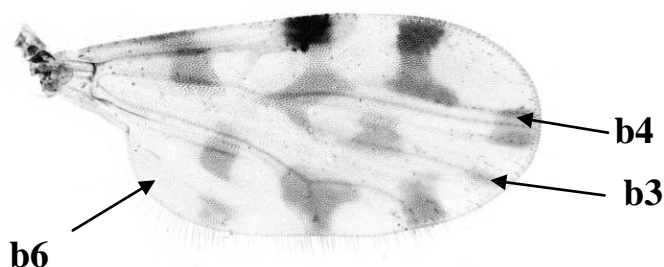
*C. wadai*



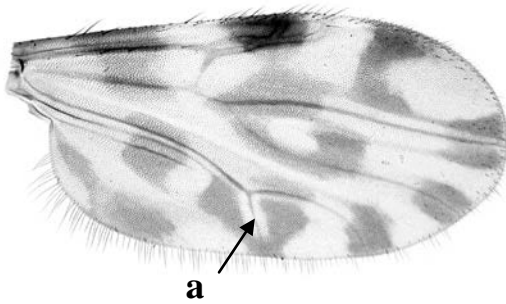
*C. orientalis*



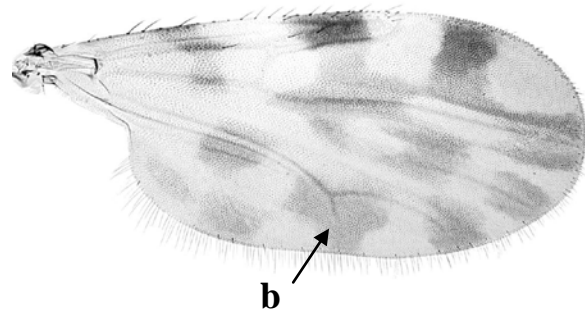
*C. imicola*



7. Part of  $Cu_1$  vein included in pale marking (a) .....*boophagus*  
 $Cu_1$  vein entirely included in dark marking (b) .....*wadai*

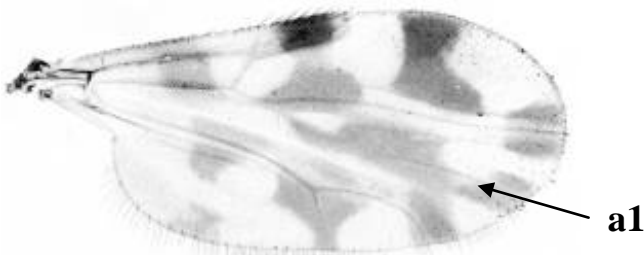


*C. boophagus*

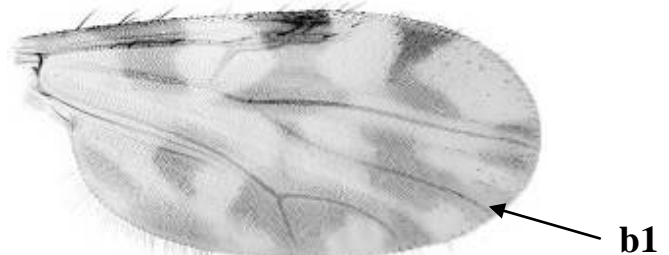


*C. wadai*

8. Apical pale marking in cell  $m_1$  reaching or crossing vein  $M_2$  subapically (a1) then narrowing apically .....*imicola*  
 Apical pale marking in cell  $m_1$  not reaching or crossing vein  $M_2$  subapically (b1) ..... 9

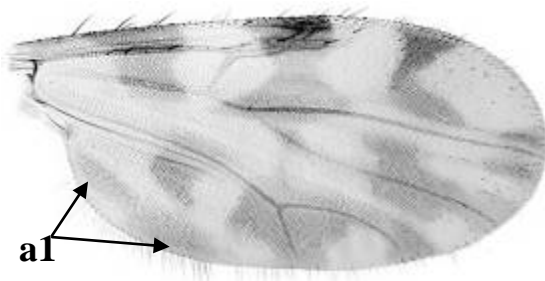


*C. imicola*

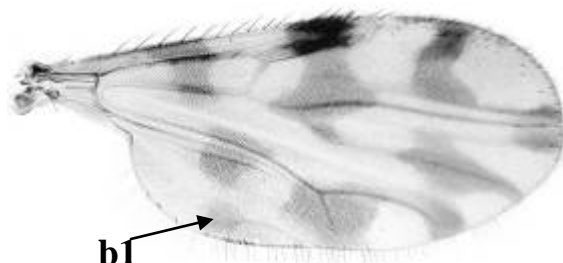


*C. orientalis*

9. Posterior dark marking in anal cell elongate and extending to base of the cell (a1) ..... 10  
 Posterior dark marking in anal cell quadrate or rounded, never extending to base of the cell (b1) ..... 12



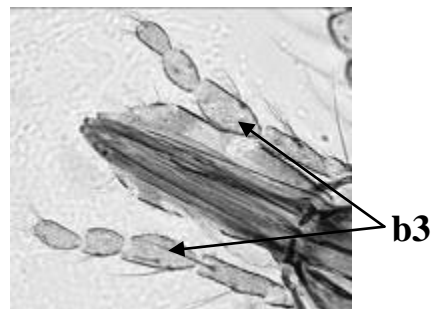
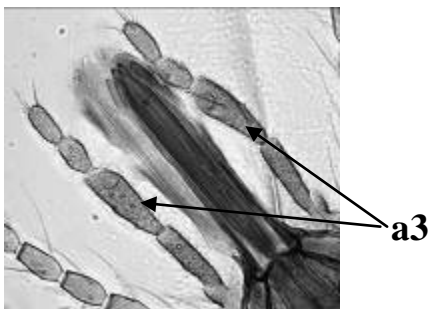
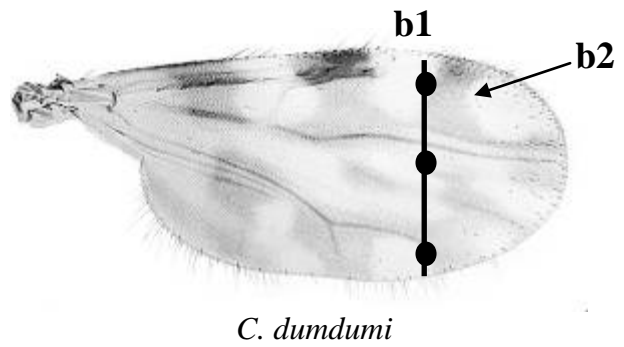
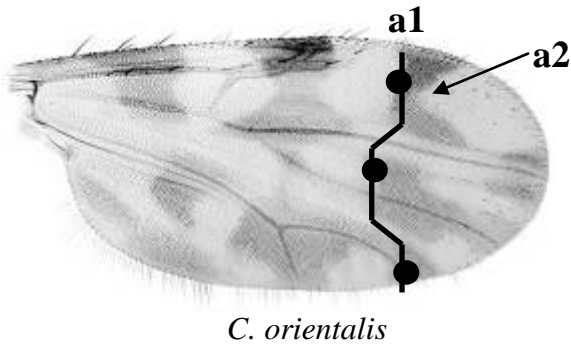
*C. orientalis*



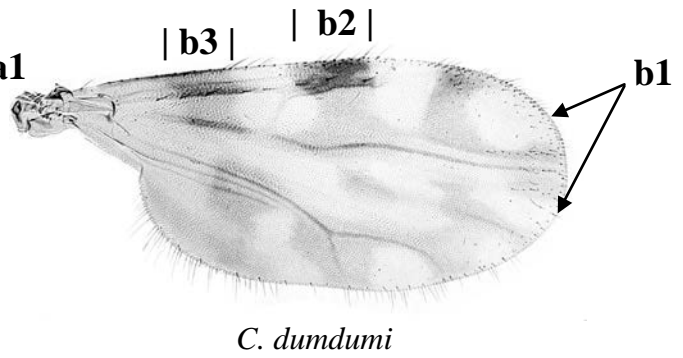
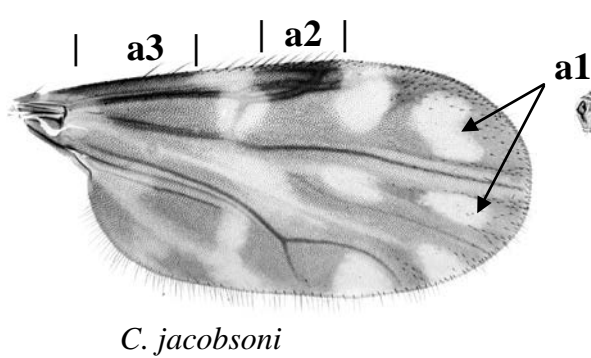
*C. fulvus*



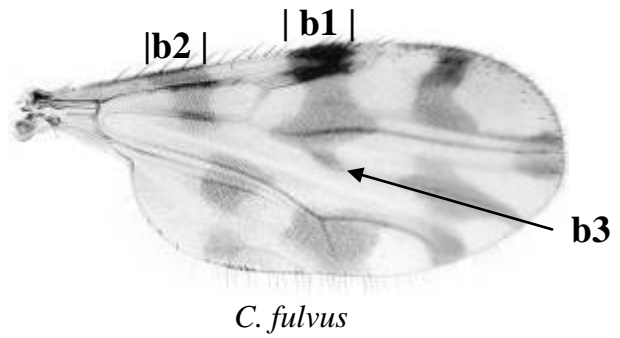
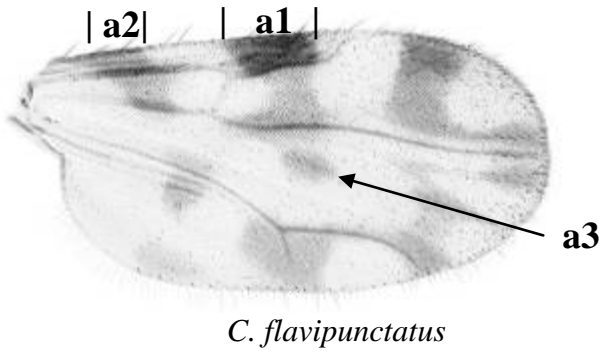
10. Distal edge of basal pale spot in cell  $m_1$  basal to distal edge of both post stigmatic spot and pale spot in cell  $m_4$  (a1), dark mark in cell  $r_5$  distinctly narrowed medially (a2), 3<sup>rd</sup> palpal segment relatively long and dark (a3)..... *orientalis*  
 Distal edges of basal pale spot in cell  $m_1$ , post stigmatic spot and pale spot in cell  $m_4$  roughly in a straight line (b1), dark mark in cell  $r_5$  not so narrowed medially (b2), 3<sup>rd</sup> palpal segment relatively short and pale (b3)..... 11



11. Pale spots in cells  $r_5$  and  $m_1$  not reaching margin of wing (a1), stigma (a2) distinctly shorter than basal dark mark on costa (a3), ..... *jacobsoni*  
 Pale spot in cells  $r_5$  and  $m_1$  reaching margin of wing (b1), stigma (b2) of similar length to basal dark mark on costa (b3), ..... *dumdumi*



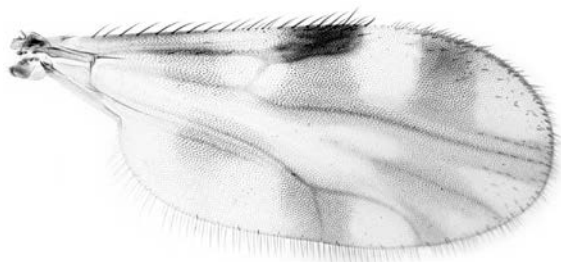
12. Stigmatic dark marking (a1) distinctly longer than basal dark mark on costa (a2), dark marking at base of vein M<sub>2</sub> more or less discrete and not part of other dark markings (a3) .....*flavipunctatus*  
 Stigma (b1) of similar length to basal dark mark on costa (b2), dark marking at base of vein M<sub>2</sub> an extension of the dark marking at base of vein M<sub>1</sub> (b3) .....*fulvus*



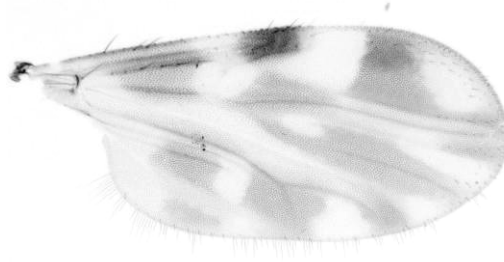
**Acknowledgements**

Wing photos provided by Ian Roper, Craig O'Brien and Karien Labuschagne. Luke Halling, Stacey Anderson and participants at the Bluetongue Vector Identification workshop in Chennai, India, July 2013 assisted with testing the key. Lara Harrup, Simon Carpenter and YK Reddy organised the workshop that inspired production of this key.

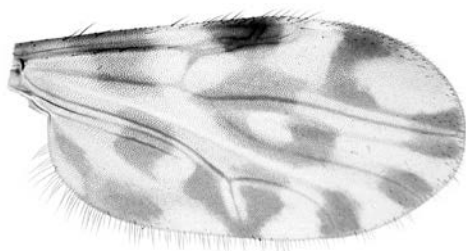
Wing picture atlas of Indian *Avaritia* of economic importance



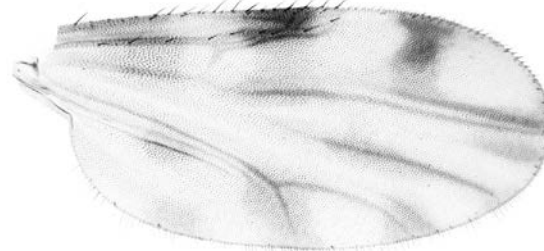
*C. actoni*



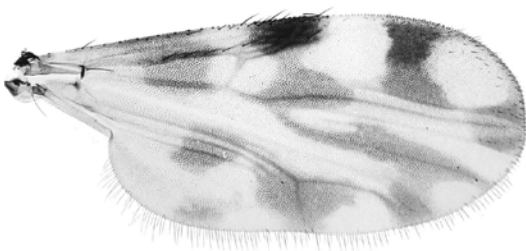
*C. asiatica*



*C. boophagus*



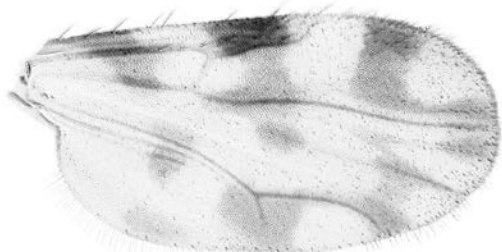
*C. brevipalpis*



*C. brevitarsis*



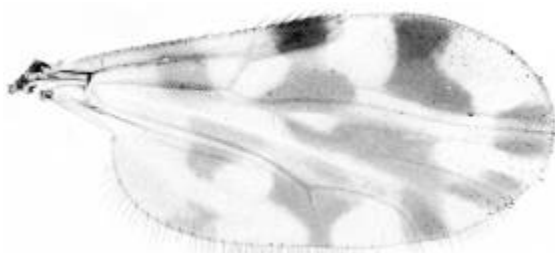
*C. dumdumi*



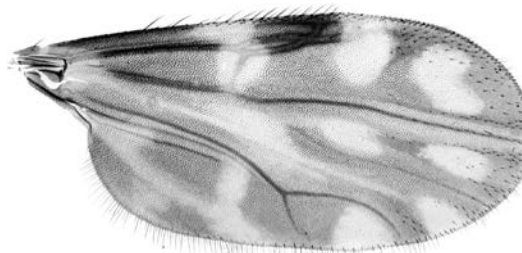
*C. flavipunctatus*



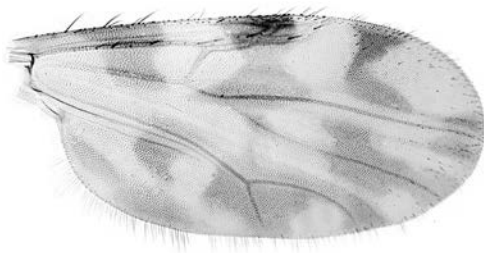
*C. fulvus*



*C. imicola*



*C. jacobsoni*



*C. orientalis*



*C. wadai*