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A SYNOPSIS OF THE INDIAN TABANIDAE (DIPTERA)

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ABSTRACT

This communication provides a synoptic discourse of scientific knowledge on the taxonomic and behavioural status of the Indian Tabanidae, with a bias to stimulate active research on these notorious flies of prime veterinary importance.

INTRODUCTION

The Tabanidae comprise horse flies and deer flies, and are popularly known as gadflies or gnats in India. They are generally robust colourful flies with huge brown or black eyes, sometimes having brilliant green or pink bands. Males are holoptic, whereas females dichoptic, *i.e.*, with a narrow space (frons) between two eyes which is generally provided with spot/spots (callus/calli) of specific configuration. The antennae are horn-like but the shape and segmentation generally varies in different genera. The wings are usually held wide apart at rest and are often with infuscations, bands or spots. The thorax and the abdomen may generally be striped or banded.

Adults generally take rest on trees. They breed on or near water-bodies. Nearly all are diurnal and are often most active in sunny weather. The majority of tabanids feed on vertebrate blood but some feed on nectar either exclusively or in supplement to blood. There are still a few as adults most probably taking meal of neither kind.

HISTORICAL REVIEW OF ACHIEVEMENTS

In India, tabanids are studied mainly because of their veterinary importance. Our knowledge on the Indian Tabanidae so far achieved, can be grouped under three inter-related disciplines.

Taxonomy : The Indian Tabanidae include a species which has been described from India herself as early as 1798 by Fabricius, who has later (1805) added three more species. Subsequently, in the nineteenth century, Wiedemann (1821 ; 1824), Macquart (1838 ; 1846 ; 1850 ; 1855), Saunders (1841), Walker (1848 ; 1850 ; 1854), Schiner (1868) and Bigot (1891 ; 1892) have described several species from different parts of India. With the beginning of the present century, Ricardo (1902 ; 1906 a, b ; 1909 ; 1911 a, b ; 1913 ; 1914 ; 1917) has contributed much to the Indian fauna and her outstanding contribution of 1911 is the most important source of reference till today. Besides, Brunetti (1912), Surcouf (1921), Austen (1922), Senior-White (1922 a, b ; 1924 ; 1927), Enderlein (1925), Szilády (1926), Schuurmans Stekhoven (1926 ; 1932), Kröber (1930), Basu, Menon & Sen Gupta (1952), Philip (1959 ; 1960 a, b ; 1962 ; 1970 ; 1972), Philip & Mackerras (1960), Mackerras (1962), Sen & Fletcher (1962), Chvála (1969), Stone & Philip (1974), Stone (1975), Datta & Biswas (1977), Datta & Das (1978) and Datta (1980 ; 1981) have also made

commendable works by describing and recording species occurring in India. A check-list of Tabanidae hitherto known, is provided synoptically in order to have a general idea of the faunal composition in India. For further details and better-understanding, the reader is referred to the works by Stone & Philip (1974), Stone (1975), Moucha (1976), Burton (1978), Burger (1981) and Burger & Thompson (1981) which incorporate species from India too.

Subfamily PANGONIINAE

Tribe PHILOLICHINI

Genus **Philoliche** Wiedemann

1. *amboinensis* (Fabricius, 1805)
2. *korosicsomana* (Szilády, 1926)
3. *longirostris* (Hardwicke, 1823)
4. *macquartiana* Chvála, 1969) (=*rufa* Macquart, 1850-preoccupied)
5. *taprobanes* (Walker, 1854) or ally
6. *varipes* (Ricardo, 1911)

Subfamily CHRYSOPSINAE

Tribe CHRYSOPSINI

Genus **Chrysops** Meigen

7. *designatus* Ricardo, 1911
8. *dispar* (Fabricius, 1798) (=*bifasciatus* Macquart, 1838 ; *ligatus* Walker, 1848 & *semicirculus* Walker, 1848)
9. *dubiens* Philip, 1979
10. *fasciatus* Wiedemann, 1821
11. *fixissimus* Walker, 1857
12. *flaviventris* Macquart, 1846
13. *flavocinctus* Ricardo, 1902
14. *indianus* Ricardo, 1902
15. *pellucidus* Fabricius, 1805
16. *pettigrewi* Ricardo, 1913
17. *stimulans* Walker, 1850

Genus **Melissomorpha** Ricardo

18. *indiana* Ricardo, 1906

Genus **Silvius** Meigen

Subgenus **Silvius** Meigen

19. *indianus* Ricardo, 1911

Tribe BOUVIEROMYIINI

Genus **Gressittia** Philip & Mackerras

20. *apicalis* Philip & Mackerras, 1960

Tribe RHINOMYZINI

Genus **Gastroxides** Saunders

21. *ater* Saunders, 1841
22. *ornatus* (Bigot, 1859)

Subfamily TABANINAE

Tribe TABANINI

Genus **Atylotus** Osten Sacken

23. *agrestis* (Wiedemann, 1828) (=*ditaeniatus* Macquart, 1838 & *pyrrhus* Walker, 1850)
24. *nemocallosus* (Ricardo, 1909)
25. *virgo* (Wiedemann, 1824) (=*albulus* Walker, 1850 & *puella* Walker, 1850)

Genus **Hybomitra** Enderlein

26. *himalayana* (Enderlein, 1925)
27. *hirta* (Walker, 1850)
28. *peculiaris kashmirianus* Szilády, 1926
29. *subcallosa* (Ricardo, 1911)
30. *wyvillei* (Ricardo, 1911)

Genus **Tabanus** Linnaeus

Subgenus **Tabanus** Linnaeus

31. *acallus* Szilády, 1926
32. *albocostatus* (Bigot, 1892)
33. *albofasciatus* Ricardo, 1911
34. *altermaculatus* Ricardo, 1913
35. *andamanicus* (Bigot, 1892)
36. *anderssoni* Philip, 1972
37. *attenuatus* Walker, 1848
38. *auriflamma* Walker, 1848
39. *aurisegmentatus* S. Stekh., 1932
40. *auristriatus* Ricardo, 1911
41. *avittatus* S. Stekh., 1926
42. *biannularis* Philip, 1960 (=*bicinctus* Ricardo, 1911-preoccupied)
43. *birmanicus* (Bigot, 1892)
44. *biswasi* Datta, 1980 (=*minusculus* Datta & Das, 1978-preoccupied)
45. *bombayensis* S. Stekh., 1926
46. *brunnipennis* Ricardo, 1911
47. *ceylonicus* Schiner, 1868
48. *conicus* (Bigot, 1892)
49. *consanguineus* Macquart, 1838
50. *crassus* Walker, 1850
51. *decoratus* Szilády, 1926
52. *demellonis* Senior-White, 1924
53. *diversifrons* Ricardo, 1911 (=*flaviventris* Bigot, 1892 & *ochrogaster* Philip, 1960-preoccupied)
54. *dominus* Datta & Das, 1978
55. *dorsilinea* Wiedemann, 1824 (=*macer* Bigot, 1892; *bicallosus* Ricardo, 1909 & *trichinopolis* Ricardo, 1914)
56. *excelsus* Ricardo, 1913
57. *explicatus* Walker, 1854
58. *flavicornis subflavicornis* Philip, 1970
59. *flavimedius* S. Stekh., 1926
60. *flavipus* S. Stekh., 1926
61. *frondosus* Szilády, 1926 (=*latifrons* S. Stekh., 1926-preoccupied=*paralatifrons* S. Stekh., 1928)
62. *fuscomaculatus* Ricardo, 1911
63. *gertrudae* Philip, 1960 (=*flavicinctus* Ricardo, 1911-preoccupied)
64. *griseifacies* S. Stekh., 1926 (=*flaviventris* Bigot *sensu* Ricardo, 1911)
65. *hirtipalpis* Ricardo, 1911
66. *hybridus* Wiedemann, 1828
67. *imparicallosus* S. Stekh., 1926
68. *indianus* Ricardo, 1911
69. *indifferens* Szilády, 1926
70. *inscitus* Walker, 1848
71. *joidus* (Bigot, 1892)
72. *jucundus* Walker, 1848
73. *kamengensis* Datta & Das, 1978
74. *khasiensis* Ricardo, 1909
75. *laotianus* (Bigot, 1890)
76. *lateralbus* S. Stekh., 1932
77. *laticinctus* S. Stekh., 1926
78. *leleani* Austen, 1920
79. *leucocnematus* (Bigot, 1892)
80. *leucohirtus* Ricardo, 1909
81. *leucopogon* (Bigot, 1892)
82. *limitatus* Stone, 1975 (=*limbatus* Szilády, 1926-preoccupied)
83. *manipurensis* Ricardo, 1913

84. *meghalayensis* Datta & Biswas, 1977
85. *melanognathus* (Bigot, 1890)
86. *miniatus* Datta & Biswas, 1977
87. *monotaeniatus* (Bigot, 1892)
88. *nephodes* (Bigot, 1892)
89. *nicobarensis* Schiner, 1868
90. *noctuinus* S. Stekh., 1926
91. *obconicus* Walker, 1850
92. *ochroceras* S. Stekh., 1932
93. *optatus* Walker, 1857
94. *orientalis* Wiedemann, 1824
95. *orientis* Walker, 1848
(=*consocius* Walker, 1850 ; *perlinea* Walker, 1850 ; *melanopygatus* Bigot, 1892 & *pagodinus* Bigot, 1892)
96. *oxyceratus* (Bigot, 1892)
97. *pallidiventer* S. Stekh., 1926
98. *parafuscomaculatus* S. Stekh., 1932
99. *parahybridus* S. Stekh., 1932
100. *provincialis* Ricardo, 1913
101. *rectilineatus* S. Stekh., 1926
102. *rubicundus* Macquart, 1846
(=*internus* Walker, 1848 & *monilifer* Bigot, 1892)
103. *rubidoides* Szilády, 1926
104. *rubidus* Wiedemann, 1821
(=*albimedius* Walker, 1850 ; *umbrosus* Walker, 1850 & *vagus* Walker, 1850)
105. *rubidus priscoides* S. Stekh., 1926
106. *rubiginosus* Walker, 1850
107. *rufiventris* Fabricius, 1805
(=*assamensis* Bigot, 1892)
108. *sagittipalpis* Szilády, 1926
109. *scutellus* Philip, 1970
110. *servillei* Macquart, 1838
111. *speciosus* Ricardo, 1911
112. *striatus* Fabricius, 1787
(=*hilaris* Walker, 1850)
113. *subhirtus* Ricardo, 1911
114. *sufis* Jaennicke, 1867
115. *tenebrosus* Walker, 1854
116. *triceps* Thunberg, 1827
(=*tenens* Walker, 1850-preoccupied)
117. *trinominatus* Senior-White, 1927
(=*angustus* Bigot, 1892 & *palpalis* Ricardo, 1911-preoccupied)
118. *trinominatus incertus* Szilády, 1926
119. *tuberculatus* Ricardo, 1911
120. *wallacei* Szilády, 1926
121. *wyvillei* Ricardo, 1911
122. *xanthoimus* Philip, 1960

Tribe HAEMATOPOTINI

Genus **Haematopota** Meigen

123. *adusta* Stone & Philip, 1974
124. *albimedia* Stone & Philip, 1974
125. *albofasciatipennis* Brunetti, 1912
126. *alticola* (Philip, 1959)
127. *alyta* Stone & Philip, 1974
128. *amala* Stone & Philip, 1974
129. *annandalei* Ricardo, 1911
130. *assamensis* Ricardo, 1911
131. *barri* Stone & Philip, 1974
132. *bicolor* Stone & Philip, 1974
133. *biguttata* Stone & Philip, 1974
134. *biharensis* Stone & Philip, 1974
135. *bilineata* Ricardo, 1911
136. *biroi* Szilády, 1926
137. *brevis* Ricardo, 1906
138. *cana* Walker, 1848
(=*montium* Szilády, 1926)

139. *casca* Stone & Philip, 1974
140. *chvalai* Stone & Philip, 1974
141. *cilipes* Bigot, 1890
142. *contracta* Stone & Philip, 1974
143. *cordigera* Bigot, 1891
(=*fuscifrons* Austen, 1908)
144. *crossi* Stone & Philip, 1974
145. *darjeelingensis* Datta, 1981
146. *demellonis* Senior-White, 1922
147. *dissimilis* Ricardo, 1911
148. *echma* Stone & Philip, 1974
149. *equina* Stone & Philip, 1974
150. *fasciata* Ricardo, 1911
151. *flavicornis* Szilády, 1926
152. *flavipuncta* Stone & Philip, 1974
153. *hardyi* Stone & Philip, 1974
154. *hindostani* Ricardo, 1917
155. *immaculata* Ricardo, 1911
156. *inconspicua* Ricardo, 1911
157. *indiana* Bigot, 1891
158. *javana* Wiedemann, 1821
159. *jellisoni* (Philip, 1960)
160. *kashmirensis* Stone & Philip, 1974
161. *lata* Ricardo, 1906
162. *latifascia* Ricardo, 1911
163. *limbata* Bigot, 1891
164. *litoralis* Ricardo, 1913
165. *longipennis* Stone & Philip, 1974
166. *malabarica* Stone & Philip, 1974
167. *marceli* Stone & Philip, 1974
168. *marginata* Ricardo, 1911
169. *matherani* Szilády, 1926
170. *melloi* Stone and Philip, 1974
171. *montana* Ricardo, 1917
172. *mouchai* Stone & Philip, 1974
173. *nathani* Stone & Philip, 1974
174. *nigrifrons* Datta & Biswas, 1977
175. *oporina* Stone & Philip, 1974
176. *pallida* Stone & Philip, 1974
177. *pattoni* Stone & Philip, 1974
178. *philipi* Chvála, 1969
179. *pisinna* Stone & Philip, 1974
180. *punctifera* Bigot, 1891
181. *roralis* Fabricius, 1805
182. *schmidi* Stone & Philip, 1974
183. *sikkimensis* Stone & Philip, 1974
184. *singarensis* Stone & Philip, 1974
185. *sparsa* Stone & Philip, 1974
186. *striata* Stone & Philip, 1974
187. *zophera* Stone & Philip, 1974

Genus **Hippocentrodes** Philip

188. *desmotes* Philip, 1959
189. *striatipennis* (Brunetti, 1912)

Tribe DIACHLORIINI

Genus **Cydistomyia** Taylor

Subgenus **Cydistomyia** Taylor

190. *aberrans* Philip, 1970
191. *assamensis* Philip, 1970
192. *indiana* Philip, 1970
193. *nigropictus* (Macquart, 1855)
194. *polyzona* (Szilády, 1926)

Subgenus **Tabanotelum** Oldroyd

195. *primitiva* Mackerras, 1962
196. *secunda* Mackerras, 1962

UNPLACED SPECIES OF TABANIDAE

197. *fulvescens* Brunetti, 1912

Bio-ecology : Studies on the bio-ecology or bionomics in contrast to that on taxonomy of the Tabanidae have generally been infrequent. Since the times of Lefroy (1907) and Baldrey (1911) with some brief behavioural studies, approach to know intensively of the immatures and their environs of certain species has been inducted by Patton & Cragg (1913). Subsequently, Fletcher (1916 ; 1917 ; 1920 ; 1921), Cross & Patel (1921), Isaac (1924 a, b ; 1925 ; 1932 ; 1933), Singh (1926), Patton & Evans (1929), Sen & Fletcher (1962) and Singh (1968) have enriched our knowledge on the life-history and behavioural affairs of several species of these flies. Besides, Mitzmain (1913 a) and Nieschulz (1935 ; 1936) have added much to it. Tabanids generally deposit their eggs in masses on vegetation, logs of wood and rocks overhanging water. The egg-masses in a few species are covered over with a chalky substance, apparently for protection of eggs (Patton & Evens, 1929). The incubation period varies from 4-7 days. The tabanid larvae are carnivorous and frequently cannibalistic. The larvae generally moult 7-8 times. The duration of the larval stage is very variable, depending upon the species and the larval food provision. It may range from 9 days to 7 months (Sen & Fletcher, 1962). According to Rao & Mudaliar (1935), the larval life lasts for 4-6 weeks in the Indian *Tabanus*. As the pupation time advances, the larva migrates to comparatively dry soil. The pupation period varies from 3-21 days. The adult flies emerge at very irregular intervals. While studying at Madras, Patton & Cragg (1913) have concluded that the life-cycle from the egg to the imago is completed in 4-5 months' time and there are 2 generations in a year, but according to Isaac (1925), the common species at Pusa have 3 generations per year. This is true to the Punjab Tabanidae also (Cross & Patel, 1921).

Parasitology : Tabanids are generally common during the rainy season. The adult females and sometimes the males too may be come across on the walls or window panes of the human dwelling. The females of most species are voracious blood-suckers by virtue of their stabbing and sucking mouthparts. They mainly attack cattle and other ungulates and may be very annoying to man. The feeding behaviour and its associated aspects of several species have been observed by many workers of which Patton & Cragg (1913), Mitter (1918), Cragg (1920), Cross & Patel (1921) and Isaac (1925) have made comprehensive studies on certain species. Additional information can be had from the works by Mitzmain (1913 b) and Nieschulz (1927). Tabanids have specific predilection for the site of feeding on blood. "Having selected a suitable spot on the skin of the host it inserts its mouthparts and usually takes a full meal before they are withdrawn. The meal may last as long as 3 or 4 minutes" ...(Cragg, 1920). They take many bloodmeals and the feeding is always interrupted. Of the diseases transmitted by these notorious flies, surra is the most important, mainly affecting horses and cattle. Mitzmain (1913b) for the first time has pointed out that the mode of transmission is merely mechanical. Basu (1945) has recorded the incidence of surra from different parts of India, whereas Menon (1957) has restricted his observations only on species of Rajasthan. Basu, Menon and Sen Gupta (1952) earlier have, however, clarified the occurrence of surra on the regional basis. According to Cross & Patel (1922), *nemocallosus* is the extremely efficient carrier.

It has also been suggested that *Tabanus* may carry anthrax in the same way (Roy & Brown, 1954). Bhatia (1935) and Kapur (1941) through experiments have held that *orientis* can act as a successful transmitter of rinderpest.

Regarding control measure, Cross (1917) has recommended castor oil for preventing tabanids from attacking camels. Sen (1939) has used a proprietary preparation of Pyrocide 20 (a concentrated extract of pyrethrum flowers) and a soap spreader in water for the control of certain cattle flies including tabanids.

DISCUSSION

The Indian territory mainly lies in the Oriental region and hence the tabanid fauna is essentially Oriental, but very many species are widespread. There are at present nearly 193 species and 4 subspecies but undoubtedly many more await discovery from India. On the other hand, much attention has not been paid to reveal many probable species complexes in India. Alongside the conventional taxonomic research, care should be taken to undertake morpho-anatomical studies so as to have a more refined and restrictive species concept of the Indian fauna, but unfortunately very little information is available on this subject except a few earlier works by Patton & Cragg (1913), Cragg (1920), Isaac (1924) and Sen (1931).

To determine the identity of species as well as to have a sound knowledge on their ecological bias is an essential index to possible control measures but it is admittedly true that there is lack of precise knowledge on most of the Indian species in this respect. It is thus essential to find out the site of oviposition, kind of substratum, frequency of appearance in a year and span of life of immatures, particularly larvae and of adult females, and resting place, host preference and other behavioural affairs associated with the biting activities of adult females. There is evidently enough scope for parasitological investigation in India where there are possibilities of at least mechanical, if not biological transmission of several animal diseases by tabanids as in certain other parts of the world. Despite application of chemical means suggested earlier, attempt to control these flies by biological means is a preferable one now-a-days. The most simple and inexpensive method is the collection and destruction of the egg-masses deposited on weeds, such as, *Polygonum glabrum*, *Phragmites karka*, *Lantana aculeata*, *Rumex nepalensis*, indigo plants, grass-blades etc. and other objects overhanging water (Sen & Fletcher, 1962). Alternatively, dissemination of egg parasites, mainly species of Chalcididae and Scelionidae (Hymenoptera) is quite effective (Patel, 1920 ; Fletcher, 1920 ; 1921 and Sen & Fletcher, 1962), but I know of no published records of pathogenic parasities infesting other immature stages of tabanids in India. Sen & Fletcher (1962) have also observed eggs to be eaten up by a species of *Hapaloderus* Motschulsky (Coleoptera : Cantharidae) at Pusa. According to them, these beetles may prove to be useful in reducing tabanid population.

In fine, I believe, there are needs and good prospectus for future realization of the avenues of research surmised above. This synthesis is expected to stimulate more serious research and to provide the public with more information about this important group of insects.

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References

Austen, E. E. 1922. Note on a small collection of Indian Tabanidae and other blood-sucking Diptera. *Trans. R. Soc. trop. Med. & Hyg., Lond.* **15** : 1-264.

Baldrey, F. S. H. 1911. The evolution of *Trypanosoma evansi* through the fly : *Tabanus* and *Stomoxys*. *J. trop. vet. Sci.* **6** : 271-291.

Basu, B. C. 1945. Distribution and seasonal incidence of surra in India. *Indian J. vet. Sci.* **15** : 277-279.

Basu, B. C. Menon, P. B. and Sen Gupta, C. M. 1952. Regional distribution of *Tabanus* flies in India and its relationship to the incidence of surra. *Indian J. vet. Sci. Anim. Husb.* **22** : 273-292.

Bhatia, H. L. 1935. The role of *Tabanus orientis* Wlk. and *Stomoxys calcitrans* Linn. in the mechanical transmission of rinderpest. *Indian J. vet. Sci. Anim. Husb.* **5** : 2-22.

Bigot, J. M. F. 1891. Dipteres nouveaux ou peu connus. *Bull. Soc. zool. Fr.* **16** : 74-79.

Bigot, J. M. F. 1892. Descriptions de Diptères nouveaux. *Mém. Soc. zool. Fr.* **5** : 602-691.

Brunetti, E. 1912. New Oriental Diptera I. *Rec. Indian Mus.* **7** : 445-513.

Burger, J. F. 1981. A review of the horse flies (Diptera : Tabanidae) of Sri Lanka (Ceylon). *Ent. scand. suppl.* **11** : 81-123.

Burger, J. F. and Thompson, F. C. 1981. The *Tabanus striatus* complex (Diptera : Tabanidae) : A revision of some Oriental horse fly vectors of surra. *Proc. ent. Soc. Wash.* **83** : 339-358.

Burton, J. J. S. 1978. The Tabanini of Thailand above the isthmus of Kra. *Entomol. Repr. Specialists*, Los Angeles : 1-165.

CHVA'LA, M. 1969. Einige neue oder wenig bekannte bremsen (Diptera, Tabanidae) von Nepal. *Acta ent. bohemoslovaca* **66** : 39-54.

CRAGG, F. W. 1920. Secretion and epithelial regeneration in the mid-intestine of *Tubanus*. *Indian J. med. Res.* **7** : 648-663.

CROSS, H. E. 1917. Experiments with emulsions for protecting camels against the attacks of blood-sucking flies. *Agric. Res. Inst. Pusa, Calcutta* **76** : 12 pp.

CROSS, H. E. AND PATEL, P. G. 1921. Surra transmission experiments. *Dep. Agric. Punjab, vet. Bull.* **5** : 19 pp.

CROSS, H. E. AND PATEL, P. G. 1922. A note on transmission of surra by *Tabanus nemocallosus*. *Dep. Agric. Punjab, vet Bull.* **7** : 7 pp.

DATTA, M. 1980. *Tabanus biswasi* nom. nov., a replacement name for *Tabanus minusculus* Datta and Das, 1978 (Diptera : Tabanidae). *Bull. zool. Surv. India* **3** : 123.

DATTA, M. 1981. A new species of *Haematopota* Meigen (Diptera : Tabanidae) from Darjeeling, India. *Bull. zool. Surv. India* **4** : 57-59.

DATTA, M. AND BISWAS, S. 1977. A preliminary study of the insect fauna of Meghalaya, India XII. *Proc. Indian Acad. Sci* (B) **86** : 127-133.

DATTA, M. AND DAS, B. N. 1978. Three new species of the genus *Tabanus* L. (Diptera : Tabanidae) from Arunachal Pradesh, India. *Bull. zool. Surv. India* **1** : 181-185.

ENDERLEIN, G. 1925. Studien an blutsaugenden Insekten I. *Mitt. zool. Mus. Berl.* **11** : 255-409.

FABRICIUS, J. C. 1798. *Supplementum entomologiae Systematicae, Hafniae* (=Copenhagen), 572 pp.

FABRICIUS, J. C. 1805. *Systema antliatorum secundum ordines, genera, species, Brunsvigae* (=Brunswick), 373+30 pp.

FLETCHER, T. B. 1916. Report of the Imperial Pathological Entomologist. *Rep. agric. Res. Inst. and Coll.*, Pusa 1915-1916 : 78-84.

FLETCHER, T. B. 1917. Report of the Imperial Pathological Entomologist. *Sci. Rep. agric. Res. Inst.*, Pusa 1916-1917 : 91-102.

FLETCHER, T. B. 1920. Report of the Imperial Pathological Entomologist. *Sci. Rep. agric. Res. Inst.*, Pusa 1919-1920 : 95-108.

FLETCHER, T. B. 1921. Report of the Imperial Entomologist. *Sci. Rep. agric. Res. Inst.*, Pusa, 1920-1921 : 41-59.

HARDWICKE, T. 1823. Description of *Cermatia longicornis* and of three new insects from Nepaul. *Trans. Linn. Soc. Lond.* **14** : 131-136.

ISAAC, P. V. 1924a. Papers on Indian Tabanidae III. *Mem. Dep. Agric. India ent. Ser.* **8** : 53-62.

ISSAAC, P. V. 1924b. Papers on Indian Tabanidae IV-VII. *Mem. Dep. Agric. India ent. ser.* **8** : 93-109.

ISAAC, P. V. 1925. Papers on Indian Tabanidae VIII. *Mem. Dep. Agric. India ent. Ser.* 9 : 21-28.

ISAAC, P. V. 1932. Papers on Indian Tabanidae IX. *Indian J. vet. Sci. Anim. Husb.* **2** : 278-280.

ISAAC, P. V. 1933. Papers on Indian Tabanidae X. *Indian J. vet. Sci. Anim. Husb.* **3** : 182-184.

JAENNICKE, F. 1867. Neue exotische Dipteren. *Abh. senckenb. naturforsch. Ges.* **6** : 311-408.

KAPUR, H. R. 1941. Experiments on the transmission of rinderpest through the agency of *Tabanus orientis*, with remarks on the feeding habits of this fly. *Indian J. vet. Sci. Anim. Husb.* **11** : 84-93.

KRÖBER, O. 1930. Neue Tabaniden und Zusätze bereits beschriebenen. *Zool. Anz.* **90** : 69-86.

LEFROY, H. M. 1907. A preliminary account of the biting flies of India. *Bull. agric. Res. Inst. Pusa* **7** : 21.

MACKERRAS, I. M. 1962. On some Oriental and Pacific Tabanidae. *Pacif. Insects* **4** : 101-113.

MACQUART, J. 1838. *Dipte`res exotiques nouveaux ou peu connus* **1** (1) : 5-221.

MACQUART, J. 1846. *Dipte`res exotiques nouveaux ou peu connus*, suppl. **1** : 5-238.

MACQUART, J. 1850. *Dipte`res exotiques nouveaux ou peu connus*, suppl. **4** : 309-465, 466-479.

MACQUART, J. 1855. *Dipte`res exotiques nouveaux ou peu connus*, suppl. **5** : 25-156.

MENON, P. B. 1957. The incidence of surra and tabanid flies in Rajasthan. *Indian J. vet. Sci. Anim. Husb.* **27** : 1-16.

MITTER, J. L. 1918. Note on the method of feeding of *Corizoneura* (*Pangonia*) *longirostris* Hardwicke, with a description of the mouthparts. *Indian J. med. Res.* **5** : 523-528.

MITZMAIN, M. B. 1913a. The biology of *Tabanus striatus* Fabricius. the horse fly of the Philippines. *Philipp. J. Sci.* (*B*) **8** : 197-221.

MITZMAIN, M. B. 1913b. The mechanical transmission of surra by *Tabanus striatus* Fabricius. *Philipp. J. Sci.* (*B*) **8** : 223-229.

MOUCHA, J. 1976. Horse flies (Diptera : Tabanidae) of the world : Synoptic Catalog. *Acta ent. Mus. Natl. Pragae*, Suppl **7** : 1-319.

NIESCHULZ, O. 1927. Ueber mehrfache Infektionen durch *Tabanus rubidus* Wied. *Centraalbl. Bakt.* **105** : 133-136.

NIESCHULZ, O. 1935. Über die Larvenstadien von *Tabanus rubidus* Wied. und *Tabanus striatus* Fabr. *Z. ParasitenKde* **7** : 639-656.

NIESCHULZ, O. 1936. Die Entwicklungsstadien von *Tabanus rubidus* Wied. und *T. striatus* Fabr. *Arch. Naturgesch.* (N. F.) **5** : 230-255.

PATEL, P. G. 1920. Report of the Imperial Pathological Entomologist. *Sci. Rep. agric. Res. Inst.*, Pusa 1919-1920 : 95-101.

PATTON, W. S. AND CRAGG, F. W. 1913. *A text book of medical entomology*, Christian Literature Society for India, London, xxiii+764 pp.

PATTON, W. S. AND EVANS, A. M. 1929. *Insects, ticks, mites and venomous animals, Part I. Medical.* Liverpool School of Tropical Medicine, H. R. Grubb, Croyden, X+786 pp.

PHILIP, C. B. 1959. Three new Tabanine flies (Tabanidae, Diptera) from the Orient. *Indian J. Ent.* **21** : 82-88.

PHILIP, C. B. 1960a. Malaysian Parasites XXXV. *Stud. Inst. med. Res. F. M. S.* **29** : 1-32.

PHILIP, C. B. 1960b. Malaysian Parasites XXXVI. *Stud. Inst. med. Res. F. M. S.* **29** : 33-78.

PHILIP, C. B. 1962. A review of the far eastern *biannularis* group of *Tabanus*, *Pacif. Insects* **4** : 293-301.

PHILIP, C. B. 1970. Further notes on Oriental Tabanidae (Diptera) IV. In *H. D. Srivastava Comm. Vol.* : 443-452.

PHILIP, C. B. 1972. A new *Tabanus* from south India (Dipt. Tabanidae). *Ent. scand.* **3** : 159-160.

PHILIP, C. B. AND MACKERRAS, I. M. 1960. On Asiatic and related Chrysopinae (Diptera : Tabanidae). *Philipp. J. Sci.* **88** : 279-324.

RAO, M. A. N. AND MUDALIAR, S. V. 1935. Some observations on the trypanosomes of cattle in south India. *Indian J. vet. Sci. Anim. Husb.* **4** : 362-398.

RICARDO, G. 1902. Further notes on the Pangoninae of the family Tabanidae in the British Museum Collection. *Ann. Mag. nat. Hist.* (7) **9** : 366-381.

RICARDO, G. 1906 a. Notes on the genus *Haematopota* of the family Tabanidae in the British Museum Collection. *Ann. Mag. nat. Hist.* (7) **18** : 94-127.

RICARDO, G. 1906 b. Description of a new fly of the family Tabanidae. *Proc. zool. Soc.* Lond. **1906** : 97-98.

RICARDO, G. 1909. Four new Tabanidae from India and Assam. *Ann. Mag. nat. Hist.* **3** : 487-490.

RICARDO, G. 1911 a. A revision of the species of *Tabanus* from the Oriental Region, including notes on species from surrounding countries. *Rec. Indian Mus.* **4** : 111-255.

RICARDO, G. 1911 b. A revision of the Oriental species of the genera of the family Tabanidae other than *Tabanus*. *Rec. Indian Mus.* **4** : 321-397.

RICARDO, G. 1913. New species of Tabanidae from the Oriental Region. *Ann. Mag. nat. Hist.* (8) **11** : 542-547.

RICARDO, G. 1914. A new species of *Tabanus* from India. *Ann. Mag. nat. Hist.* (8) **14** : 359.

RICARDO, G. 1917. New species of *Haematopota* from India. *Ann. Mag. nat. Hist.* (8) **19** : 225-226.

ROY, D. N. AND BROWN, A. W. A. 1954. *Entomology* (Medical & veterinary) including insecticides & insect & rat control. Excelsior Press, Calcutta, ix+ 413 pp.

SAUNDERS, W. W. 1841. Descriptions of four new Dipterous insects from central and northern India. *Trans. ent. Soc. Lond.* **3** : 59-61.

SCHINER, J. R. 1868. *Reise der österreichische Fregatte Novara, Diptera* **2** (1, B) : vi+ 388 pp.

SCHUURMANS STEKHOVEN, J. H. JR. 1926. The tabanids of the Dutch East Indian Archipelago. *Treubia* 6 (suppl.) : 1-551.

SCHUURMANS STEKHOVEN, J. H. JR. 1928. The bloodsucking arthropods of the Dutch East Indian Archipelago IX. *Zoo. Jb.* **54** : 425-448.

SCHUURMANS STEKHOVEN, J. H. JR. 1932. The bloodsucking arthropods of the Duch East Indian Archipelago X *Arch. Naturgesch.* (N. S.) **1** : 57-94.

SEN, S. K. 1931. Notes on the bionomics and anatomy of *Corizoneura longirostris* Hardwicke. *Indian J. vet. Sci. Anim. Husb.* **1** : 24-28.

SEN, S. K. 1939. The possibilities of cattle fly sprays in India. *Indian J. vet. Sci. Anim. Husb.* **9** : 339-348.

SEN, S. K. AND FLETCHER, T. B. 1962. *Veterinary Entomology and Acarology for India.* Indian Coun. Agric. Res., New Delhi, ed. i+668 pp.

SENIOR-WHITE, R. 1922a. Notes on Indian Diptera II. *Mem. Dep. Agric. India ent. Ser.* **7** : 103-107.

SENIOR-WHITE, R. 1922b. Notes on Indian Diptera III. *Mem. Dep. Agric. India ent. Ser.* **7** : 107-169.

SENIOR-WHITE, R. 1924. New Ceylon Diptera III. *Spolia zelon.* **12** : 375-406.

SENIOR-WHITE, R. 1927. *Catalogue of Indian Insects*, **12** : 1-70. Government of India, Calcutta.

SINGH, K. 1926. Surra transmission experiments. *Dep. Agric. Punjab, vet. Bull.* **16** : 20 pp.

SINGH, S. 1968. Life-history and biology of *Tabanus rubidus. Res. Bull. Punjab Univ. New Ser. Sci.* **19** : 113-122.

STONE, A. 1975. *A Catalog of Diptera of the Oriental Region* **2** : 43-81.

STONE, A. AND PHILIP, C. B. 1974. The Oriental species of the Tribe Haematopotini (Diptera : Tabanidae). *U. S. D. A. Tech. Bull.* **1489** : 1-240.

SURCOUF, J. M. R. 1921. Family Tabanidae, *in* Wytsman ed., *Genera Insectorum* **175** : 1-182.

SZILA'DY, Z. 1926. New and Old world horse flies. *Biol. hung.* **1** : 1-30.

THUNBERG, C. P. 1827. Tabani septendecim novae species descriptae. *Nova Acta Upsala* **9** : 53-62.

WALKER, F. 1848. *List of the specimens of dipterous insects in the Collection of the British Museum* **1** : 1-229.

WALKER, F. 1850. *Insecta Saundersiana*, or *characters of undescribed insects in the Collection of W. W. Saunders. Diptera* **1** : 1-76.

WALKER, F. 1854. *List of the specimens of dipterous insects insects in the Collection of the British Museum* **5** : 1-330.

WALKER, F. 1857. Catalogue of the dipterous insects collected at Sarawak, Borneo by Mr. A. R. Wallace, with descriptions of new species. *J. Proc. Linn. Soc. Lond., Zool.* **1** : 105-136.

WIEDEMANN, C. R. W. 1821. *Diptera exotica*, Kiliae. **1** : xix+244 pp.

WIEDEMANN, C. R. W. 1824. *Analecta entomologica ex Museo Regio Hafniensi maxime congesta.* Kiliae : 1-60.