INTRODUCTION

The chironomid midges are accomplished objects of nuisance to the human society. These midges do neither bite human creatures nor transmit any disease to them, but emerge in profuse numbers and settle on the tracts of vegetation near waterpools. They are known to form one of the most common components of all freshwater biotopes and do occur in subaquatic situations as dump moss or algal flora or inclined moist rock-surface covered with microflora. The specialised habitats occupied by these midges within the Indian territory include tree-holes, hollow stumps of bamboo-shoots and water filled leaf-axes (Sublette and Sublette, 1973). They are also known to inhabit running water usually avoided by mosquitoes (Bates, 1949) and are positively phototropic congregating as 'pest-worms' on the lighted window walls and other places where they, after death, pile up and emit offensive/unpleasant odour. Sometime their number swell to an extent so much so that outdoor living on the water front becomes practically impossible. The motels are said to suffer economic losses due to tourists' allerginess to the very presence of these insects. There are instances where the dead midges littered motorable roads so that the latter become slippery for safe driving and had to be temporarily closed to vehicular traffic (Beck and Beck, 1966).

The larvae of chironomid insects are popularly known as blood-worms which are being used as ideal material for cytological studies. These worms often turn up in water supplies and cause considerable concern to persons who are frightened by their presence in the drinking and bathing waters. That many fishes thrive on the larvae, pupae and imagines of these midges is an established fact.

The increasing urbanisation in U.S.A. of the lakes and streams has resulted in a large-scale eutrophication of these water pools creating a situation which is highly suited to the increased production of the chironomid midges (Odum, 1953). The various extraneous materials which are put into the lakes and streams from the sources like domestic sewage, industrial effluents, ground crop fertilisers etc. create a situation highly conducive to vigorous breeding of the midges. Such a nutrient load obviously augments their food-supply by increasing growth of algae and other plants and also by diminishing the population of predators, carnivorous fishes and insects through depletion of oxygen in water. Some developed countries including U.S.A. are alive to this menacing situation and have started to evolve national policies for an effective eradication of these midges.

Of the chironomid midges, those belonging to the subfamily Orthocladiinae are wide-spread both ecologically and geographically. They are usually frequent in upland, cool, fast-flowing streams with some of them living in low land streams and lakes. A few of them are known to be tubiculous and plankton feeders.

Amongst the European workers engaged on midge-taxonomy, studies of entire life-history of these insects form the essential basis. It is interesting that this approach is becoming more popular amongst the workers in U.S.A. and Canada. The works of Edwards (1929, '31) and Freeman (1954-61) who favoured the idea/concept of a large broad-based genera might have produced considerable impact on the subsequent American workers. It may be noted in this connection, that at the time when Edward's (1929, '31) works were published, a few students outside Europe had little experience as to the collection of midges from the nature and any worth-mentioning knowledge on the morphology of the immature stages. Despite the excellent taxonomic works done by Thienemann (1944) and Brundin (1956) based on the morphology of the immature forms, it is curious that even now greater emphasis is being laid by the European workers on the adult structures for the purpose of taxonomic study. It was Fittkau (1962) who introduced a new approach to the study of taxonomy by taking into consideration the morphology of both the juvenile and the immaginal forms in an integrated manner.

The taxonomic works on the Indian forms of Orthocladiinae are indeed meagre compared to those on American and European forms and date back to Kieffer (1906, '11, '13). Till date, the sub-family Orthocladiinae are represented by nineteen nominal genera from the Oriental region, of which only four valid genera such as Brillia Kieffer, Cricotopus van der Wulp, Heterotrissocladius Sparck and Parametriocnemus Goetghebuer, have so far (prior to the present study) been recorded from India. The taxonomic position of each of the ten genera reported in this study is reviewed as follows :

The genus Brillia Kieffer was erected by Kieffer in 1913 on the basis of Brillia bifida Kieffer from Clare Island, U.K. Later, three species of this genera such as, sylvestris Goet. modesta Meigen and petrensis Kieffer were synonomised with it. The first Indian species, Brillia kultia which was described by Singh (1958) on the basis of specimens collected from Punjab, happens to be the only representative form hitherto known from the Orient.

The genus Eukiefferiella was coined by Thienemann (1926a) on the basis of Dactylocladius longicalcar Kieffer (1911). Subsequently, the genus Nanocladius Freeman was synonomised with it. Later on, Edwards (1929) considered Eukiefferiella as a subgenus of the genus Spaniotoma created by him. However, Brundin (1956) reaffirmed the generic status of Eukiefferiella. Only one unnamed species has been recorded by Reiss (1968) from Nepal.

The genus Heterotrissocladius was erected by Sparck in 1923 on the basis of the morpholocal distinctiveness of the larvae and pupae of three species namely, Metriocnemus longicollis Kieffer, Metriocnemus cubitalis Kieffer and Metriocnemus triangulifer Kieffer. Edwards (1929) though considered it to be a subgenus of the genus Metriocnemus van der Wulp, its generic status was revoked [revived] by Brundin (1956). Metriocnemus cubitalis Kieffer was fixed as the type-species of this genus by Goetghebuer (1940). Two species, Metriocnemus chandra and Metriocnemus kuluensis described by Singh (1958) from India were later placed by Sublette and Sublette (1973) under the genus Heterotrissocladius Sparck.

The genus Limnophyes was introduced by Eaton (1875) on the basis of Limnophyes pusillus reported from Kerguelen Island, Antarctic Ocean. Edwards (1929) considered it as a subgenus of the genus *Spaniotoma* Edwards, presumably owing to his failure to distinguish the type-specimens lying in the British Museum (Natural History) from *Camptocladius aterrimus*. However, on the basis of the striking differences between the immature and adult stages of *Limnophyes* and those of *Camptocladius* (*Phaenocladius*) shown by Thienemann (1921) and others the taxonomic status of the genus was given a fresh look. The first Oriental species, *Spaniotoma* (*Limnophyes*) *fuscinymus* was described by Tokunaga (1940) from Formosa and subsequent workers like Strenzke (1950) and Brundin (1956) upheld the generic status of *Spaniotoma* as distinct from *Limnophyes* Eat.

The genus *Metriocnemus* was coined by Van der Wulp in 1874 and subsequently, its generic status was confirmed by many workers such as Johannsen (1932), Thienemann (1937c), Edwards (1929), Goetghebuer (1932), Zavrel (1941), Brundin (1956) and others. *Chironomus albolineatus* was fixed up as its type-species by Coquillet (1901) from a mixed population containing more than one genus. Later, Edwards (1929) selected *Metriocnemus fuscipes* as its type-species for its more appropriateness than any other species, and it is in this background Brundin (1956) interpreted the genus *Metriocnemus* to be followed by subsequent workers.

Brundin (1956) also sank the genus *Chasmatocladius* Kieffer as the synonym of *Metriocnemus* v.d. Wulp. Two valid Oriental species, *Metriocnemus discretus* and *Metriocnemus nigrescens* were described by Johannsen (1932) from Java. Kieffer (1911) recorded one species, *Metriocnemus callinotus* from India, but owing to the non-availability of the type-materials at the Indian Museum its validity could not be checked up.

Parametriocnemus was erected by Goetghebuer (1932) as a subgenus of the genus, *Metriocnemus* v.d.Wulp on the basis of the type-species, *Metriocnemus stylatus* Kieffer (1924) collected from Egypt. It was again raised to the status of a genus by Brundin (1956). The single Oriental species, *Parametriocnemus fusiger* was described by Kieffer under the genus *Metriocnemus* from Simla, India.

The genus *Paraphaenocladius* was established by Thienemann (1926) and *Metriocnemus ampullaceous* (♀♀) Kieffer was fixed by him as its type-species. Edwards (1929) considered it as a subgenus of the genus *Metriocnemus* and selected *Metriocnemus impensus* (Walker) as the type-species of the subgenus. Subsequently, Brundin (1956) reaffirmed the distinct generic status of *Paraphaenocladius* to be followed by others till now.

The genus *Rheocricotopus* was erected by Thienemann and Harnisch (1932). Previously, Edwards (1929) considered it as a subgenus of the genus *Spaniotoma* which was his own creation. Later, Brundin (1956) reaffirmed the valid generic status of *Rheocricotopus* to be followed by Lehman (1969) and other workers. *Chironomus effusus* Walker was selected as the type-species of the genus by Brundin (1956). Three species namely, *Rheocricotopus lobalis*, *Rheocricotopus mediocris* and *Rheocricotopus rigida* described earlier erroneously under the genus *Spaniotoma* Edw. are, prior to the present study, known from the Oriental region (Java). Recently, two more species, *Rheocricotopus godavarina* and *Rheocricotopus nepalensis* have been described by Lehman (1968) from Nepal.

The genus *Thienemannia* was coined by Kieffer (1911) on the basis of species *Thienemannia clavaticornis* (=*lobata*) described from Arran, North Wales, U.K. Edwards (1929) held it a subgenus of the genus *Metriocnemus* V.d.Wulp and fixed up *Thienemannia gracilis* (Kieffer) as the type-species of the subgenus. Subsequently, Brundin (1956) confirmed its generic entity and also sank the genus *Symmetriocnemus* Thienemann as the synonym of *Thienemannia*. Prior to the present study, no species of this genus had been recorded from India.

The genus _Trichocladius_ was erected by Kieffer (1906) on the basis of _Trichocladius fuscicornis_ Kieffer, recorded from Chile. Edwards (1929) considered it as a subgenus of the genus _Spaniotoma_ Edw. and in his opinion _Trichocladius_ Kieffer represented a 'species-group' occupying a position in between _Orthocladius_ v.d.Wulp and _Cricotopus_ v.d.Wulp. However, it cannot be ascertained properly whether _Trichocladius_ Kieffer, is a valid genus or not as the original description of Kieffer is too inadequate being fragmentory and further because the original material on the basis of which _Trichocladius_ was erected is reported to be damaged or missing. However, one valid species of the genus namely, _Trichocladius oriplanus_ described by Kieffer in 1911 from Darjeeling is known from the Oriental region.

Taxonomic terminologies and other procedures : The modes of specific description accepted here mainly follow those of Sæther (1975) for the species belonging to the genus _Limnophyes_ Eat. and of Saether (1969), Sublette and Sublette (1966-74) and Reiss (1968, '71) for the species belonging to other genera. In some cases, the modes of description presented by authors like Brundin (1949, '56), Beck and Beck (1959), Fittkau (1962), Fittkau and Lehman (1969) and Wirth (1947) have been taken into account as and when it was deemed fit.

The specific characters have been described as well as illustrated mostly on the basis of the male individuals of a species while the females of the same species have been described in certain selected features only. Throughout this work, the holotype and allotype have been determined on the basis of a male and a female individual respectively. In describing the antennal segments of any species the first segment i.e. scapus which remains suppressed very much and overlain by the large globular pedical (second segment) in Orthocladiinae particularly in males (Fittkau, 1962 and Frommer, 1967) has not been considered except in some cases of female individuals where the scapus appears to be as large and prominent as the pedical.

The terminologies used in this study are mostly after Brundin (1956), Chaudhuri and Das Gupta (1971, '72), Crampton (1942), Cook (1949, '56), Fittkau (1954), Matsuda (1970), Schlee (1968), Saether (1969, '71, '74, '75), Sublette (1966) and Townes (1945). These are explained here in reference to a hypothetical figure (Fig. 1) as follows :

The term 'seta' has been preferred to 'bristles', 'hairs', 'spines' and 'chaeta' following the work of Saether (1971).

The vertex represents the top of cranium in between and behind the compound eyes; postocular setae refer to those situated behind the compound eyes, while the coronal setae mean setae situated over the corona (Fig. 1) including the coronal suture. The term 'palpomere' has been used in place of palpal segment following Das Gupta and Wirth (1968); the palpomere I appears to be weakly sclerotised and faintly delimited from the rest of the maxilla. Similarly the term 'tarsomere' and 'flagellomere' have been referred to the tarsal segment and antennal segment respectively. The terms 'acrostichals', 'dorsocentrals' are used here in places of 'dorsomedian' and 'dorsolateral' setae respectively. The terms like pronotals, median pronotal and lateral pronotal and prealar have been used for better understanding of chaetotaxy.

The notations used here in reference to the wing venation (Fig. 1) in general follow those of Lindenberg (1964, '66) except that i) $M_4 + Cu_1$ is taken as Cu and M_4 is called as M_{3+4}, since Linderberg's rudimentary vein M_3 cannot be accepted as a vein of separate entity and ii) fork of R is considered here as Fr. The position and the number of sensory organs on or near the vein R are also taken into account (Fig. 1).

In understanding the morphological characteristic of the hypopygium, the term 'gonocoxite' and 'gonostylus' previously used by Smith (1969) in reference to the male hypopygium of chironomid insects have been retained here in preference to 'coxite' (basistyle) and 'stylus' (dististyle). In case of females, the term 'genitalia' has been used in place of hypopygium. The apodemes of gonocoxite and sternum I (Wensler and Rempel, 1962) are referred to as 'coxapodeme', and 'sternapodeme' the latter being often divided into transverse sternapodemes and two lateral sternapodemes. The term 'phallapodeme' has been taken for apodemes of hypopygia while the preapical projection of the gonostylus has been called as 'crista dorsalis' (Saether, 1975). The term 'notum' indicates the sclerotised bridge formed by the fusion of the dorsal rami of gonapophysis IX along most of the length.

The measurements of the structural parts including setae have been considered in millimetres (mm) except otherwise stated. The figures mentioned in the first and second parenthesis of the text indicates the range of variation and usual number respectively.

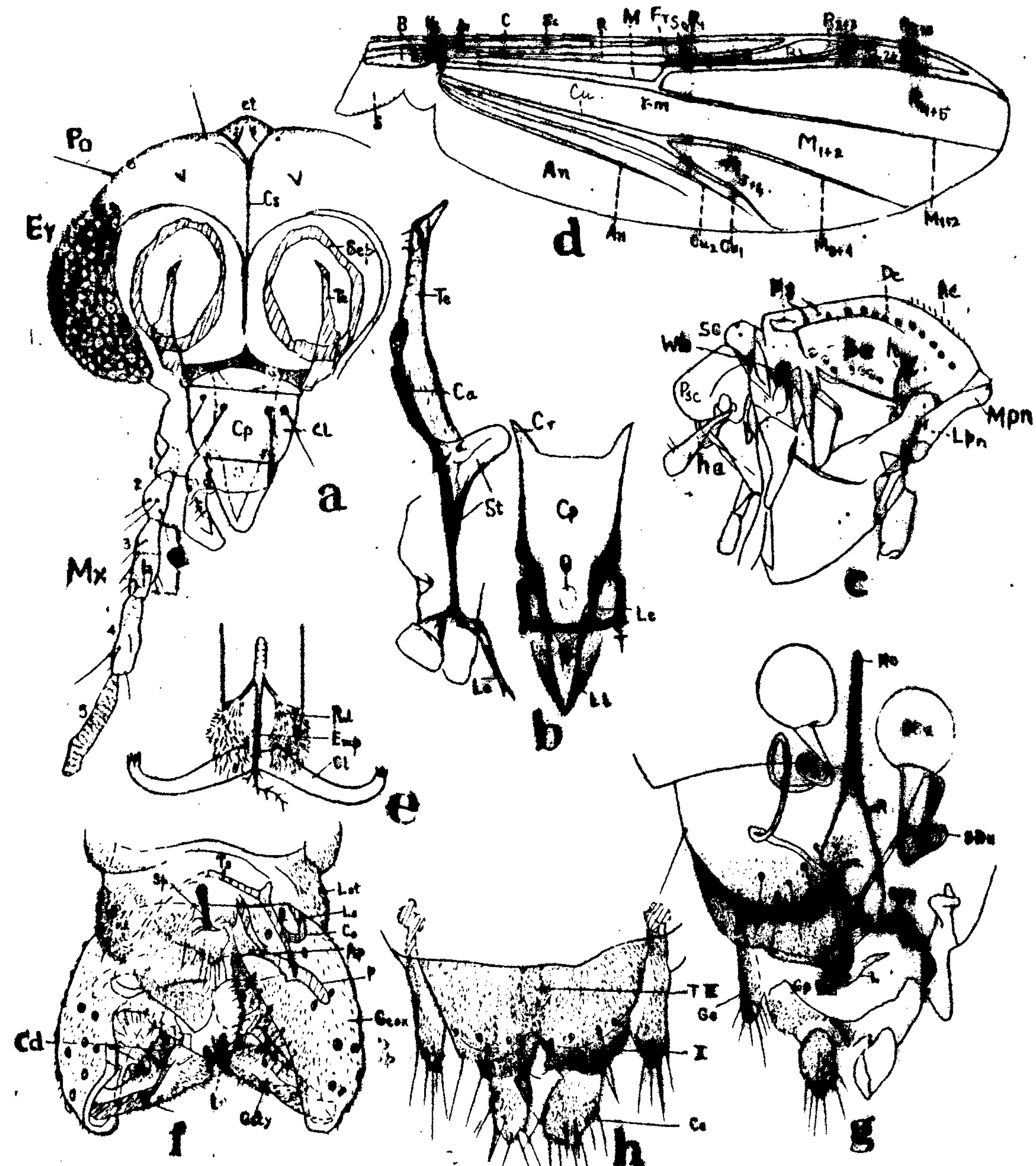

Fig.1. Morphological structures of a typical Orthocladiid midge
(Vide explanation on Pages 14-17)

Explanation of Fig. 1

Morphological structures of a typical Orthocladiid midge.

A. Head showing different structures

B. Mouth parts showing tentorium and cibarial pump

C. Thorax

D. Wing

E. Terminal part of a hind leg.

F. Male hypopygium

G-H. Female Genitalia

Abbreviations :

Ac - Acrostichals

An - Anal vein/Anal cell

Ap - Anal point

Ar - Arculus

B - Brachiolum

C - Costal vein

Ca - Cardo

Cd - Crista dorsalis or preapical projection

Co - Anal cercus

Cl - Claw

Cly - Clypeus

Co - Coxapodeme

Cp - Cibarial pump

Cr - Cornua

Cs - Coronal suture

Csa - Coxosternapodeme

Ct - Coronal triangle

Cu - vein Cu

Cu_1 - vein Cu_1

Cu_2 - vein Cu_2

Dc - Dorsocentral

Ey - Eye

Emp - Empodium

Fr - Fork of Vein R

Gc - Gonocoxite of female genitalia

Gcox - Gonocoxite of male hypopygium

Gsty - Gonostylus of male hypopygium

Gp VIII - Gonapophysis VIII

H - Humeral pit

Ha - Halteres

Hc - Humeral cross-vein

L - Labium

La - Lacina

Le - Labrum-epipharynx

Ll - Labial lonchus

Ls - Lateral sternapodeme

Lst - Laterosternite

Lpn - Lateral pronotal

M - Vein M

M_{1+2} - Vein M_{1+2}/Cell M_{1+2}

M_{3+4} - Vein M_{3+4} /Cell M_{3+4}

Mpn - Median pronotal

Mx - Maxillary palp

No - Notum of abdomen of female

O - Orifice

P - Phallapodeme

Pa - Prealar

Ps - Prescutellar

Psc - Postscutellum

Pul - Pulvillus

Po - Postocular

R - Vein R

R_1 - Vein R_1 / Cell R_1

R_{2+3} - Vein R_{2+3} / Cell R_{2+3}

R_{4+5} - Vein R_{4+5} / Cell R_{4+5}

S - Squama

Sc - Vein Sc.

Sca - Seminal capsule

Sct - Scutellum

Scp - Scapus

SDu - Duct of Seminal capsule

SE - Spermathecal eminence

Sp - Spine of the penis cavity

St - Stapes

So - Sensory organ sensilla chaetica and their positions

T - Torma

Ts - Transverse sternapodema

Te - Tentorium

T IX - Tergum IX

t - tooth of gonostylus

V - Vertex

Wb - Base of the wing

X - Tenth abdominal segment

The abbreviations used in this work have been explained later. The colour of the head, thorax, scutum, scutellum, legs and other parts were noted from both dry and preserved specimens. The shadings of the several illustrations incorporated here, however, indicate the differences of colour tones rather than the actual colour of the body parts. How the measurements have been taken are explained as follows :

Length of body : length of the thorax from the apex of pronotum to the posterior end of metanotum plus the length of abdomen from the anteromedian margin of Tergum I to the apex of gonocoxite as introduced by Saether (1969).

L/W (palpal ratio) : length of the palpomere III divided by its maximum width (Fig.1)

AR (antennal ratio) : length of the elongated flagellomere (last one in most cases) plus that of the segments distal to it divided by the combined length of basal flagellomeres (Townes, 1945).

Length of wing : distance from the basal arculus to the tip of wing in both sexes.

Breadth of wing : distance from the outer margin of vein R_1 to the tip of vein Cu_1 in both sexes.

Costal length : distance from the basal arculus to the tip of costa (C) in both sexes.

CR (Costal ratio) : Length of the costa divided by length of the wing.

VR (=venarum ratio) : distance between the arculus and the fork of Cubitus (f-cu) divided by the distance between the arculus and the base of r-m cross-vein (Fittkau, 1954).

LR (=leg ratio) : the length of tarsomere I divided by the length of tibia.

TR (=tarsal ratio) of hind leg : length of the tarsomere I of the hind leg divided by length of the tarsomere II of the same leg.

Length of seminal capsule : distance from the tip of capsule to the base of its neck.

HR (=hypopygium ratio) : the length of gonocoxite divided by the length of gonostylus (Schlee, 1966).

HV (=hypopygium value) : length of the gonocoxite divided by the length of the gonostylus multiplied by 10 (Saether, 1967a and 1968).

The materials of this study including types have provisionally been kept in the collections of insects in the museum of the department of Zoology, The University of Burdwan. The types and other specimens will, in due course, be deposited to the National collections of insects at the Zoological Survey of India, Calcutta, U.S. National Museum, Washington, British Museum (Nat.Hist.), London, Canadaian National collections of insects, Ottowa, Bishop Museum, Honolulu and Zoological Institute of Leningrad, U.S.S.R.